

Pardosa hyperborea (Araneae: Lycosidae): A first report from Disko Island (West Greenland), with remarks on the biogeography of the species

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Abstract

Disko Island (West Greenland) is a diversity hot spot with a remarkable fauna and flora at the border between the low and the high arctic. The spider fauna of this island was investigated by hand sampling and pitfall trapping between June and August in 2003 and 2004. About 1000 specimens belonging to the family Lycosidae were collected representing the five species: *Arctosa insignita* (Thorell, 1872), *Pardosa furcifera* (Thorell, 1875), *P. glacialis* (Thorell, 1872), *P. groenlandica* (Thorell, 1872) and *P. hyperborea* (Thorell, 1872). For *P. hyperborea* this is the first record on Disko Island and the northernmost record in West Greenland. We give a detailed description of the discovered population on Disko Island and some brief remarks on the morphology and holarctic distribution of this species.

Dansk sammendrag

Disko-øen (Vestgrønland) er et biodiversitets "hot spot" med en bemærkelsesværdig fauna og flora beliggende på grænsen mellem lav- og højarktisk. Edderkoppefaunaen på denne ø blev undersøgt i juni-august i 2003 og 2004 ved håndindsamling og pitfall-fælder. Omkring 1000 individer tilhørende familien Lycosidae blev indsamlet med repræsentanter fra de fem arter: *Arctosa insignita* (Thorell, 1872), *Pardosa furcifera* (Thorell, 1875), *P. glacialis* (Thorell, 1872), *P. groenlandica* (Thorell, 1872) og *P. hyperborea* (Thorell, 1872). For *P. hyperborea* er det den første observation på Disko-øen og den nordligste i Vestgrønland. Vi giver en detaljeret beskrivelse af den fundne population på Disko-øen og korte bemærkninger om morfologien og den holarctiske distribution af denne art.

Introduction

Wolf spiders (Lycosidae) are one of the species richest families (2324 species) among spiders and are common all around the world with the exception of the Antarctic. However, a number of species are reported for the Arctic. There are eight species known in Greenland (Larsen *et al.*, 2003), including *Pardosa albomaculata* (Emerton, 1855), *Pardosa furcifera* (Thorell, 1875), *Pardosa glacialis* (Thorell, 1872), *Pardosa groenlandica* (Thorell, 1872) and *Pardosa hyperborea* (Thorell, 1872), which belong to the genus *Pardosa*, as well as *Alopecosa exasperans* (Cambridge, 1877), *Arctosa alpigena* (Doleschall, 1852) and *Arctosa insignita* (Thorell, 1872) of the *Lycosa* group. Their distribution in Greenland

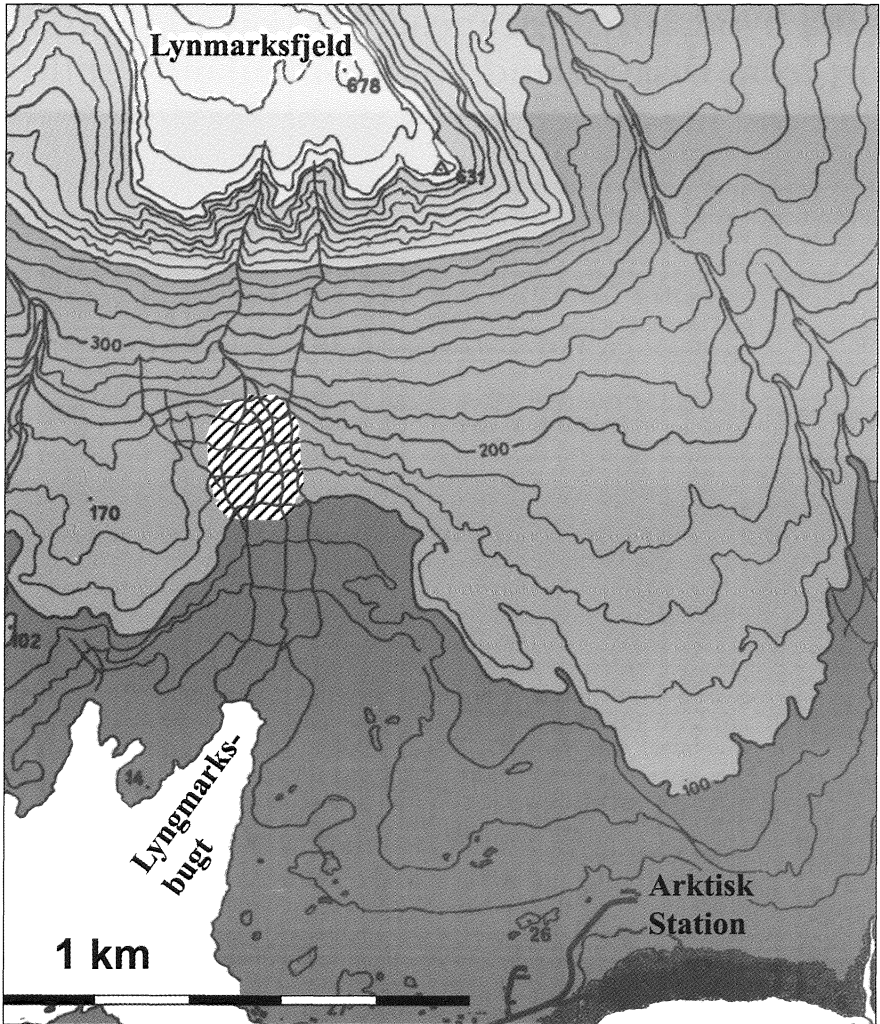


Fig. 1. Sampling sites

Map of the study site near Queqertarsuaq on Disko Island, showing the location of the *P. hyperborea* population (hatched area) in the Lyngmarks Bay – Lyngmarks glacier area.

is limited due to environmental factors such as favourable microclimate conditions. The diversity found on Disko Island is unique for low arctic Greenland and a result of the favourable local climate, lowlands and mountains, rank ground and the numerous homothermic springs.

So far the occurrence of *P. hyperborea* in west Greenland has been reported from Ilua in the south (59° N) to the Manitsaq district (65° N) and in east Greenland only from three localities (61° N, 70° N and 71° N) (Brændegård, 1946; Holm, 1967; Marusik *et al.* 2006). According to Holm (1967) typical localities for this species are herb fields on mountain slopes as well as *Salix polaris* and *Sibbaldia procumbens* communities in snow beds. *P. hyperborea* can also be found under stones in heaths and at the seashore.

Study area and methodology

In 2003 and 2004 spiders of the genus *Pardosa* were collected in the surrounding of Qeqertarsuaq, Disko Island (West Greenland). In 2003 hand collections were conducted within one day by one experienced and 12 inexperienced collectors in the Lyngmarks Bay area and along the way to the top of Lyngmarksfjeld until 500 m altitude (Fig.1). Each place was sampled twice, once in the morning and once in the afternoon. In 2004 the same places were sampled as well as additional sites: (I) an area with a presumed high diversity – (for arctic conditions) – and with homothermic springs (Engelskmans Havn) and (II) the surrounding of Copenhagen University's Arctic Station (69°15'N, 53°34'W) and (III) the area until the top of Lyngmarksfjeld (800 m a.s.l.). Altogether 28 pitfall traps were placed pair wise at 14 sampling sites as soon as the snow was melted. First traps were placed in early June and stayed in the field until mid August. Traps were checked on a weekly basis. Additional hand collections were done by an experienced collector on favourable days.

Collected spider material from 2003 is kept in the collections of the Biological Institute, Stuttgart University. The material from 2004 was added to the collections of the Zoological Museum Copenhagen (ZMUC).

Micro-Photographs of epigynal and pedipalpal structures were obtained by calculating the extended depth of field pictures from image stacks taken of prepared alcohol material from *P. hyperborea* with a Zeiss Axioskop 20 Microscope and a Nikon Coolpix 4500 Digital camera. Calculations of the final images were performed with ImageJ 1.37c (Rasband, 1997-2007).

First report of *P. hyperborea* for Disko Island

About 1000 specimens of the family Lycosidae were collected in 2003 and 2004. The most abundant species were *P. glacialis* and *P. groenlandica*. *P. furcifera* and *A. insignita* were found less frequently. The occurrence of these two species was limited to altitudes below 100 m a.s.l., especially to sheltered bays (Lyngmarks Bay) and the areas with homothermic springs such as in Engelskmans Havn. Findings of the four species mentioned above have been reported previously by Holm (1967), Dondale & Redner (1990) and Larsen & Rasmussen (1999). For the first time we report the findings of *P. hyperborea* on Disko Island. Individuals of this species were found only in a limited area (Fig. 1). These findings are the northernmost documented occurrence of *P. hyperborea* in West Greenland. The explored study site inhabiting the *P. hyperborea* population is located on a steep, south faced slope between 100 m and 200 m altitude on the way from the Lyngmarks Bay to Lyngmarksfjeld. This heath slope shows *Betula nana*, *Cassiope tetragona*, *Empetrum hermaphroditum*, *Pyrola grandiflora*, *Salix glauca* and *Vaccinium uliginosum* as characteristic vegetation elements (Fig. 2). *P. hyperborea* (Fig. 3) usually is found in areas with a milder climate, predominantly in south Greenland (Brændegård, 1946). In Canada it was typically found on sphagnum bogs, low-lying spruce forests, rocky hillsides, lichens in arctic and alpine tundra as well as needle mats in forests of jack pine, black spruce and balsam fir (Dondale & Redner, 1990). Comparable results have been reported by Hoffmann (2002) for studies in Finland. She found *P. hyperborea* to prefer arid habitats with a semi dense or limited dwarf birch vegetation. It was rarely found in mere birch forest or alpine heaths.

The spider fauna on Disko Island was extensively investigated by Holm, Böcher and Larsen in the period between 1962 and 1999 respectively. Due to the limited occurrence of *P. hyperborea* it might have been overlooked by these workers, or the present study area might not have been in the scope of their interest. Another explanation might be, that

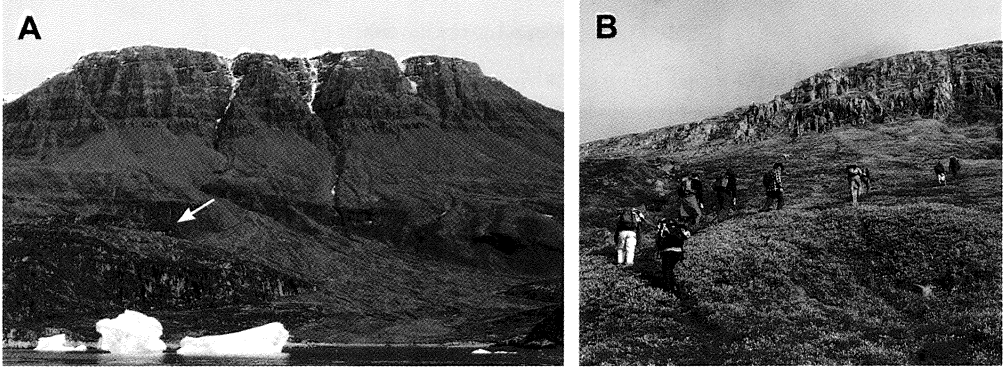


Fig. 2. Habitat overview

Photograph of the sampling area with a view on Lyngmarks Bay and the Lyngmarks glacier area. Location of the discovered *P. hyperborea* population indicated by an arrow (A). Photograph of the discovered location of the *P. hyperborea* population (B).

the species may have been absent on Disko during the investigations of the previous workers. Findings today, therefore, may be due to new emerged favourable microclimatic conditions caused by climate change impact on Disko Island displayed by an increased air temperature of 0.4°C per year in the period between 1991-2004 (Hansen *et al.*, 2003). The influence on the growing season can be seen by the increased number of growing season days (GD) (air temperature above 5°C) and growing degree-days (GDD), with GDD being the effective temperature sum indicating the intensity of the growing season. For Disko Island the GDD increased from only 64 in 1992 to 376 in 2003, and the GD increased from 36 in 1992 to 114 in 2003. Considering the favourable climate and that Disko Island is situated at the boarder of low arctic, this area represents a hotspot for species broadening their area of distribution.

The hypothesis might be disfavoured by the findings of *P. hyperborea* by Sørensen (1898) and Böcher (in Marusik *et al.* 2006) in Northeast Greenland. As these Authors reported only very small numbers of collected specimens taken together with the missing reports for this species between 61°N and 71°N at the east cost it hast to be considered rare in these localities too. The occurrence in the Scoresby Sund area might be correlated to the occurrence of hot springs and a considerably favourable microclimate in the phytosphere as reported by Karlson *et al.* (2003), which demonstrated remarkably high GDD values for this latitude.

In terms of global climate change and the attempts of monitoring the influence on fauna and flora it might be interesting to follow the development of the *P. hyperborea* population on Disko Island.

Remarks on the biogeography of *P. hyperborea*

P. hyperborea displays a holarctic distribution (Fig. 4). For almost the complete nearctic independent findings were reported (Sørensen, 1898; Brændegård, 1946; Holm, 1958, , 1967; Hillyard, 1979; Dondale *et al.*, 1987; Dondale & Redner, 1990; Dondale *et al.*, 1997; Böcher, 2001; Larsen & Scharff, 2003). In Greenland the distribution is limited to the south and south-west. No detailed data are available for Europe (Staudt, 2001). According to Muster *et al.* (2006) the distribution in south and central Europe is limited to the upper subalpine and alpine zone. For the eastern paleartic region only limited number of reports on *P. hyperborea* are available (Koponen *et al.*, 1997; Marusik *et al.*, 2001). To

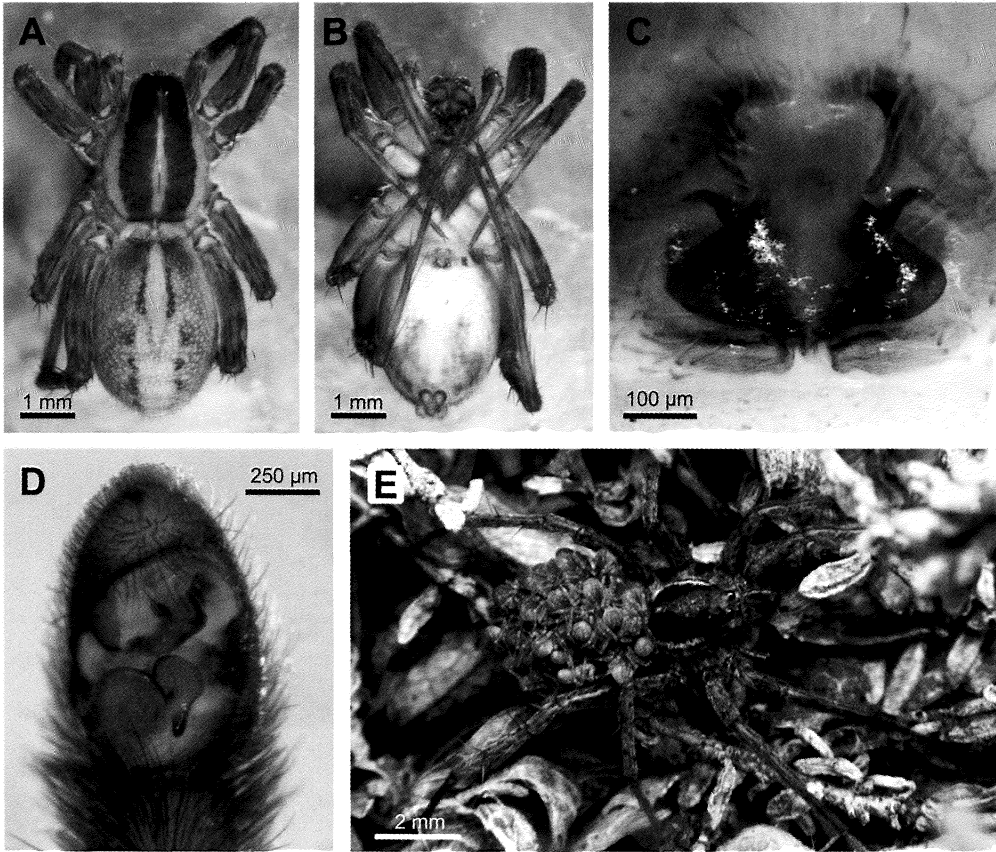


Fig. 3. *Pardosa hyperborea* from Disko Island
 Adult female of *P. hyperborea*, (A) dorsal view, (B) lateral view and (C) details of epigynal structures; (D) External male genitalia. (E) Female of *P. hyperborea* from the sampling area carrying newly hatched spiderlings (July 2004).

unravel the circumpolar distribution patterns of *P. hyperborea* it will be necessary to obtain more detailed data on the distribution of this species in the eastern palearctic.

Investigations of molecular divergence and diversity of several European populations by Muster *et al.* (2006) indicated, that a revision of the *Pardosa saltuaria* group and probably some additional holarctic lycosid species is necessary. For the five established members of the European *P. saltuaria* group (*Pardosa oreophila* (Simon, 1937), *Pardosa evelinae* (Wunderlich, 1984), *Pardosa saltuaria* (L. Koch, 1870), *Pardosa drenskii* (Buchar, 1968), *Pardosa hyperborea* (Thorell, 1872)) they suggest that a system of three accepted species would be more appropriate to represent the geneologic reality: *P. drenskii* (Buchar, 1968) from the Balkans; a hitherto unnamed species from the Pyrenees; and *P. saltuaria* (L. Koch, 1870) from all central and northern European localities. The necessity for a revision of the *P. saltuaria* group is also supported by differences in the external male genital structures of the Greenlandic *P. hyperborea* specimens observed by the author's (unpublished data). Differences in the external male genital structures and epigynal structures had been observed and reported already by Holm (1967) and Brændegård (1946), also with the result to distinguish the Greenlandic specimens from the Euro-

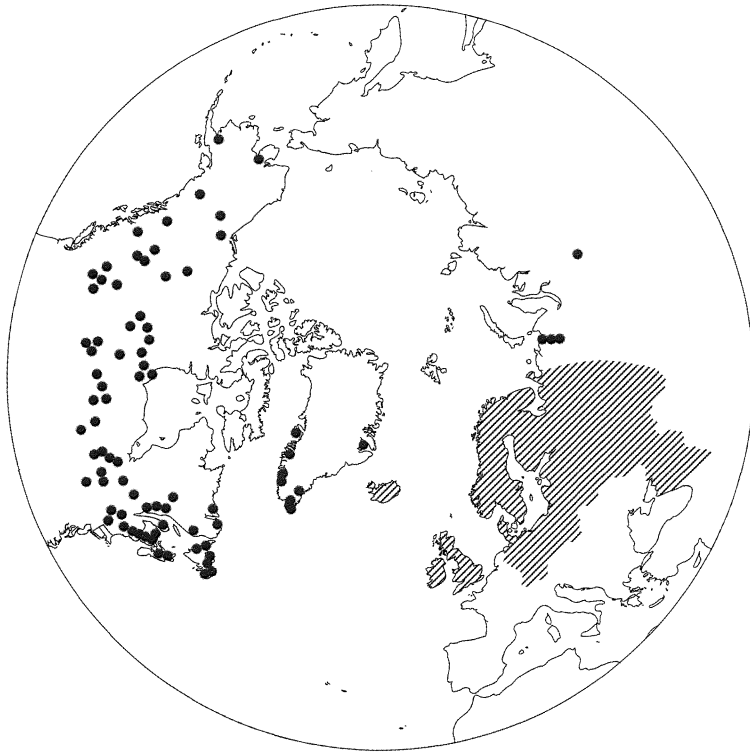


Fig. 4. Distribution map

Holarctic distribution of *P. hyperborea* (black circles, hatched area) taken from: (Sørensen, 1898; Brændegård, 1946; Holm, 1958, 1967; Hillyard, 1979; Dondale & Redner, 1987, 1990; Dondale *et al.*, 1997; Koponen *et al.*, 1997; Böcher, 2001; Marusik *et al.*, 2001, 2006; Staudt, 2001; Larsen & Scharff, 2003)

pean ones. These observations call for a circumpolar taxonomic revision of the *Pardosa saltuaria* group. However, this is beyond the scope of this study. We therefore await the results from a morphologic reinvestigation and a circumpolar molecular phylogenetic study of the *P. saltuaria* group.

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