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Isopod physiological and behavioral responses to drier conditions: An experiment with four species in the context of global warming

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ABSTRACT

In the context of global warming, an increase in soil drought is suspected by the IPCC predictions and litter breakdown activity could be affected. An experiment was conducted using microcosms (controlled conditions) and woodlice which are recognized as shredders of litter and bioindicators of global warming. The impact of relative air humidity (90 and 50% RH) on litter breakdown by woodlice was studied through the monitoring of one behavioral (distribution of individuals on microcosms), one morphological (Absolute Growth Rate) and four physiological traits (Survival rate, Relative Consumption Rate, Relative Growth Rate, Feeding rate). Four species of isopods known to have different microclimatic sensitivities (*Armadillidium vulgare*, *Porcellio scaber*, *Oniscus asellus*, *Philoscia muscorum*) were used simultaneously. Sensitivities of males and females have also been tested.

Main results showed that the seven studied parameters under the two relative humidity conditions were not affected in the same way according to the species nor genders. *A. vulgare* is the most affected species followed by *O. asellus*. The least affected species are *P. scaber* and *P. muscorum*. Their morphological and physiological differences allow to the most evolved species to be more resistant to drier conditions but in return they are no longer active, which can affect soil functionality. With global warming, it could be envisaged that woodlice spend less time foraging and more time seeking refuge to reduce the risk of mortality from desiccation stress. Modifying the feeding behavior of terrestrial isopods could slow down litter degradation with consequences on the process of organic matter recycling.

1. Introduction

Soil invertebrates play an important role in ecosystem dynamics. They contribute to provide many ecosystem services such as litter degradation that allows nutrients to return to the soil [1,2]. They live in interaction with the biotope and integrate all the variations: physical, chemical, biological, and climatic. Among them, terrestrial Isopoda, better known as woodlice, form an important component of soil macrofauna in many ecosystems [3,4]. They live mainly in litter and feed on dead organic matter. They are key regulators of ecosystem functions as organic matter degradation and nutrient recycling [4,5]. For example, Mocquard et al. [1,6] estimated that in an oak forest in western France, isopods with a mean annual biomass of 20 kg live weight ha^{-1} annually ingest 210 kg ha^{-1}. These soil organisms stimulate microbial activity by litter fragmentation [1,7]. The pieces of several centimeters, swallowed by the woodlice, are transformed into fractions of a few microns in their fecal pellets. Consequently, the surface attackable by bacteria, fungi, and other elements of the microflora is increased. So, they favor the chemical degradation activity and the mineralization process by the soil micro-organisms (bacteria, fungi, algae and actinobacteria). The microbial activity is intense into their faecal pellets where conditions (heat, moisture and fragmented organic matter) are optimal for microflora. The microbial activity is intense into it. Thus, the direct impacts of these litter transformers on the mineralization of carbon are often underestimated, such as David [8] points out. Indeed, they produce faeces in large amounts and allow a return of essential nutrients for plants [1,8]. So, woodlice are considered by many authors as a prominent component of the litter macro-transformer community (soil arthropods) in many temperate habitats [7,9,10]. They are ubiquist, easy to sample and identify [1,11]. Thus, many studies use terrestrial isopods as bioindicators [5,12] to highlight anthropogenic impacts such as urbanization [13,14], metallic soil pollution [15–18] intensive agriculture and habitat modifications [12] and more recently to study the impacts of global warming and global changes [7,9,19–23].

Moisture is a key factor in the distribution of terrestrial isopods which represent a successful example of the colonization of terrestrial

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