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(Review Article)

The Effect of Environmental Pollutants on The Activity of Honeybee

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Abstract

This study aims to examine the primary environmental pollutants that affect the behavior and activity of honey bees, considering their ecological and economic importance. Through a comprehensive analysis of existing scholarly works, it has become apparent that a multitude of environmental contaminants are extensively dispersed within our immediate surroundings, exerting a substantial impact on the colonies of bees. The loss and weakening of bee populations can be attributed to a variety of contaminants, including electromagnetic radiation, plant toxins, industrial waste, and emissions, as well as antibiotic and pesticide pollution. Consequently, the consequence ofthis is the decline in numerous bee species, commonly referred to as Colony Collapse Disorder (CCD), which has emerged as a highly significant ecological concern during the last twenty years. In conclusion, this phenomenon leads to a decline in the yield of various essential crops, as honey bees serve as crucial pollinators within the ecosystem.

Keywords: Bougainvillea cultivars, IBA, rooting.
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Introduction

The honeybee, *Apis mellifera L*., is a social insect that has captured human interest since ancient times. Its economic importance is not limited to the production of honey, royal jelly, beeswax, and other products. It extends to pollination, a crucial process for the formation of fruits and grains in fruit trees, field crops, and wild plants. This pollination process results in an increase in agricultural production per unit area of up to 37%, and sometimes even more, reaching up to 80%, as in the case of cucurbits. Honeybees also contribute significantly to improving the quality of fruits and seeds due to their pollination [1]. Honeybees are responsible for pollinating nearly 90 crops in the United States, valued at $14.6 billion annually, and a similar value is estimated in Canada, according to the Canadian Agriculture and Food Organization [2]. Due to their significant role in pollinating plants, honeybees visit various components of the ecosystem, including water, air, and plants, to obtain their nutrition from nectar and pollen, which they transport into the hive. Consequently, honeybees and their products play a significant role in detecting environmental pollution from heavy metals, pesticides, and radioactive materials [3]. In recent years, there has been a clear increase in interest in breeding and caring for honeybee colonies and diversifying their products. This is due to their importance. in various fields, including agriculture, medicine, cosmetics, and nutrition [4]. Additionally, beekeeping has played a clear role in providing employment opportunities and satisfying the desires of hobbyists in this field [5]. The annual honey production varies from year to year due to various factors, including climate conditions, diseases, parasites affecting honeybees, the use of chemical pesticides and antibiotics to control agricultural pests, especially those that affect beehives, such as wax moths, Varroa, mites, small hive beetles, wax moths, and diseases like European and American foulbrood and Nosema [6]. Honeybee, *Apis. mellifera L*., has shown sensitivity to many common insecticides, and low levels of pesticides can act as stressors on the colonies of this species. Several studies have suggested that the phenomenon of honeybee loss and their failure to return to their hives or their death can be attributed to various factors, with insecticides being one of the most significant factors [7]. In recent years, a global phenomenon known as colony collapse disorder (CCD) has emerged, becoming a highly concerning environmental issue. CCD ultimately leads to losses in the production of numerous strategic crops. Beekeepers have experienced losses ranging from 30% to 90% of their hives in recent years, and the exact main and direct cause of this phenomenon has not been determined. It has been attributed to multiple reasons, which exert environmental pressures that negatively impact the honeybee's immune system and make them more susceptible to diseases [8]. It has become evident that the decline of honeybee populations poses a serious threat both locally and globally. Given the limited studies in the environmental field and their effects on honeybee populations and their products, this study aims to review sources on environmental pollutants and their impact on honeybee colonies and their products. Environmental Pollution: Environmental pollution is considered one of the most significant problems facing humanity throughout the third millennium. This is a result of the increasing human activity in all areas of life and the continuous competition for resources among various living organisms, with humans at the forefront. The environment has historically been characterized by a delicate and constant balance among its different components. These elements interact within what is called the ecosystem, and each component of the environment plays its role in maintaining this ecosystem intact, continuous, and effective [9]. Honeybees are economically important insects. However, the initial perception of honeybee products as healthy, natural, and clean is not entirely accurate. Honeybees suffer from various diseases and are attacked by several predators. Moreover, their products are also susceptible to contamination from various sources. The primary source of contamination is polluted water. Additionally,

air, soil, and plants are additional sources of this pollution. Honeybees transport pollutants into their hives and, consequently, into their products, resulting in significant losses. These pollutants include heavy metals such as cadmium, lead, mercury, radioactive isotopes, organic pollutants, and pesticides. Another source is the use of antibiotics and chemicals by beekeepers, such as tetracycline and various chemical substances, to combat wax moths [10]. Despite the significant services modern technology has provided to humans and the rapid advancement in all fields, especially the use of chemical pesticides, which has contributed to increasing agricultural crop productivity and reducing or eliminating diseases transmitted by insects to humans and animals, these chemical compounds have the ability to pollute the air, water, soil, and food. Their presence leads to changes in the qualitative characteristics of different parts of the biosphere, resulting in harmful effects on humans, animals, and plants. Many international organizations, such as the World Health Organization (WHO), the Food and Agriculture Organization (FAO), and the U.S. Environmental Protection Agency (EPA), have warned about the health risks associated with the use of chemical pesticides since 1950, and these warnings continue [11].

1. Electromagnetic Radiation Pollution:

The increasing reliance on telecommunications for the exchange of various essential information has become a necessity for humanity. However, from a biological perspective, this reliance has resulted in many side effects and changes in the lifestyle of other living organisms. These profound changes disrupt the natural balance in the ecosystem. One of the significant problems affecting bee populations is the use of mobile phones, wireless devices, and satellites. Recent studies have revealed that cell phone towers and all types of communication systems that use directed wave systems have a significant impact on the behavior and biology of honeybee populations [12] Bees are exposed to the influence of electromagnetic waves resulting from electrical power transmission towers, mobile phone towers, and the Internet, as these emitted waves affect the behavior of honey bee colonies, and thus this effect will lead to pressure on the genes specific for this behavior over time [13], according to El- Halabi and others [14] said that honey bee workers navigate to the locations of their food using the sun’s rays as a compass, but on cloudy days they may rely on ultraviolet rays, which may be affected by the radiation emanating from communications towers spread in areas where bee colonies are located, as indicated by Sharmal and Kumer [15] through his observations that placing a mobile phone inside the beehives for a month and using it for 50 minutes a day led to the eggs not hatching and turning into the larval stage by 80%.Such environmental pollutants have an impact on honey bee colonies, and honey bees can also be used to study the extent of environmental pollution with electronic pollution. In a study conducted in India, it showed that mobile phones affected the queen’s laying of eggs and bee hives and led to the colonies being severely weakened. Some researchers theorize that radiation from communication and broadcast devices interferes with the honeybee's navigation systems, preventing worker bees from finding their way back to their hives. In 2006, researchers at Lando University conducted a pioneering study on the effects of radio frequencies (RF) on honeybees. They found that RF frequencies reduced the bees' ability to return to their hives and noticed a slight decrease in honey weight within the hives [16].

2. Heavy Metals:

Metals are materials that possess high electrical conductivity and luster properties. They are naturally present in nature, and their structures and distribution in the atmosphere depend on environmental factors, especially physical and chemical factors. Heavy metals are metallic elements with higher atomic weight and density greater than five times that of water. Regarding the toxicity of heavy elements, it is intertwined and depends on the dose absorption, exposure method, and exposure duration. Heavy elements such as cobalt (Co), chromium (Cr), iron (Fe),

manganese (Mn), copper (Cu), nickel (Ni), magnesium (Mg), selenium (Se), molybdenum (Mo), and zinc (Zn) are essential nutrients necessary to maintain vital physiological functions. However, exposure to certain heavy metals may cause harm to living organisms. Some heavy metals, like arsenic (As), lead (Pb), chromium (Cr), cadmium (Cd), and antimony (Sb), can potentially cause harm to living organisms. Their presence at certain threshold levels can lead to damage by altering the biological mechanisms of living organisms. They are considered potential toxins as they accumulate in the environment, causing disturbances in ecosystems and threatening life. These metals replace binding sites in proteins or deteriorate oxidation processes, resulting in cellular damage and poisoning. The presence of heavy elements can occur naturally in the environment due to atmospheric and volcanic factors or through human industrial, agricultural, and pharmaceutical activities. Environmental pollution is more severe in areas containing mining, metallurgical, and smelting facilities, among other industrial operations. The top ten most toxic and polluting metals are mercury (Hg), lead (Pb), and cadmium (Cd), according to the World Health Organization ranking [17]. Analysis of honey bee tissue and pollen was used to monitor the environment surrounding the bees and determine the distribution of dangerous chemical pollutants, including heavy metals, pesticides, and environmental pollutants, in addition to its impact on honey production and honey bee colonies [18].Recently, attention has been paid to the problem of analyzing and estimating the toxic effect of heavy metals in honey, which is considered, on the one hand, an important natural product because it contains both physical and chemical components, and on the other hand, a complex viscous chemical. In addition to estimating the toxicity of heavy metals in honey, adequate analytical methods must be found. To monitor it, bees and their products were proposed as a vital indicator of environmental pollution because they cover large areas [19].

3 **Toxic plants**:

Poisonous plants are a problem for honey bees in special circumstances that are generally confined to limited areas, so poisoning honey bees with plants is less of a problem as a result of pesticide poisoning. Nevertheless, toxic plants can cause serious losses in bee populations in certain situations and limited areas [02]. Some plants can produce toxic chemicals for honeybees, which can be found in nectar, pollen, honeydew, or royal jelly. Certain plants, like ziziphus, which is considered a crucial source of nectar, have been found to be toxic to honeybees under specific stressful conditions. For instance, when there is a lack of plant cover in harsh environmental conditions such as drought, extreme temperatures, and limited alternative nectar sources, bees may be forced to forage on toxic plants since they become their only available food source. Moreover, in humid conditions, the toxicity of available food sources often decreases [21]. Plants produce toxins as secondary metabolites in their metabolic processes. These metabolites may serve as waste products or have defensive functions against other plants, insects, or herbivorous mammals. Plants benefit from pollination by bees to initiate the fertilization process, which culminates in seed production. Insects, including bees, have an ongoing ability to develop resistance to chemicals, whether human-made pesticides or those produced by plants. Some plants reduce nectar production by producing toxins that inhibit nectar production. Over time, bees may become incompatible with foraging on these plants [20].

4.Industrial Pollution:

In the past, the use of filters in factory chimneys was found to lead to the deposition of significant amounts of fine particles produced by factories on nearby plants and in the soil in many areas surrounding these factories [23]. Attention to environmental pollution avoidance has led to the implementation of technical solutions aimed at reducing the emission of chemical vapors from factories. However, there is still doubt that fluorine from metal plant emissions may

poison bees at levels present on nearby plant surfaces. Some plants absorb these chemicals from the soil and can cause bee poisoning when they collect nectar and pollen from these plants [24]. Due to the spread of air pollutants to many agricultural areas where bee populations are present, the effect of these pollutants on bees has been studied. Bees placed inside small cells continuously for four days were exposed to different concentrations of ozone, a component of factory emissions. The study found that ozone had a slight effect on bees at 0.25 parts per million (ppm) and disturbed bees at 0.5 ppm. However, its effect disappeared without causing harm at concentrations of 1 to 5 ppm. Bees exposed to air that had passed through ozone filters showed no signs of distress [20].

5. Antibiotic Pollution:

Antibiotics have been used in beekeeping for over 70 years, including substances like sodium sulfathiazole, streptomycin, erythromycin, lincomycin, monensin, streptomycin, enrofloxacin, and more. These antibiotics have been used by beekeepers to prevent and treat European and American foulbrood diseases in Argentina, Canada, and the United States [25]. Oxytetracycline has been used to treat American and European foulbrood diseases in bees, with the tetracycline group being the most commonly used in the veterinary field to treat various veterinary diseases and promote growth [26]. Residues of antibiotics like streptomycin were detected in four out of 248 honey samples in Belgium, while two out of 72 samples contained tetracycline residues. In India, 14% of tested honey samples were found to be contaminated with tetracycline and chloramphenicol residues [26].

6. Agricultural Pesticides:

Studyingthe impact of pesticides on honeybee populations is crucial because agriculture involves the use of chemicals to combat various agricultural pests. At the same time, agriculture relies on honeybees to pollinate crops and produce large quantities of fruits and seeds. Therefore, it is essential to adopt pesticide-use practices for pest control while ensuring the survival of beneficial insects like honeybees [27]. Honeybees are highly sensitive to many widely used pesticides in agricultural pest control programs. This sensitivity places them at constant and significant risk of chemical poisoning, which can compound other issues affecting bees, such as parasites and diseases [02]. The United States of America is among the leading countries relying on honeybees as pollinators for various crops. However, hive populations have decreased by 45% over the past 60 years, from 1966 to 1970, due to the pressure of using organochlorine, carbamate, organophosphate, and pyrethroid pesticides. This maintained losses at this percentage without increasing them, as the non-spraying of pesticides during crop flowering contributed. In the years that followed, losses in honeybee hives increased due to diseases affecting the hives, such as varroa, mites and wax moths, and a shift in the approach to protecting economic crops from pests by introducing genetically engineered crops and using new classes of pesticides, namely neonicotinoids and phenylpyrazoles, which are systemic. The most toxic pesticides to honeybees can be categorized into five groups: chlorinated pesticides, organophosphorus pesticides, carbamate pesticides, pyrethroid pesticides, and neonicotinoid pesticides. Among these groups, neonicotinoids are considered the most dangerous and toxic to honeybee populations [28]. Neonicotinoid pesticides were first introduced in the 1990s and have become the most widely used pesticides in various countries worldwide. Due to their incorporation into seed coatings and their capacity to dissolve in water and be absorbed by plant roots, which enable these systemic pesticides to move within the plants and reach the leaves, their widespread use increased in the early 21st century. This systemic protection against insects that feed on the plants has made neonicotinoids an extremely common choice for pest control. In the United States, for example, neonicotinoid pesticides were used on corn crops at rates ranging from 79% to 100% of

total pesticides used in 2011 [29]. Crops consume only about 5% of the administered dose of these pesticides, while the remaining percentage spreads in the environment. Reports in recent years from several European countries and the United States have indicated a growing decline in honeybee populations. Extensive research has identified various factors contributing to this decline, including viral diseases, varroa mites, mobile phone networks, nutritional stress, environmental conditions, heavy metal pollution, and pesticides. Pesticides, in particular, have been implicated in causing 80% of honeybee colony losses in Spain, with pesticide-contaminated pollen being the main source of protein for bees across different seasons [30]. Foraging honeybee workers are exposed to pesticides in flowering fields treated with chemicals. This exposure leads to pesticide residues adhering to their bodies. When contaminated pollen is brought back to the hive by foragers, it can negatively affect the colony. It can result in the death of young forager bees, reduce their production of royal jelly, and impact the queen's behavior. This can eventually end up in colony collapse, making it difficult to determine the specific loss of food production or monetary value when honeybees are poisoned by pesticides. Dead forager bees accumulating in front of the hive entrance are a clear indicator of pesticide poisoning [31]. According to Francisco et al. [32], the main contaminants in honey are residues of pyrethroid pesticides used by beekeepers inside the hives to treat varroa mites; these residues account for 81.8% of the total; therefore, measuring pesticide residues is important to measuring their effects on beekeepers' livelihoods and the degree to which they influence consumers due to the pesticide impact on honey products.

7. The Physiological and Behavioral Impact of Pesticides on Bees

Honeybees' critical foraging and food-searching behaviors can be severely disrupted by exposure to bees are less resistant to pesticides compared to other insect species. The document The author refers to several enzymes, such as glutathione-S-transferases, monooxygenases (P450s), and cytochrome P450 carboxylesterases [35]. While lethal concentrations of neonicotinoid pesticides. Moreover, migratory honeybee colonies have been observed to have higher levels of neonicotinoid residues than stationary ones. This has led researchers to believe that pesticide pollution is a major reason for colony migration and abandonment, in addition to other factors [33]. The mechanisms through which pesticides affect honeybees and cause their deaths can vary. Some pesticides may specifically target the digestive system, causing paralysis or altering its normal function to the point where bees cannot feed themselves. Bees then suffer from starvation and dehydration. The bee's abdomen often swells after such exposure. Other pesticides primarily affect the nervous system through various mechanisms, leading to the paralysis of legs and wings as well as disruption of the digestive and respiratory systems. Common symptoms of pesticide poisoning include regurgitation, impaired orientation, sluggishness, and an inability to forage. Many bees remain inside the hive, awaiting their deaths. Their abdomens become distended, and they display abnormal grooming behavior, stumble in movement, fall to the ground, and experience wing detachment from their bodies. A large proportion of the colony may die indirectly due to hunger and dehydration. Determining the exact amount of damage or monetary value when bees are poisoned by pesticides is challenging, but the presence of a large number of dead worker bees accumulating in front of the hive is a clear indication of pesticide poisoning [31]. In the United States, a study by Mullin et al. [34] used GC/MS and LC/MS-MS to identify pesticide residues in samples of migratory honeybees and others. A grand total of 121 pesticides have been identified as having substantial toxicity levels for both mature honeybees and their offspring. Significant environmental issues have been brought forward. According to the cumulative impact of these drugs and their immediate connection with Colony collapse disorder (CCD) is the term used for this event. Due to a significant economic loss Colony collapse disorder (CCD) holds significant value for pollinators in their natural habitat. Reduced yield of several significant crops [34]. Due to the absence of several genes required for the synthesis of essential enzymes involved in chemical metabolism Honey

research has shown that old bees with poor nutrition are more affected by pesticides than young bees because old bees have lower levels of vitellogenin hemolymph protein and antioxidants compared to young bees, which are influenced by

the effects of pesticides [36]. Furthermore, research has demonstrated that the insecticide imidacloprid Honeybees experience noticeable effects within a limited duration, primarily affecting the central region of their digestive system. Consequently, there is decrease in stomach capacity. Repairing damage to the primary region of the stomach can be achieved by the regeneration of stomach cells. However, the bee's capacity to restore damage is reduced by the accumulation of pesticides, resulting in the consequences of repeated exposure. Consequently, this finally results in inadequate eating habits, thereby worsening the issue. It leads to hunger and mortality. Worker bee exposure to the pesticide stunts the development of the hypopharyngeal glands. This directly affects the production of royal jelly, which eventually causes the colony's strength to gradually decrease [37].

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(مقالة مراجعة)

تأثير الملوثات البيئية على نشاط خلايا نحل العسل

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الخلاصة

تهدف هذه الدراسة إلى دراسة الملوثات البيئية الأولية التي تؤثر في سلوك ونشاط نحل العسل، نظرا لأهميتها البيئية والاقتصادية. من خلال تحليل شامل للأعمال العلمية الموجودة، أصبح من الواضح أن كثير من الملوثات البيئية منتشرة على نطاق واسع داخل محيطنا المباشر، مما يؤثر إلى حد بعيد على مستعمرات النحل. يمكن أن يُعْزَى فقدان وإضعاف أعداد النحل إلى مجموعة متنوعة من الملوثات، بما في ذلك الإشعاع الكهرومغناطيسي والسموم النباتية والنفايات الصناعية والانبعاثات، بالإضافة إلى التلوث بالمضادات الحيوية والمبيدات الحشرية. ونتيجة لذلك، فإن نتيجة ذلك هي انخفاض عدد كثير من أنواع النحل، الذي يشار إليه عادة باسم اضطراب انهيار المستعمرة (CCD)، الذي ظهر باعتباره مصدر قلق بيئي كبير للغاية خلال العشرين عامًا الماضية. في الختام، تؤدي هذه الظاهرة إلى انخفاض إنتاجية المحاصيل الأساسية المختلفة، حيث يعمل نحل العسل كملقحات مهمة داخل النظام البيئي.

الكلمات المفتاحية: الملوثات البيئية، التسمم النباتي، CCD، الملقحات، طوائف النحل