Comparisons of breeding range structure for Dunlin *Calidris alpina* and Curlew Sandpiper *Calidris ferruginea*: conservative and nomadic tundra waders

Elena G. Lappo

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Differences in spatial distribution and numbers inside the breeding ranges are compared for two arctic waders. These differences are mainly connected with the breeding strategy of the species, the level of their site fidelity. The criteria and the scheme of the breeding range structure are proposed. Extrapolated maps of the breeding range for both species are compiled according to recent data.

E.G. Lappo, Institute of Geography, Russian Academy of Sciences, Staromonetny, 29, Moscow, 129017, Russia.

INTRODUCTION

The Calidrid waders have a great diversity of breeding strategies. It is of particular interest to determine how differences in breeding strategies are reflected in the geographical distribution and abundance. The breeding ranges of Dunlin *Calidris alpina* and Curlew Sandpiper *Calidris ferruginea*, two closely related tundra waders, have been investigated in this study.

The Dunlin is a circumpolar species breeding in low arctic tundras. It is a highly site-faithful species with a return rate more than 70% (Tomkovich 1994). Curlew Sandpiper breeds in high arctic tundras. It is less site-faithful with sharp inter-year changes of density and breeding localities within the breeding range (Ryabitsev 1993; Tomkovich & Soloviev 1994).

This study focuses on the comparison of the breeding range structure for a nomadic and a conservative (site-faithful) tundra wader.

MATERIALS AND METHODS

Data on breeding distribution and densities of Dunlin and Curlew Sandpiper were extracted from literature sources and museum collections as well as being collected by the author in different localities of the Russian Arctic during the field work in 1990-94 in the International Arctic Expedition (IAE) of the Russian Academy of Sciences and in the "Tundra Ecology-94" Expedition (Goryachkin *et al.* 1994). Results were also obtained from colleagues who kindly provided unpublished observations.

The breeding range of each species is characterised by two maps: a map of breeding records with geographical co-ordinates and an extrapolated map which shows the structure of the range and the core areas. The detailed maps for both species will be published separately elsewhere (Lappo & Tomkovich in press).

Maps of breeding ranges (Figures 1 and 2) were made with help of the method of landscape extrapolation (Brunov 1982; Lappo in press). The borders of breeding ranges are determined by the limits of tundra subzones or their vegetation associations. The tundra zone has been divided into three subzones: southern, typical and arctic according to Chernov (1985).

Breeding wader species have an uneven distribution within their breeding range and their density also varies. Indeed, in some areas birds are more than usually abundant whilst in others they are scarce or even absent. By investigating different characteristics (breeding density of the species in different parts of its breeding range; regularity of breeding in a site; and the diversity of potential breeding habitats *etc.*), it is possible to determine the structure of the breeding range (Isakov 1957; Lappo in press).

RESULTS AND DISCUSSION

Criteria for the breeding range structures

The breeding ranges of birds usually consist of core areas (optimal part) and peripheral areas. Core areas are, by definition, of greatest importance for a population since these areas hold the highest densities, have regular breeding, and usually have the largest diversity of occupied habitats *etc.* (Brunov 1982; Lappo in press). Among these characteristics, density is usually considered as of special significance in determining the structure of breeding ranges. Indeed, it is very appropriate to characterise the structure of breeding range of Dunlin given the characteristics of high site fidelity and small fluctuations in population size. These characteristics are

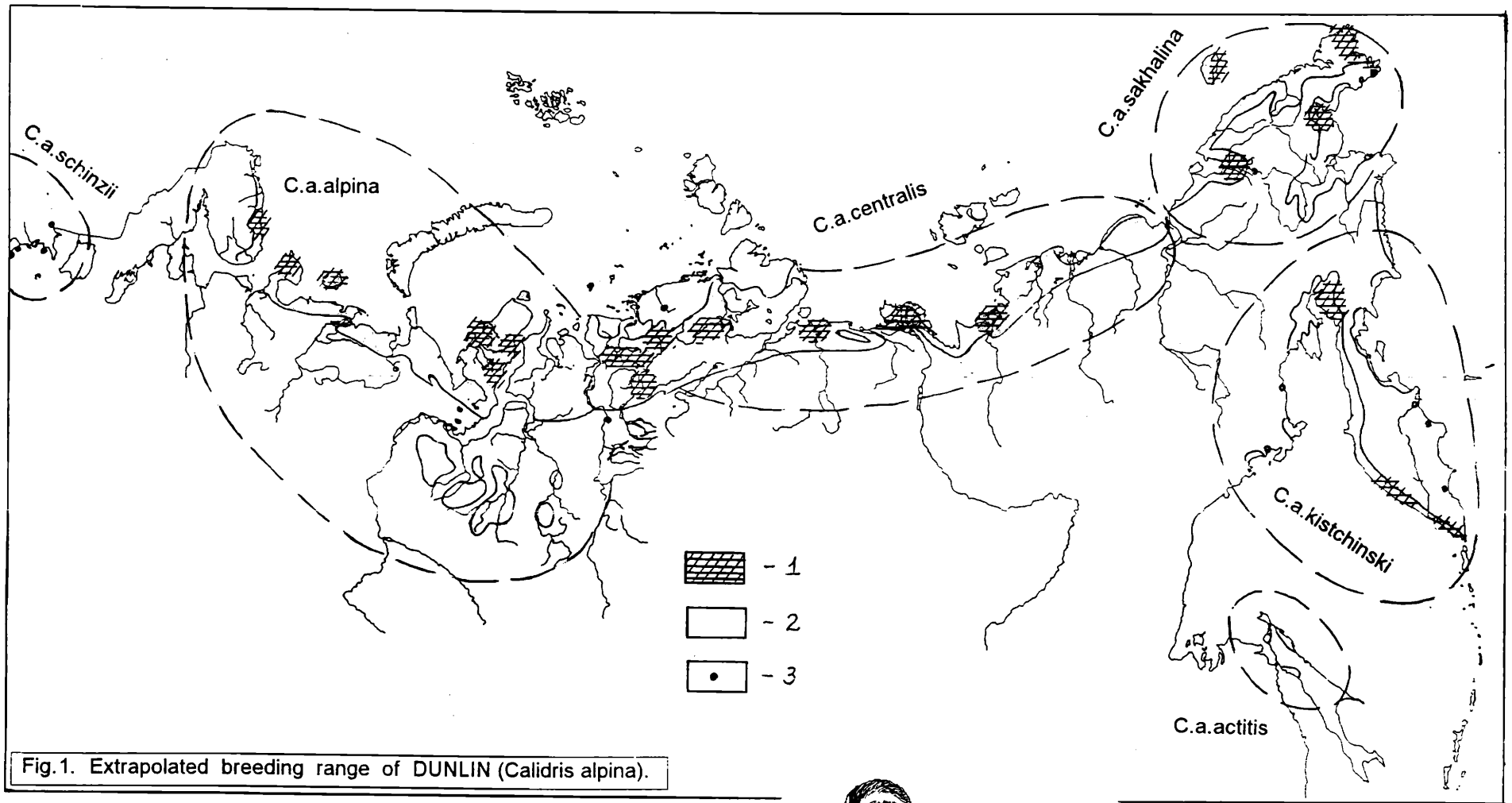
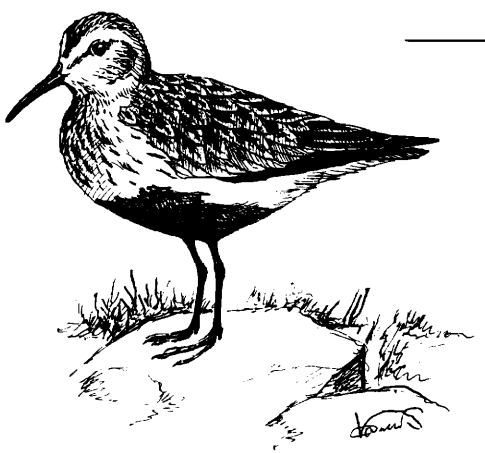


Fig.1. Extrapolated breeding range of DUNLIN (Calidris alpina).



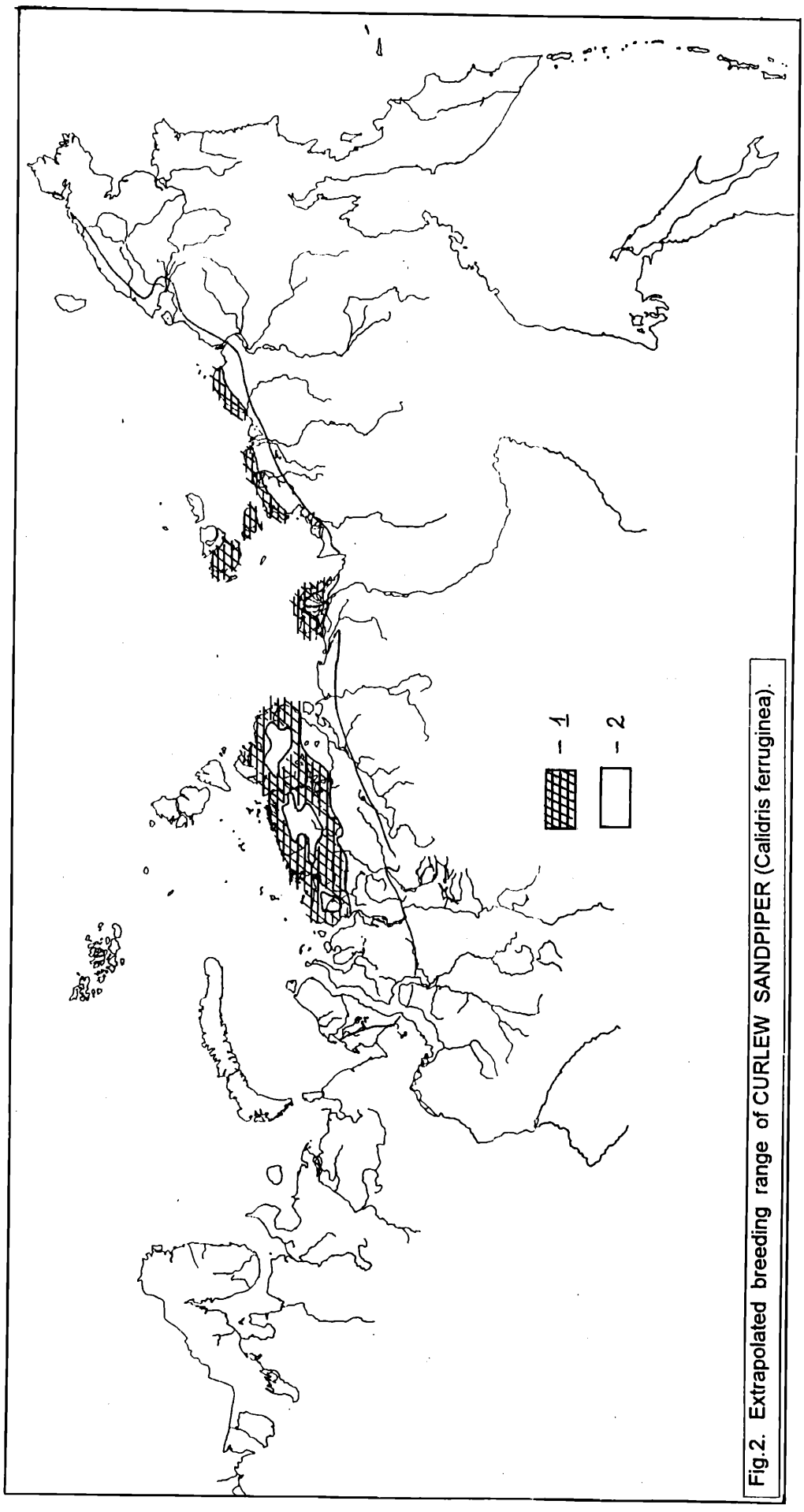


Fig.2. Extrapolated breeding range of CURLEW SANDPIPER (Calidris ferruginea).

not shown by Curlew Sandpiper which has large annual variations in densities. It is, however, possible to use other criteria to investigate range structure, such as how regularly breeding occurs at a site, with density being supplemental.

THE STRUCTURE OF THE BREEDING RANGES

There are three elements to the range of Dunlin:

1) In core areas densities are always high since birds return every year to their regular breeding territories as a consequence of the wide spectrum of breeding and feeding habitats (Figure 1.1);

2) sub-optimal areas hold low or moderate densities of birds (Figure 1.2); and

3) isolated breeding localities occur outside of the main breeding range (Figure 1.3).

For Curlew Sandpiper there are only two zones:

1) A core area is occupied by breeding birds annually. Density variations are medium (Figure 2.1).

2) A sub-optimal area which has sporadic and irregular breeding (Figure 2.2). In many places the species does not breed every year. This may be the result of population fluctuations, changing weather, or food condition *etc.*

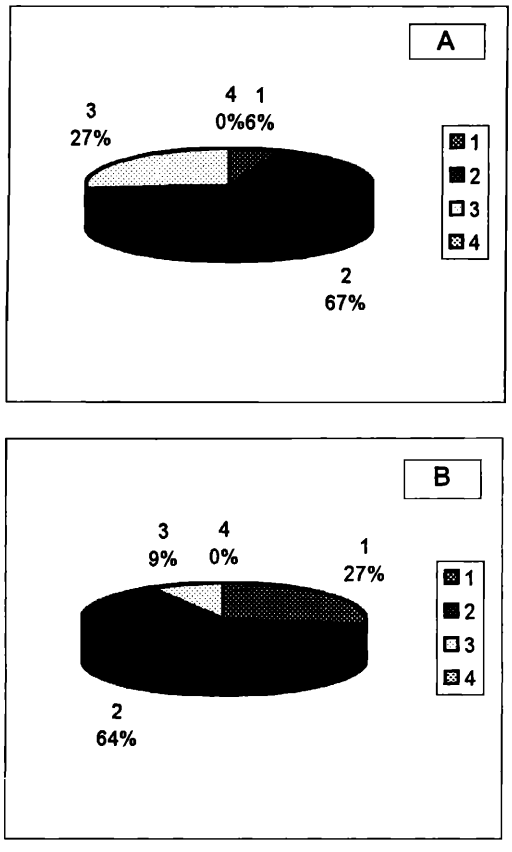


Figure 3. Zonal structure of the breeding ranges of Dunlin (A) and Curlew Sandpiper (B). 1 = arctic tundra, 2 = typical tundra, 3 = southern tundra.

DIFFERENCES IN DISTRIBUTION OF BIRDS AND IN STRUCTURES OF RANGES

The strong site fidelity of Dunlin is reflected by a high level of population differentiation (six subspecies are now recognised in the Russian Arctic - Lappo & Tomkovich in press). Each subspecies has its own habitat preferences and "limits" of breeding density. Even within one subspecies, several populations can exist: for example, an isolated southern population of Dunlin inhabits palsa bogs in the West Siberian taiga (Figure 1).

In contrast, Curlew Sandpiper has much lower site faithfulness: only two controls are known of birds from marking areas within the breeding range (north and east Taimyr; Underhill *et al.* 1993; Tomkovich *et al.* 1994). As a result of this low site fidelity, birds move widely within the breeding range, explaining why the species is monomorphic (Tomkovich & Soloviev 1994).

The ranges of both species overlap in the typical tundra subzone of Siberia but the range of Curlew Sandpiper is generally more northerly than that of Dunlin. In contrast to Curlew Sandpiper, only those subspecies of Dunlin (*Calidris alpina centralis* and partly *C. a. alpina* and *C. a. sakhalina*) are taken into consideration, whose ranges are more or less sympatric with that of Curlew Sandpiper.

If the zonal structure of the ranges are compared (Figure 3) we can see that both ranges embrace all three tundra subzones but to a differing extent. The largest part of breeding ranges of both species is situated in the typical tundra (67% for Dunlin subspecies and 64% for Curlew Sandpiper), and the smallest part of the ranges of Dunlin subspecies lies in arctic tundra (6%), but of Curlew Sandpiper - in southern tundra (9%). About 27% of the Dunlin's range is in southern tundra and for Curlew Sandpiper the same proportion occurs in arctic tundra.

Breeding density (nests per km^2) were compared in the areas where both species breed: at Yamal Peninsula (Yaibary Station, Ryabitsev 1993) and at Taimyr Peninsula (Medusa Station, IAE data). Yaibary is in the core area for Dunlin, but Curlew Sandpiper is near the western limit of its range. On Meduza, Dunlin is at the northern limit of its range, and Curlew Sandpiper at the edge of its core area. At Yaibary Dunlin has the maximum density up to 33 nests per km^2. Densities can vary between years by a factor of 1.4. At Meduza its maximal density is only 1.2 nests/km^2, but the between year variation is by a factor of 3.4. Thus in the core area the breeding density is high, and its variation is moderate, but at the northern limit of the range density is much less, and the variation larger. The maximal density of Curlew Sandpiper is generally much less than that of Dunlin, but between year variation is large. At Yaibary the maximal density of Curlew Sandpiper is 1.3 nests/km^2, but this can vary between years by a factor of 7.7. At Meduza the maximal density is 4.0 nests/km^2, which can fluctuate by a factor of 5.7.

Within the breeding range of Curlew Sandpiper there is a rather broad belt where sporadic and irregular breeding

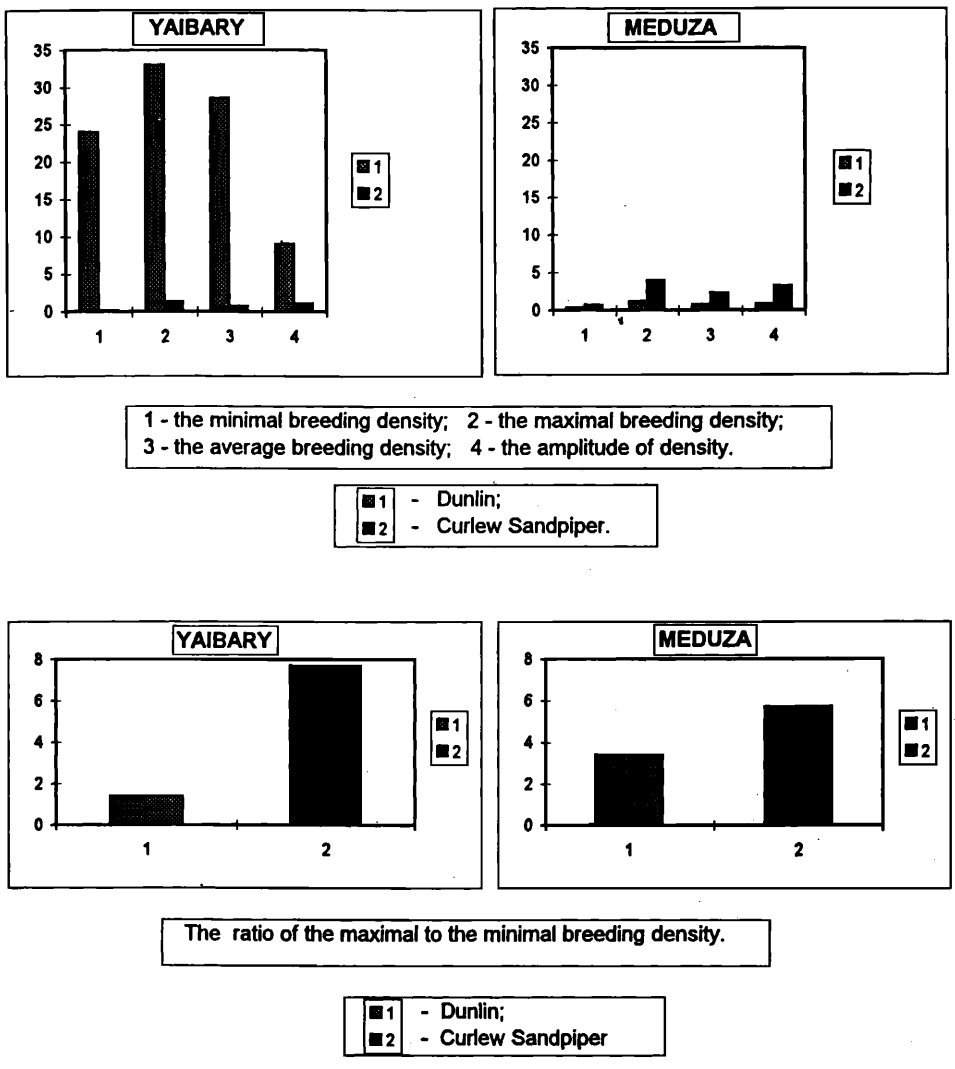


Figure 4. Comparison of the breeding densities of Dunlin and Curlew Sandpiper at Yaibary (Yamal Peninsula, Ryabitsev 1993) and Meduza (Taiymyr Peninsula).

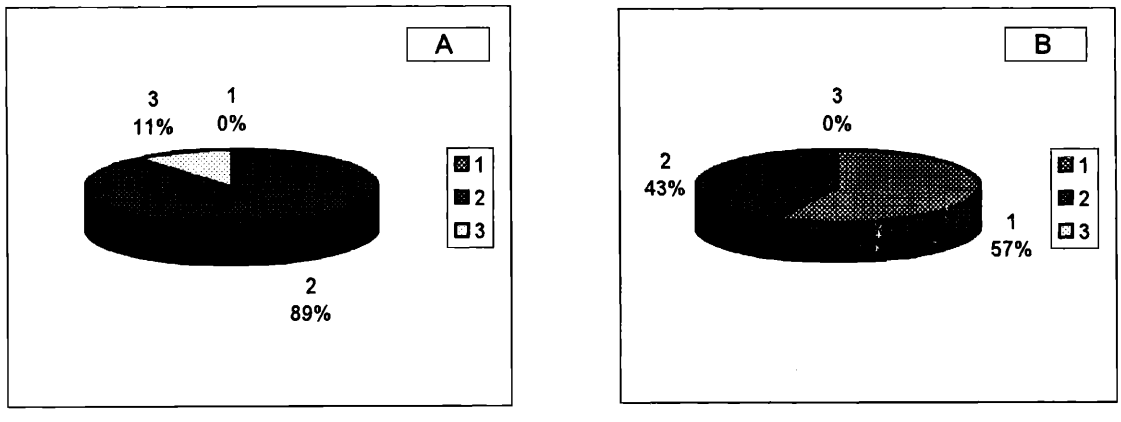


Figure 5. Zonal structure of the core areas of the breeding ranges of Dunlin (A) and Curlew Sandpiper (B). 1 = arctic tundra, 2 = typical tundra, 3 = southern tundra.

occurs, situated in the core area from the south. The species breeds in this belt only in some years, and this area covers nearly 65% of the extent of the whole breeding range. When the spring is cold and late, Curlew Sandpipers breed in southern tundra subzone. Several breeding records are known for southern tundras of Taimyr, in particular in 1989 and 1992 seasons with late spring and cold summer (Volkov 1989; Karpov *et al.* in press). So, for Curlew Sandpiper the "maximum breeding range" is shown (Kistschinski 1988). This "maximum

breeding range" is larger than the area occupied by breeding birds in any one season.

Curlew Sandpiper and Dunlin have different habitat preferences. So, the same areas on both maps are inhabited in different ways: for example, in the typical tundra subzone Curlew Sandpiper breeds in dry tussock tundra on watersheds but Dunlin mostly inhabits wet tundra with pools and lakes. However, the small scale of the map (1:30 000 000) does not enable these fine-scale differences in habitat selection to be highlighted.

The core area of Dunlin is represented mostly by patches, located in large river valleys and deltas, tundra with extensive bogs, and lowlands with lakes mostly in typical tundras. Of the core Dunlin area, 89% lies in typical tundras with the rest being in southern tundra. The extent of the whole Dunlin breeding range (very roughly estimated) is approximately 1 640 000 km^2. The core area is nearly 30%. Thus the highest densities occur in only a small part of the overall range.

The core area of Curlew Sandpiper is a region which coincides with the arctic tundra and northern part of typical tundra subzones in Taimyr and several areas on the Yakutian coast. More than half of the core breeding area of Curlew Sandpiper is situated in the arctic tundra (57%) with the rest (43%) in the typical tundra. The size of "maximal breeding range" for Curlew Sandpiper is nearly 1 000 000 km^2, although only 35% of this can be considered as a regular breeding area.

The core breeding areas of both species are nearly allopatric. They slightly overlap in the typical tundras of Taimyr. This overlap covers 3% and 5% of the sizes of the whole breeding ranges of Dunlin and Curlew Sandpiper respectively. These intensively populated areas are most interesting ones which enable interspecific comparisons of density dynamics and spatial distribution.

The analysis of the breeding ranges allows us to the conclude that different breeding strategies in tundra wader species are reflected in different types of use of breeding areas. As a result can be described only by different approaches to structuring of their ranges.

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