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Studies on papilio polymnestor as a bio-indicator species of climatic changes

Manisha N Kulkarni[1], Swapnesh S Rangnekar[2]
[1] Department of Zoology, Institute of Science, Madame Cama Road, Fort, Mumbai, Maharashtra, India
[2] Department of Environmental Studies, SIWS N. R. Swamy College of Commerce and Economics, Mumbai, Maharashtra, India

Abstract
Climate change is not new and species have traditionally responded to these changes over evolutionary timescales. Climate change poses a great risk to biodiversity acting upon other drivers. The key question today is how will organisms respond to the current apparently rapid rate of anthropogenic climate change? By using butterflies as an early warning indicator, effects of future climate change scenarios can be determined. The present study was focussed on Blue Mormon (*Papilio polymnestor*) as a bio-indicator of climatic changes. The butterfly is most common in forests that receive heavy rainfall, leading to evergreen vegetation. It is more common in late monsoon. The research authors have confirmed the appearance of the species in early winter and late winter. The unusual appearance can be correlated with extended rainfall pattern in the research area. The reasons for such climatic changes are numerous. The strategic threats posed by global environmental and development problems are the most complex and potentially devastating of all the challenges to our security. In order to mitigate these worse effects policy makers should aim to execute eco-friendly practices. Approaches could include changes in conventional agricultural practices, afforestation programmes, designing and implementing waste management plan, controlling indiscriminate urbanization, etc.

Keywords: *papilio polymnestor*, climate change, butterfly, bioindicators, eco-friendly practices

Introduction
Environmental problems are always inter-related. A solution to one problem may create another concern. Human activity over the past 200 years had a profound influence on our planet. Many environmental problems which the world is facing are due to over-population and degradation of present environmental conditions. Along with the rapid population growth, the ecological damages are also increasing exponentially.

Global warming is believed to be to be one of the central environmental issues. It poses a large risk not only to water table, fuels, minerals, forests, atmosphere, etc. but also to the biodiversity and wildlife habitats. According to the report of Inter-Governmental Panel on Climate Change (IPCC) set up by United Nations Environment Programme (UNEP), the globe is already 0.5 degree Celsius warmer than the pre-industrial times. The world has started suffering from its consequences such as rise in temperature, increased sea level, recurring natural disasters, etc.

Smaller wild species as a unit are actually very efficient sensors of environmental changes. This is equally true in case of butterflies. Butterflies, like all insects, are poikilothermic (cold blooded) organisms and climate change affects their rate of development, physiology, behaviour, ecology and reproductive success. Because of their quick response to a variety of phenomena, from habitat loss to global warming, butterflies make admirable indicators of climate change. Scientists have found a strong connection between butterfly population fluctuations and weather. The European Commission has taken the initiative to study the climatic changes by using butterflies as biosensors as mentioned in their report. It may not be just an effect on the butterfly population; climate change also affects the survival of larval food plants through drought or flood.

The current study uses "Blue Mormon butterfly (*Papilio polymnestor*)" as an early warning indicator of climate change scenarios. This is a very large, black coloured butterfly with glistening pale blue markings. It is a Swallowtail butterfly included in family Papilionidae. Because of a longer wingspan, it has good migration capacity. The butterfly has been very well studied by Mr. Keihimkar (Bombay Natural History Society, Mumbai) and the behaviour pattern is noted in the guide book – "The Book of Indian Butterflies". It is most common in the forests that receive heavy rainfall, due to which evergreen vegetation is predominant. It also occurs in wooded urban areas in which its larval host plants are predominant. It is endemic to peninsular India and Sri Lanka. It is more common in late monsoon.

Fig 1: Blue Mormon (*Papilio polymnestor*) found in the research area

A number of researchers have worked on the butterfly diversity in the vicinity of the current research area. Aitkin and Comber reported 95 species from Mumbai and its surroundings (1903), Best (1951) reported 105 species from Mumbai. Kurve and Pejavar (2004) documented 41 species of butterflies from Bandodkar College Campus located in the city of Thane whereas Kurve and Patwardhan (2005) documented 56 species from the same locality. But there are a very few recent studies conducted for such small green areas. A number of researchers in India have studied the migration pattern of the swallowtail butterflies. It indicates that Blue Mormon is seen throughout the year in southern states except in the months of June and July. It is seen in the Western Ghats of Maharashtra in post monsoon period after which it disappears in winter season. His pattern was rightly documented by Dr. Kunte in his book "Butterflies of Peninsular India" and Arun P. R. through his research.

Materials and Methods

Study area: A village– "Vanjarwadi" located in the northern Western Ghats was selected as a research area. The research area has its own importance as Western Ghats is one of the "Biodiversity Hotspots". The village is located in Raigad district of Maharashtra, India. Earlier less important area, it was the agricultural land for local tribes. Currently, the region is amongst various human interventions. It is located at a distance of 45 km from Mumbai, 46 km from Thane and 32 km from Navi Mumbai – all being highly urbanised and industrial areas. The research area has several ecologically important regions around such as Mor be dam (5 km), Karnala bird sanctuary (16 km), Matheran hill station (12 km) and Rasayani industrial estate (4 km).

The average temperature in summer varies from 27 to 39 degree Celsius while the average winter temperature varies between 11– 26 degree Celsius. July to September provides medium levels of rainfall and the area looks beautiful during monsoons with lusting greeneries. The area is adry deciduous forest. The vegetation mainly includes *Ficus bengalensis, Tectona grandis, Bauhinia racemosa, Bombax ceiba, Ficus religiosa, Etlingera elatior, Bambusa bambos, Delonix regia* etc. Thus the region is a profusion of indigenous as well as exotic varieties. The characteristic of the area is the flowering plants such as *Lantana Camera, Lantana involucrata, Ipomoea quamoclit, Hibiscus rosa-sinensis, Tagetes erecta,* etc. These species are excellent attractors of butterflies.

Data Collection: The Vanjarwadi research area was extensively surveyed during the research period of January 2010 to January 2011. This twelve month study included several trails within the area to trace the butterfly diversity, especially the presence of Blue Mormon variety. The method involved Standard walk method given by Pollard and Pollard and Yates that involves walking along the paths and simultaneously recording the species diversity. Existing paths were used for the walk. The species were recorded on the sunny days from 08:00 to 15:00 hours. The identified butterflies were directly recorded. "The Book of Indian Butterflies" by Kehimkar I., BNHS publications was used as a guide book for butterfly identification.

Results: The research area recorded the presence of 68 species of butterflies belonging to all the five families. Family Nymphalidae was found to be predominant while the family Hesperidae was the least common. The butterfly species such as Common Jezebel (*Delias eucharis*), Common Mormon (*Papilio polytes*), Common Albatross (*Appias albina*), Common Gull (*Cepora nerissa*), Common Evening Brown (*Melanitis leda*), Dingy Line Blue (*Petrelaea dana*), Grass Jewel (*Chilades trochylus*), Lime (*Papilio demoleus*), Common Pierrot (*Castalius rosimon*), Rice Swift (*Borbo cinnara*), etc were commonly found. These butterflies were attracted to natural puddles on rocky depressions, river banks as well as garbage dumps and burnt wood.

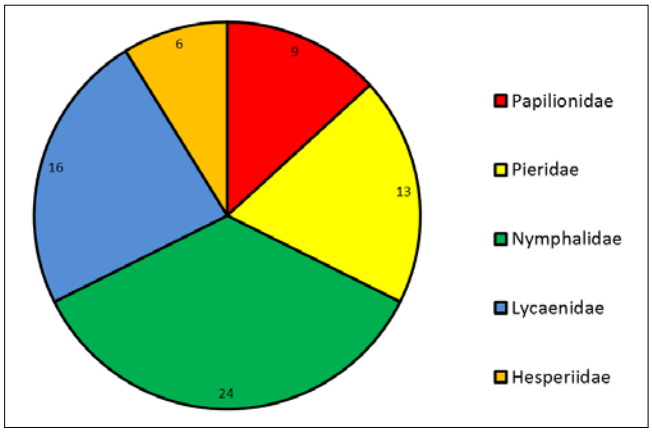

Fig 2: Butterfly distribution according to families in Vanjarwadi, Maharashtra, India.

Blue Mormon butterfly (*Papilio polymnestor*) was widely found to be present throughout the research area. According to its ideal behaviour, the butterfly was rarely seen in June-July. It made its appearance from early August onwards and the count was on the peek in late monsoon period. The butterfly was found in proximity to the flowering shrub varieties and around *Citrus* species. It was also seen in wet soil patches along the river banks in mud pudddling. The maximum density of the migrating butterfly was during 11:00 to 13:00 hours throughout the research period. The abundance slowly started declining from 15:00 hours onwards. The butterfly showed its appearance in winter from August to early January, after which it disappeared.

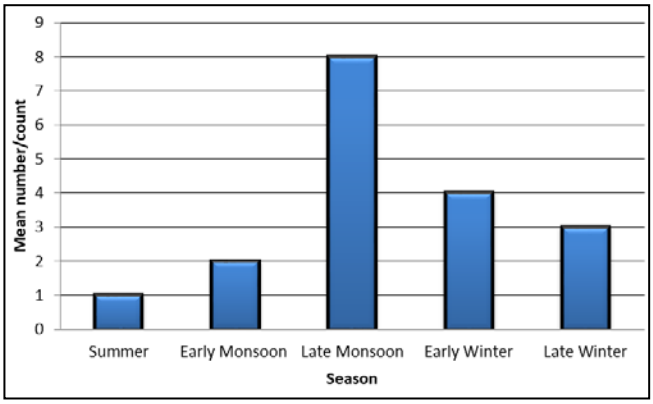

Fig 3: Seasonal distribution of Blue Mormon (*Papilio polymnestor*)

Discussion

The Blue Mormon butterfly survives in evergreen forests. The butterfly is a resident of southern Western Ghats as published by Dr. Arun P. R. through his research. It is a post monsoon visitor to northern Western Ghats in Maharashtra

but disappears in winter. This distribution pattern has been studied for a number of years by different researchers. This pattern is accurately documented by Dr. Kunte in the book "Butterflies of Peninsular India".

The said pattern was not followed this season as the butterfly showed its presence in winter season indicating climatic changes. The current season received a rainfall exceeding its usual duration of June – September. The extended rainfall pattern may be correlated to the regional climatic changes occurring because of several environmental problems. This also causes changes in migration pattern of the butterflies as was studied by George Mathew and C. F. Binoy in their research on migration of Blue Mormon and other swallowtail butterflies in India.

At present, the area is suffering from severe deforestation and replacement of indigenous plants with the exotic ones. It is increasingly turning the dry deciduous forest into a scrub forest. A number of anthropogenic activities such as mining, quarrying, brick manufacturing, etc. require soil for which the hills are destroyed. The soil from these excavations is piled up, that gets flushed off to the nearby river beds. It is causing siltation of rivers and eutrophication of lakes.

The land use pattern is also shifting gradually. A prior agricultural land is now converted into restaurants, resorts and other human settlements. This is further causing loss of green cover. The biggest threat to the local ecology is the lack of waste management system. The waste is open dumped and burnt. It further leads to fire hazards and increased local temperature. All of the above environmental hazards are causing climatic changes that are well indicated by Blue Mormon.

The research area is under regular threats from ever-expanding and ever-demanding urban settlements. In order to mitigate these worse effects, policy makers should aim to execute eco-friendly practices. The research scholars suggest probable solutions for reducing climate change effects. The recommendations include changes in conventional agricultural practices, increased use of renewable energy sources, preventing deforestation, increased afforestation programmes by plantation and seed dispersal, restricting area for grazing, restrictions on mining, quarrying and brick making, appropriate designing and implementation of waste management plan, controlling indiscriminate urbanization, exerting control over increasing restaurants, clubs, gaming zones, resorts, etc. Implementing sustainable development measures could restore environmental quality and help to minimize the adverse effects of climatic changes.

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