Akshardhara Research Journal
Single Blind Peer-Reviewed & Refereed International Research Journal
E ISSN -3048-8095 / December 2024 / Special Issue 1 Volume I

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# Impact of Climate Change on Insect Populations

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**Abstract:**
*Extreme weather occurrences, variations in the pattern of rainfall, and an increase in the average world temperature all point to the existence of climate change. The flora, fauna, and population dynamics of insect pests would all be impacted by these long-term and seasonal changes. Changes in the geographical distribution of voltinism may also be a result of global warming, which benefits multivoltine species more than other species. A crop cultivated under 2 high CO may change the nutritional content of the plants, change the quantity of insects, and accelerate the rate at which herbivores consume their food. In addition to these effects, elevated CO also demonstrated some influence on the population abundance of pests. Therefore, the dynamics of insect pest populations would shift as a result of climate change. Therefore, an important factor in the dynamics of insect populations is temperature rise. In general, outbreaks and range shifts in forest insect populations are being caused by climate change. Crop pests, the balance of ecological relationships, and food security are all impacted by these effects of climate change on insect populations. We will talk about in this essay. The effects of climate change on populations of insects.*

**Keywords:**
Climate Change, Insect Populations, Temperature, Ecosystems, Growth Rate, Pollination, Nutrient Cycling, Genetic Diversity, Evolution

**Introduction:**

One of the most significant anthropogenic pressures on the environment is climate change. The concomitant consequences may be quite detrimental, particularly with regard to the risks to species survival and the range of ecological services that biodiversity offers.

The group of animals most affected by climate change are insects, which are vital components of many ecosystems. Individual insects, populations, and species, as well as entire insect communities, are all at risk. In a unique experts' warning series, the researchers talk about the effects of the steady increase in the earth's surface temperature on insects' physiology, behavior, phenology, distribution, and species interactions. [1]

Insect populations are significantly impacted by climate change. Their diurnal activity, growth rate, population dynamics, and diapause can all be directly impacted. In addition, range expansion, higher overwintering survival, more generations annually, greater danger of invasive species and insect-borne plant diseases, and altered interactions between natural predators and host plants are all potential effects of climate change. Furthermore, insects' migratory patterns and geographic ranges can be altered by climate change, resulting in the removal of low-temperature barriers and the creation of new ecological niches. The impact on insect biology and phenology might be further complicated by the modification of competitors and host plants brought about by climatic changes. In addition, the physiology of insects may be impacted by climate change, resulting in an acceleration of their growth, metabolism, and reproduction. This increased density of insects may then consume and infest agricultural land. Insects will be directly impacted by climate change as: [2].

- The geographic range of insects
- The timing of life cycles of insects
- The population dynamics of insects
- The natural habitats of insects
- The structure and composition of ecosystems

**The Effects of Long-Term Climate Change on Insects**

Not everyone can easily observe the effects of climate change, particularly when it comes to insects. Insects are impacted by our planet's slow warming in subtle ways. Only when certain

 

thresholds are reached can changes in insect populations and their habitats become apparent. Global warming is not occurring equally; ecosystems at higher latitudes are being affected at a faster rate.

An important effect of this warming is that insect's metabolic rates are accelerated. Although there is a limit to this benefit, it can lower their fertility and possibly result in mortality. Additionally, as a result of reduced genetic variety, insect populations may become less adaptive as a result of climate change. The balance of insect communities is essentially upset by climate change, which may jeopardize the insects' survival unless they can adjust to the fresh surroundings. [3]

**Important Insects to our Ecosystem & Food Production:**

The production of food and the health of our ecosystems depend greatly on insects. They are critical to preserving the ecological balance and delivering necessary ecosystem services. The following are some main arguments for why insects are essential:

1. **Pollination:** Blooming plants require the assistance of insects, especially bees, butterflies, and other pollinators. By moving pollen from the male to the female portions of flowers, they facilitate fertilization and the development of seeds and fruits.
2. **Decomposition and Nutrient Cycling:** The decomposition process depends heavily on insects, particularly flies and beetles. They decompose dead organic waste into simpler chemicals, including animal corpses and fallen leaves. Plants can absorb the nutrients that are released back into the soil during this breakdown process. Insects contribute to the ongoing nutrient recycling that supports plant development and preserves soil fertility in ecosystems.
3. **Natural Pest Control:** Another important function of insects is in pest control. Aphids, caterpillars, and mites are among the dangerous pests that are consumed by a variety of predatory insects, including parasitic wasps, ladybugs, and lacewings. Insects help control the populations of these pests by feeding on them, which lessens the demand for artificial pesticides in agriculture.
4. **Support for Food Webs:** Insects are the cornerstone of food webs, giving a variety of creatures, such as mammals, birds, reptiles, and amphibians, their food. Since insects are the main source of food for animals that eat them, disturbances in insect populations may have a domino effect on species that eat higher trophic levels. Insect loss can cause decreases in insectivorous species, which can have an impact on ecological stability and biodiversity.
5. **Soil Aeration:** Ants are examples of insects that are crucial to soil aeration. By digging tunnels, they enhance the structure of the soil, making it easier for water and air to enter and increasing the availability of nutrients for plants. This procedure improves drainage, soil fertility, and the general health of the surrounding ecosystem.
6. **Genetic Diversity and Evolution:** With estimated populations in the millions to tens of millions, insects exhibit a remarkable diversity of species. Because of this diversity, ecosystems are more genetically variable overall, which promotes resilience and adaptation to environmental changes. [4]

**Review of Literature:**

The effect of climate change on the proliferation of insect pests was amply demonstrated by a number of works of literature. An increase in temperature attracts termite pests, bed bugs, woodboring beetles, ants, clothes moths, flies, mosquitoes, and fleas. According to Noland et al. (1949), for example, the growth rate of Blattella germanica, the German cockroach, will nearly double with a 3°C (5.4°F) increase in temperature. An increase in temperature of 5°C (9°F) has the same effect on Plodia interpunctella, the Indian meal moth. [5]

(Prakash, 2014) Climate change and related phenomena, such as rising global temperatures and atmospheric carbon dioxide concentrations, heat waves, flooding, strong storms, droughts, and other extreme weather occurrences, are the main topics of current scientific research and agronomy. Therefore, when the tendency to reduce yield loss owing to such conditions develops, more attention is paid in agricultural research to the abiotic elements indicated above. Changes in precipitation patterns may be more significant than temperature rise in terms of crop production, particularly in regions where dry seasons pose a hindrance to agricultural output. Pests are a

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significant biotic component that are also impacted by weather disruptions and climate change. The interactions between pests, the environment, and natural enemies are all directly impacted by temperature rise, as are the pests' ability to reproduce, survive, disseminate, and maintain population dynamics. [6]

**Objectives:**

- Understanding how climate change affects insects is vital when it comes to informed and targeted conservation efforts.
- Saving insects from climate change requires action at both a global and individual level.
- Population dynamics change with climate means, variances, or the interaction.

**Research Methodology:**

The overall design of this study was exploratory. The research paper is an effort that is based on secondary data that was gathered from credible publications, the internet, articles, textbooks, and newspapers. The study's research design is primarily descriptive in nature.

**Result and Discussion:**

A population of insect's lives in the following environments:

- Temperature, wind, humidity, light, and pesticides are examples of physical (abiotic) factors.
- Biologic (biological) factors include rivals (other organisms that occupy the same area or food supplies), natural enemies (predators, parasitoids, and illnesses), food sources, and other members of the same bug species.

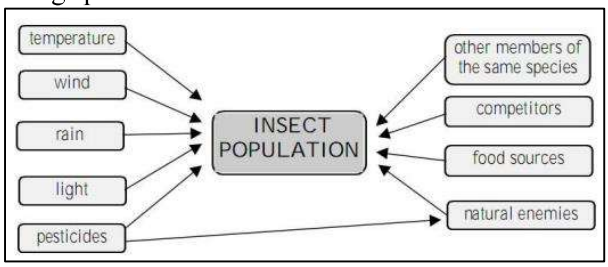


**Figure 1: Insect Population**

**Abiotic factors**:

Abiotic elements of the insect environment mostly consist of air and water currents, temperature, moisture, light, and others. It has been discovered that they have a major impact on insects. An ecosystem's abiotic factors, such as light, moisture content, and temperature, are not constant.

**Climate Change and Insects:**

The natural world and the organisms that inhabit it are being impacted by climate change in a variety of ways. Climate change will affect all species, though to varying degrees. Since insects have cold blood, their body's temperature and that of their surroundings are rather constant. As a result, it may be argued that the temperature has the greatest impact on all aspects of their life cycle, from behavior to survival. One to five additional life cycles for insects per season could result from a 2 °C increase in temperature, according to expert estimations. [7]

- **Impact of temperature**

The region where migratory insects overwinter may grow, or they may arrive at their destination much earlier. Higher temperatures may cause insects to transition through sensitive life stages more quickly, which could shorten the time window for parasitism. The gender ratio could be affected by development during hotter periods, though. Thrips have been shown to exhibit this, with the effect that the reproduction rate falls. Due to the soil's ability to act as an insulating medium, a number of insect species that spend important stages of their lives there may be more resistant to temperature changes than those that live above ground. Insect winter mortality may be reduced by warmer temperatures, which would lead to an increase in population. Crops may use ground further north as bug populations rise, and insects are expected to accompany this expansion.

- **Impact of rising CO2 levels:**

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It is generally thought that changes in the host crop indirectly affect how CO2 affects insects. Rising CO2 levels have been shown to have significant impacts on pest insect populations. According to a study, insects damaged soybeans produced under settings with higher CO2 by 57% more than those cultivated in the current atmosphere. Moreover, the experiment required the use of a pesticide in order to proceed. This increase in damage is thought to have been induced by heightened quantities of simple sugars, which were measured in higher concentrations in the elevated environment

As the climate changes, farmers will probably see significant effects on their management practices. As previously noted, it is anticipated that insects would expand their geographic range, succeed in reproducing, and overwinter. As a result, as populations grow, farmers will have to deal with a greater variety of animals and insects. [8]

- **Response of Insect Pests to Increased Temperature**

Because of their very sensitive physiology, insects typically double in metabolic rate for every 10°C increase in temperature. Accordingly, numerous studies have demonstrated that rising temperatures have an effect on insect fecundity, survival, generation time, population size, and geographic range. The potential for changes in the population and dynamics of pests is determined by a number of factors, including movement, metabolism, metamorphosis, and host availability (Figure 2).It is reasonable to assume that an increase in temperature should be linked to changes in insect population growth rates and an increase in herbivory, given the distribution and behavior of insect pests. [9]

For insects that live most of their life cycle under the soil, the consequences of rising temperatures are less pronounced because soil acts as a thermally insulating barrier, reducing the influence of temperature fluctuations. Aphids, for instance, are less vulnerable to the aphid alarm pheromone that they typically emit in response to insect predators and parasitoids in warmer climates, which may result in a rise in predation. The main environmental elements that control whitefly populations are temperature, general humidity, and precipitation. Elevated temperature and high humidity have a positive correlation with the growth of whitefly populations.

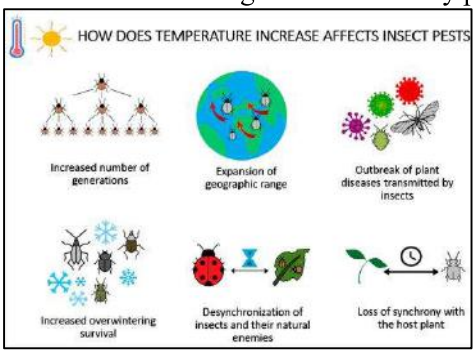


**Figure 2: Effects of temperature rise on agricultural insect pests.**

**Impact of climate change on beneficial insects**

The natural enemies of the insect pest are impacted by climate change in many different ways. Higher temperatures, increased CO2 levels, and decreased precipitation allow plants a variety of nutritional options for diverse insect pests, which ultimately affects the fitness of predators and parasitoids that feed on insect pests. The main cause causing variations in caterpillar parasitism is precipitation fluctuation, even in the presence of a diverse range of host and parasitoid species. When dry circumstances and water stress are combined, mealy bug parasitism in cassava (Manihot esculenta) is decreased. Natural enemies locate their herbivore hosts in response to their movement and tolerance to environmental extremes. When pea plants grow at high CO2 levels, predatory insects like Oechalia schellenbergii have been found to be more successful in killing cotton bollworm larvae. Similarly, it was discovered that greater CO2 levels improved the success of Leis axyridis, a coccinellid predator, in feeding on Aphis gossypii, the aphid. [10]

**Impact of climate change on invasive insect species**

 

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Significant environmental changes caused by climate change include variations in temperature and precipitation, the frequency of extreme weather events, the composition of the air, and the cover of the land. Temperature, atmospheric CO2 content, and the availability of nutrients are the primary variables that determine an organism's ability to survive. Changes in these factors most likely have the potential to stress ecosystems and increase the likelihood of invasions. Invasive alien species pose the biggest threat to biodiversity loss globally, according to the Convention on Biological diversity (CBD). They do significant harm to agriculture, forestry, and aquatic ecosystems by changing their geographic structure, function, and variety. Both directly and indirectly through biotic interactions, insects' physiology and behavior are impacted by climate change.

The main causes of human and global climate change are predicted to be the introduction, establishment, spread, impact, and modifications in the efficacy of mitigation techniques of invasive insect species. Since many tropical plants can withstand the phenological changes, global warming is predicted to have a greater ecological impact, including the introduction of new pests and altered phenological events like flowering periods, primarily in plants of temperate species. The primary factor supporting the introduction of crops or cultivars sensitive to insects is the influx of novel insect pests. For instance, between 2018 and 2019, the fall armyworm, or Spodoptera frugiperda, a newly introduced invasive species from Africa, made its way to a number of nations, including Australia, India, Thailand, Myanmar, China, Republic of Korea, Japan, Philippines, and Indonesia. Temperature and development rate have a direct impact on the biology, dispersion, and abundance of the species. Since insect development takes place within a specific temperature range, variations in temperature will subsequently impact the rate of development, the length of the life cycle, and ultimately the likelihood of survival. Insect metabolism and activity increase when ambient temperature rises to almost the thermal optimum for them.

According to a new study, insect biodiversity is being adversely affected by the combined effects of agricultural intensification and climate change. We examine insect responses to climate change and climatic extremes in this synthesis "warning paper," including what is known about them, what is still unknown, and what important suggestions scientists can make to the public and policy makers to lessen the negative effects. We discuss the consequences of both gradual and enhanced climatic variability, or the frequency of intense, abrupt, and punctuated occurrences (Figure 3), as well as how these effects may be influenced by other drivers of global change. To assist our joint efforts to create an ecologically sustainable future, we must acknowledge and respond to the compelling evidence of the effects of climate change on insects. [11]

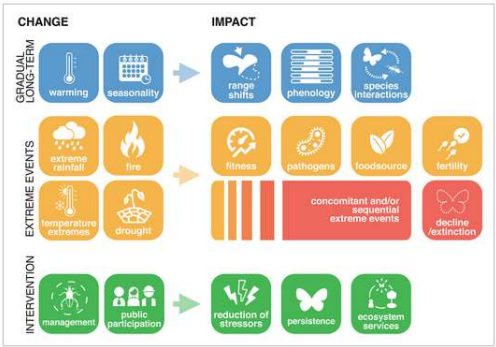


**Figure 3: There are two main groups into which the effects of climate change on insects can be divided: The interventions include formal mitigation of change through policy and public initiatives, which in turn help to lessen consequences in many ways. The long-term changes are gradual, and the extreme occurrences will become more frequent and severe.**

**Conclusion:**

India has greater difficulties due to the alarming effects of climate change. Different agroclimatic zones experience varying levels of insect pest damage, primarily as a result of the varied effects of abiotic elements like temperature, humidity, and rainfall. These conditions also cause changes in crop diversity and a rise in the occurrence of insect pests, which ultimately lead to

yield losses. For rural farmers whose livelihoods directly depend on agriculture and other climate-sensitive industries, it will have major environmental and socioeconomic effects. Understanding how crop plants, insect pests, and their natural enemies respond to abiotic stress is crucial for developing new plans for pest management initiatives in the future.

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