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Diversity and Ecological Function of Soil Animals

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Abstract: The biomass of soil invertebrates is usually less than 10% of the total biomass of soil organisms, but they are rich in species, with various feeding behaviors and life history strategies. There are complex interactions among soil animals and between soil animals and microorganisms. The ecological function of soil animals is mainly realized by feeding effect and non-feeding effect. The diversity of soil animals in different habitats decreased with the increase of soil depth. The changes of soil temperature, soil available P, organic matter and soil moisture are the main factors affecting the geographical distribution of soil animal diversity in Changbai Mountain basalt platform. Protozoa have a large number and rapid turnover, so the contribution of protozoa' metabolic activity (i.e. feeding) to carbon and nitrogen mineralization can approach or even exceed that of bacteria. However, the metabolic process of most small and medium-sized soil animals contributes much less to the mineralization of carbon and nitrogen than that of soil microorganisms, but they can regulate the mineralization of carbon and nitrogen by feeding.

Keywords: Soil Animals; Diversity; Wetland Ecology

Introduction

Soil is the habitat with the richest biodiversity on the earth. The highly heterogeneous spatial structure and complex and diverse substrates in soil provide various habitats for biological groups with different sizes, physical activities, behaviors and characteristics. Soil animals account for about 23% of all described biodiversity in the world. One gram of soil contains tens of thousands of protozoa, dozens to hundreds of nematodes, and a large number of mites and collectables. However, considering that most soil animals have not been recorded or described, this figure may be greatly underestimated. Generally, they are divided into microfauna according to their body width (the average body width is less than 0.1 or 0.2mm, such as protozoa and nematodes), medium (mesofauna) (average body width is 0.1 or 0.2-2mm, such as jumping insects and mites), macrofauna (with average body width larger than 2mm, such as earthworms and polyphaga soil animals) and megafauna (with average body width larger than 2cm, such as mole). Among them, the first three types mainly refer to invertebrates in the soil. Soil biodiversity plays an important role in maintaining carbon and nitrogen cycle in terrestrial ecosystem.

1. Definition and geographical distribution of soil animals

Soil animals refer to animal groups that often or temporarily inhabit the soil environment, including large plant residues, and carry out certain activities in it, which have a certain impact on the soil. There are many kinds of soil animals, including protozoa, flatworms, mollusks, annelids, arthropods and vertebrates. At present, about

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1,500 protozoan species, 30,000 nematodes, 50,000 mites, 7,600 jumping insects, 4,000 earthworms, 43,768 spiders and 40,000 surface beetles have been found in the soil. There are obvious differences in the population, species and quantity of soil animal communities in different temperature zones. According to Shao Yuanhu's investigation, the order of soil animal groups in different temperature zones is Tianmu Mountain in Zhejiang (733 species) > Xishuangbanna in Yunnan (607 species) > Jianfengling in Hainan (486 species) > Changbai Mountain > alpine grassland (204 species). Basic situation of animal species, groups and dominant species under land cover in different areas of China. Among them, the mining areas where the soil is seriously polluted are mainly springtails, mites and nematodes; The mites in Xixi Park with high soil humidity account for the vast majority, while in Horqin Sandy Land in the ecotone between agriculture and animal husbandry in the north, the dominant populations are Tenebrionidae, Chironomidae larvae and Formicidae, accounting for 41.79%; The lower temperature tundra zone of Changbai Mountain is mainly composed of Acridoidea and jumping insects, while the soil animal groups in tropical rain forest and subtropical evergreen broad-leaved forest belt are significantly higher than those in tundra zone of Changbai Mountain, mainly composed of mites and springtails. In Tiantong Mountain evergreen broad-leaved forest belt, springtails and mites account for 92.17% and large soil animals Diptera account for 45.30%.

2. Diversity of soil animals

Protozoa in soil are very primitive single-celled animals, with small individuals, large numbers and abundant species. Evidence from the past 10 years shows that the diversity of soil protozoa is greatly underestimated by traditional morphological identification. According to ecological groups, it is mainly divided into four groups: flagellates, naked amoebas, shelled amoebas and ciliates. Soil protozoa mainly feed on bacteria. When available bacterial resources are exhausted, some protozoa will feed on fungi, algae and other animals. Flagellates are the most abundant and active protozoa, which mainly feed on bacteria. The number of flagellates is about 100 per gram of soil in desert soil and 100,000 per gram of soil in forest soil. Their feeding activities play a very important role in the turnover of soil nutrients. Naked amoeba is very active and abundant in farmland, grassland and forest, especially in cultivated soil. They devour ciliates, bacteria, fungi and algae. It can enter the small gap inside the soil aggregate to feed on bacteria. Compared with naked amoeba, the number of shellfish amoeba is relatively small, and it likes to inhabit the wet forest soil. Compared with the above protozoa, the number of ciliates is less, with only 10-500 ciliates per gram of litter or soil.

3. Ecological function of soil animals

3.1 Ecological functions of small soil animals (taking protozoa and nematodes as examples)

In the soil food web, protozoa and most nematodes are regarded as small soil animals because of their small size; their mobility in soil is limited, and they have little influence on the change of soil physical structure. Protozoa occupy some important nodes in the food network because of their large number, rapid turnover and their role as the main bacterial consumers. It is generally believed that their ecological function is mainly reflected in that they can regulate the microbial population by feeding on microorganisms, for example, they can inhibit pathogenic microorganisms. In addition, the carbon-nitrogen ratio of protozoa is generally larger than that of their main food-bacteria. By feeding on bacteria, they can release excess nitrogen to stimulate plant growth. Protozoa eating bacteria can also affect plant growth in other ways: protozoa around plant roots can selectively feed on specific bacterial groups, thus affecting the production of plant hormones associated with bacteria, such as indoleacetic acid. Protozoa can also be used as food source for some other animals in soil food web. In recent years, due to the development of technology, such as electron microscope and molecular technology, the above classification has undergone rapid and fundamental changes. Although their ecological importance is widely accepted, there are still many unknown ecological functions of well-classified soil protozoa.

3.2 Ecological functions of medium-sized soil animals (taking mites and jumping insects as

examples)

Different from protozoa and nematodes, mites and jumping insects are generally representative of medium-sized soil animals. They mainly feed on fungi, bacteria and plant litter debris, and a few can also prey on other small soil animals. They often have a great influence on litter breaking, and at the same time, they can regulate microbial community by feeding. For example: Jumpers can suppress plant pests by feeding on plant pathogens or parasitic pests. The decomposition of litter by oribatid mites is mainly reflected in three aspects:

(1) Eating litter directly;

(2) Breaking litter or affecting the spread of microorganisms through physical movement;

(3) The decomposition of litter is indirectly affected by feeding microorganisms. These effects are beneficial to the decomposition of organic matter and improve soil fertility.

3.3 Ecological functions of large soil animals (taking earthworms as an example)

Earthworms are a common large-scale soil animal group. Besides feeding, digestion, excretion and secretion, they can also play their ecological functions by digging holes and other non-feeding activities. The functions of earthworms in the ecosystem are mainly manifested in three aspects:

(1) Effects on key processes such as soil organic matter decomposition and nutrient cycling;

(2) Effects on soil physical and chemical properties;

(3) Interaction with plants, microorganisms and other animals. Specifically, earthworms can feed on microorganisms and nematodes by directly ingesting soil and litter, or indirectly change the community structure of microorganisms or nematodes by earthworm dung.

3.4 Ecological functions of predators (taking spiders and beetles as examples)

In recent years, more and more ecologists pay attention to the trophic cascade of predators. Predators with large size on the surface, such as spiders and surface beetles, play a role in the soil ecosystem mainly through the downward effect, that is, predators change the species composition of soil animals by inhibiting the number of soil animals in the debris food web, thus indirectly affecting ecosystem processes such as litter decomposition and nutrient cycling.

4. Research prospects

At present, there are still the following problems in the study of wetland ecosystem by soil animals:

(1) The research methods and means of soil animals need to be further improved;

(2) Lack of research on the action mechanism of soil animals in the process of material and energy transformation and soil formation in wetland ecosystem;

(3) Lack of basic research work on composition, species, quantity and distribution of wetland soil fauna;

(4) Lack of comprehensive research, which usually separates soil animals from soil microorganisms, lack of comprehensive research on soil biodiversity, and lack of research on physiological and ecological effects of interaction between soil animals and microorganisms;

(5) Lack of research on the mechanism of ecological function of soil animals.

In the future, the research on soil animals in wetland ecosystem will give priority to or should be strengthened, including the following points.

4.1 Study on the response of soil animals to global change

Soil animals are an important part of wetland ecosystem. The impacts of global changes such as climate change, rising carbon dioxide concentration, acid rain and nitrogen deposition on soil animal communities and their response mechanisms are analyzed from a global perspective.

It will become one of the hot spots in the field of soil animal research.

4.2 Study on ecological function of soil animals

Although soil animal biomass accounts for only a small part of soil organic components, it is one of the driving forces of biogeochemical cycle. In wetland ecosystem, the relationship among soil animals, microorganisms, plants and soil, the function and efficiency of soil animals in material circulation and energy flow of wetland ecosystem, and the internal ecological process and ecological function mechanism of soil animals are limited by research methods and means, so the research in this field is still few at present. In the future, we

should continue to devote ourselves to the research on the role of soil animals in the ecological process of wetland ecosystem and the ecological function mechanism of soil animals.

4.3 Application of soil animals in wetland restoration

Soil animals play an important role in improving wetland substrate structure, increasing substrate fertility, decomposing litter layer and promoting nutrient circulation. As an indispensable component of wetland ecosystem, soil animals play an important role as consumers and decomposers. If some beneficial soil animals can be introduced in wetland restoration, the function of the reconstructed ecosystem will be improved and the process of wetland restoration will be accelerated. The application research of soil animals in wetland restoration in the future is worth looking forward to.

5. Conclusion

To sum up, there are various direct or indirect relationships among different soil animals, and most studies on soil animals only focus on a certain group, which not only underestimates the role of predator diversity in ecosystem, but also ignores the regulatory role of competition or cooperation between predators in ecosystem structure and function. Therefore, it is very important to analyze the influence of soil animals on soil ecological processes and related aboveground plants at the level of food web. The task faced by soil ecologists is to integrate the new knowledge of research in recent 20 years into the new ecological framework of biodiversity and function research with new methods, so as to serve the cognitive nature and the sustainable development of human society.

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