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THE EFFECTS OF CLIMATE CHANGE ON THE MULBERRY INSECT FAUNA IN INDIA'S TEMPERATE AND SUBTROPICAL REGIONS

Tripathi V. K.
Deptt. of Zoology T. D. College Jaunpur

Tiwari A. K.
Deptt. of Zoology Dr. B.S. Porte Govt. College, Pendra C. G.

Singh Prashant
Director Vindeshwary Fish Tal Jaunpur
Corresponding Author : sncpga@gmail.com

ABSTRACT:

Climate change is likely to be recognised as a severe threat to the existence of species and the integrity of the environment on a global scale. Global warming gases (GHGs) such as carbon dioxide (CO2), methane (CH4), and nitrous oxide (NO2) are the primary cause of the increase in global temperatures (NO2). Combustion of fossil fuels, rapid industrialization, deforestation, agricultural activities, luxury/modernization of lifestyle (including home appliances), the expansion of space travel, grazing of livestock, wetland destruction, and land use change are all factors that contribute to an increase in these greenhouse gas emissions. Other elements that have a role are as follows: Although the influence of climate change on soil health and the sericulture industry has not yet been proven, a variety of hypotheses have been advanced to explain why this is happening. According to a number of academics from different Indian institutes, the buildup of human greenhouse gases in India's atmosphere over the next several decades would have a substantial impact on sericulture practises and the economy of the country's temperate areas. The tropical parts of India might have a somewhat positive or helpful influence as a result of this. Despite the likelihood of severe damage to sericulture in tropical regions like as Karnataka and Tamil Nadu, Andhra Pradesh, and West Bengal, minor to marginal losses may be seen in Jammu and Kashmir, and the Sub-Himalayan region of northeastern India.

INTRODUCTION:

Climate change is likely to be recognised as a severe threat to the existence of species and the integrity of the environment on a global scale. It is largely regarded to be the most important and urgent danger to human existence that has been or will exist throughout the twenty-first century. Statistically, a rise in the mean or variability of the climate over a long period of time (often many decades or more) may be ascribed to natural internal processes, external forcing, or long-term human changes in the composition of the atmosphere or land use. It has been said that human activity alters the global atmosphere, which is in addition to natural climate variability seen over comparable periods of time by the United Nations Framework Convention on Climatic Change (UNFCCC). Under the United Nations Framework Convention on Climate Change (UNFCCC), there is a distinction between human-induced climatic change and naturally occurring climate variability.

Since the beginning of the industrial revolution, the temperature of the atmosphere has increased. Some experts think that fossilised tree leaves dating back 55 million years have led them to conclude that the globe was warming at the time. It has also been suggested that climate change was responsible for a three-fold rise in CO2 levels during the Paleocene epoch. Global warming gases (GHGs) such as carbon dioxide (CO2), methane (CH4), and nitrous oxide (NO2) are the primary cause of the increase in global temperatures (NO2). Burning fossil fuels, fast industrialization, deforestation, agricultural operations, luxury/modernization of lifestyle (home appliances), space exploration, grazing, wetland degradation, and land use change are all causes that are causing a rise in these greenhouse gases emissions. Human action is one of the other variables. Global warming is predicted to increase by 1.4oC to 5.8oC on average between 1990 and 2100, according to climate models based on the increase in greenhouse gases. This may result in a more rapid increase in temperature at the surface of terrestrial zones and more dramatic local fluctuations, according to climate models. According to the Intergovernmental Panel on Climate Change, if global temperatures increase by around 2.0 degrees Celsius over the next 100 years, the harmful consequences of global warming will begin to spread to the majority of areas of the globe. It is predicted that 20 percent to 30 percent of plant and animal species would be threatened with extinction as a result of climate change. Another forecast made by the IPCC was that climate change might be a result of a variety of scenarios by the end of the century:

- Temperatures are expected to climb between 1.8oC and 4.0oC, with a range of 1.1oC to 6.4oC conceivable.
- A sea level increase of 28 to 43 centimetres is most expected.
- It's possible that Arctic summer sea ice may vanish by 2050 or so.
- It is quite probable that the number of heatwaves will rise.
- A possible rise in the strength of tropical storms.

1.1 Global Scenario of Climate Change:

According to the Intergovernmental Panel on Climate Change (2007), worldwide GHG emissions from industrialization and housing (69.1 percent) and agriculture and associated sectors (including deforestation) (31.9 percent) account for roughly one-third of total global GHG emissions in 2004. The breakdown of annual greenhouse gas emissions by industry is provided. In terms of total global greenhouse gas emissions, CO2 accounts for about two-thirds of total emissions; however, only 18 percent of total emissions are attributed to CH4, and only 9 percent are attributed to N2O emissions. Agriculture and its associated sectors are also considered to be responsible for more than a third of all CO2 emissions, half of all CH4 emissions, and two-thirds of all N2O emissions, according to some estimates. In contrast, agriculture is one of the few businesses capable of both reducing emissions and sequestering them in agricultural soils, making it one of the most environmentally friendly. In addition to decreasing its own emissions, soil carbon sequestration in agricultural soils may be able to offset emissions from other sectors, such as transportation.

1.2 National Scenario of Climate Change:

India's energy sector accounted for more than two-thirds of the country's net CO2 eq emissions (58 percent), followed by the industrial sector (22 percent), agricultural (17 percent), and garbage (11 percent) (3 percent). When it submitted its report to the United Nations Framework Convention on Climate Change, the Indian government stated that sea

level rise in the coming decades could inundate large areas of the western coast, from Gujarat through the Konkan to southern Kerala, and cause significant damage to river mouths on the eastern coast. These are the dangers that experts believe exist. Furthermore, it has been predicted that some coastal locations may entirely disappear in the future. Summer monsoon rains provide 75 percent of India's total annual precipitation, making agriculture a highly dependant industry in the nation. Floods will occur in certain areas, while droughts will occur in others, according to the climate model. Furthermore, according to a World Bank study, drought-prone areas in Andhra Pradesh and Maharashtra, as well as flood-prone districts in Orissa, are already approaching their climatic tolerance limits. Climate change is likely to raise temperatures by 4.0 degrees Celsius in some portions of Kutch and Rajasthan in the next decade, according to a recent report. It is also estimated that the average temperature in India has risen by around 0.5 percent during the previous century or so as a result of human-caused greenhouse gas emissions. The consequences of recent emissions will take decades to manifest themselves, and global temperatures are expected to rise by more than 2.0 degrees Celsius if current patterns continue. Several Indian academics predict that the buildup of human greenhouse gases in the atmosphere will cause temperatures to rise by 0.5 to 4.0 degrees Celsius in various parts of the country over the next several decades, which will have a significant impact on Indian agricultural and sericulture economic practises.

SERICULTURE INSTITUTIONAL SETUP IN INDIA:

The Central Silk Board, which is governed by the Ministry of Textiles of India's Ministry of Textiles, is a statutory organisation with official status. It was created in April 1949 in line with an Act of Parliament, making it one of the first commodities boards to be constituted. (Act No. LXI of 1948, as amended.) The Central Silk Board is responsible for overseeing and developing the country's silk industry, which includes all sericultural endeavours (CSB). Currently, the Central Silk Board has an excellent institutional structure, with research and development wings located in several regions of the country that collaborate on a variety of projects.

Research and development activities are carried out by the BSMTC, BTSSO, the Central Sericultural Germplasm Resource Center, Raw Sliks Material Banks, Regional Offices, Seed Coccon Procurement Center, Seribiotech Laboratory, Textile Testing Laboratory, and the Seri Kisan Call Center, among others, in various parts of the country. As well as having their own departments that offer master's degrees in sericulture and have full-fledged research and development units to help the sericulture sector grow, state governments, other central and state institutions, and other private organisations also have their own departments that provide master's degrees in sericulture.

2.1 Impact of climate change on Sericulture:

Because it is a poikilotherm (highly sensitive to temperature fluctuations), the silkworm Bombyx mori (Lepidoptera) belongs to the order Lepidoptera. The temperature range of 24–28 degrees Celsius is good for silkworm development. According to current forecasts, the cultivation area of the mulberry tree may be diminished as a consequence of global climate change. Enzymes found in the mesophyll of C4 plants, such as mulberries (Morus alba), are more efficient in fixing CO2 than enzymes found in the mesophyll of C3 plants (Morus alba). ribulose biphosphate carboxylase/oxygenase (RuBis CO) is an enzyme that is used by C3 plants to react with CO2 in the presence of ribulose biphosphate (RuBP), which has a low substrate specificity. To

compensate for this inefficiency, the stomata of C3 plants remain open for a longer period of time, resulting in an increase in evapotranspiration. Or, to put it another way, C3 plants thrive in colder, wetter climates with greater CO2 concentrations than C2 plants.

Higher CO2 levels, in the absence of other stressors, have the potential to increase plant yield through photosynthesis and stomatal conductance. However, the beneficial direct impact of elevated CO2 can be offset by other effects of climate change, such as increased temperatures, higher tropospheric ozone concentrations, and altered precipitation patterns. Increased CO2 levels may be beneficial to C3 crops. It is possible to have both direct and indirect effects on the environment due to climate change. Direct effects include changes in temperature, precipitation, or carbon dioxide concentrations; indirect effects include changes in soil moisture, as well as the distribution and frequency of pests and diseases.

In recent years, several pests and diseases have been discovered to be severe restraints on the production and productivity of mulberry leaves as a consequence of intensive growing practises and the indiscriminate use of pesticides and nitrogenous fertilisers. Because of changes in climate and agriculture, insect pests of mulberry have also evolved and adapted to new environments. In addition to the Bihar hairy caterpillar (Diacrisia oblique), the Pink mealybug (Maconellicoccus hirsutus), the Thrips (Pseudodendrothrips mori), and other mites, there are rootknot disease (Metloidogyne incognita), leaf rust (Peridiospora mori), and other diseases. In mulberry, it is reported that the pink mealy bug Maconellicoccus hirsutus has 346 host plants and causes leaf yield loss of 4500 kgs/ha/year. This results in farmers being denied the opportunity to brush their mulberry fields for 450 dfls/ha/year and their cocoon output declining by 150 kgs/ha/year. Karnataka has been home to an aggressive leaf webber called as Diaphania pulverulentalis since 1995, when it first appeared in Tamil Nadu and Andhra Pradesh. Since then, it has spread to other states, including Tamil Nadu and Andhra Pradesh. During the months of October to February and October to December, D. pulverulentalis is more widespread in the Krishnagiri and Salem regions than in the rest of the country. The bug also had a negative impact on leaf yield, which was cut by 12.8 percent (average incidence: 21.77 percent). The phenotypic expression of an organism is significantly influenced by environmental factors such as temperature and humidity.

SERICULTURE IN INDIA:

In India, sericulture has been practised since ancient times. The silk worms were carried to India from China through Tibet, according to some theories; however, others believe that the silk worms were tamed by Aryans and tribes in the Himalayas and later spread to other parts of the nation. According to the Hindu epic chronicles, sericulture was practised in India more than 2000 years ago, according to the Vedas. Sericulture contributes significantly to the economy. Sericulture was in full bloom in India long before the arrival of Dutch and English traders, and it was only 500 years ago that it gained prominence. Kashmir and West Bengal, respectively, are the most ancient locations for breeding silkworms and creating bivoltive and multivoltine silk, according to historical records. Because to the East India Company's control over the silk industry from 1761 to 1795, India was able to export 2.4 million kg of silk each year throughout that period. For a long period of time in the 16th and 17th centuries, the East Indian Company imported a considerable quantity of raw silk and silk goods from India. Raw silk from India is sent to England in the years 1772, 1785, and 1795 at rates of 180000, 324307, and 38035 lb per year, respectively.

Currently, the states of Karnataka, Kerala, Andhra Pradesh, Tamil Nadu, Assam, Uttar Pradesh, Uttaranchal, Madhya Pradesh, Bihar, Maharashtra, Manipur, Himachal Pradesh, Punjab, Meghalaya, Arunachal Pradesh, Gujarat, Mizoram, Nagaland, Orissa, and Tripura produce nearly 97 percent of the country's mulberry silk. Other states that produce mulberry silk include Gujarat, Mizo

A total of five different varieties of silk are produced across the world: Mulberry silk, tropical tasar, eri, muga, and temperate (or oak) tasar. India is the world's second-largest producer of raw silk, behind China, and the country is the world's largest purchaser of both raw silk and silk garments. Muga silk (Antheraea assama Helfer), wild tasar silk (Antheraea mylitta Drury), wild mulberry silk (Bombyx mori L.), semi-domesticated Eri silk (Philosomia ricini Boisdual), and mulberry silk (Bombyx mori L.) are the only types of silk produced in India (Antheraea assama Helfer). A total of 35,261 metric tonnes (MT) of raw silk was produced by the Mulberry plant in India in 2018-19, accounting for 71.50 percent of the entire output. Tasar accounted for 8.44 percent, Eri for 19.40 percent, and Muga for 0.66 percent of the interim total raw silk production. India's raw silk production increased by 10.52 percent (35261 MT) in 2018-19 as compared to the previous year (31,906 MT). The production of bivoltine raw silk reached a new high of 6,911 MT in 2018-19, representing a 17.6 percent increase over the previous year (Central Silk Board, 2019). The Central Silk Board published a report in 2019 stating that

Agriculture and agro-based firms play a crucial role in rural economic growth in developing countries such as India, where they are particularly important. Sericulture is one of the numerous rural enterprises that have sprung up as a consequence of a shortage of land, a lack of economic returns, and the fact that farming can only be done in one or two seasons out of the year. Sericulture is a kind of agriculture that involves growing plants in a pond. Women in rural areas have a plethora of options to work with silk worms, while their male colleagues are out in the fields harvesting crops. It has lately emerged as a main employment as well as a substantial cash crop for the country as a result of the development of new technologies in mulberry cultivation and silkworm handling by sericulturists, owing to the efforts of scientific and technological institutions. Sericulture has been mentioned as a prospective career choice because to its minimal initial investment, high productivity, and ability to generate revenue. The industry, especially in rural and semi-urban areas, offers tremendous potential as a source of job opportunities.

It is important to note that the silkworm b. Mori only eats the leaves of the Morus alba L. (Urticales: Moraceae) plant, which serves as the silkworm's only source of nutrition. To ensure the continued expansion of the silk industry, the quality and quantity of silkworm cocoons are crucial. So in order to achieve the goal of high-quality cocoon production, a variety of factors, including mulberry leaves (38%), weather types (37%), rearing techniques (9.3%), silkworm races (4.2%), silkworm eggs (3.1%), and other factors (8.2%), must be considered. Mulberry leaves (38%) and weather types (37%) are the most important factors to consider.

PESTS AND DISEASES OF MULBERRY:

When it comes to raising the silkworm cocoon production, a number of factors, such as mulberry leaf quality and silkworm ramping, are important considerations to keep in mind. To achieve a high-quality and large-quantity cocoon crop is possible via the use of a suitable raising house, the maintenance of appropriate sanitary conditions and cleanliness, and the preservation of the crop, among other methods. All of these variables must work together in

order to get the optimum cocoon yield. As a result, in Indian farming, quality of the mulberry leaf is the most crucial factor to consider since it has a greater influence on silk quality than any of the other characteristics. Consequently, the nutritional content of the mulberry leaf is crucial to the production and quality of silk thread. Due to the fact that the mulberry leaf is easily available throughout the year, there are a variety of ailments and pests to cope with. Scientists have found mulberry pests that are both insect and non-insect based in nature.

Mulberry pests are divided into two categories: non-insect mulberry pests and insect mulberry pests. Non-insect mulberry pests are the more common of the two. Despite the fact that there are several insect pests in the mulberry system, only a few non-insect species, such as mite and snail populations, have been identified as causing consistent damage to the plantation. The majority of mulberry pests may be divided into three groups depending on how they feed: sap suckers, defoliators, and borers. Sap suckers are the most common form of mulberry pest. Sap suckers utilise a stylet (a needle-like stalk) to breach the plant cell wall on the mulberry leaves or stem in order to get access to the juice contained inside the plant cells. This permits them to extract the sap from the tree. There are a variety of variables that contribute to the formation of an undersized mulberry plant, including sap suckers that remove nutrients from the leaves while sucking. When the honey dew created by the sap sucking bugs, which is the principal source of black sooty mould, accumulates on the mulberry leaves, the leaves become worthless as a consequence of the damage that has occurred. Sap-sucking insects inject hazardous substances into the plants, causing them to droop. Some sucking insects also serve as vectors for the transmission of plant disease, causing the plants to droop. Mealy bugs, thrips whiteflies, scale insects, and a few different species of mites are among the most common sap draining pests of mulberry trees. The second type of mulberry pests, known as defoliators, is distinguished by the presence of mouth parts that are specially adapted for biting and chewing on different portions of the plant. These pests cause the leaves of mulberry trees to become skeletonized, or the whole plant to be defoliated. Caterpillars, beetles, and grasshoppers are examples of defoliators, but they are not the only ones. 3) The stem borers are a third kind of mulberry insect pest that burrows into the stems of the plants and destroys the tissue inside the stems. Regardless of the large number of pests that contaminate and injure the mulberry (in excess of 300), just a small number of these mulberry pests are believed to be critical for its survival.

4.1 Impact of climate change on insect pests:

Climate change has the potential to have a large impact on agricultural pests that attack irrigation systems. Changes in phenology, dispersion, community composition, and ecosystem dynamics are all influenced by climate change, which has an impact on insect pest populations. Pest host ranges may expand, natural enemy synchronisation may be broken, and the frequency of pest breakouts and upheavals may increase as a result of these changes. Climate change affects insect populations in a number of ways, and as a consequence, insects' status as pests alters as well. The increased vegetative growth and bigger crop canopy, as well as the thick foliage, caused by increasing CO2 levels make pests more likely to survive in a more humid micro-environment as a result of increased CO2 levels. Increasing temperatures have the potential to cause pest populations to reemerge unexpectedly if the quality of food, i.e. the nitrogen content of plants, increases as a result of the increased temperature. Stress also has the additional impact of decreasing the efficiency of

plant defence systems, leaving plants more sensitive to pests. In order to account for this variation, the effect of temperature on insect pests varies from species to species.

As a result of the movement in the classification of numerous pests from secondary to primary, a number of minor pests have been upgraded to major pest status, as well as a few new pests. In general, the severity of Helicoverpa armigera (Hubner), the incidence of mealy bugs, particularly Phenacoccus solenopsis Tinsley and Paracoccus marginus on cotton, sugarcane woolly aphid, Ceratovacuna lanigera Zehntner, and tobacco caterpillar Spodoptera litura (Fabricius) on several crops, as well as the severity of Helicoverpa armigera (Hubner), has declined Boisduval, a variety of mirid species, as well as the pigeonpea-damaging Maruca vitrata (Geyer), as well as the silver-leaf whitefly Bemisia argentifolii, the sugarcane leafhopper Pyrilla perpusilla, and other species, are among the pests that have been found in rice. On the plantain, the walker, Tanaostigmodes cajaninae, feeds on pigeonpea; the diamondback moth, Plutella xylostella (Linnaeus), feeds on cruciferous crops; the rhinoceros beetle, Oryctes rhinoceros (Linnaeus), feeds on coconut and oil palms; the Tea mosquito bug, Helopeltis antoni It's a great moment to be a Meyric right now. When it comes to species and biodiversity, climate change will have the greatest impact. According to an assessment of over 1700 species, it has been projected that 15 percent to 37 percent of wild species might go extinct by the year 2050 if global warming continues at its current rate. Pest outbreaks are caused by a variety of circumstances, but human activities (such as plant trade, the unintended introduction of vectors for certain diseases, changes in agricultural practises or land usage) are commonly recognised as having a substantial influence. If pests are introduced to new areas, they have the potential to have a significant economic and environmental impact. Official control expenditures for fireblight (Erwinia amylovora) in Switzerland, for example, were estimated to have totaled 19 million euros between 1989 (when the sickness was first discovered) and 2007.

DISEASES OF MULBERRY PLANTS:

Mulberry yields that are below average might be linked to a number of circumstances, including mulberry tree diseases. It is possible that fungus, bacteria, or viruses are responsible for mulberry sickness, as well as nutritional deficiencies and a range of other reasons. Mulberry plants are prone to a variety of illnesses, which are widespread in areas where the fruit is farmed. Different parts of the plant are sensitive to different diseases. Certain mulberry pests and illnesses obstruct J&K's attempts to promote sericulture by destroying many of the state's cocoon harvests, which is one of the state's focus areas for improving sericulture. This group of diseases, which are both airborne and soil-borne, cause a 10-20 percent reduction in both leaf yield and leaf quality. Mulberry diseases may be divided into two categories:

5.1 Foliar Diseases:

Leaf spot: Cercospora moricola is the bacterium that causes this sickness. Variable-sized brownish black specks with uneven distribution might be seen. This disease affects mulberry crops mostly during the rainy season and its leaves are unsuitable for silkworm rearing. It is responsible for 10-12 percent of the total loss of mulberry crops.

Powdery mildew: Phyllactinia corylea is the bacterium that causes this illness. Crop losses from this disease range from 5 to 10 percent, with the majority occurring during the winter and monsoon seasons.

Leaf rust: Serotelium fici is the fungus that causes leaf rust. A higher incidence of the illness occurs throughout the winter months and during times of heavy rains. The disease mostly damages the plant's mature leaves.

5.2 Root Diseases

Root knot: Meloidogyne incognita is the disease's primary causative agent (nematode). During the course of the year, this illness is most prevalent in sandy sills that have been watered. Some 20% of mulberry production is lost to this disease.

Root rot: Rhizoctonia bataticola (Macrophomina Phaseolina) and associated microorganisms such as Fusarium solani F. and oxysporum/Botriodiplodia theobromae are the primary causes of this disease. Mulberry might lose up to 15% of its yield to this disease, depending on the environment and the condition of the soil.

Mulberry silk accounts for 76% of the country's total raw silk production. Consequently, the best mulberry silk can only be produced using high-yielding mulberry types and silkworm breeds. While cocoon quality is dependent on the quality of mulberry leaves, they should also be rich in nutrients.

CONCLUSION:

Soil health and the sericulture business may be negatively affected by climate change, however the cause of this has yet to be determined, although numerous hypotheses have been put up. In the next few decades, several researchers from various Indian institutions predict that the accumulation of anthropogenic greenhouse gases in the atmosphere could raise temperatures from 0.5 to 4.0o in various parts of India, changing practises and economies of sericulture dramatically in the temperate region and marginally or positively in the tropical region. Emerging pests are of special concern on all continents in light of increased global commerce and climate change. An increasing number of scientists are concerned that the emergence of these new species is not only inflicting direct crop losses to the agricultural and associated industries, but may also damage ecosystems and be responsible for biodiversity loss. All those involved in plant health face significant hurdles when new pests emerge (citizens, researchers, growers, plant protection services, international bodies, etc.). The biology and epidemiology of emerging pests, as well as the reasons behind pest emergences, both need more study. Tools to anticipate the spread and establishment potential of pests are also needed to be developed and improved upon. Emerging pest control relies heavily on prompt discovery and the availability of appropriate diagnostic instruments. Efforts should continue to be made to enhance information sharing and collaboration throughout the many areas of the globe since these species pose a danger to both cultivated and non-cultivated settings. The impact of climate change on sericulture is based on predictions and has not yet been confirmed. [Read more...] about as a result of climate change, tropical areas like Karnataka, Tamilnadu, Andhra Pradesh, West Bengal and Uttar Pradesh would be badly impacted, while small losses may be seen in Jammu Kashmir and the Sub-Himalayan region of North-Eastern India.

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