Effect of topography on groundcover species composition on inland dunes: a comparative study of heathlands and pine mono-stands from N Poland

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Location and methods
Location of the study site
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- Extent of the European sand belt (after Zeeberg 1998)
- Areas of inland dune occurrence in Poland

The Investigated Military Area
Naturally revegetated area (NRA)
Scots pine (*Pinus sylvestris*), managed mono-stands (PMS)

Naturally revegetated area (NRA)

border of the military area
area formed at present by natural succession mainly
Field research:
- In total 184 plots (400 m²) investigated:
  - 33 in NRA
  - 151 in PMS (25 in pine stands ≤ 20 years)
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- In total 184 plots (400 m²) investigated:
  • 33 in NRA - 11 in depressions (D), 11 in north- (N), and 11 in south-facing slopes
  • 151 in PMS (25 in pine stands ≤ 20 years) - 45 in depressions (D), 53 in north- (N), and 53 in south-facing (S) slopes (in stands ≤ 20 years: 9, 8 and 8 plots, respectively)
- In each plot:
  • species composition of herbaceous species was determined (1 - presence; 0 - absence)

Data analysis:
- Based on presence/absence of particular species the Ellenberg indicator values (Ellenberg et al., 2001) were calculated for each plot with Juice 7.0 software: light (L), temperature (T), moisture (F), reaction (R) and nitrogen (NIT).
- Relations between species composition of ground vegetation, ecosystem type (NRA vs. MPS), and Ellenberg Indicators were studied in the redundancy analysis (RDA) performed with the CANOCO package v. 4.5.
- Differences between mean values were examined with non-parametrical tests (U Mann-Whitney or Kruskal-Wallis) in STATISTICA software v. 9.0. Detected differences were deemed significant if p < 0.05.
Results
Mean (+SD) number of species stated in plots of naturally revegetated area (NRA) and pine mono-stands (PMS)

![Graph showing mean number of species in NRA and PMS plots.](image-url)
Mean (+SD) number of species stated in naturally revegetated area (NRA) and in pine mono-stands (PMS) by topographical positions (D – depressions, N – north-facing slopes, S – south-facing slopes)
Mean (+SD) number of species stated in naturally revegetated area (NRA) and in pine mono-stands (PMS) by topographical positions (D – depressions, N – north-facing slopes, S – south-facing slopes)
Mean (+SD) Ellenberg indicator values (L – light, T – temperature, M – moisture, R – reaction, NIT – nitrogen) in naturally revegetated area (NRA) and in pine mono-stands (PMS)

Soil water storage (mm) calculated to the depth of 65 cm for soils located in depressions (D), north- (N) and south-facing slopes (S) in NRA and PMS (Sewerniak et al. 2017, modified)
Mean (+SD) Ellenberg indicator values (L – light, T – temperature, M – moisture, R – reaction, NIT – nitrogen) in naturally revegetated area (NRA) and in pine mono-stands (PMS)
RDA ordination diagram showing relations between species composition, ecosystem type (NRA, PMS), topographical positions (D, N, S) and Ellenberg indicators (L – light, T – temperature, M – moisture, R – reaction, NIT - nitrogen)

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Intra-dune depressions


Veronica officinalis
Deschampsia flexuosa
Carex pilulifera
Convallaria majalis
Vaccinium v.-idaea
RDA ordination diagram showing relations between species composition, ecosystem type (NRA, PMS), topographical positions (D, N, S) and Ellenberg indicators (L – light, T – temperature, M – moisture, R – reaction, NIT - nitrogen).

North-facing slopes

Species abbreviations: agr.cap - Agrostis capilaris, cal.epi - Calamagrostis epigejos, cal.vul - Calluna vulgaris, car.are - Carex arenaria, car.eri - Carex ericetorum, con.maj - Convallaria majalis, cor.can - Corynephorus canescens, des.fle - Deschampsia flexuosa, dry.car - Dryopteris carthusiana, dry.fil - Dryopteris filix-mas, fes.ovi - Festuca ovina, fes.rub - Festuca rubra, , hie.pil - Hieracium pilosella, peu.ore - Peucedanum oreoselinum, pol.odo - Polygonatum odoratum, rub.pli - Rubus plicatus, rum.ace - Rumex acetosella, sen.vis - Senecio viscosus, sol.vir - Solidago virgaurea, spe.mor - Spergula morisonii, vac.myr - Vaccinium myrtillus, vac.vit - Vaccinium vitis-idaea, ver.off - Veronica officinalis, ver.teu - Veronica teucrium, vin.hir - Vincetoxicum hirundinaria
RDA ordination diagram showing relations between species composition, ecosystem type (NRA, PMS), topographical positions (D, N, S) and Ellenberg indicators (L – light, T – temperature, M – moisture, R – reaction, NIT - nitrogen)

South-facing slopes

Conclusions
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• Although in planted pine stands the diversity of ground vegetation is obliterated, however, also in such managed ecosystems the effect of land relief on ground vegetation occurs.

• Intra-dune depressions are (micro) „hot spots” of ground vegetation diversity in oligotrophic environments of inland dunes in central Europe. Following the occurrence of relative fertile soils in the depressions, the locations should be used to introduce admixtures of broadleaved species.
Low biodiversity = high susceptibility to hazards
(pest gradations, windthrows, fires etc.)
Windthrows in pine stands in Polish lowlands

11/12 August 2017: Forests in 80 000 hectares destroyed at one night!!!
Forest fires in conifer stands

3000 hectares of pine stands burnt in 1992
Distribution of intra-dune depressions (black dots) in the dune area studied by Jankowski (2001)

Total area: **100 ha**

Percent of the area of the intra-dune depressions: **ca. 2%**

Number of contours of the depressions: **55**
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References


• Sewerniak, P., Jankowski, M., 2017. Topographically-controlled site conditions drive vegetation pattern on inland dunes in Poland. Acta Oecologica 82, 52-60.
