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Impact of Climate Change on Honey-Bee Populations and Diseases

Isha Slathia and N. K. Tripathi

Department of Zoology,
University of Jammu, Jammu-180001, Jammu and Kashmir, India

(Corresponding author: Isha Slathia, 18ishasingh@gmail.com)
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ABSTRACT: *Apis mellifera*, is the most economically valuable pollinator of agricultural crops worldwide. Bees are also crucial in maintaining biodiversity by pollinating numerous plant species whose fertilisation requires an obligatory pollinator. *Apis mellifera* is a species that has shown great adaptive potential, as it is found almost everywhere in the world and in highly diverse climates. In a context of climate change, the variability of the honey bee's life-history traits as regards temperature and the environment shows that the species possesses such plasticity and genetic variability that this could give rise to the selection of development cycles suited to new environmental conditions. Although we do not know the precise impact of potential environmental changes on honey bees as a result of climate change, there is a large body of data at our disposal indicating that environmental changes have a direct influence on honey bee development. In this article, the authors examine the potential impact of climate change on honey bee behaviour, physiology and distribution, as well as on the evolution of the honey bee's interaction with diseases. Conservation measures will be needed to prevent the loss of this rich genetic diversity of honey bees and to preserve ecotypes that are so valuable for world biodiversity.

Key words: *Genetic variability, plasticity, fertilization, physiology, bio-diversity*

INTRODUCTION

At every bite of food, one must thank either a bee or a bird or an insect or a mammal for their pollination services. *Apis mellifera*, is the most economically valuable pollinator of agricultural crops worldwide. Bees are also crucial in maintaining biodiversity by pollinating numerous plant species whose fertilisation requires an obligatory pollinator. Pollination is not only mutually beneficial to interacting plants and animals, but also serves humanity directly through the yield of many crops, and indirectly by contributing to the healthy functioning of unmanaged terrestrial ecosystems (Costanza *et al*, 1997, Nabhan and Buchmann, 1997, Klein *et al*, 2007, Abrol, 2007, 2008). From the data of 200 countries, 35% of world food production depends on pollinators. Of 115 crops, 90 crops entirely depend on bee pollinators. The potential impact of climate change is on honey bee behaviour, physiology and distribution, as well as on the evolution of the honey bee's interaction with diseases. A change in climatic conditions is bound to have an impact on the survival of these ecotypes or on honey bee species that are closely associated with their environment. Migration and changes in their lifecycle and behavior could help them to survive in new biotopes. Climate change could destabilize relationships between flowers and pollinators, and pollinators will need to be protected to ensure that they continue their

pollination function, which is so important for the economy and for the ecological balance; a recent molecular study confirmed the significance of the evolutionary branches of *Apis mellifera*. Anthropogenic changes in habitats and climate have resulted in various kinds of disorders like colony collapse, attack of mites-*Varroa* destructer, protozoans-nosema, bacteria and virus. Varroa weakens the bee's immune system and encourages viral growth (Chen *et al.,* 2006).

MATERIAL AND METHODS

The material consisted of different populations of *Apis mellifera* Family Apidae which were collected from the nests or hives associated with plants and vegetation and also from their natural habitat. All the samples were suffering from symptoms of depopulation, sudden collapse, paralysis or dark colour and varroa infestation. To compare the virus loads in diseased and apparently healthy colonies, another 15 bee samples were obtained from healthy colonies of selected apiaries. From every sample, 60 bees were investigated for *Nosema apis* spores and *Malpighamoeba mellifica* cysts. The abdomens were separated from the thoraces; they were crushed and homogenized in 3 ml of water. Three drops (100 µl) of the suspension was placed onto a slide, covered by a slip, and examined under a light microscope, initially at a magnification of x200, followed by a magnification of x400. To detect infestation with the tracheal mite *Acarapis woodi*, the thoraces of 50 bees from each sample were dissected. The heads and forelegs were removed, and the thoraces were cut in front of the middle pair of legs and at the base of the forewings. These thin disks were placed into glass vials containing 8% KOH solution and heated in a boiling water bath for approximately 20-min until the muscle tissues were macerated. After heat treatment, the exposed first pair of thoracic trachea was examined under a dissecting microscope (magnification, x20 to 40X. In case suspicious color changes were found in the trachea, the affected trachea was removed from the thorax and examined at a magnification of x200 under a light microscope to detect infestation with *Acarapis woodi*. All bee samples were visually examined for *Varroa destructor* mites.

RESULTS AND DISSCUSSIONS

Climate change can have an impact on honey bees at different levels and it can have a direct influence on honey bee behaviour and physiology. It can alter the quality of the floral environment and increase or reduce colony harvesting capacity and development. Climate change may lead to a sharp increase in rate of extinction.

Table 1: Expected increase in crop yield due to bee pollination.

Crop	Pollination requirements	Expected percent increase in yield due to cross-pollination	No. of bee colonies needed per ha.
Almond	Highly cross pollinated	20	5 - 8
Apple	Highly cross pollinated	20	2 - 3
Citrus	Often cross pollinated	20	2 - 3
Coconut	Pollen transfer is essential	5	2 - 3
Grape	Often cross pollinated	20	2 - 3
Guava	Cross pollinated	10	2 - 3
Mango	Bee visit is helpful	3	2 - 3
Papaya	Pollen transfer is essential	10	2 - 3
Mustard rape	Mostly cross pollinated	20	3 - 5
Sesamum	Often cross pollinated	20	2 - 3
Sunflower	Cross pollinated	20	2 - 4
Cotton	Often cross pollinated	10	2 - 6

Table 2: Population decline of honeybees in world scenario.

Country	% age decline	Duration
Germany	57	Last 15 yrs.
U.K	61	Last 10 yrs.
U.S.A	>50	Last 20 yrs.
Poland	>35	Last 15 yrs.
India	>40	Last 25 yrs.
Brazil	>53	Last 15 yrs.
Netherland	58-65	Last 25 yrs.
China	>50	Last 20 yrs.

Thomas *et al.,* (2004) studied five regions of the world and predicted that if the present rate of climate changes continues, 24% of species in these regions will be on their way to extinction by 2050. It can define new honey bee distribution ranges and give rise to new competitive relationships among species and races, as well as among their parasites and pathogens. From present investigations it was observed that Climate change had lead to movements of honey bees of different species and races, bringing them into contact with pathogens with which they had never co-evolved, as had occurred with *Varroa* destructor and *Apis mellifera*. It was observed that climatic changes influenced honey bee foraging and colony development due to reduction in nectar and pollen production. Climatic changes led to formation of new biotypes from ecotypes which may or may not be resistant to various parasites and pathogens. Present status of beekeeping in Kashmir Division (2009-2011) 2009:35,000 out of 40,000 *Apis mellifera* bee colonies had died by the end of December. Up to 31 Feb. 2011: 36,000 out of 40,000 wiped out. After *Varroa destructor* invasion in Jammu 7000 out of 31,000 and in Kashmir 4000 out of 40,000 colonies are left. Honey Bees and other species that pollinate plants life are declining at alarming rate which has threatened the existence of plant life and this downward trend could damage dozens of commercially important crops. A decline in pollinator populations is one form of global change that actually has credible potential to alter the shape and structure of terrestrial ecosystems. The decline in pollinator population and diversity presents a serious threat to agricultural production and conservation and maintenance of biodiversity in many parts of the world. One indicator of the decline in natural insect pollinators is decreasing crop yields and quality despite necessary agronomic inputs. The honeybees, pollinate more than 90 commercial crops, have declined by 30 percent in the last 20 years. This has posed a great challenge to agricultural production.

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