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МИНИСТЕРСТВО ОБРАЗОВАНИЯ И НАУКИ РЕСПУБЛИКИ КАЗАХСТАН

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КОСТАНАЙСКИЙ ГОСУДАРСТВЕННЫЙ ПЕДАГОГИЧЕСКИЙ ИНСТИТУТ

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(24-27 апреля 2017 г., Костанай, Казахстан)*

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**РЕДАКЦИЯ АЛҚАСЫ
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В сборнике опубликованы материалы III Международной научной конференции «Биологическое разнообразие азиатских степей». В докладах рассмотрены итоги исследований и перспективы сохранения биологического разнообразия степных экосистем, островных и ленточных лесов и водного-болотных угодий степной зоны Евразии, охраны природных территорий и популяций видов особого природоохранного значения, формирования экологической сети и вклада вузов в изучение биоразнообразия. Книга предназначена для ученых и практиков, работающих в области изучения и сохранения биологического разнообразия, преподавателей вузов, аспирантов, студентов, работников природоохранных учреждений.

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MICRO-ENVIRONMENT – VEGETATION INTERACTIONS IN THE SANDY
FOREST-STEPPE OF NAURZUM NATURE RESERVE, KAZAKHSTAN

*Взаимодействия микросреда - растительность в песчаной лесостепи
Наурузумского заповедника, Казахстан*

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Introduction

Micro-environmental patterns are among the main drivers of plant species composition and vegetation pattern on small spatial scales (Deák et al. 2015). Forest–grassland mosaics offer especially diverse micro-environmental conditions, mostly with the grasslands as the more sun-lit, drier and warmer habitats and the forests as the shadier, moister and cooler ones (Erdős et al. 2014). The resulting environmental heterogeneity increases the overall diversity of such mosaic landscapes compared to landscapes containing solely grasslands or forests (Manning et al. 2006, Erdős et al. 2015).

The dry sandy forest-steppe vegetation of Naurzum Nature Reserve in Northern Kazakhstan is a typical example for a natural forest-grassland mosaic. Grasslands are dominated by psammophytic bunchgrasses, while forest patches are either made up of *Pinus sylvestris* or broad-leaved trees like *Betula pendula* and *Populus tremula*. The broad-leaved type is restricted to wind-blown depressions, where the groundwater is closer to the surface, while the pine groves alternate with grasslands in a seemingly random pattern. Thus, it can be assumed that differences in the micro-environmental conditions of pine groves and grasslands can be attributed solely to the presence or absence of trees. Since (i) these groves are at their limit of their tolerance regarding macroclimatic conditions and (ii) the transpiration rate of groves is likely to be higher than that of xeric sandy steppes, it is questionable whether groves create moister micro-environments in their undergrowth than what is experienced in the neighbouring grasslands. Thus, their role in increasing landscape level plant diversity is not self-evident either. In our study we aimed to identify the effects of pine trees on the micro-environmental conditions and to assess the significance of these on the herb layer as well as on the overall diversity of the landscape.

Material and methods

The study was carried out in the sandy landscape of the Naurzum Nature Reserve of Northern Kazakhstan. This area is an internationally recognized natural heritage (Bragina 2016), consisting of the southernmost forest-steppe remnants of Kazakhstan. In accordance with this geographical position, the climate is strongly continental, with an annual precipitation of 240-260 mm, a mean annual temperature of 1.3 °C and with extreme differences between winter and summer temperatures (Bragina 2009). Despite the arid climate, capillary water above the water table is within a reachable depth for pine trees (Hoffmann and Usoltsev 2001), although conditions are suitable for the formation of scattered grove patches only (Fig. 1).



Figure 1 - Typical landscape structure of the sandy areas of the Naurzum Nature Reserve, Northern Kazakhstan. *Pinus sylvestris* groves alternate with psammophytic grasslands, forming a unique mosaic of habitats. (Photo by A. Kelemen)

We selected nine pine grove and nine adjacent grassland sites and measured the soil moisture content of the upper 20 cm layer of the soil in five replicates in each grove and grassland using a TDR soil moisture meter with a precision of 0.1 v/v%. In two groves and two grasslands, we also measured air temperature (°C) and relative air humidity (%) 5 cm above ground level using Voltcraft DL121-TH microclimate sensors. Measurements were done once in every minute for a 24-hour period, with a resolution of 0.1 °C and 0.1%. In each grove and grassland, we surveyed the vegetation of the herb layer (including tree and shrub saplings shorter than 50 cm) using three 5 × 5 m relevés (54 relevés in total). We recorded all vascular plant species in the quadrats and estimated their cover in per cent. All environmental and botanical measurements were performed in July 2016, in a relatively dry period.

Soil moisture values were averaged within localities and were compared with a paired Wilcoxon-test because of the non-normal distribution of the data. The microclimatic data of the two groves and the two grasslands were averaged, leading to one data set describing groves and another one describing grasslands. Microclimate data were averaged for hours, leading to 24 records for the measurement period. We split these up to daytime (6 a.m.–6 p.m.) and night-time measurements (6 p.m.–6 a.m.), with 12 records each. The microclimate of the groves and grasslands was compared with paired t-tests. We calculated average species richness (i.e. species number per quadrat) and average total cover in the herb layer for the habitats. To account for the nested design of the sampling, the two vegetation variables were compared between pine groves and grasslands using linear mixed-effects models, with site as the random factor. On the basis of the species descriptions by Komarov (1968–2002), we categorized plant species into four groups (sand steppe species, zonal steppe species, mesic grassland species and forest species) and calculated the cumulative cover of each group in each relevé. Generalist species that could be assigned to more than one group were not excluded but their cover was split up among the relevant groups.

Statistical analyses were performed in an R environment. Mixed models were built with the *lme* function of the *nlme* package (Pinheiro et al. 2015). *P*-values below 0.05 were considered significant.

Results

Soil moisture values were very low in both habitats. Pine groves had generally lower values ($0.62\% \pm 0.66\%$, mean \pm SD) than adjacent grasslands ($1.46\% \pm 1.10\%$, mean \pm SD), but the difference was only marginally significant ($W=38.5$, $P=0.058$). Daytime air temperature averaged $38.87\text{ }^{\circ}\text{C}$ in the grasslands and $31.22\text{ }^{\circ}\text{C}$ in the pine groves; the difference was confirmed statistically as well ($t=3.103$, $P=0.010$). Night-time data were also significantly different between the habitats ($t=-3.555$, $P=0.005$), but they showed an opposite pattern, with lower values in the grasslands ($15.09\text{ }^{\circ}\text{C}$ in average) and higher ones in the pine forests ($16.95\text{ }^{\circ}\text{C}$ in average). Daytime air humidity was similar in the grasslands and the pine forest (40.71% and 43.74% , respectively) and they did not differ from each other according to the t-test ($t=0.700$, $P=0.498$), while at night the grasslands were more humid than the forests (91.51% and 74.18% , respectively; $t=-8.89$, $P<0.001$).

We detected a total of 57 species during the vegetation sampling, of which 16 occurred only in the grasslands (e.g. *Dianthus acicularis*, *Jurinea cyanoides* and *Potentilla incana*), 12 only in the pine groves (e.g. *Allium lineare*, *Equisetum hyemale* and *Veronica spuria*) and 29 had records in both habitats. Average species richness and the cover of the herb layer were significantly higher in the grasslands than in the pine groves (Fig. 2).

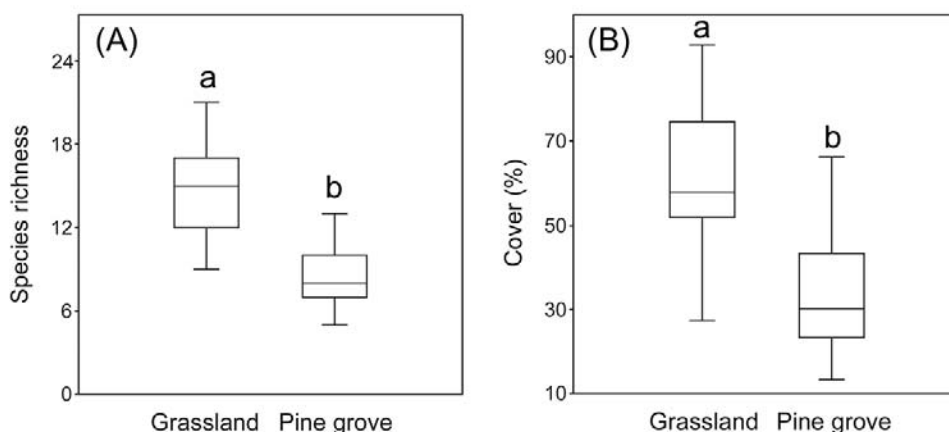


Figure 2 - Species richness (A) and plant cover values (B) in the herbaceous layers of the studied habitat types of Naurzum Nature Reserve. Lower case letter indicate significantly different groups according to the linear mixed-effects models ($t=-9.97$, $P<0.005$ for species richness and $t=-7.32$, $P<0.001$ for plant cover)

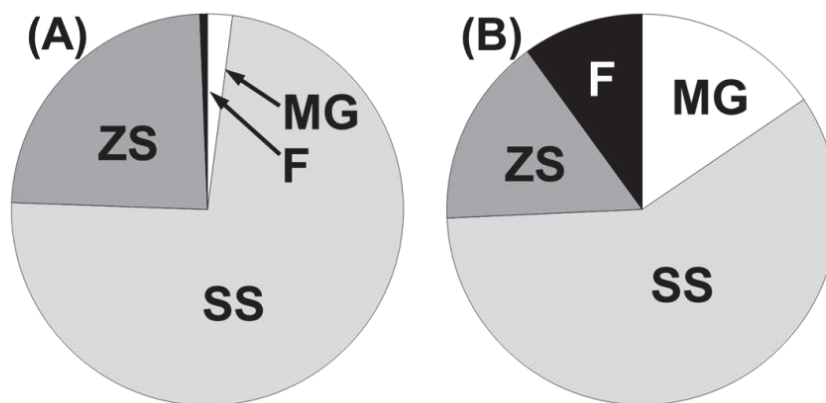


Figure 3 - Percentage share of the plant species groups in the sandy grasslands (A) and pine groves (B) of Naurzum Nature Reserve. SS: sandy steppe species; ZS: zonal steppe species; MS: mesic steppe species; F: forest species

Sand steppe species formed the most common species group in both habitats. Forest species were negligible in grasslands, while their share in the plant cover of pine groves was higher, although it was still the rarest group. The distribution of mesic grassland species between the two habitat types was similar than that of the forest species, but mesic ones were somewhat more abundant. Zonal steppe species had intermediate shares both in the grasslands and pine groves.

Discussion

The pine groves of Naurzum Nature Reserve are the southernmost relicts of an extensive boreal forest zone that characterized present-day Northern Kazakhstan in prehistoric times (Hoffmann and Usoltsev 2001). Being so unique in habitat structure in the ocean of grasslands, these woody patches are refuges for boreal animal species like the Moose (*Alces alces*) and the Black Grouse (*Tetrao tetrix*) and serve as nesting grounds for endangered birds of prey, including the Asian Imperial Eagle (*Aquila heliaca*) and the Red-footed Falcon (*Falco vespertinus*) (Katzner et al. 2006). Despite the obvious positive effects on the regional fauna, it was not self-evident, whether these groves have a positive effect on the plant communities as well.

Interestingly, pine trees create drier conditions under their canopy than what is detectable in the adjacent sandy steppes. This finding is opposite to the general pattern of forest-grassland mosaics and can be traced back to at least two reasons. Pine trees may absorb a higher amount of water from the soil than grasslands and their canopy also intercepts precipitation, a considerable proportion of which evaporates before reaching the ground. These effects have been shown to be able to invert the effects of trees on the moisture budget of the forest floor at the macroclimatic tolerance limits of trees (Cubera and Moreno 2007), like the present study area. In addition, trees hamper photosynthesis under their canopy through intercepting solar radiation, and decaying pine leaves in the litter emit allelopathic agents (Hänninen et al. 2011). Thus, the reduction of water and light availability and the adversely modified soil chemistry make conditions more severe in the undergrowth of pine groves than outside the canopy. As a clear consequence, both vegetation cover and species richness were much lower in the undergrowth of pine groves than in the open grasslands. Temperature, however, was in line with the expectable pattern, with cooler values in the groves during the day and warmer ones at night. Lower daytime temperature coupled with the wind-shading effect of the tree canopy may reduce the negative effects of low water availability through lowering evapotranspiration rates.

The net effect of the unique micro-environmental conditions led to the development of a very special species composition in the undergrowth. Woody communities these groves may be, the conditions are deficient to sustain a true forest herb layer. Instead, roughly 90% of their herb layer cover is composed of grassland species, meaning that these groves are virtually grasslands. However, the species group profile of the groves indicate that these quasi-grasslands serve as shelters not only for the few forest-specific species but also for several mesic grassland species; these together making up the twelve “grove-specific” species, which would be absent or much scarcer in the open grasslands without pine groves.

We thus conclude that the special, mostly adverse micro-environmental effects of the trees led to the development of compositionally unique plant assemblages in the pine groves, which substantially contribute to the overall plant diversity of the sandy landscapes of the Naurzum Nature Reserve.

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СОДЕРЖАНИЕ ЛОШАДИ ПРЖЕВАЛЬСКОГО (*EQUUS PRZEWALSKII* POLJAKOV)
В ПИТОМНИКЕ АССОЦИАЦИИ «ЖИВАЯ ПРИРОДА СТЕПИ»

Keeping of przewalski`s horse in the nursery of the wildlife of the steppes association

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В Евразии из диких лошадей осталась только лошадь Пржевальского (*Equus przewalskii* Poljakov). Обитавший в европейских степях степной тарпан был уничтожен людьми в XVIII–XIX вв. Исчез в природе и лесной тарпан, последние особи которого убиты в начале XIX в. Дикие лошади подвида, жившего в Джунгарии и западной Монголии, отмечены в природе в 1967-1969 гг. [1,2,5]. Н.М. Пржевальский из центрально-азиатского путешествия в 1876–1877 гг. привез в Россию скелет и шкуру дикой лошади, по которым описали новый вид. Лошадей

АЗИЯ ДАЛАЛАРЫНЫҢ ЕРЕКШЕ ҚОРҒАЛАТЫН ТАБИҒИ АЙМАҚТАРЫ
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