

Zackenberg Ecological Research Operations (ZERO): A new research facility in High Arctic Greenland

Hans Meltofte

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H. Meltofte, Dansk Polar Center, Strandgade 100 H, DK-1401, København K, Denmark.

So far, most research on the breeding grounds of Arctic waders has taken place during only one or a few seasons. In particular, this applies to High Arctic Greenland, where no wader population has been studied over more than a few years. Due to this, we have almost no data on the annual variation in population size, breeding phenology, breeding success or other important parameters in the understanding of population dynamics and ecology of these populations (Meltofte 1985).

With the establishment in 1995-1996 of the Zackenberg Research Station possibilities for long-term research have improved considerably. The station, which is owned and run by the Danish Polar Center, is situated close to Daneborg in central Northeast Greenland (74°28'N, 20°34'W). This is within the range of most wader species breeding in High Arctic Greenland, including the Nearctic populations of Great Ringed Plover *Charadrius h. hiaticula*, Red Knot *Calidris canutus islandica*, Sanderling *Calidris alba*, Dunlin *Calidris alpina arctica* and Ruddy Turnstone *Arenaria i. interpres*, which winter in the Old World.

The aim of the station is to facilitate long-term research on the dynamics of a High Arctic ecosystem. The framework programme of 'ZERO' seeks to document ecosystem structures and functioning in an undisturbed High Arctic environment, enabling long-term demonstration of the effects of the anticipated Global Climate Change.

An important part of ZERO is the baseline programme - Zackenberg Basic - that monitors a wide range of physical as well as biological parameters. The programme includes 'anything' from water and sediment transport in the main river to population dynamics in muskoxen. For the birds, it includes annual variation in population size, breeding phenology and success in a number of selected species and study areas. The remaining part of the biological programme includes monitoring of plant reproductive phenology, arthropod occurrence and phenology, lemming and muskox population dynamics and mammalian predators. The biological part of the programme is undertaken by two biologists, including myself.

THE STUDY AREA

Zackenberg is the name of a 1 372 m high mountain - the jagged mountain - west of the Zackenberg valley, where

the station is situated. The valley, exposed to the south, covers an area of c. 50 km² of Arctic heathland, marshes, gravel plateaus and more or less vegetated slopes from sea level up to an altitude of about 600 m. Several types of lakes and ponds are found in the area and snow regimes vary from 'early snow free' (May) to 'late thawing' (late June or early July) habitats. Adjacent valleys extend up to 30 km into the mountainous hinterland.

Only June, July and August have positive mean temperatures - all of them below +5°C! The climate is continental with long periods of sun 24 hours a day, but spells of inclement weather may occur anytime during the summer.

Within the Zackenberg valley, a bird census area of 20 km² has been established ranging from the coast and up to 600 m a.s.l. The area is subdivided into an intensive study area of 6 km² and a remaining more extensively covered subdivision. The bird populations in the intensive area are followed during the entire breeding season throughout June, July and early August, while the populations in the more extensively covered area are mapped only during the territory establishment and egg-laying period in mid June, and then followed more opportunistically during the rest of the breeding season.

WADER AND WATERFOWL POPULATIONS AT ZACKENBERG

In Greenland, most waders breed in the High Arctic part. Hence, nine out of the 11 species of waders breeding in Greenland have their main occurrence in the High Arctic. In fact, waders are the most common birds on the lowland tundra of Northeast and North Greenland.

Table 1 presents the results of the first breeding bird survey performed at Zackenberg in 1996. Since the whole monitoring programme was being set up, and detailed maps were not available this summer, the numbers must be taken with some precaution. Nevertheless, it appears that large populations of waders are found in the area. A total of about 250 pairs of waders was found within the census area, and good numbers are breeding in the remaining parts of the valley as well. Compared to other census areas in High Arctic Greenland, the Zackenberg area shows population densities comparable to the best sites (Meltofte 1985; Boertmann *et al.* 1991). The 23-30 pairs (plus pairs outside the census area) of Red Knot

constitute the largest population known from any study area in High Arctic Greenland.

As in most other study areas, waterfowl populations were modest. Long-tailed Skuas bred in good numbers, although with no success. The foxes took one clutch after the other, and only one young was found; it did not survive either.

In addition to the species listed in Table 1, Barnacle Goose *Branta leucopsis*, Common Eider *Somateria mollissima*, Gyr Falcon *Falco rusticolus*, Sabine's Gull *Larus sabini*, Glaucous Gull *Larus hyperboreus*, Arctic Tern *Sterna paradisaea*, Northern Wheatear *Oenanthe oenanthe*, Common Raven *Corvus corax* and Arctic Redpoll *Carduelis hornemanni* breed near Zackenberg.

Table 1. Estimated number of pairs within the 18.79 km² census area at Zackenberg, Northeast Greenland, 1996. Any site claiming/territorial pair/male is considered member of the local population.

Species	West of main river (3.39 km ²)	East of main river (15.41 km ²)	Total
Red-throated Diver <i>Gavia stellata</i>	0	1	1
King Eider <i>Somateria spectabilis</i>	0	2-3	2-3
Long-tailed Duck <i>Clangula hyemalis</i>	1-2	4-6	5-8
Rock Ptarmigan <i>Lagopus mutus</i>	1	3	4
Great Ringed Plover <i>Charadrius hiaticula</i>	11-12	40-46	51-58
Red Knot <i>Calidris canutus</i>	2-4	21-26	23-30
Sanderling <i>Calidris alba</i>	10-13	45-55	55-68
Dunlin <i>Calidris alpina</i>	19-26	38-45	57-71
Ruddy Turnstone <i>Arenaria interpres</i>	6-8	31-40	37-48
Red-necked Phalarope <i>Phalaropus lobatus</i>	0	0-1	0-1
Long-tailed Skua <i>Stercorarius longicaudus</i>	5-6	17-21	22-27
Snow Bunting <i>Plectrophenax nivalis</i>	>19-21	29-32	>48-53

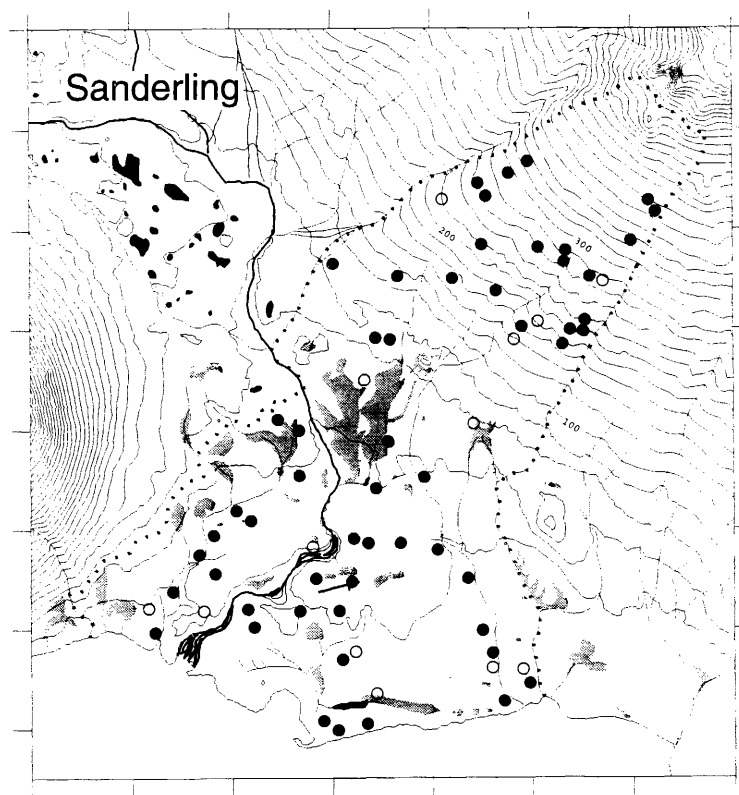


Figure 1. The distribution of Sanderling *Calidris alba* territories with the Zackenberg census area, 1996. Uncertain territories are shown with open symbols. The wettest marshes are shaded, altitude contours are shown at 20 m intervals, and the markers on the frame denote 1 km intervals. The research station is situated at the runway in the lower centre of the map.

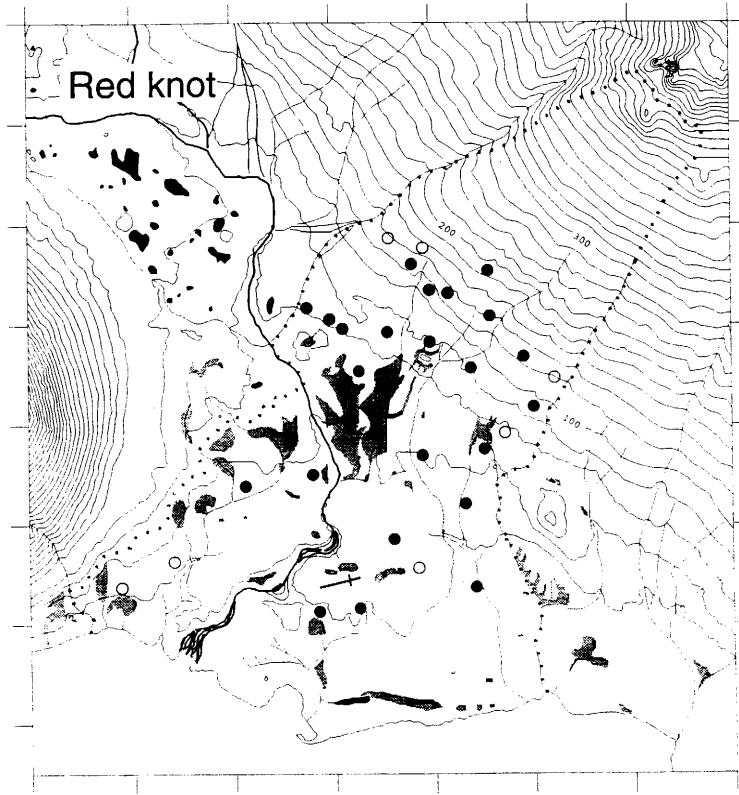


Figure 2. The distribution of Red Knot *Calidris canutus* territories within the Zackenburg census area, 1996. Conventions as for Figure 1.

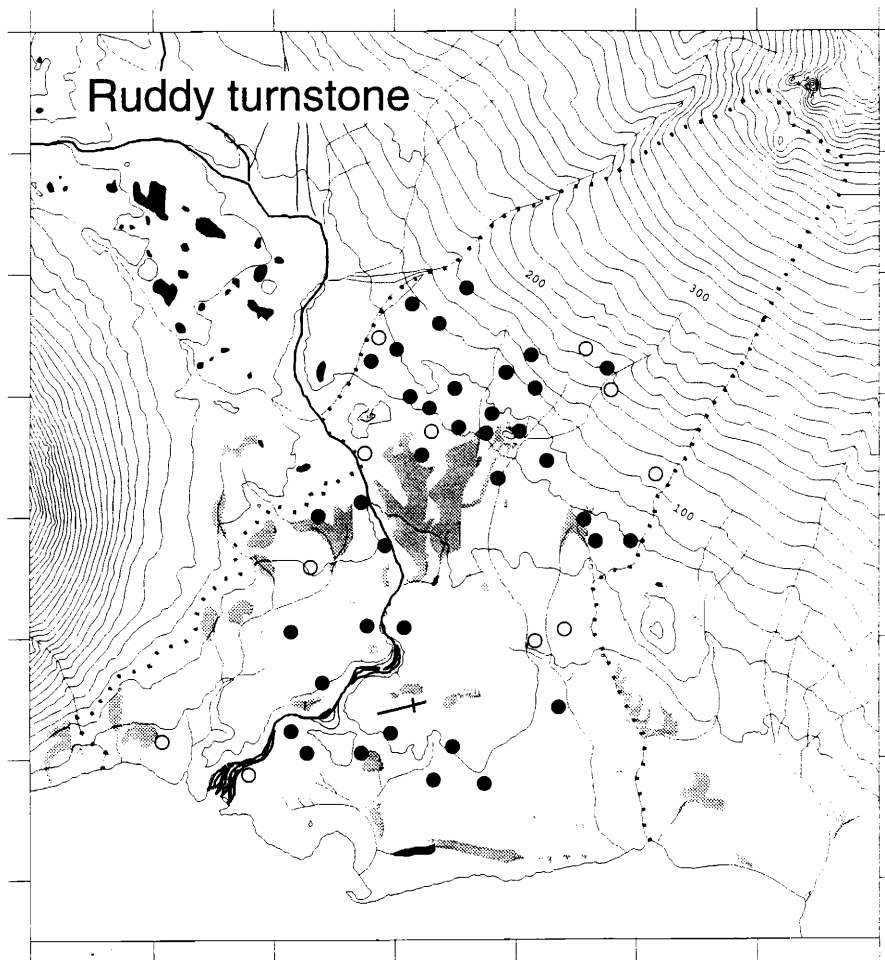


Figure 3. The distribution of Ruddy Turnstone *Arenaria interpres* territories within the Zackenburg census area, 1996. Conventions as Figure 1.

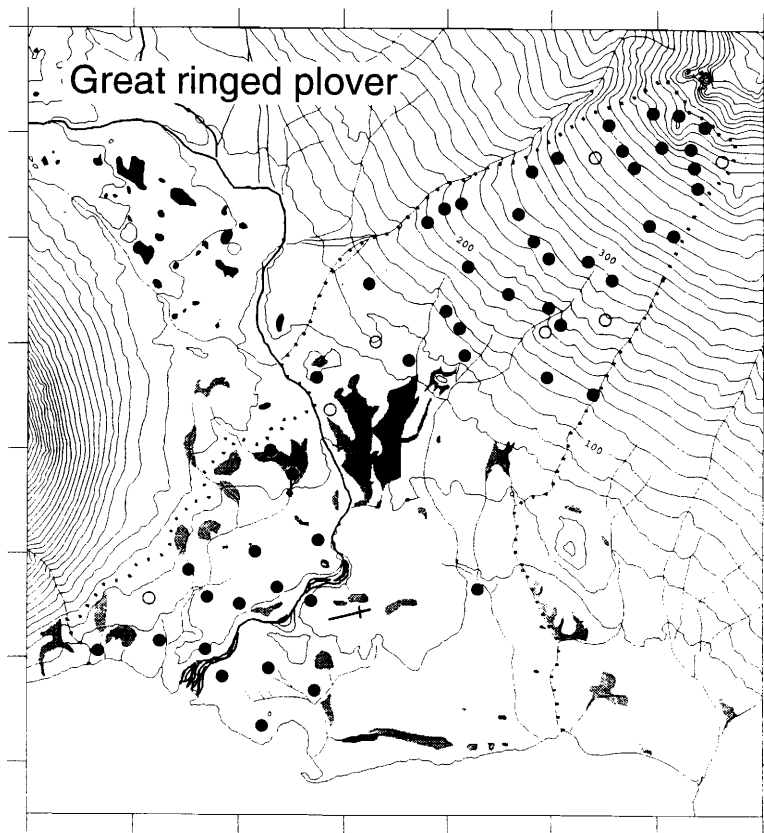


Figure 4. The distribution of Great Ringed Plover *Charadrius hiaticula* territories within the Zackenberg census area, 1996. Conventions as for Figure 1.

DISTRIBUTION PATTERNS WITHIN THE AREA

The census area at Zackenberg covers a variety of habitats ranging from early snowfree raised delta terraces around the station, over densely vegetated but late snow free dwarf shrub heath and marshes in the lowland, to decreasingly vegetated and early snowfree gravel slopes towards the upper census area limit at 600 m a.s.l. on the mountain to the Northeast.

These habitat differences are clearly reflected in the distribution patterns of the individual wader species. While Sanderlings are breeding on sparsely vegetated and early snowfree ground in most of the area (Figure 1), Red Knots and Ruddy Turnstones predominantly breed on the well vegetated and relatively early snow-free lower expanse of the mountain slopes, *i.e.* up to an altitude of about 200 m (Figures 2 and 3). Besides modest numbers on the delta terraces, Great Ringed Plovers are found - as the only species - in full density all the way up to the upper limit of the area (Figure 4). Naturally, most Dunlins breed in the lowland marshes (Figure 5).

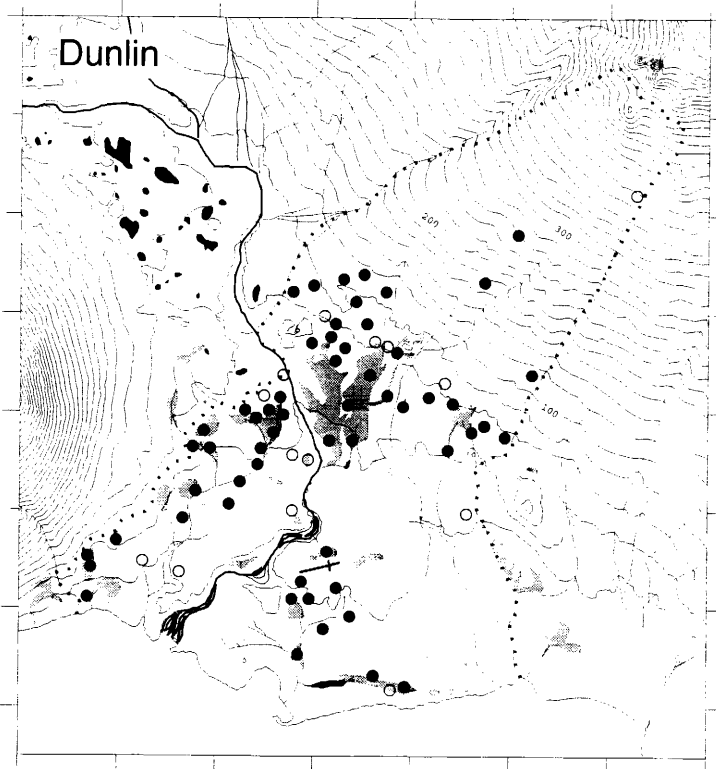


Figure 5. The distribution of Dunlin *Calidris alpina* territories within the Zackenberg census area, 1996. Conventions as for Figure 1.

BREEDING PHENOLOGY IN WADERS

In High Arctic Greenland there is a highly significant correlation between progress of snow melt and onset of breeding in waders (Meltøfte 1985). In early snow free areas like continental North Greenland, egg-laying starts a few days after the birds' arrival, one to three weeks earlier than in late thawing areas.

In 1996, most clutches at Zackenberg were initiated in mid June (Table 2). This is close to the average for High Arctic Greenland (Meltøfte 1985). However, considering the fact that 1996 had relatively little and early thawing snow cover it is surprisingly late for the normally early breeding Turnstones. The likely explanation is that Zackenberg is not an early snow free 'oasis'. Among many factors that pointed to Zackenberg as an appropriate site for a research station was the fact that the snow regime is characteristic of an area intermediate between the cool, humid and snow rich outer coast and the warmer, sunny and arid inland close to the Inland Ice. This means that profound annual as well as long-term variations in *e.g.* snow cover, progress of snow melt and hence the breeding phenology of waders can be expected.

FLEDGING SUCCESS IN WADERS

Little is known about breeding success in Arctic waders. Unfortunately, a proper monitoring of this is not possible at Zackenberg either. It is far too time consuming for a broad monitoring programme like this. However, an attempt is made to obtain an index of the annual variation in regional fledging success. This is done by counting the number of juvenile (and adult) waders on the tidal flats every third day in a miniature 'wadden sea' at the former and the present deltas of the Zackenberg river. Here up to 325 waders have been recorded during the post-fledging period in late July and August. Such numbers of post-breeding waders probably occur only in few places in High Arctic Greenland.

Table 2. First egg dates for waders at Zackenberg 1996 as estimated from incomplete clutches, egg floating, hatching dates, weights of pulli and observations of newly fledged juveniles.

Species	Median date	Range	N
Great Ringed Plover <i>Charadrius hiaticula</i>	17 June	13-25 June	3
Red Knot <i>Calidris canutus</i>	11 June	9-12 June	2
Sanderling <i>Calidris alba</i>	16 June	8-28 June	8
Dunlin <i>Calidris alpina</i>	11 June	6-24 June	11
Ruddy Turnstone <i>Arenaria interpres</i>	19 June	8-28 June	14

At least, these counts will provide the first systematic data set on post-breeding phenology and departure of waders from Northeast Greenland.

WELCOME TO ZACKENBERG

In my opinion, the key to understanding of the population dynamics of Arctic waders is found on the breeding grounds (Meltofte 1985, 1993, 1996). In particular, the pre-breeding and egg-laying periods, *i.e.* the period between arrival around 1 June and initiation of incubation, is critical. During this period snow covers most of the productive habitats and temperatures are still low and unpredictable. Simultaneously, the birds compete for favourable territories and need nutrients for the production of clutches of large eggs. Studies on this, together with studies on the central aspect of reproductive success call for a concerted action by wader researchers.

Obviously, many other issues are available to research as

well. Although ZERO gives priority to studies on the functioning and dynamics of the local ecosystem, the facilities are open to all kinds of research. The only limitation is the maximum of 20 persons we can accommodate at any time. The daily charge is DKR 275 (c. \$50) for full accommodation. All traffic to and from Zackenberg is by chartered aircraft. You should count on a cost of DKr 16 000 (c. \$2 700) for the round trip ticket between Iceland and Zackenberg.

The station is manned from around 1 June until around 1 September. Accommodation is in 7.5 m² cabins in 'Weatherhaven' shelters, while five 43 m² houses serve as wet and dry lab, work space, office, telecommunication room, mess, washroom and accommodation for permanent staff.

Further information, including the 'ZERO Site Manual' and the newsletter 'ZERO News' is available from the Danish Polar Center, Strandgade 100H, DK-1401 Copenhagen K, Denmark. These papers, together with a summary of the '1st Annual Report 1995' (Meltofte & Thing 1996) are also available on the web (<http://www.dpc.dk>), where you even find an application form for access permit. Applications for the summer field season must be received at the Danish Polar Center no later than 31 December of the preceding year. The database, with all monitoring data collected at Zackenberg will be available via our home page.

For specific questions, please contact Henning Thing on e-mail hth@dpc.dk or me on mel@dpc.dk.

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