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ORIGINAL RESEARCH PAPER

Zoology

EFFECT OF FOREST FIRE ON THE SOIL MICRO-ARTHROPOD DIVERSITY AND COLONISATION

KEY WORDS: Microarthropods, Soil physico-chemical parameters, Forest fire, Sucession

Jose Anjooriya* Molecular Biodiversity Lab, Department of Zoology & Wildlife Biology, Government Arts College, Udhagamandalam -643002, The Nilgiris, Tamilnadu, India.*Corresponding Author

Senthilkumar Narmatha Molecular Biodiversity Lab, Department of Zoology & Wildlife Biology, Government Arts College, Udhagamandalam -643002, The Nilgiris, Tamilnadu, India

Priya Malarvizhi Molecular Biodiversity Lab, Department of Zoology & Wildlife Biology, Government Arts College, Udhagamandalam -643002, The Nilgiris, Tamilnadu, India

ABSTRACT

A study was conducted to have a comprehensive understanding of the variety and soil analyses before and after a controlled fire. Sample quadrates of 100 x 100 m were purposely burned. Chemical factors such as organic carbon, phosphorus, potassium, iron, copper, and zinc were analysed in addition to soil parameters such as water-holding capacity and pH. Similarly, the design of several microarthropods such as Collembola, Mites, Hymenoptera, Coleoptera, Woodlice, and Diplopods was analysed. Before the controlled fire, moderate levels of Organic Carbon, Phosphorus, and Potassium were detected in the soil; after the fire, these levels increased by a factor of two. These findings demonstrate that the controlled fire had an effect on the soil's chemical qualities. The diversity of microarthropods was abundant before a controlled fire, but declined after the fire

Introduction

Forest fire is widely recognized for its major impact on forest ecosystems, and the altered disturbance caused by effective fire suppression may pose a threat to biodiversity. In the event of a forest fire, vegetation, soil properties, and soil diversity are adversely affected. There is increasing recognition among conservation biologists of the importance of invertebrates to the functioning of healthy ecosystems, especially since they are the largest component of terrestrial biodiversity Zhang (2011). Gerlach et al., (2013) argue that it is imperative to consider the effects that different disturbances may have on them. A school of thought holds that fire is essential, namely the slash and burn method. This method is used to shift agricultural practices and to move people from one area to another. Arthropods in fire-maintained habitats have typically been studied in two general ways: the ecological and economic consequences of fire as a pathogen control measure Brennan and Hermann (1994). By altering foliar characteristics, species composition, soil moisture, and temperature, fire can indirectly affect arthropod communities Mitchell (1990). It can sometimes increase soil pH, increase temperature and moisture fluctuations, as well as affect vegetation composition Haimi et al., (2000).

Moretti et al., (2004) found that studying the fire effect shows that fire is an important evolutionary force that makes it possible for a lot of different species to live together. Soil is the most precious nonrenewable resource on Earth, as it facilitates the growth of terrestrial flora and the direct and indirect evolution of life on the planet. Soil invertebrates (earthworms, ants, termites, collembolan, and so on) outnumber soil vertebrates in a single square metre of soil. Mites (Acari) and springtails (Collembola) are the two arthropod species that contribute considerably to decomposition, nutrient cycling, and soil formation by lowering the size of organic particles and promoting the colonisation of fungi and bacteria Vlug and Borden (1973).The role of soil invertebrates in soil processes and their interaction with abiotic factors are well understood, as are their dramatic effects on the regulation of microbial activity, soil aggregation, hydraulic properties, decomposition, the formation of soil organic matter, and plant growth, among others. Invertebrates play the following roles in sustaining soil fertility: Nutrient cycling, litter feeding and fragmentation, mineralization of nutrient elements, soil structure, soil mixing and the formation of pores and voids, formation of soil aggregates, decomposition of animal waste.

Collembola, mites, Hymenoptera, Coleoptera, woodlice, and diplopods are soil invertebrates. The majority of these organisms are collembola and mites, followed by diplopods. The colonisation of these insects and the increase in soil fertility are the initial causes of forest rejuvenation. This promotes the quickest growth of herbs and shrubs, which is then followed by continuous forest succession up to the climax community. Understanding the processes of colonisation and the preparation of the soil by these organisms requires immediate attention. The purpose of this research is to compare the physical and chemical qualities of soil before and after a controlled fire, as well as the variety of microarthropods before and after the fire.

METHODOLOGY

a. Study group

The present study focused on the following soil invertebrates.

1.Collembola are a common and ubiquitous group of arthropods found in soils across the globe. The neighbourhood is home to more than 6,500 species. Collembola are small, wingless, and possess a spring-like device on their abdomen. They use tail-like appendages that fold under the body to jump. The body is elongate or spherical, mostly tiny but occasionally greater than 1/8 inch. Some are yellowish brown or grey, but white predominates. Collembolan plays a crucial function in the degradation of plant litter and the formation of soil microstructure.

2. Soil acarians include mites that feed on decomposing plant matter and microflora (bacteria and fungi). Prostigma and Mesostigma species may also prey on micro- and mesofauna (e.g., nematodes, collembolans, and worms). Oribatids are the most dominant group of Acari. They are the most vital organisms in the breakdown process. The oribatids are the most successful soil arthropods, with over 9000 species in 172 families, the majority of which hinder the soil/litter system. Lifespans of one or two years appear to be typical for oribatids in temperate soil. They have a lifespan of three to five years in cold soil.

3.The huge insect order Hymenoptera includes sawflies, wasps, bees, and ants. Over 150,000 live species of Hymenoptera and over 2,000 extinct species have been described. Ants are eusocial insects of the family Formicidae that have colonised nearly every land mass on the planet. They are regarded as ecosystem engineers and make up a significant portion of animal biomass. Ants play a major role in below-ground processes by altering the physical and chemical environment through their influence on plants, microorganisms, and other soil organisms. They are either directly or indirectly involved in the energy and material flow throughout the environment. The construction of ant nests alters the soil's physical and chemical properties by increasing its drainage and aeration through the formation of underground galleries and by transforming organic matter and in-corporation nutrients by food storage, which also has an effect on nutrient immobilisation and humification.

4.Ground beetles are significant indicators of pollution, the success of habitat restoration efforts, and habitat fragmentation and conservation within natural systems. In agroecosystems, beetles are a suborder of coleopteran insects Koivula (2011). They inhabit nearly every ecosystem with the exception of the ocean and polar regions. They interact with the ecology in several ways and frequently consume plants and fungus for food.

5.Woodlice (also called sow bugs, pill bugs and slaters) are terrestrial isopods (class of Crustacean, sub-order Isopoda) of the family Oniscidea, which have invaded terrestrial habitats from aquatic environments Paoletti and Hassall (1999). Terrestrial isopods are accepted as the only suborder of crustaceans in which almost all species (approximately 3600) are completely free of the aquatic environment Broly et al., (2014). Woodlice are the most prominent terrestrial detritivores, ingesting and processing litter and affecting biomass and activity of litter-colonizing micro-biota in grassland and forests. Zimmer et al., (2005).

6.Diplopoda is the largest class of terrestrial Arthropod following Insecta and Arachnida. A major component of terrestrial ecosystems throughout the temperate, subtropical and tropical zones of the world, they are ecologically important as saprophagous, or consumers of dead plant material, and are important biogeographical indicators because of their profound diversity and geological age, as well as low vagility Hopkin and Read (1992).

Sampling plots and firing

The study selected sampling plots of 100 x 100 m which having dense bushy vegetation. Fire lines were created around the sampling plots and artificially fire was initiated and burned the plot. The study was repeated in six different distant plots having bushy vegetation.

Sample collection

At least four soil samples were collected from each of the plot before the firing and after 10 days from the burnt soil. Samples were collected in plastic bag of 20cm length and 15cm breath. The plastic bag is estimated to have a surface area of 300cm2 which is further expressed in square meter similar to that of quadrates. The collected soil samples were kept in the Berlese Tullgren funnel and the soil micro-arthropods were extracted using the heat avoidance behavioural method.

Identification of Microarthropods

Micro-arthropods isolated were identified using the various keys Moldenke et al.,(1991).The various micro-arthropods are identified as described above and more elaborated as Opilioacariformes, Parasitiformes, Ixodida (ticks), Holothyrida (holothyrans), Mesostigmata. Oribatida, Astigmataand Prostigmata. Collembollans were identified according to the Key of Salmon (1951).

RESULTS

Figure 1 demonstrates that the physical parameters decrease following a fire, but the chemical parameters increase or remain unchanged. It is also noted that the proportion of collembola and coleoptera substantially decreases following a fire figure 2. The proportion of mites in burnt soil appears to be excessively higher than in unfired soil. Comparing densities reveals that all microarthropod species appear to be declining, and recolonization is a gradual process Figure 3. The study demonstrates that although the nutrient content appears to grow, colonisation is a sluggish process influenced by various physical and chemical criteria.

Figure 1: Soil physico-chemical parameters before and after fire.

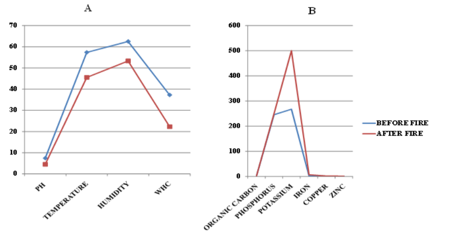


Figure 2: Proportion of microarthropod density before and after fire

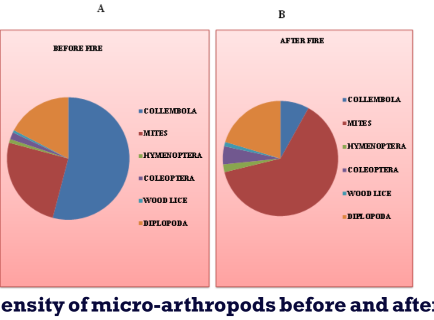
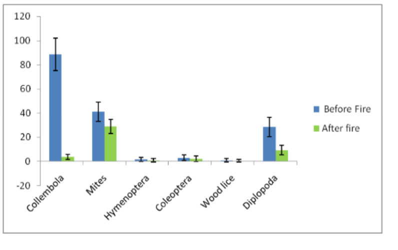


Fig 3: Density of micro-arthropods before and after fire.



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