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Some Notes on the Impact of Millipedes (Myriapoda: Diplopoda) on Fungi and Bacteria

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Abstract

Millipedes, crucial detritivores belonging to the class Diplopoda, play a pivotal role in nutrient cycling, heavily affecting fungi and bacteria and exerting a remarkable influence on litter decomposition and soil fertility. Fungi ultimately benefit from dispersal activities of the animals although they may initially experience reduction in the form of feces. The process of litter breakdown by millipedes promotes bacterial growth, contributing to elevated nitrogen content in feces and enhanced microbial activity throughout the soil system. These complex associations emphasize the ecological importance of millipedes in maintaining ecosystem functioning.

Keywords: Arthropods; Diplopods; Microbes; Mutualism; Ecology

Abbreviations: pH: Potential of Hydrogen

Introduction

The class Diplopoda, with an estimated global fauna of 80,000 yet-to-be-described species, stands as the third most diverse group of terrestrial arthropods, currently comprising of roughly 12,000 described species classified into 16 orders, over 2,900 genera and 144 families [1-4]. Their significant contribution as efficient decomposers, nutrient recyclers and biogeographic indicators is important in maintaining the overall ecological balance [5]. Moreover, these detritivores are thought to have played a significant role in early soil formation and the establishment of terrestrial nutrient cycling processes [6,7]. The relationships between millipedes and microorganisms, particularly fungi and bacteria, represent a vital yet unexplored aspect of ecological research. These interactions play very essential roles in the fundamental process of decomposition, actively shaping nutrient cycling and soil fertility within ecosystems. Despite their significance, these interactions have received minimal attention in the scientific community. Therefore, we seek to shed light on some of the ways millipedes influence the populations of fungi and bacteria through this contribution.

Fungal and Bacterial Relationship with Millipedes

Fungi and bacteria, as vital microbes, play a crucial role in nutrient cycling by employing enzymes to break down complex polysaccharides that other organisms cannot. In the case of millipedes, the existence of these microbes facilitates the availability of simple sugars, calcium and vitamins on litter and feces surfaces [8]. The presence of millipedes affects fungi, causing a population reduction in feces [9]. Moreover, millipedes' capability to interfere with the mobilization of nitrogen from litter to mycorrhizae through their feeding behavior results in an increased movement of nitrogen in the substrate [10].

The vertical movement of invertebrates, such as millipedes, through the soil system promotes the dispersion of microorganisms, subsequently leading to an increase in litter decomposition. Fungi are frequently found both on and in millipedes. The notion has been that fungi most likely to be dispersed by millipedes are those that produce numerous spores and that have spores which readily germinate. However, much of the supporting evidence for this idea comes from samples cultured on plates. Laboratory culturing plates tend to favor the growth of organisms that excel at colonization [11]. Arthropod-assisted dispersal, though, could be especially critical for poor colonizers with limited self-dispersal abilities. The degree of success in millipede dispersal of poor colonizing fungi remains uncertain but it is not challenging to imagine how millipedes could carry much smaller fungal spores or fragments of fruiting bodies and thus disperse them. Given that feces with a pH greater than 6.5 are conducive to fungal growth [8], the promotion of fungal communities in feces should be anticipated. Nevertheless, in experiments conducted on soil fauna feces, Hanlon [12] initially observed no significant difference between fungal respiration on litter particulate versus feces. However, when the feces were inoculated with different organisms after passage through the gut, bacterial respiration was shown to be low while fungal respiration was high. Interestingly, when inoculation occurred through the passage through the gut of the millipede, bacterial standing crops increased by seven times. Millipedes contribute to the propagation of microorganisms through their death and

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subsequent decomposition. In laboratory cultures where millipedes die and their exoskeletons remain on the substrate, the growth of fungi and molds on these exoskeletons have been observed (personal observation of the authors). Decaying millipede remains exhibit a higher calcium content compared to living millipedes [13]. The reason behind this increase is believed to be the colonization of decomposing remains by fungi which elevate the calcium levels. Consequently, decaying millipedes serve as valuable resources for fungal, and potentially bacterial, populations. The gut of millipedes provides a suitable environment for microbial activities supported by various factors such as optimal pH levels, peristalsis and the presence of secreted, digestible products within their digestive systems. One of the most important effects of millipede respiration and fecal production is the significant rise in the nitrogen content of the substrate primarily in the form of ammonium found in their feces. This increase in nitrogen compounds along with pH within the feces harbors greater microbial diversity compared to the parent litter [12,14]. Notably, millipede feces contain substantially higher bacterial populations compared to the original litter [15].

There is strong evidence of well-established colonies of *Pseudomonas stutzeri*, specifically within the gut of *Glomeris hexasticha* (Brandt) and possibly in the guts of certain other arthropods [16]. The conditions within the millipede's gut, characterized by high humidity and low oxygen levels, are suitable for anaerobic bacteria [17]. Nevertheless, some researchers have observed a limitation in growth due to the lack of availability of monosaccharides [18]. It is known that certain bacteria face challenges in decomposing carbon compounds. Hence, it is possible that the survival of bacterial communities within the millipede gut is limited due to the absence of other organisms capable of performing this decomposition.

Conclusions

In summary, this study highlights the impact of millipedes on microbial communities, notably fungi and bacteria, and their crucial contributions to nutrient cycling and litter decomposition. Fungi assume a crucial role in the context of millipede-facilitated nutrient cycling by participating in litter decomposition and elevating calcium levels through their presence in feces and on millipede exuviae. Additionally, the gut of millipedes provides an ideal habitat for diverse bacterial populations to thrive. However, the survival of such bacterial communities in this environment may be constrained by the lack of certain factors. Despite this limitation, the process of litter breakdown by millipedes promotes bacterial growth, contributing to elevated nitrogen content in feces and facilitating the dispersion of microorganisms throughout the soil system.

The intricate association between millipedes and microbes showcases the dynamic relationships that shape ecosystem functioning and highlight the role of these arthropods in microbial dispersal and propagation. Greater recognition of the central role diplopods play in shaping microbial dynamics will surely assist in better managing and conserving ecosystems for the benefit of the broader ecological balance.

Author Statements

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References

1. Brewer MS, Sierwald P, Bond JE. Millipede taxonomy after 250 years: classification and taxonomic practices in a mega-diverse yet understudied arthropod group. PLOS ONE. 2012; 7: e37240.
2. Shelley RM. A revised, annotated, family-level classification of the Diplopoda. Arthopoda sel. 2002; 11: 187-207.
3. Shelley RM. Taxonomy of extant Diplopoda (Millipeds) in the modern era: perspectives for future advancements and observations on the global diplopod community (Arthropoda: Diplopoda). Zootaxa. 2007; 1668: 343-62.
4. Sierwald P, Bond JE. Current status of the myriapod class Diplopoda (Millipedes): taxonomic diversity and phylogeny. Annu Rev Entomol. 2007; 52: 401-20.
5. Hopkin SP, Read HJ. The biology of millipedes. Oxford Science Publications. 1992.
6. Bonkowski M, Scheu S, Schaefer M. Interactions of earthworms (Octolasion lacteum), millipedes (Glomeris marginata) and plants (Hordelymus europaeus) in a beechwood on a basalt hill: implications for litter decomposition and soil formation [Octolasion lacteum] [Glomeris marginata]. Appl Soil Ecol. 1998; 9: 161-6.
7. Lawrence JM, Samways MJ. Litter breakdown by the Seychelles giant millipede and the conservation of soil processes on Cousine Island, Seychelles. Biol Conserv. 2003; 113: 125-32.
8. Webster J. Coprophilous fungi. Trans Br Mycol Soc. 1970; 54: 161-80.
9. Hanlon RDG, Anderson JM. Influence of microarthropod feeding activities on microflora in decomposing oak leaves. Soil Biol Bioche. 1980; 12: 255-61.
10. Anderson JM, Leonard MA, Ineson P, Huish SA. Faunal biomass: A key component of a general model of nitrogen mineralization. Soil Biol Bioche. 1985; 17: 735-7.
11. Visser S. Role of the soil invertebrates in determining the composition of soil microbial communities. In: Fitter AH, Atkinson D, Read DJ, Usher MB, editors. Ecological interactions in soil: plants, microbes and animals. Vol. 4. Oxford, Boston: Blackwell Publishing Scientific. 1985; 297-317.
12. Hanlon RDG. Some factors influencing microbial growth on soil animal faeces II. Bacterial and fungal growth on soil animal faeces. Pedobiologia. 1981; 21: 264-70.
13. Seastedt TR, Tate CM. Decomposition rates and nutrient contents of arthropod remains in forest litter. Ecology. 1981; 62: 13-9.
14. Cárcamo HA, Abe TA, Prescott CE, Holl FB, Chanway CP. Influence of millipedes on litter decomposition, N mineralization, and microbial communities on a coastal forest in British Columbia, Canada. Can J For Res. 2000; 30: 817-26.
15. Anderson JM, Bignell DE. Bacteria in the food, gut and feces of the litter feeding millipede Glomeris marginata (Villers). Soil Biol Bioche. 1980; 12: 251-4.
16. Szabo IM, Nasser EGA, Striganova BR, Rakhmo YR, Jäger K, Heydrich M. Interactions among millipedes (Diplopoda) and their intestinal bacteria. Ber Naturwiss Ver Innsb. 1992; 10: 289-96.
17. Ghilarov MS. On the interrelations between soil dwelling invertebrates and soil microorganisms. In: Doeksen J, van der Drift J, editors. Soil organisms. Amsterdam: North-Holland. 1962; 255-9.
18. Anderson JM, Ineson P. Interactions between soil arthropods and microbial populations in carbon, nitrogen, and mineral nutrient fluxes from decomposing leaf litter. In: Lee JA, McNeill S, Rorison IH, editors. Nitrogen as an ecological factor. Oxford: Blackwell Scientific Publications. 1983; 413-32.