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POLLINATORS AND POLLINATION

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Abstract

Bees are important for maintaining ecological equilibrium and biodiversity in the natural world. They perform one of the most well-known ecosystem services, namely pollination, which is essential for food production. The honey bee is a commonly dispersed flying insect that collects nectar from flowers and makes honey. Honey bees are mustard yellow and brown in color. They have a stocky body with a lot of hairs on it, to that pollen sticks. Apples, cranberries, melons, carrots, blueberries, cherries, almonds, etc. are a few examples honey bees pollinate themselves. Honey bees out caste all the different varieties of insects that pollinates or bees globally, which makes them the most operative food crops' pollinator. Pollination is needed for many domestic and imported fruits and vegetables. This paper discusses that if there is any chance of increasing the pollinator diversity, which will improve pollination service by altering the behavior and resulting a greater functional efficiency of the agricultural aspects on a larger scale, and provides a wider idea of the different types of bees and a clearer chance to understand how bees pollinate and how other species pollinate in their respective ways. It talks about their importance in our ecosystem and how they function, as well as the worldwide decline in insect pollinators, which has raised questions about the availability of pollination services to agriculture

Key words: Bees, Bumble Bees, Flowers, Nectar, Pesticides, Pollen, Pollination, Pollinators.

Introduction

1.1.About Bees

Wasps and ants are close relatives of honeybees, which are flying insects. Except for Antarctica, they can be found on all 7 continents. Pollen and nectar are the primary sources of nutrition for bees of all kinds. Pollination would be difficult and time-consuming without bees; insect pollination is estimated to be responsible for one-third of human food supply.

A proboscis, or long, straw-like tongue, is used by bees to drink nectar from deep inside blossoms. Bees have three body segments, two legs, and two antennae (the top skull, and the front-stomach). Honey bees are the socio creatures those who animate in hives. The population of the hive is made of one queen, a limited 100s drone bees, and 1000s of worker honeybees.

1.2.Queen Bees

Each hive has one queen bee, which is the mother of all the other bees. During the spring and summer, she is the colony's most fertile participant, laying about 1,500 eggs every day. Queen bees have long abdomens and short wings, which set them apart from the rest of the hive. Queen bees will leave the hive soon after birth for a very productive week, in which bees will mate with almost 15 drones during a 3-day cycle prior returning for laying eggs. If the colony swarms, the queen will not leave the hive again (looking for a new home). Honeybees don't build a hive that is visible from the outside. Whether it's a hollow tree, an empty fallen/broken log, or a traditional human-made bee-hive, they choose hollow spaces to live in. They do build the interior of their hive though. Honeybees manufacture specific wax i.e. beeswax of their own, to that they use for building hexagonal shaped within their hive.

1.3.Drone Bees

The larger bees that hang around hives are known as drones. They remain there in the spring and summer, but they leave on a daily basis to seek out Drone Congregation Areas (DCAs) in the hopes of joining a mating flight. It is their responsibility of mating along with queens belonging other hives and if drones do get the chance to marry, they will die shortly thereafter. These bees will live up to 90 days without mating (that's twice as long as a worker bee!).

1.4.Worker Bees

Worker bees are the most recognizable members of the hive-honeybee, accounting for almost all of the colony's population. Worker bees are all female and do nearly all of the hive's tasks. The worker bee is assigned various tasks to perform at different times in her lifetime, 45 days later. Worker bees are in charge of every other thing ranging from feeding the new born larvae (baby bees) to taking care of the queen, cleaning hives, gathering pollen, protecting their colonies, and constructing it.

1.5.About Pollination

Pollination is the process of grains being relocated from a male anther of the flower to its stigma(female). Any living organism, including plants, has the goal of producing offspring for the next generation. Plants can produce offspring in a variety of ways, including by producing seeds. The genetic material used to grow a new plant is included in seeds. Pollen can only be passed from flowers of the same genes to produce seeds. A species is a group of individuals capable of openly interbreeding with one another, but which do not interbreed with members of other species due to geographic, reproductive, or other barriers.

Pollination is essential for the roughly 250,000 blossoming plant species that depending upon pollen allocation from the anther of the flower to reproduce through the stigma[1]. The flowers' anther is the stamen's topmost portion, which is the reproductive portion of the male flower. Pollens are contained and released by the anther, which is usually made up of four pollen sacs. stigma is covered by a sticky material, or flower's female reproductive part, which absorbs and traps pollen seeds. Water, birds, or insects, depending on the plant type, wind and gravity transport pollen to stigma from anther. Pollen from pine trees and corn, for example, is light and easily spread by the wind. Pollen produced by plants is sticky and dense, making it difficult to blow from flower to flower. These plants use other agents to transport pollen, such as flies. An insect, such as a honey bee, brushes against pollen on the outside of the anther as it approaches a flower and transports it to the stigma. Pollen grains need only come into contact with the stigma of the same flower or another flower on the same plant to be effective. Pollen may be brought to the stigma of a flower on a particular plant (but species from same plant). Bees who make honey are vegetarians. The entrees on their dinner plates are nectar and pollen obtained from flowering plants. Bees make honey by collecting nectar, that is the insects' main source of carbohydrates. Honey gives bees the energy they need for flight, colony upkeep, and other everyday tasks. Pollen, also known as "bee bread," is the primary protein source for bees. Pollen also supplies fatty acids, nutrients, and vitamins to bees. Pollen protein is required for hive growth and the production of young bees. Table 1 shows different pollinators and their properties which affects their capability to pollinate and shapes of flowers, and nectar.

Table 1: Different Pollinators and Their Properties Which Affects Their Capability to Pollinate and shapes of flowers, and nectar.

Traits/Creatures	**Wind**	**Flies**	**Moths**	**Butterflies**	**Bees**	**Birds**	**Beetles**	**Bats**
Pollen	Abundant, molecular, can't	Modest in amount	Limited	Modest in amount	Limited, usually sticky and	Modest	Ample	Ample

	detect with naked eyes				scented			
Color	Lite green, brown, colorless, petals absent or compact	dull and Pale-dark brown/purple; marked with transluce nt spots	Purple, Pale and dull red, pink, white	Very bright colors including white red, purple	Yellow, blue, Bright light, UV	Orange, scarlet, white	Off white, green	Off white, purple, green
Nectar	None	Generally absent	Ample or hidden	Hidden, but at ample.	Present usually	Deeply hidden, but ample	Present but not totally hidden	Hidden but plentiful
Odor	None	Rotten	Sturdy sweet, usually emitted after dark	Fresh	Fresh, mild, pleasant	None	Not so strongly fruity or rotten	Released at night, strong, musty.
Nectar guides	Absent	Absent	Absent	Present	Present	Absent	Absent	Absent
Flower shape	Regular, small and stigmas exerted	Trapped shapes like webs, funnel shaped	Tubular, without any mouth	Landing pad to be wide, narrow tube like	Shallow, tubular having some platforms to land onto	Large, funnel/ cup shaped	Large, bowl shaped	Closed during the day, bowls, regular shaped

A honey bee colony can range in size from ten thousand to one lakh bees, dependent on the current season, temperature, and nectar availability - and blossoms those who are pollen bearing. Per year, an average size colony of twenty thousand bees produces around 125 pounds of pollen.

One worker bee visits thousands of flowers in 1 day, making 12 trips to the hive or even more. The bee will fly up to five miles from the hive on these foraging trips. While those honeybees are collecting pollens from a very wide range of different flowers, each trip is limited to one plant species and one type of pollen. Agriculture relies heavily on honey bees, Honey, royal jellies, pollen, bees wax, or venom are among the few hive items manufactured by these hardworking social insects, which is all harvested and consumed by humans for countless nutrition aspects and pharmaceutical purposes.

1.6.Self-Pollination

Self-pollinating plants can breed even in the absence of animal pollinators. Self-pollination, on the other hand, decreases genetic variation. The pollen falls on the stigma of the same flower as the anther opens. Plants have evolved a number of sexual tactics to attract pollinators and disperse pollen from one flower to another of the same genus in order to encourage cross-pollination and increase genetic diversity.

1.7.Cross-Pollination

Anthers open on one flower, and pollen is carried to the stigma of another flower by a vector (wind, insects, or animals). Pollinators can visit multiple flowers on a single plant or multiple flowers of the same species on a variety of plants. To stop self-pollination, certain plants have evolved self-incompatibility mechanisms. Even if a flower has been abundantly pollinated with its own seeds, a physiological obstacle makes it difficult or unlikely for it to fertilize itself.

1.8.Specialized Pollination

There are several examples of specialized plant and pollinator interactions in which flowers and insects have evolved to one another to achieve mutually beneficial goals. This are a strong example of co-evolution. To read more about these critical interrelationships visit the Coevolution Institute website. Some orchids have figured out how to attract pollinators by creating flowers that look like female butterflies. Males of the same genus will try to copulate with the flower, unwittingly picking up pollen before visiting another female-mimicking flower, since these flowers imitate female insects too convincingly using sight and/or smell.

Plants and pollinators have coevolved physical traits that make good interactions more possible. Plants benefit from attracting a certain pollinator to their flower, meaning that their pollen is brought to another flower of the same genus, resulting in efficient reproduction.

1.9.About Pesticides

One class of pesticides or neonicotinoids, has lately been studied extensively by the researchers to determine their impact on bees due to their widespread industrial use on field crops. "Widespread" means that systemic neonicotinoid insecticide-coated seed by 2018, was planted on more than 90% of the approximately corn's 88 million acres and half of the soybeans' 89 million acres' planted in the United States. Neonicotinoids are used by homeowners in their yards and gardens, on the other hand, may be just as important in urban areas.

Neonicotinoids are a form of insecticide that attacks the insect's nervous system. They're safer to use than much older insecticides because they're more selective and have higher toxicity for such insects compared to mammals. If they are eaten or come into contact with them, insects are poisoned. All of the most often used are particularly poisonous to bees. Bee-warning boxes are found on the labels of products containing these active additives, along with essential recommendations for minimizing bee exposure that must be followed. Bee-warning labels are not present on neonicotinoid-coated corn and soybean crop. Neonicotinoids are injected or sprayed into the plant's bottoms in the stem, or into the roots in a soil application, and they move upwards in xylem sap internally within the plant, where they can later penetrate nectar and pollen. Following a foliar mist, pesticides are mostly found in leaf tissue.

Neonicotinoids, like any other insecticide, can damage pollinators if they come into close contact with them, which can happen when a neonicotinoid is applied inappropriately or on a developing or soon-to-grow vine, or when bees are exposed to seed-coating during planting. However, scientists have discovered that treating canola seeds with a seed coat can be harmful to native bees nourishing on canola in treated seed fields. Both have been shown to hurt bees, but the combination of stressors appears to be especially harmful. Bees and other pollinators that rely on flowers for food consume pollen as a source of protein. Pollen is a source of protein for the bees to rear their offspring, while nectar includes carbohydrates. Places which are flowerless for example, mowed lands of gardens with rigid weed controlling, severely pavements in the villages, and fields equipped with little plants' diversities, have little nutrients for the bees, resulting in inadequate nutrition and immune system compromise. Nutritionally damaged bees are more prone to disease and pesticides.

Literature Review

The pollinator profits from its variation to a certain type of flower species because it ensures that it will be able to locate or consume essential supplies such as nectar, pollen. Mutualistic partnerships are those in which both parties profit. Pollen may be spread by animals, water, and wind. The type of pollinator that visits the flowers affects the flower's appearance, color, odor, nectar, and structure. Pollination syndromes are traits that can be used to predict the kind of pollinator that will help the flower reproduce successfully.

The pollination efficiency of bees is determined by the for-aging inhabitants in the grounds as well as their action over the flower. Subsequently foraging behavior in the grounds and among individuals is a function of their natural and inevitable reactions to different environmental incitements, ecologic studies into the quantitative/qualitative features of foraging on economic crops are essential for the bees. This would aid in the evaluation of the resulting interrelationships in order to effectively control and use them as potential pollinator bees. With the help of the pollinating worth of different bees' pollinator has been expansively considered in the past, most of those experiments were conducted under a small range of environmental conditions. Pollination by animals is important for the sexual reproduction of certain crops, and can also provide calories and micronutrients to humans. Additionally, the weakening of pollinating types may result in a decline in plant types. For instance,

Most scientists believe that a number of factors are driving bee-pollinator population decreases, comprising lack of habitat (flowers) which deliver pollens and nectars from different flowers, bee or pollinator pace and temperature, and the relationship between the two, pesticide contact, pests, or pathogens. Both has been shown to damage bees, but there is evidence that the combination of stressors is particularly dangerous. Pollen being sources of protein for other pollinators and bees, and nectar is a source of carbohydrates for them. Pollen is also needed for them to their young ones. Places without flowers, for example mowed parks with stringent weed-control, densely paved villages, and fields with little plant diversity, have little food for bees, resulting in inadequate nutrition and immune system compromise. Bees that are malnourished are more vulnerable to disease and pesticides. Bees are affected by a variety of predators and pathogens. One of the highest destructive causes affecting honeybee deterioration is the Varroa mite, a parasitic mite that feeds on honey bees. In hives damaged by the Varroa mite, other parasites and pathogens may become a bigger concern.

The flower pollinating speed with the honey bees improved with temperature [2]. All of the honeybees that were observed collected equally nectar, pollen. Persons collecting nectar/pollen solely were not discovered. Witnessing bees as they left the hives, it was discovered that within the first minutes of their journey, the bees mostly collected nectar, then gradually began to gather pollen with increasing speed.

Wrona stated that honeybee pollination productivity improved with increasing temperature and reduced along increasing wind hustle[3]. Bees' pollinating competence is determined by their scavenging crop activity and their field's population. Meanwhile foraging behavior in the field and among individuals is a function of their natural and inevitable replies to different environmental spurs, environmental soundings into the quality-wise quantifiable features of scavenging on commercial crops are essential.

Szabo and Smith establish that Scavenging behavior is shown to be definitely associated with a appropriate mixture of light temperature as well as intensity, but not along the light strength alone[4]. Flight has a dual threshold of these conditions because light intensity and temperature have a clear negative relationship. When light intensity and temperature were combined, female scavenging activity was clearly correlated, but when temperature was not taken into account, it was not.

Wanigasekara and Karunaratne Identifying bees which are visiting flower for the vegetable crop Solanum violaceum, as well as the efficacy of buzz pollination by bees on fruit and seed production in Sri Lanka, were the goals of their current research[5]. Buzzing bees were the primary ones to visit Solanum flowers, accompanied by non-buzzing bees.

Nunez reported that Morning activity was linked to nectar flow, while evening activity was linked to photoperiod[6]. These studies show that there is no consistent trend of how various environmental factors influence bee pollination behavior. The most likely explanation seems to be the omission of certain contributing factors that directly influence pollination behavior, as well as the random collection of a very less suitable types that have either no communication or function within different means, resulting in indecisive outcomes. As the ecosystem which is network of interconnected variables that affect bee behavior as well as plant physiology, without taking into account a broad matrix of variables, a complex learning process such as cross-pollination will be unfinished. These were the driving forces behind the current study, which investigated the effects of

temperature, air, solar radioactivity, comparative humidity, light strength, nectar/sugar deliberation, soil temperature, and wind velocity on bee-flower associations.

Gallai, N. et al. in their study researched about the usability of the food production risk worldwide due to the decline of insect pollinators Non-food crop production, livestock raising, and natural vegetation will all be affected, although this paper does not go into detail about them[7]. Using a bio-economic strategy, they calculated a global value of € 153 billion for pollinators' contribution to the growth of used crops specifically for human consuming food, which are about 9 percent of the global value of human food production.

Rachael Winfree Here in her study mentioned the use of meta-analysis to blend the literature on how human disturbances such as habitat destruction, deforestation, forestry, and cultivation affect bees, the most significant group of pollinators[8]. She gathered 130 impact sizes from 54 experiments that measured bee profusion and/or species productivity in relation to human disturbance. Disturbance had a major negative influence on both species fertility and bee profusion.

On the petals of flowers foraged by bees, as well as in the nectar and pollen, pesticide/insecticide residue can be found. These chemicals can kill bees or have a variety of non-lethal effects, such as making it difficult for them to find their hive or providing food for their larvae. Depending on the substance, pesticide toxicity for bees can range from highly toxic to relatively stable and also the amount of revelation. When pollinators are subjected to many pesticides, the consequences may be serious. Since bees forage in a variety of environments, they are likely to be exposed to a complex combination of chemicals.

Discussion

Although the controlled pollinator, despite the fact the Western honey bee Apis mellifera has been declining for at least a decade, the pollinator problem was not generally recognized up until the honey bee population in the United States was decimated by Colony Collapse Disorder (CCD). Bumble bees and other pollinators, in addition to honey bees, are now believed to be declining as a result of the combined effects of pesticide use and habitat degradation by Homo sapiens. Although, primary priority has previously been on honey bees, there is also a need for a special topic that incorporates other pollinators.

3.1.Tension Through Pathogen

S. L. Bushmann et al. investigated whether the pervasiveness of Nosema contagion was previously connected to the use of profitmaking bumble bees. Bumble bee rearing facilities have been shown to spread pathogens to local bumble bee colonies in the past, but it's unknown if using profitable bumble bees in the field will increase the pathogen's contagion rate.

In comparison to wild bumblebees sampled in lowbush blueberry fields without them, wild bumblebees tested in low bush blue berry fields with a past of profitable bumble bee usage, the study found no higher Nosema infection rate. Other factors may have weakened the immune systems of the hosts bees, raising the risk of infection and resulting in population decline. Bad environments or toxins utilized in blueberry crops that ends up in the pollen or nectar ingested by the bees may be to blame for these problems[10]. To understand why this native species became infected at such a rapid rate, further research is needed.

3.2.Stress from Transportation

Only regulated pollinators are subjected to such stressors. For example, around 1 million controlled honeybee societies are transported throughout the US each year to pollinate almonds in California[11]. Imagine being moved through 3 time zones in a suffocating cramped atmosphere with inadequate air circulation.

3.3.Impact through Climate Change

Global transformation is a hot subject right now, but nothing is understood about how it would affect pollinators. What is the association amongst honey yield and the climate, first and foremost? Secondly, how

much spatial uncertainty does current and future climate change forecasts contain? They produced a series of bio-climatic models and integrated them into a geographic information system to find the best honey-producing areas in current and future climate change scenarios[12]. In general, the standard model projected that, both honey yields and ideal honey production areas will decrease as a result of climate change. Temperature tendency of seasonally changing, as well as the mean temperature of the wettest quarter, which was found to be negatively correlated with honey yields, and the precipitation of the showery month, which was found to be definitely correlated with honey yields, were all found to be negatively correlated with honey yields, were all identified as significant bioclimatic variables in the models.

3.4.Plant-Pollinator Interactions

Both biotic and abiotic influences are known to influence soil quality, which can have a direct effect on plant development, production, and pest resistance. As a result, S. A. Cameron et al., investigated whether soil improvements of vermicompost influenced the behavior-physiology of Bombus impatiens, a bumble-bee type[13]. Improvement in appears to be beneficial to pollinators because it greatly improved bee visit durations and decreased the time it took for them to find flowers for the first time. Bumblebee workers who ate flowers from plants growing in improved soil had slightly greater and more active ovaries, indicating that these flowers provided healthier nutrition to bees. Pollen from these plants did have a slightly higher protein content, as well as a slightly higher nectar sugar content, but not by much. It would be interesting to read more about the nutrients that have been supplemented in these vermicompost-supplemented. Plant pollinator communications are often assumed to be mutualistic and coevolved. And there's the fact that not all travelers can be good pollinators.

Conclusion

With the help of this review paper we are trying to put light on the declining traditional practices of pollination for producing even very common food crops or fruits, which is being artificialized by the pesticides and several other fertilizers to increase their productivity but in return the nutrient and quality factors of the crop/fruit is declining which is dependent on many other factors as well but pollination being the foundation to growth of any fruit/crop. In this review paper, we also tried putting light towards the very intramolecular aspect of the pollination and bees dis-involvement in the process of pollinating the flower. The decrease in the bee-population is another issue to be discussed thoroughly but one main reason for this is that the use of insecticides and poisonous pesticides. These practices, in general, put an end to societies of bees to zero.

There is a chance of raising pollinator diversity, which would increase pollination service by altering behavior and resulting in a greater practical productivity of agricultural aspects on a larger scale, and offers a broader understanding of the various varieties of bees and a better chance to consider how bees and other insects pollinate in their own unique ways. Their importance in our ecosystem is impeccable and as decline rate is worth putting light on and that should be preserved. We are equipped with all the information regarding their life cycle and whatever is affecting their strength, and how they function, as well as the worldwide decline in insect pollinators, which has raised questions about the availability of pollination services to agriculture. Honeybee species' ability to offer optimum pollination services has decreased significantly over the last 20 years. Contrary to expectations, during this time, insects pollinated crop yield have increased significantly, suggesting that wild pollinators contribute much more to crop pollination than previously thought. Elucidating these results would be useful in leading new innovations in successful pollination administration at a field and landscape scale, as insect pollinated crops which are expected to develop progressively significant to farming in the near future.

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