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Effects of Locusts on Ecological Balances

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Abstract: In recent years, locust plagues have disrupted ecological balance, threatened agricultural production and food security, and have become a global concern. Understanding the multifaceted impacts of locusts and devising effective control strategies is crucial for maintaining ecological stability. This paper delves into the profound impacts of locusts on ecosystems, covering their effects on crops, animals and soil microorganisms. It also explores various strategies to mitigate these impacts, including biological, chemical and agricultural control methods. Research findings show that locusts not only cause significant damage to crops, leading to reduced yields and the spread of diseases, but also disrupt the food chain and soil nutrient cycling. The use of natural enemies such as starlings, parasitic wasps, and fungi for biological control provides an environmentally friendly solution. Chemical control can be effective in the short - term but requires careful selection and application to minimize environmental harm. Agricultural measures, such as field sanitation and crop rotation, also play a vital role. Overall, this study contributes to a comprehensive understanding of the interactions between locusts and ecosystems. By providing a set of effective control strategies, it contributes to maintaining ecological balance, safeguarding agricultural production and ensuring food security for communities vulnerable to locust plagues.

Keywords: Ecological balance, impact, solution.

1. Introduction

In the vast tapestry of the global ecosystem, locusts have emerged as a significant and often menacing force. In recent years, the frequency of locust disasters has escalated alarmingly. For instance, in 2020, East Africa faced one of the most severe locust invasions in decades [1]. Swarms of desert locusts, with their voracious appetites, swept across countries such as Kenya, Ethiopia, and Somalia. These swarms could consume as much food in a day as an entire city's population, leading to devastating consequences for local agriculture.

Locusts are not just a regional concern. In Asia, countries like Pakistan and India have also witnessed major locust outbreaks. In 2019-2020, Pakistan was hit hard, with locusts attacking vast areas of crops, threatening the livelihoods of millions of farmers [2]. These insects have a unique ability to form massive swarms, which can travel long distances, covering up to 150 kilometers in a day [3]. Their sudden appearance and rapid spread make them a formidable challenge to control.

The impact of locusts extends far beyond the destruction of crops. Their presence can disrupt the entire food chain. When locusts devour large amounts of vegetation, it affects the herbivores that rely on those plants for food. This, in turn, can have a cascading effect on predators that feed on the

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herbivores. Additionally, the damage to agricultural land can lead to soil degradation as the protective cover of plants is removed, increasing the risk of erosion and further disrupting the ecological balance.

Research on locusts has been extensive both domestically and internationally. In the international arena, organizations like the Food and Agriculture Organization (FAO) of the United Nations have been at the forefront of studying locust behavior, population dynamics, and control methods. Their research has focused on understanding the environmental factors that trigger locust outbreaks, such as rainfall patterns and temperature changes [1]. Scientists have also been developing innovative pest control strategies, including the use of biopesticides and precision agriculture techniques to target locust swarms more effectively.

Domestically, in countries affected by locusts, local research institutions have been conducting studies tailored to their specific geographical and ecological conditions. For example, in China, research has been carried out on the ecological characteristics of locusts in different regions, aiming to develop more sustainable control measures. Chinese scientists have explored the relationship between locust populations and the health of grassland ecosystems, as locusts are a common problem in grassland areas [4]. These studies have provided valuable insights into the local mechanisms of locust outbreaks and potential ways to mitigate their impact. The motivation for this study is to develop more effective and sustainable solutions to protect agricultural production and global ecosystems by delving deeper into this issue. Secondly, although current research is extensive, there is still a gap in fully understanding the complex interactions between locusts and various components of ecosystems.

2. Multiple impacts of locusts on ecosystems

Locusts have a significant impact on the ecological balance, and the locust plague from 2019 to 2022 has had a great impact on the world. The plague in Kenya is the worst in 70 years. In Ethiopia and Somalia, locusts reproduce rapidly and form large groups. For example, in Kenya, there's a group that's 40 kilometers long and 60 kilometers wide, which can have 150 million locusts. These bee colonies started from their breeding grounds in Somalia and spread to many countries such as Ethiopia, Kenya, Somalia, Uganda, South Sudan, Djibouti, Eritrea, Tanzania, Congo, which are dry deserts. Desert locusts reproduce quickly and fly far, possessing two natural abilities: solitary (solitaria) or grouped (gregaria). When there are fewer locusts, the solitary Desert locusts usually stay in the dry deserts of Africa, the Near East, and Southwest Asia, where annual rainfall is less than 200 millimeters. This dry area is about 15 million square kilometers and includes around 30 countries. However, when there are a lot of locusts, about 31 million square kilometers and over 60 countries can be in danger from the Desert locust swarms, which affects about 20% of the world's land. Because of all these things, the Desert locust is thought to be the most dangerous pest that moves around in the world [5]. In general, locusts consume crops in a large number of ecological aspects and seriously damage agricultural ecosystems.

Locusts mainly have a great impact on crops, organisms, and microorganisms. Locusts are very harmful to crops, mainly reflected in the following aspects. Once the ecological balance is broken, it will have a negative impact on the growing environment of crops, indirectly affecting the growth and yield of crops [6]. First, locusts eat a lot and can quickly eat up the leaves of the crop. Taking wheat, corn, rice and other food crops as an example, locusts will chew the leaves into nicks, or even eat the whole leaf, seriously affecting the photosynthesis of crops, so that crops cannot produce enough organic matter to maintain growth and development, resulting in slow growth, short, thin crops [7]. Second, when locusts are hungry, they will bite the stalk of the crop, preventing the transport of water and nutrients, so that the crop will die due to lack of nutrition and water. For example, when the stalks of cotton, soybeans and other crops are bitten by locusts, the plants cannot grow normally, which affects the yield [7]. Third, locusts will eat flowers and fruits of crops, resulting in flowers do not

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pollen penetration properly, fruit poor development or fall off. For example, locusts on farms can cause damage to the flowers and fruits of fruit trees, reducing the yield and quality of fruit [7]. Fourth, locusts may carry pathogens such as germs and viruses during the feeding process, and when they transfer between different crops, they will spread these pathogens to healthy crops, causing various diseases. For example, the virus disease spread by locusts will make crops appear yellow leaves, curled, deformed and other symptoms, seriously affecting the growth and yield of crops [7]. Last, the mass breeding and outbreak of locusts will cause serious damage to the ecosystem. They will consume plant resources excessively, leading to the reduction or even extinction of some plant populations, which will affect the survival of other organisms that feed on these plants and destroy the ecological balance.

Locusts also have a major impact on all types of animals. Locusts, being extremely voracious plant-eaters, have a significant impact on various organisms. They compete with other herbivores for food, like in grasslands where sheep and cows struggle to find enough grass because locusts eat all of them, that behavior will cause animals to lose weight, get sick more easily, and some may even starve to death thus reducing their population in the area [8]. For carnivores, both of these things affect them. Smaller animals, such as certain birds, lizards and spiders, benefit from large numbers of locusts as a food source, and their numbers may temporarily increase. However, if locusts disrupt the plant-based food chain too severely, large carnivores will face problems. For instance, with fewer herbivores available to hunt due to locust-induced plant shortages, they have to compete with each other, and their numbers might decline [8]. Locusts also affect insects and small invertebrates. They can displace other insects from their habitats by consuming the plants they rely on, and damage flowers, which troubles pollinators like bees and butterflies, making it difficult for plants to reproduce and for these pollinators to survive. Additionally, locusts sometimes prey on small invertebrates, reducing their numbers [8].

Moreover, the activities of locusts might impact soil microorganisms. By consuming large amounts of plants, less plant litter and root exudates are entering the soil, altering nutrient cycling. With less plant material to decompose, bacteria and fungi, which are crucial for making the soil fertile, can't function as effectively, ultimately messing up the entire ecosystem as the soil becomes less suitable for plant growth. When locusts arrive in huge swarms, they cause a major disruption to the microorganisms living in the soil. These locusts are incredibly hungry and devour plants at an astonishing rate. Imagine crops or natural vegetation being stripped bare in a short time. This means that the normal cycle of plant matter returning to the soil is severely interrupted. Normally, as plants complete their life cycle and die, their leaves, stems, and other parts fall to the ground. Also, plant roots exude substances into the soil. These bits of decaying plant material and root exudates serve as a vital food source for the bacteria and fungi that live in the soil. Bacteria, which are tiny single-celled organisms, and fungi, with their thread-like structures, rely on this organic matter to survive and reproduce. But with locusts consuming plants so voraciously, there's a drastic reduction in the amount of this plant-derived food available for these microorganisms. The bacteria and fungi in the soil play a crucial role in the ecosystem. They are nature's recyclers. The bacteria break down complex organic compounds in the dead plant material into simpler substances through a process called decomposition. Fungi, with their hyphae that spread through the soil, help in further breaking down the tough parts of plants. Together, they transform the dead plant matter into nutrients like nitrogen, phosphorus, and potassium. These nutrients are essential for new plants to grow. They are absorbed by plant roots and used for various functions such as building plant cells, making leaves green through photosynthesis, and producing flowers and fruits. However, when locusts disrupt this process by reducing the amount of plant material available for decomposition, the bacteria, and fungi struggle. Their population growth slows down because they don't have enough food. They can't break down as much plant matter, so fewer nutrients are released into the soil. As a result, the soil becomes less fertile. With less fertile

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soil, new plants find it harder to grow. They may not have enough nutrients to develop strong roots, healthy leaves, or produce a good yield of fruits or seeds. This has a ripple effect throughout the ecosystem. Fewer healthy plants mean less food and shelter for herbivores, which in turn affects the carnivores that prey on them. Birds that rely on plants for nesting materials or insects that feed on plants are also impacted. In short, locusts can completely throw off the delicate balance of the soil's microorganisms. This disruption not only affects the immediate soil environment but has far-reaching consequences for the entire ecosystem, changing the way plants grow, and animals interact, and ultimately altering the overall structure and function of the environment. In economic terms, it has caused great hardship to the lives of local people, with millions of people facing food insecurity and falling into hunger and poverty [9].

3. Strategies for mitigating the impact of locusts

To control the impact of locusts on all types of animals, crops, and microorganisms, several methods are proposed in this paper. The first is biological control, which is a natural and eco-friendly way of dealing with locust populations, controlling their numbers mainly by introducing natural enemies. Starlings are good at catching locusts due to their keen eyes and excellent flight ability. It is recommended that starlings be brought to areas where locusts are causing problems by building special birdhouses. These should be 2-3 meters off the ground, in an open area near a field with a good-sized entrance. Hoopoes also eat locusts and prefer areas with short grass and open spaces. Planting trees like oak or elm, which hoopoes like to nest in, can make the area more appealing to them. In addition to birds, some insects and fungi also help. In the case of parasitic wasps, for example, female wasps seek out locusts and lay their eggs inside. When the eggs hatch, the baby wasps eat the inside parts of the locusts and kill them. These helpful wasps can be raised in special insect-breeding places. When locust populations begin to increase, releasing them into the field can achieve locust population control. The fungus is also important, when the spores of this fungus come in contact with the locust's shell, the spores begin to grow and enter the locust's body eventually killing them. By making spores of this fungus in the lab and using a small handheld sprayer to place them in locust-infested areas [10].

Secondly, chemical control of locust populations using insecticides can work well in the short term, but the choice of insecticides needs to be locust-specific so that they do not cause too much harm to other animals and useful insects. Some pesticides have special ingredients that are bad for locusts but not as bad for birds, mammals, and helpful bugs. It is important to read and follow the directions on pesticide labels and to spray insecticides at the correct time. Locusts are weakest in the early waking stage and their shells are still soft enough not to move much. If the locusts are in a small area, they can be spot sprayed instead of spraying everywhere. This uses less insecticide and is better for the environment. It is also important to note that chemicals can build up in the soil and water, which can harm the beneficial elements in the soil that help make nutrients and keep the soil good, in addition to potentially contaminating the water supply and affecting the animals in the water, causing enrichment of the food chain [11].

Finally, agricultural measures are also important, and there are many things' farmers can do to control locusts through agricultural measures. Keeping the fields clean is one of the easiest and best ways. Immediately after harvesting you should compost or properly burn any leftover oranges, which eliminates places where locusts can hide and lay their eggs. Crop rotation is another great tool, for example, if a field is planted with wheat this time (which locusts really like), it can be planted with beans next time, which locusts don't like much and which breaks their food cycle. Early detection of locusts is the key to preventing a small problem from becoming a big one. Farmers should check their fields regularly, at least weekly when locusts are likely to be present. They should look for signs such as chewed leaves, locust eggs, or the locusts themselves, and use a little insecticide promptly to

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control the problem. In some places, farmers get together to form groups or cooperatives to share information about locust sightings. In this way, they can get information and act on it more quickly, calling in professional pest controllers if necessary. Locusts have a wide and complex impact on the ecological balance of crops, animals, and microorganisms, to some extent providing resources for certain organisms and causing serious damage to ecosystems during outbreaks. In the future, it is necessary to strengthen the monitoring of locust population dynamics and conduct in-depth research on their interactions with various components of the ecosystem. The combination of biological, physical, chemical, and other prevention and control measures is used to control locust populations within a reasonable range, maintain the stability and balance of ecosystems, and ensure the normal functioning of agricultural production, biodiversity conservation, and ecosystem services [12,13].

4. Conclusion

In conclusion, locusts, as a crucial element within the ecosystem, wield a wide - ranging impact on ecological balance, specifically exerting significant influence over crops, animals, and soil microorganisms. As analyzed, locust plagues, like the one from 2019 - 2022, cause extensive damage to agricultural production, disrupt the food chain, and imbalance soil nutrient cycling. To counter these impacts, biological control, such as introducing natural enemies like starlings, hoopoes, parasitic wasps, and fungi, chemical control with locust - specific insecticides, and agricultural measures like field cleaning, crop rotation, and early detection, have been proposed. This research helps to understand the complex relationship between locusts and the ecosystem, providing valuable strategies for maintaining ecological stability. However, this study has limitations; for example, the effectiveness of biological control may be affected by environmental factors, and chemical control may lead to long - term pollution. In the future, more in - depth research on locust behavior and ecological interactions is needed. Strengthening international cooperation in locust monitoring and control will also be crucial to better maintain the ecological balance and agricultural sustainability.

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