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# Distinctiveness of the epigeic spider communities from dune habitats on the Danish North Sea coast

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**Abstract**

Pitfall traps were operated through a full year in dune and heathland habitats of the Hanstholm Reserve close to the North Sea coast of NW Jutland, Denmark. Transect lines were laid out in the dune adjacent to the beach, and dunes 400-700 m from the shore. The following main habitat types could be distinguished: yellow dune, grey dune, *Empetrum/Calluna* heathland, low pine plantation, sandy areas with sparse vegetation and *Sphagnum* bog. The full-year catches of every trap were analysed with Canonical Correspondence Analysis (CCA), using topography and vegetation (species, coverage and height) as environmental variables.

The greatest faunistic differences were between the near-beach (yellow dune) communities and the rest, in spite of great differences in habitat conditions (e.g. humidity) and structure of the vegetation. Several (even some dominant) species were unique to the yellow dunes and were not found in the grey dunes only a few hundred meters inland.

**Key words:** Araneae, coastal dunes, habitat mosaic, habitat selection

## INTRODUCTION

The spider fauna of coastal dune habitats in Northern Europe have been thoroughly studied in recent years (Finland: Perttula 1984; Sweden: Almquist 1973; England: Duffey 1968; Germany: Schultz 1995; Schultz & Finch 1996; Belgium: Bonte et al. 2000). Clausen (1987) reported on dune and dune heath spiders from the Danish island Læsø in the Kattegat Sea. The extensive dune system along the Danish North Sea coast has not been similarly investigated before from an ecological point of view. In 1997 we therefore initiated a study of the dune spiders in the Hanstholm Reserve, situated at the 'shoulder' of northwestern Jutland. Due to their location, these dunes are more exposed to the prevailing (north)westerly winds and occasional storms than any other places along the Danish west coast. A pauperised fauna could therefore be expected compared to less exposed areas.

Dunes are dynamic landscapes regularly subjected to the modifying forces of wind (Ranwell 1972). Topographically they are hilly, often with steep slopes. This means that dune systems will always be mosaics of vegetation types varying in environmental conditions and being in different stages of successional development. Typical coastal dune profiles (cf. Duffey 1968; Ranwell 1972) are usually modified by local conditions. At Hanstholm no foredune is present because autumn and winter storms erode into the yellow dune, which is heavily influenced by shifting sand. Behind the

yellow dune is a dune slack/dune heath ranging 400-600 m inland. At the site of investigation two high grey dunes raises here. Their slopes present a diversity of habitats: typical grey dune vegetation, windbreaks with bare sand, low pine plantation (planted to prevent windbreaks), dune heath, and at the lowest parts of the dune slack there are seasonally water-logged *Sphagnum* bogs. Our aim was to characterise the epigeic spider communities of this mosaic area and analyse how the changes in species composition relate to changes in habitat. In this preliminary report we present only some major patterns, while leaving a detailed analysis of the data to be published elsewhere.

## METHODS

### Sampling

A total of 88 pitfall traps were laid out in a series of 10 transects and were all operated through a whole year (11 May 1997 to 11 May 1998). The traps consisted of a plastic flower pot forming a stable hole in the ground, into which was fitted a removable plastic beaker (diam. 11 cm) with preservative. The latter contained a 2-3% formalin solution mixed ca. 4:1 with ethylene glycol, with a few drops of detergent added. The addition of ethylene glycol served to avoid winter freezing and complete desiccation during summer. The traps were covered by a small wooden roof (12 * 12 cm) in order to prevent rain water filling the traps. Emptying was done every two weeks during the warm season and every four weeks during winter, with fresh preservative supplied on each occasion.

### Sites

The transects all started from the top of a dune and were placed in four directions perpendicular to each other. They were not exactly in the four compass directions, however. The deviation was due to the fact that the dunes were shaped by the prevailing WNW-winds. For simplicity we refer to the main compass directions, but in reality the transects are slightly clockwise displaced (ca. 30°). The length of the transects and the number of traps in each transect varied depending on how the habitats changed in the different directions. We refer to three trap sites, corresponding to three dune tops. Trap site A was in the yellow dunes by the shore of the North Sea. The top of the dune (18 m a.s.l.) was only 5 m from a steep slope to the beach, eroded by the sea. The two trap transects started at this dune top. One ran north, parallel with the coastline at 5-10 m distance; the other ran east, inland from the coast. Sites B and C were further inland, 500 m and 650 m from the coast, respectively, and should be classified as grey dunes, except where winds had broken up the dune and created bare depressions. Both sites started on tops situated 28 m a.s.l. (known locally as Kobbelsbakke and Bøjebakke, respectively). Site B had a covering of low pines of varying density on parts of the N and W transects. Otherwise, most of the transects crossed a mosaic of bare sandy spots, grey dune vegetation, dwarfshrub heath, and mixtures of these vegetation types. The two south transects were extended somewhat further than the others into a low heathland bog.

On one occasion (20 July 1997) we recorded the habitat characteristics of the immediate surroundings (diam. 1 m) of each trap. The vegetation height and the coverage of the dominant plant species (>5%) or unvegetated area was noted. We also estimated the approximate altitude a.s.l. height a.s.l. of each trap. The direction of the slope of each trap was recorded (N, E, S, W) and the steepness of the slope (0 = plain, 1 = weak slope, 2 = steep slope).

For some presentations, the trap sites have been categorised into six main vegetation types, though the surroundings of some traps were intermediate between these:

-White dune: > 50% *Ammophila arenaria* was present, often as a monoculture. Most trap-sites were strongly influenced by shifting sand; white dunes occurred only at site A.

-Grey dune: mixture of *Ammophila arenaria*, *Carex arenaria* and other plants;

-Bare dune: > 50% bare sandy area or covered

with low (~1 cm) lichens or moss;
-Heath: *Empetrum nigrum* was the dominant dwarf shrub; only few places was *Calluna vulgaris* present to any extent;
-Bog: low-lying, more or less flooded during winter and spring. Vegetation consisted of >50% *Sphagnum* with *Molinia coerulea*, *Erica tetralix* or *Narthecium ossifragum*; deep (ca. 10 cm) turf layer;
-Pine plantation (*Pinus mugho*, ½-2 m high, ca. 50 years old) on N and W slopes of site B. The ground was covered with dead needles or a thick layer of moss.

**Analysis**
Spiders were identified to species level and a matrix with the total catch of each species in each of the 88 traps was produced. A similar matrix was made for the topographical and vegetation recordings (only dominant species included). The two files served as species- and environmental factor files for analysis in the CANOCO 4 program (ter Braak & Smilauer 1998). A canonical correspondence analysis (CCA) was used to compare the species distributions in relation to the traps and habitat factors.

## RESULTS

**Faunistics**
A total of 22200 individuals were identified from 170 species. Several species were recorded for the first time from Denmark: *Evansia merens*, *Porrhomma egeria*, *Walckenaeria capito*, *Sitticus distinguendus*, *Cheiracanthium campestre* and *Micaria lenzi*. Other rare or previously rarely recorded species are: *Maro lepidus*, *Trichopterna thorelli*, *Hypsosinga sanguinea*, *Clubiona genevensis*, *Haplodrassus moderatus*, *Micaria aenea*, *M. dives* and *Synageles venator*.

**Canonical correspondence analysis (CCA)**
In the sites-plot (Fig. 1A) the species composition of the traps from the yellow dune transects (site A) is clearly distinguished from that of the traps of the two 'inland' sites (sites B and C). The classification according to main vegetation type reveals some separation of the communities of these habitats, but also some intergrading. However, there is a clear gradient along the first CCA-axis, with the more vegetated (and presumably more humid) habitats to the left and the bare, dry habitats to the right. The yellow dune traps and the bare inland dune traps have similar positions along the first axis, probably due to the influence of shifting sand at site A. They are clearly separated along the second axis, which may reflect a humidity gradient. Table 1 presents the overall capture statistics in relation to the habitat types. The yellow dune is the habitat with most exclusive species (i.e. species found only in this habitat). The distinctiveness of the yellow dune spider community is particularly revealed by the dominance of exclusive species: it amounts to nearly 10% against c. 0.8% at most in the other habitats.

Fig. 1B indicates which species and habitat factors are mainly responsible for the differences. *Hypomma bituberculatum*, *Pelecopsis nemoralis*, *Troxochrus scabriculus*, *Clubiona frisia*, *Sitticus distinguendus*, *Micaria dives*, *Tibellus maritimus* and *Marpissa nivoyi* are species that are completely or nearly completely restricted to the yellow dune habitat. Similarly, *Arctosa perita*, *Alopecosa fabrilis*, *A. accentuata*, *Sitticus saltator* and *Aelurillus v-insignitus* are more or less restricted to the bare 'inland' dune habitat. The heath habitat has hardly any species of its own; the dominant species here are mostly habitat generalists that extend their occurrence into the various adjoining habitats, both the drier and the more humid ones. The trap-plot (Fig. 1A) shows a surprising overlap between the traps in the pine plantation and the heath bog. Many of the exclusive species of the pine habitat are tree-dwelling (e.g. *Drapetisca socialis*, *Lepthyphantes obscurus*, *Zygiella atrica*), but only singletons were caught because these species are not recorded well with pitfall traps. The similarity with the bog and heath fauna is due to the dominance of euryhygric and euryoecious generalists like *Centromerita concinna*, *Lepthyphantes mengei*, *Pardosa nigriceps*, *Trochosa*

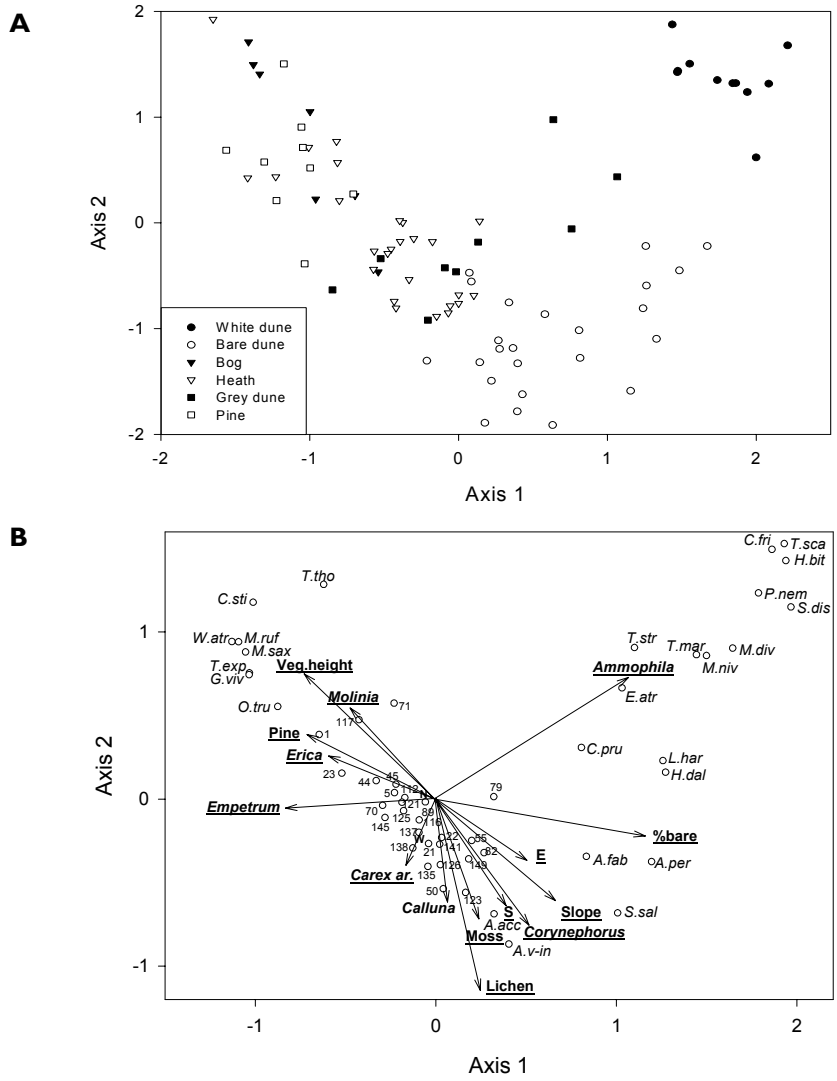


**Fig. 1.** Canonical Correspondence Analysis of dune spider communities from the Hanstholm Reserve, Denmark. **(A)** Trap plot, traps categorised according to habitat of trap surroundings. **(B)** Species and environmental factor plot. Species with >100 individuals (or >10 if of high indicator value). Abbreviated species names: A.acc *Alopecosa accentuata*, A.fab *Alopecosa fabrilis*, A.per *Arctosa perita*, A.v-in *Aelurillus v-insignitus*, C. fri *Clubiona friesia*, C.sti *Crustulina sticta*, E.atr *Erigone atra*, C.pru *Centromerus prudens*, G.viv *Gongylidiellum vivum*, H.bit *Hypomma bituberculatum*, H.dal *Haplodrassus dalmatensis*: L.har *Leptothrix hardyi*, M.div *Micaria dives*, M.niv *Marpissa nivoyi*, M.ruf *Macrargus rufus*, M.sax *Meioneta saxatilis*, O.tru *Ozyptila trux*, P.nem *Pelecopsis nemoralis*, S.dis *Sitticus distinguendus*, S.sal *Sitticus saltator*, T.exp *Tallusia experta*, T.mar *Tibellus maritimus*, T.sca *Troxochrus scabriculus*, T.str *Thanatus striatus*, T.tho *Trichopterna thorelli*, W.atro *Walckenaeria atrotibialis*, 1 *Ero furcata*, 5 *Euryopis flavomaculata*, 21 *Centromerita bicolor*, 22 *Centromerita concinna*, 23 *Centromerus dilutus*, 44 *Lepthyphantes ericaeus*, 45 *Lepthyphantes mengei*, 50 *Macrargus carpenteri*, 55 *Meioneta rurestris*, 70 *Peponocranium ludicrum*, 71 *Pocadicnemis pumila*, 79 *Stemonyphantes lineatus*, 82 *Tapinocyba praecox*, 89 *Walckenaeria antica*, 112 *Alopecosa pulverulenta*, 117 *Pardosa pullata*, 121 *Trochosa terricola*, 123 *Hahnia nava*, 125 *Agroeca proxima*, 126 *Scotina gracilipes*, 135 *Drassodes cupreus*, 137 *Drassyllus pusillus*, 138 *Gnaphosa leporina*, 141 *Haplodrassus signifer*, 145 *Micaria pulicaria*, 149 *Zelotes longipes*.

**Table 1.** Capture statistics for the spider sampling program in Hanstholm Reserve, NW Jutland , Denmark (May 1997 – May 1998).

| | White dune | Bare | Grey dune | Heath | Bog | Pine | Total |
|---|---|---|---|---|---|---|---|
| No. pitfall traps | 13 | 24 | 9 | 26 | 7 | 9 | 88 |
| No. individuals per trap | 157 | 223 | 250 | 334 | 341 | 177 | |
| No. species per trap | 36.8 | 35.5 | 40 | 42.3 | 44.7 | 40.3 | |
| No. species per habitat | 102 | 92 | 122 | 88 | 87 | 99 | 170 |
| Exclusive species | 11 | 4 | 2 | 8 | 9 | 8 | |
| Exclusive species % | 9.16 | 0.07 | 0.09 | 0.23 | 0.50 | 0.82 | |

*terricola* and others. The bog had some rarities but otherwise few specialists (e.g. *Trochosa spinipalpis*), probably due to its limited size. It was dominated by hygrophilic generalists (*Centromerus dilutus*, *Peponocranium ludicrum*, *Pocadicnemis pumila*, apart from those mentioned above).

Slope had some effect on the distribution of spiders (Fig. 1B), but this is probably due to its correlations with % bare ground, because bare habitats tended to occur mainly where the slope was steep and it was difficult to maintain a stable vegetation. The aspect of the slope had very little influence; in particular N- and W-facing slope vectors are situated close to the origin of the CCA-plot. Vegetation height is highly correlated with pines; also the bog vegetation was quite rich and on average higher than the heath and bare dune, especially where there were *Vaccinium* or *Erica*.

## DISCUSSION

The recording of 170 spider species in a one-year sampling program from a very restricted area gives no indication of a pauperised fauna in this highly wind-exposed dune system. This number is c. one third of all spider species known in Denmark, in spite of the fact that a very special set of habitats were studied. On the contrary, the high number of new and rare species provides evidence of a high conservation value of the Hanstholm Reserve. Some of these rarities were captured in the yellow and bare dunes, others in the bog or the heathland. Thus, the mosaic nature of the coastal dune landscape contributes significantly to the biodiversity. This underscores the importance of preserving extensive areas of relatively undisturbed habitat where the natural mosaic is still present, as in the Hanstholm Reserve. Fortunately the reserve is highly protected, e.g. from 1st April to 15th July public access is prohibited.

It remains to be established whether the dune fauna of the western coast of Jutland is generally so rich and diverse. Some of the peculiar habitat types, e.g. the bog, could easily disappear if and when areas are developed for tourist utilization. Because the results of this study particularly emphasise the nature value of the yellow dune, which is the habitat utilised by bathing guests all along the coast, there is a need for studies of the dunes that are more exposed to the wear of tourism. In particular, it is important to establish to what extent the exclusive species of the yellow dune compared to habitat generalist species tolerate such exploitation of the dunes.

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