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Distribution patterns of planted-shrubs of different restoration ages in artificial sand-fixing regions and effects on soil property in the southeastern Tengger desert

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The plant density and spatial distribution in artificial vegetation is obviously initialized at the planting stage. Plants dynamics and spatial pattern may change over time as the result of interactions between individual plants and habitats, but whether this is the case for desert shrubs in artificial sand-fixing regions is largely unknown. Here we examined changes in plant density and distribution patterns of three shrubs (Artemisia ordosica Krasch., Caragana korshinskii Kom., and Hedysarum scoparium Fisch.) in different regions restored for 27, 32 and 50 years (R27, R32, R50), respectively. The vegetation analysis showed that A. ordosica were the dominated species across the 3 restoration regions. The density of A. ordosica and H. scoparium showed a significant increase from R27 to R32, then decreased in R50. However, there was no C. korshinskii survive in R27. The density of C. korshinskii was also low in R32 and R50. The variance-to-mean ratio (VMR) was used to characterize the spatial distribution patterns to fit the observed frequency distributions of densities of the three shrubs. A. ordosica and C. korshinskii all showed significantly clumped distribution in three restoration regions. For H. scoparium, it showed uniform distribution in R27 and R50, however showed clumped distribution in R32. We also quantified changes in soil physio-chemical properties in different restoration regions. The proportion of sand-sized particles in the topsoil was reduced sharply; the proportion of silt and clay increased greatly from 17.3 and 4.6 to 21.4 and 10.4%, respectively. N and K contents were not significant different among R27 (0.52 and 0.93 g/kg, respectively) and R32 (0.59 and 0.98 g/kg, respectively), but has significant differences with R50 (0.78 and 1.06 g/kg, respectively). P content and soil organic matter content gradually increased with successional age. The results showed that compared to C. korshinskii and H. scoparium, A. ordosica seems to be more suitable in revegetated desert areas. Pattern analysis suggested a successive replacement of C. korshinskii, which had low proportions of survived shrubs, by the dominant A. ordosica. The soil properties were also significantly improved after restoration. This study contributes to understanding of the distribution patterns of shrubs plants and their effects to soil property in revegetation projects in arid desert area.