Biological Times Volume No. 4 | Issue No. 7 | Pages 38-39

Colony Collapse Disorder (CCD) in (*Apis mellifera* L.): Reasons and Remedies

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ABSTRACT

Apis mellifera is a vital pollinator of both agricultural and wild plants. The catastrophic global drop in honeybee population in recent years has been caused by a phenomenon known as Colony Collapse Disorder (CCD). The main causes are viral and fungal diseases, parasitic mites (*Varroa destructor*), exposure to neonicotinoid insecticides, climate change, inadequate nutrition brought on by habitat loss, the management of *V. destructor*, and the impact of CCD. CCD has major ecological and economic ramifications. To minimize the bee mortality and support a pollination ecosystem. The practical solutions are improved pesticide application practices, integrated pest and pollinator management, habitat restoration, and awareness programs for farmers and beekeepers. By addressing and underlying causes of CCD and putting science-based solutions into practice, the honeybee population is promised to survive, protecting biodiversity and food security.

Keywords: Colony Collapse Disorder (CCD), Apis mellifera, Climate change, Pollination, management

To cite this article: Nadeem M, NA Khan, A Khan, M Ibrahim, M Bilal & Noman. Colony Collapse Disorder (CCD) in (*Apis mellifera* L.): Reasons and Remedies. Biological Times. 2025. July 4(7): 38-39.

Introduction

A. mellifera is believed to have originated in either Africa or Asia and subsequently expanded spontaneously throughout Europe, the Middle East, and Africa [1]. 87.5% of blooming plants rely on pollinators that are animals to reproduce. 35% of worldwide production volumes and 87% of the world's most significant food crops utilize animal pollination. Honeybees are necessary for both natural and agricultural ecosystems [2]. Major reductions in both wild and managed honeybee populations have occurred recently due to factors, including a spike in pests and diseases (such as the ectoparasitic mite *V. destructor*), pesticide use, climate change, a shortage of melliferous plants for feed, and intensified agriculture. These are practices that raise severe worries in the field of science as well as in the rural (agricultural) sector [3]. An estimated €153 billion is the annual economic value of insect pollination. Although all of these advantageous roles, these pollinators are currently suffering several dangers that are causing them to decline [4]. Pollinators are vital to biodiversity and ecological health due to their interaction with flowering plants approximately 225 million years ago [8]. Pollinators contribute to clean air and soil stability, and within the lithosphere, they are necessary for the maintenance of a healthy ecosystem [10]. According to climate forecasts, if this rate of warming persists, temperatures will rise to 1.5°C by 2040. Extreme weather events are becoming more often and severe in some areas as a result of global warming. Diverse pollinators have been found to suffer from various effects of climate change [12]. The bee population decreases by 30% annually due to climate change [13]. Two major factors linked to the worldwide decline in bee populations are habitat loss and edge effects brought on by habitat fragmentation [14].

Signs and Symptoms

When worker bees leave their hives and leave a queen and enough food behind, it's known as colony collapse disorder [5]. Due to bacterial and fungal diseases of the honeybee, the colour of larvae changes and shrinks. The signs of IAPV disease include paralysis, reduced flying ability, crawling, orientation changes, and wing shaking [7]. The physiology and communication of nocturnal pollinators are impacted by heavy metals and industrial waste [8]. The Varroa mite's eating habit causes it to inject viruses directly into the hemolymph, which has been linked to the spread of viruses through sexual or oral contact. Mites find a suitable home in the honeybee hive. The most dangerous annoyance to honeybee colonies globally is *V. destructor*, an obligatory parasite that can target various *A. mellifera* castes and developmental stages. Neurotoxic chemicals found in neonicotinoids cause symptoms such as fainting, trembling, hyperactivity, and tremors, which impair bee motility [15].

Causes of Colony Collapse Disorder

Bacterial, parasite, viral, and fungal infections can all be the cause of CCD. This phenomenon is triggered by the use of pesticides in crops, unsanitary hive conditions, and inadequate nutrition for bees [5]. European foulbrood and American foulbrood (AFB) (bacterial), Chalk brood (fungal) diseases, which result in a reduction in population number, honey production, and colony strength overall. The Israeli Acute Paralysis Virus (IAPV), Deformed Wing Virus (DWV), and Chronic Bee Paralysis Virus (CBPV) are among the viral infections that damage colonies and result in deformities, early death, and paralysis [6]. The most harmful substances to honeybees are neonicotinoids (nerve poisons). Bees are impacted by neonicotinoids at the molecular level [7]. *V. destructor* mites greatly boost pathogenicity and make it easier for viruses to propagate [9]. Honeybees suffer as a result of a poor diet. Pollen and nectar levels are inadequate [15].

Impact of CCD

Certain honeybee viruses have been found in a variety of pests, including small hive beetles, hornets, and ants. viruses can spread and propagate across great geographic distances [9]. The extinction of bees has serious economic ramifications. More than 100 million US crops depend on bees, and pollinators are expected to generate an additional $18 billion in crop production revenue by 2021. Bees are anticipated to contribute more than $15 billion to the US [10]. Animal pollination raises worldwide crop yields by an additional USD 235–577 billion per year, with the Mediterranean, Southern, and Eastern Asia, and Europe experiencing the biggest economic gains. Without animal pollination, 5–8% of crop production would be lost globally [11].

Remedies and Mitigation Strategies

When the crop is not in flower, pesticides that are less hazardous to honeybees are administered; they are not applied in the morning or evening when bees are active [7]. Habitat restoration, environmentally friendly farming practices, and integrated pest control reduce the usage of pesticides. Genetically modified crops, which reduce the negative impact on pollinators, are examined. Providing nest site provision and farmer education all help the bee population survive and procreate. Support and long-term pollination services are offered via the Pollination Information Management System (PIMS) and Integrated Pest and Pollinator Management (IPPM) [8]. Reducing infections requires managing the ectoparasitic (*V. destructor)* mite population, which has a major influence on viral prevalence and virulence in bees [9]. The most important characteristics of food supply are undoubtedly the quantity, quality, and regularity of pollen and nectar [15].

Conclusion

The multifaceted phenomenon known as Colony Collapse Disorder (CCD) in *A. mellifera* has disastrous effects on economics, agriculture, and ecosystems globally. Numerous factors, such as infections, parasites, pesticide exposure, habitat loss, inadequate nutrition, and climate change, have been connected to the fall in honey bee numbers. Neonicotinoid, Varroa destructor mites, and viral infections, including DWV and IAPV, are the main causes, as they significantly impair bee immunity and behavior. Bee extinction upsets the natural balance of the ecosystem and the crops that depend on pollination. Thanks to the number of mitigation techniques: habitat restoration, less toxic pesticide use, use of fluvalinate, a pyrethroid to control *V. destructor,* integrated pest and pollinator management, and awareness among farmers and beekeepers can all increase survival and bee products. Global collaboration and technological advancements are essential for sustainable solutions and saving pollinators for future generations. Academics, policymakers, the general public, and farmers must collaborate to protect the pollinators.

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