

## 松嫩平原湿地异质生境对土壤线虫群落特征的影响

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**摘要:**【目的】湿地是最具有生产力的生态系统类型之一，对全球气候变化具有重要的缓冲作用。生境异质性直接或间接地促进土壤食物网的多样性，植被特征介导的自下而上产生的效应可以显著影响土壤生物群落的结构与组成。【方法】为探究湿地异质生境对土壤线虫群落结构和功能的影响，在植被预调查基础上选取样地，该实验于 2022 年 7 月进行，从不同的栖息地选择三个地块，分析样本地块内的土壤线虫群落、植物和土壤环境因素。采用改进的浅盘分离-蔗糖离心法从土壤中提取线虫，分析了线虫的群落组成结构、分布特征、多样性和营养类群。【结果】(1) 研究区域总体上以捕食-杂食线虫和植物寄生性线虫为主，羊草生境中线虫群落的类群个体数、多样性、丰富度在采样期间均为最大值。线虫功能足迹在样地中表现为羊草 (*Leymus chinensis*) > 膨囊薹草 (*Carex schmidtii*) > 小叶章 (*Cladonia angustifolia*) > 星星草 (*Puccinellia tenuiflora*) > 碱斑。(2) 与其他样地相比较，小叶章生境土壤线虫通道指数 (NCR) 显著低于其他生境，其土壤分解过程以真菌通道为主，而其他生境均以细菌通道为主。(3) ANOSIM 检验结果显示，生境异质性显著影响了 4 个营养类群和总体线虫群落的组成。Pearson 相关性分析和冗余分析结果显示，植物对土壤食物网的直接影响效应更为显著，土壤理化性质则间接影响线虫群落的结构，土壤全磷、含水量、pH 和植被中的湿生植物重要值是影响土壤线虫群落结构和组成的主要环境因子。【结论】本研究表明松嫩平原湿地生境异质性影响了土壤线虫的群落特征，羊草生境中土壤线虫的类群个体数、多样性、丰富度均为最高。总体来说，膨囊薹草样地由于其食物网的稳定性对于湿地的改善和近自然修复有望产生更大的影响，研究结果有助于从土壤生物学角度理解松嫩平原湿地地下生态系统过程和功能。

**关键词:** 土壤线虫；植被类型；群落结构；松嫩平原；湿地异质性

## Effects of heterogeneous habitat on soil nematode community characteristics in the Songnen Plain wetland

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### Abstract

**Objective:** Wetlands are recognized as highly productive ecosystems that play a crucial role in mitigating global climate change. The spresence of diverse habitats within wetlands directly or indirectly contributes to the enhancement of soil food webs. Moreover, the characteristics of vegetation have a significant impact on the structure and composition of soil biological communities, thereby influencing bottom-up effects.

**Methods:** To investigate the impact of habitat heterogeneity on soil nematode communities in the Songnen Plain wetland, this study focused on five heterogeneous habitats in the region. These habitats were selected based on a preliminary investigation of plant community characteristics. The experiment was conducted in July 2022, and three plots were chosen from different habitats to analyze soil nematode communities, plants, and soil environmental factors within sample plots. Nematodes were extracted from the soil using an improved shallow dish separation and sucrose centrifugation method. The study analyzed the community composition structure, distribution characteristics, diversity, and nutrient groups of the nematodes.

**Results:** Our findings indicate the following: (1) The soil nematodes in the study area are predominantly omnivorous-predators and plant-parasites. The habitat of *L.chinensis* exhibits the highest number of soil nematode individuals, Shannon index ( $H'$ ), and Margalef species richness index ( $SR$ ). The functional footprint of nematodes in the sample plot follows this order: *L.chinensis* > *C.schmidtii* > *D.angustifolia* > *P.tenuiflora* > Alkali habitat. (2) The channel index of soil nematodes in the *Deyeuxia angustifolia* habitat is significantly lower compared to other habitats. Fungal channels dominate the soil decomposition process in this habitat while bacterial channels dominate in others. (3) The ANOSIM test results demonstrate that habitat heterogeneity significantly influences the composition of four nutrient groups and the overall nematode community. Pearson correlation and redundancy analyses reveal that total phosphorus, soil moisture content, soil pH, and the importance value of hygrophytes in vegetation are the primary environmental factors affecting the structure and composition of soil nematode communities.

**Conclusions:** Our research findings demonstrate that the heterogeneity of wetland habitat in the Songnen Plain has a significant impact on the community characteristics of soil nematodes. Specifically, the *Leymus chinensis* habitat stands out with the highest number of individuals, diversity, and richness of soil nematodes. Additionally, the stability of the *Carex schmidtii* plot is expected to play a crucial role in enhancing the restoration and natural improvement of wetlands due to its stable food web. These findings contribute to a deeper understanding of the processes and functions of the underground ecosystem in the wetlands of the Songnen Plain focusing on a soil biology perspective.

**Key words:** Soil nematode; Vegetation type; Community structure; Songnen Plain; Wetland heterogeneity