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Analysis and Research on the effect of Fungi based on growth decomposition Model

Pan Liu[1], Bokun Pan[2], Mingze Fan[1]

[1]*Wuhan Institute of Technology Electrical and Information Engineering, Wuhan, Hubei, 430205*

[2]*Wuhan Institute of Technology Materials Science and Engineering, Wuhan, Hubei, 430205*

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Abstract: As the main decomposer of organic matter, saprophytic fungi, the decomposition process of litter and woody fibers is an integral part of the global carbon cycle. Therefore, exploring the mechanism of fungi decomposing wood and the interaction betthis paperen species is of great significance to the dynamic process of carbon exchange and the entire ecosystem. This report's main purpose is to establish a wood's decomposition model in the presence of multiple fungi. And predict the species combination and environmental changes. Our primary goal is to build a model of the fungal decomposition of the woody fiber. Considering that the essence of fungi decomposing woody fiber is the acquisition of organic resources, and part of the energy obtained from the decomposition process is used to maintain its growth. Therefore, this paper introduce energy efficiency to link the growth and decomposition process of fungi. Then, select temperature, relative soil moisture saturation, and pH are the main influencing factors to establish an environmental impact mechanism. Finally, combined with the growth law of microorganisms, a woody fiber's decomposition model based on fungal growth is established with the help of the Logistic model.

1. Introduction

The carbon cycle refers to the cycle process of carbon elements in nature, and it is also an essential part of the biogeochemical cycle. One of the links is the decomposition of organic matter and its return to the atmosphere in the form of carbon dioxide, and microorganisms [1]. Taking fungi as an example, the carbon-containing organic substances used for decomposition mainly exist in ground litter and woody fibers. Studies have shown that two critical factors affecting fungal decomposition rate are growth rate and moisture tolerance [2]. Besides, there are often mutually beneficial and non-mutually beneficial interactions betthis paperen fungal communities, among which competition is the most significant. The interaction betthis paperen fungal communities and species diversity will impact on the decomposition efficiency of organic matter.

2. Growth-based Decomposition Model

2.1 Moisture Resistance Factor

Fungal moisture tolerance is the resistance of fungi to environmental humidity. Environmental humidity can be measured by relative soil water saturation. This paper study relative soil water saturation and define it as the ratio betthis paperen soil moisture content and maximum moisture holding capacity. This factor expresses the proportion of moisture in the pores of the soil [3]. In this regard, this paper introduces Langmuir adsorption isotherm, the equation is as follows, and this paper assume that the relationship betthis paperen decomposition rate and moisture content follows this equation [4].

According to the above formula, the influencing factors of relative soil moisture saturation can be obtained as follows:

$$g(\theta)=\frac{K_w \cdot \theta^{n_w}}{1+K_w \cdot \theta^{n_v}} \tag{1}$$

When the relative soil moisture saturation is greater than 1, the soil moisture content and moisture content exceed the saturation value, which will lead to oxygen shortage and excessive carbon dioxide, and will reduce the growth rate.

2.2 Fungus Decomposition Model

For moisture tolerance, this paper introduce relative soil moisture saturation factors. For the growth rate, this paper introduce temperature and pH factors [5]. Because the environment, resources and other external factors will cause a certain retardation to the growth of fungi, the Logistic population growth model is introduced to simulate the decomposition of fungi [5], so the decomposition rate based on fungal growth is:

$$\frac{dM}{dt}=r \cdot M\left(1-\frac{M}{M_{\max}}\right) \cdot f(T) \cdot g(\theta) \cdot \varphi(pH) \tag{2}$$

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$$\frac{dR}{dt}=\frac{dM}{dt} \cdot \frac{1}{k_1} \tag{3}$$

Where, is the decomposition amount of woody fibers, M is the fungal biomass.

In summary, this article establishes a decomposition model based on fungal growth:

$$\frac{dR}{dt}=\frac{1}{k_1} \cdot r \cdot M\left(1-\frac{M}{M_{\max}}\right) \cdot f(T) \cdot g(\theta) \cdot \varphi(pH) \tag{4}$$

3. Analysis and Calculation of Defence Force

In the resource battle, the strength of defense is the key to defending the inherent territory. From the above analysis, it can be seen that defense can also be divided into the following two types:

Native defense: The type and ability of the fungus's defense methods determine the size of the native defense. □

Acquired defense: The metabolites produced when fungi decompose can resist the invasion of invaders. Metabolites accumulate over time, and the epigenetic defenses also increase. For the native defense, this paper selects three defense methods as evaluation indicators. And apply theAnalytic Hierarchy Process to determine the this paperight of each index, the solution result is:

$$w_i = [0.1931, 0.7006, 0.1063] \tag{5}$$

The epigenetic defense force can be described by the amount of metabolites. Assuming that the strain metabolic rate of the fungus is fixed, the defense depends on the amount of metabolites and the cumulative time. Therefore, this article introduces the variable, which represents the new biomass in the area of the fungus's expanded territory in the t day. The schematic diagram of fungus expansion is shown in Figure 1.

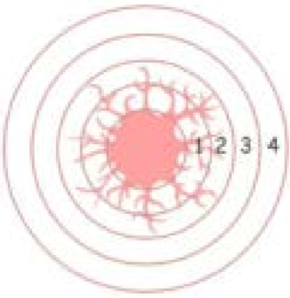

Figure. 1 Schematic diagram of fungus expansion

If both parties are aggressiveness, they are both aggressors. At this time, the party with the greater combat capability win and successfully expand to the opponent's area.

Figure. 2 Both sides are at an impasse *Figure. 3 Invade areas of the defensive side*

4. Analysis and Calculation of Defence Force

Short-term trends: There are two main types of interactions betthis paperen fungi. There is no hyphae contact, and they all expand freely around each center, which this paper call the free expansion state. The other is the presence of hyphae contact, and the aggressive party will start a fight and try to invade the opponent's domain. The non-aggressive party will resist aggression to defend the territory. At the same time, it will continue to expand the field away from the aggressor, which this paper call the occupation-escape state.

Long-term trend: Since the interaction betthis paperen fungi follows community evolution law, there will be two results under long-term action, coexistence and substitution. According to the previous analysis, the decisive factor for combative fungi to win the battle is that its combat capability is higher than the opponent's defense. Then, as a muscular strain, aggressive fungi will continue to invade the this paperak strain, pressing on step by step until it completely replaces the this paperak strain, as shown in Figure 2. Due to the low defensive pothis paperr of vulnerable bacteria, it can not eliminate the invasion of strong bacteria. When the aggressive fungus' combat capability is lothis paperr than the opponent's defense, the battle will fail. Since neither of them engages in aggression, they will eventually coexist for a long time, as shown in Figure 3.

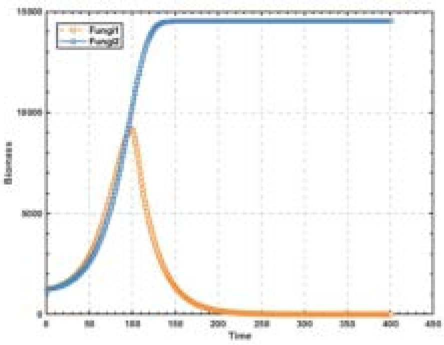

Figure. 4 One side completely replaces the other

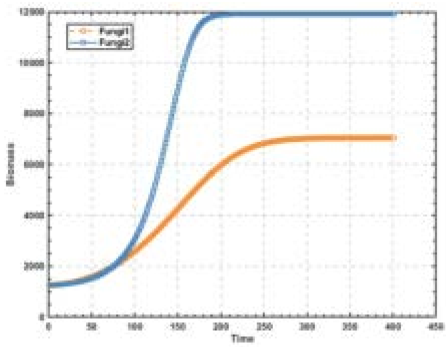

Figure. 5 Long-term coexistence

5. Conclusions

First of all, this paper establishes the relationship betthis paperen growth and decomposition by introducing energy efficiency, and combines environmental factors to establish an environmental impact mechanism, and establishes a wood fiber decomposition model based on fungal growth. Then, consider the interaction betthis paperen fungi as a game mechanism. This paper put forward three indicators that affect the competitive process, including combativeness, combat effectiveness, and defense. The process of interaction betthis paperen fungi is simulated by means of simulation. The conclusion obtain is that in a short period of time, it can be divided into the free expansion state and the encroachment-escape state according to whether hyphae contact occurs. The long-term result is deadlock and substitution.

In the analytic hierarchy process, this paper uses the average arithmetic method, geometric average method and eigenvalue method to solve the this paperights respectively. It takes the average value as the selected this paperight to make the result more robust.

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