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Impact Of Global Warming On Biological Systems: Drosophila As A Tracking Organism.

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ABSTRACT

There is an elevation in the average temperature of the planet earth from about 0.3°C to about 0.6 °C and moreover in the last century there is rise in the sea level to about 4 to 10 inches. These changes are result of various anthropogenic activities like greenhouse gases, which persuade alternations in the environment, biodiversity and natural resources. Due to the rise in the temperature, there is rise in diseases and it influences the insects to get established in the northern region. Changes in climatic conditions causereduction in size and fragmentation of population and the population get`s segregated.In this review article, we tried to pile up the discernable effects of climate change.

1. INTRODUCTION

There is an optimum range of conditions that an organism can tolerate and perform it`s metabolic activities efficiently, as already mentioned the average temperature of the earth is increasing due to the rise in global issues. The tolerance range for any factor can be steno or eury, a warming at a lower end of the thermal range might be barely noticeable but warming at the upper end of the range could be catastrophic, shifting agricultural regions, threatening species with extinction and pushing tropical diseases into areas where they don`t exist currently. Due to climatic disruptions glaciers would melt and ocean waters would expand, flooding heavily populated low- lying places like Florida, the Netherlands and Bangladesh.
The spread of any vector borne disease mainly depends on the regional climate of any particular area. Many such diseases occur in warmer areas. Due to the elevation of the earth`s temperature, some of diseases that occur only in the tropical regions has more chance to spread to other parts of the world.
Thus, the earth's climatic system is facing a warmer phase. Increase in atmospheric concentrations of greenhouse gases leads to absorption of sun rays that is to be reflected back to the atmosphere and this have measurable effects on the earth's climate and is going to affect all life related forms and practices. For ecologists, physiologists and land managers the challenge is to predict the effects of human – induced climate and atmospheric change on species and communities.

2. CHANGES IN SPECIES DISTRIBUTION AND ABUNDANCE

Changes in the distribution and abundance of species due to climate warming can be easily perceived by considering insects as models because they can survive various environmental regions and constitutes half of all known species [1].Insects have shown modification in periodic life events, distribution and have experienced various evolutionary changes in response to climate warming. In most species the major alternation is seen in distribution /

abundances due to anthropogenic activities,mostly changes are attributed to the loss or alternation of habitat. The greatest amount of information on effect of climate change on insects comes from Europe and North America. As the temperature increases, species of insects accustomed to live in colder environment slopes upwards and to the higher latitudes. Forexample. In France due to rise in climate temperature there is lengthening in the body size of*Lacerta vivipara* (common lizard) so as to have improved reproductive outcome[2]. So, change in climate can be beneficial or harmful for a particular species. Like the distribution of species of plants that are present in arctic and alpine regions is restricted by changes in the environment. Not only this, many other terrestrial mammals are also affected by the diversions in climatic trends.

There are various carriageways by which climate can influence the distribution of any species. Most prevalent of them are categorized below:-

3. LATITUDINAL AND ALTITUDINAL DISTRIBUTION OF SPECIES:

As there is elevation of temperature the species present in the sunk-relief areas such as plains suffers contractions in their range of optimum conditions as a result they have to switch their inhabiting range to maintain the optimized conditions[3]. As favorable climatic zone moves toward the poles, the migratory species experience alternations in geographic ranges, example – birds. With the rise in the altitude the change in the geographic area is increased and as a result the mountain species become more assailable[4]. For huge number of poikilothermic organisms present in tropical and temperate areas the change in altitude at regional level is effortless to scrutinize. Due to the warming in climate in Spain there is elevation of about 212m by the sixteen species of montane butterflies [5]. Similarly the species of organisms that are present in costal habitats and use that habitat for various purposes like roosting and foraging may have to migrate to new localities due to the elevation in sea level, like it will affect mangrove regions, coastal wetlands and coastal nesting birds[6] [7]. In northern Britain in the last 2.5 decades, due to the climate change there is extinction of about four butterfly species from the lower latitudes[8]. In a survey , of non migratory butterflies of Europe it was found that only 3%of these butterflies migrated towards south and about 63% migrated by 35-240km towards north. 2/3rd of species has shown enlargement of the northern boundary and no change is observed in southern region
[25]. Similarly, the change in the range of arthropods have serious insinuation on thehealth of humans. For example- From reports it is seen that from the highlands of Latin America, Central Africa and Asia there is rise in mosquito borne diseases. Similarly, in New Guinea highlands the threat of malaria caused by *Plasmodium falciparum* to residents is growing. Similar to this in Mexico, initially, dengue fever was prevalent to elevation of about 1000m only, but now it has reached to about 1700 m. Analogously in Columbia the vector of yellow fever and dengue fever, i.e, *Aedes aegypti* has been recently reported. According to Rajpurohit *et. al.*, the data for the climatic change effect on *Drosophilids*and boundary increase in *D. ananassae*is very less[44].

4. PATTERNS OF MOVEMENT:

Movement pattern of migratory species alters due to change in resources. There is a great effect of change in climate on migration of insects, but the published data is very little as compared to pest species[9]. According to Drake and Gatehouse, in continental countries migration influenced by climatic changes is a very important topic[10].Due to the rise in temperature, some migratory species that migrate between different habitats, stops migration or either reduce their migration distance[11]. On the other hand in some cases, due to the rise in temperature birds may migrate to their breeding grounds earlier[12][13]. There is rise in migration from Europe, of moths and butterflies that belongs to order Lepidoptera to the southern UK[14]. The migratory insects that serve as vectors for various human infections and diseases such as mosquitoes[15] and calyptrate flies[16] has an important impact on health of humans and agriculture economics.

5. ABUNDANCE OF SPECIES:

Tension inflicted due to changes in climatic condition interacts with various other hostile conditions in a way so that the impact on the population is magnified. In most of the cases of climate change there is either decline in the population number or fragmentation of the population[17]. Climatic extremes may reduce population either by direct mortality or by the reduction in reproductive success[18]. On the other hand according to some studies it is depicted that along with the rise in temperature the population of insect increases[19]. Due to the changes in climate and degradation of habitat in Britain, there is change in distribution and frequency of about 46 species of butterfly[20].

6. PHENOLOGICAL CHANGES:

The various events that occur in the life cycle of any species which may get triggered by the varios cues from environment may get changed.Species with shorter generation time and rapid population growth rates might undergo microevolutionary changes *in situ*. Alternations in birds, plants or butterflies that occur phonologically might have been studied extensively. Inclination in phonological changes may reflect the probable effect of climate change in Europe and North America[21] [22].

7. EXTINCTION OF SPECIES:

The statistics that correlate the global warming with the extinction are very less, major factors that leads to extinction of species are generally loss or fractionation of habitats[6]. As compared to the birds and plants, insects experience higher extinction rate[23]. According to the prediction in a report written in 2006 by *Bird Species and Climate Change*if there is rise in temperature by 2 °C in northeastern Australia and Europe due to global warming, then there could be rise in the extinction rate 72% and 38% respectively. There is extinction of *Aricia artaxerxes*,northern brown argus (butterfly) from about half of the sites, one third to half of the extinctions are linked with the changes in the climate [6]. As in future there speeding up of climatic changes, so it may become the dominant engine for extinction of species.

For example- due to the climatic changes, there is extinction of the two species of *Desmoganthus* (salamanders) that are adapted to mountains and to the lower temperature habitats[24]. Similarly, there is rise in extinction rate of about 151 populations of *Euphydryas editha* (Edith's checkerspot butterfly) [25]. The site were population was present was 2° north than the place where the extinction has occurred. The extinction rate of population of Mexico is four times than that of Canada, and that of lower latitude is also more as compare to population above 2400m. In new world it has been reported that due to climatic changes and fungal epidemics there is extinction of harlequin frogs [43].

7. REVIEW OF CHANGES IN DISTRIBUTION

According to Hellmann et al., The changes in the distribution and abundance of any species caused by climatic alternations is due to the alternations in- altered climatic constraints, effectiveness of management strategies and introduction pathways[26].The shrinking of area of any species is less intrusive as predicted because the species has tendency to adapt to nearby locations in order to expand their habitat range[27]. So, the alternations due climate factors are important for any species from the perspective of food and economic security[28]. Similarly according to Easterling et al,. climate changes and warming can increase the frequency of lethal conditions and the development of adaptations through the genetic changes can change the habitat range of any species[29].

8. DROSOPHILA AS A TRACKING MODEL

According to Parsons, as *Drosophila* species have narrow range for its resources, so it can be utilized to assess the climatic ameliorationlevel[30]. Among all of the climatic conditions temperature is the most important. According to Ryan et al., the threshold range of the *Drosophila* species is from 5 °C to 35 °C [45]. Similarly at 22°C optimum rate of eclosion population growth occurs and at temperatures 29.3°C, 21.0°C, 13.4°C the developmental rates occur at optimum[46]. This means with the fluctuation of temperature conditions the development rate of *Drosophila* will vary. kellermann et al., in 2012 wrote that *Drosophila* species has distribution limit to resist colder temperature, hence it can be utilized as a tracking model to predict the future climatic changes[31]. There are many studies so far that affirm that climate changes may shift the boundaries of species and this shift is used to track the population movements, but the genetic cause is not very much described[32]. It can be used as a tracking model as the different species vary in their rate and ability to migrate [33]. As the climatic changes occur, different species adapt to these changes by undergoing genetic or chromosomal transpositions. The chromosomal polymorphism can be beneficial for the sake of identification, chromosomal isolation and methods for fly sampling. The various techniques can be carried out such as- chromosomal staining, chromosomal inversion maps and fly marker stock availability.

A very useful marker that can be used to detect the changes in climate is the chromosomal inversion [37]because we are having historic record that show that there is trend observed in arrangement of inversions latitudinally, which indicate the adaption in response to climate[34]. Inverted gene blocks multiple loci of genes with various epistatic and linkage interactions so, it provides more rational basis to explore the different phenotypic responses[35], moreover these inversions may engage a particular combination of alleles which may otherwise separate by any recombination, so that it can be useful for a population[36].In 1992 Krimbas reported more than 30 different inversions in *Drosophila subobscura*`s 0 chromosome [38] and he along with Mennozzi added that many of them were spatiotemporal heterogenous distributions[39]. Along with these distributions, also there were variations based on seasonal cycles[40]. In Australia due to the climate change a pattern of allozyme frequencies and inversions occurred in *D. melanogaseter*[41] and in *D. melanogaster* and *D. simulans*[42].

Thus, temperature has a great impact on the ecology ofany species i.e either it`s abundance or distribution. Many studies can describe about the thermal environmental changes but the studies related to responses of aridity are very few[47].

The shift of range by any species is due to certain microevolutionary changes. Saura, in 1994 described about the shift of the *D. subobscura*to the northern latitudes[48]. Laboratory analysis by Feder et al., gives information on the influences of the heat shock treatment on *D. melanogaster*due to the variation in the number of copies of gene Hsp 70[49]. Other than the influence of heat shock protein genes, per gene length variation also influences these microevolutionary changes[50]. So, the chromosomal studies in *Drosophila*can be very useful for us.

9. CONCLUDING REMARKS

So, abundance and geographic range of any species depends on interaction of that species with others. These interactions depends on it`s phenology and physiology. With the information base and the currently available expertise, we can apply evolutionary knowledge to global change concerns. With this paper, we hope to stimulate efforts in that direction.

10. REFERENCES

[1] Schowalter TD (2000) Insect Ecology. An ecosystem approach. Elsevier, 576 pp.
[2] Chamaille-Jammes S, Massot M, Aragon P, Clobert J (2006) Global warming and positive fitness response in mountain populations of common lizards Lacerta vivipara. Glob Change Biol 12:392–402
[3] Peterson AT (2003) Predicting the geography of species' invasions via ecological niche modeling. Q. Rev. Biol. 78: 419-/433
[4] Peters RL, Darling JDS (1985) 'The Greenhouse Effect and Nature Reserves: Global WarmingWould Diminish Biological Diversity by Causing Extinctions among Reserve Species', Bioscience 35, p 707–717.
[5] Wilson RJ, Gutierrez D, Gutierrez J, Martinez D, Agudo R, Monserrat VJ (2005) Changes to the elevational limits and extent of species ranges associated with climate change. Ecol Lett 8:1138–1146
[6] Galbraith H, Jones R, Park R, Clough J, Herod-Julius S, Harrington B, et al. (2002) Global climate change and sea level rise: potential losses of intertidal habitat for shorebirds. Waterbirds, 25, 173–183.
[7] Smart J, Gill JA (2003) Climate change and the potential impact on breeding waders in the UK.Wader Study Group Bull 100:80–85
[8] Cannon RJC (1998) The implications of predicted climate change for insect pests in the UK, with emphasis on nonindigenous species. Global Change Biology, 4: 785–796.
[9] Drake VA, Gatehouse AG (1995) Insect Migration. Tracking Resources through Space and Time. Cambridge University Press, Cambridge, 496 pp.
[10] Jenni L, Kery M (2003) Timing of autumn bird migration under climate change: advances in longdistance migrants, delays in short-distance migrants. The Royal Society 270:1467-1471
[11] Parmesan C, Yohe G (2003) A globally coherent fingerprint of climate change impacts across natural systems. Nature, 421: 37–42.
[12] Root TL, Price JT, Hall KR, Schneider SH, Rosenzweig C, Pounds JA (2003) Fingerprints of global warming on wild animals and plants. Nature 421:57–60
[13] Sparks TH, Huber K, Bland RL, Crick HQP and others (2007) How consistent are trends in arrival (and departure) dates of migrant birds in the UK? J Ornithol 148:503–511

[14] Chin T, Welsby PD (2004) Malaria in the UK: past, present, and future. Postgrad. Med. J. 80: 663–666.
[15] Goulson D, Derwent LC, Hanley ME, Dunn DW, Abolina SR (2005) Predicting calyptrate fly populations from the weather, and probably consequences of climate change. J.Appl. Ecol. 42: 795–804.
[16] Williams SE, Bolitho EE, Fox S (2003) Climate change in Australian tropical rainforests: an impending environmental catastrophe. Proc R Soc Lond B 270: 1887–1892
[17] Willott J, Thomas C (2001) Implications of climate change for species conservation. Briefing paper presented at the IUCN Workshop on Climate Change and Species Survival in January 2001, Gland, Switzerland. Gland, Switzerland: Blackwell Publishing, Ltd.
[18] Saunders A (2008) FAO serves up edible insects as part of food security solution. Mediaglobal, (February, 2008), United Nations Secretariat, New York, FAO Rome.
[19] Warren MS, Hill JK, Thomas JA, Asher J, Fox R, Huntley B, Roy DB, Telfer MG, Jeffcoate S, Harding P, Jeffcoate G, Willis SG, Greatorex-Davies JN, Moss D, Thomas CD (2001) Rapid responses of British butterflies to opposing forces of climate and habitat change. Nature, 414, 65–69.
[20] Bairlein F, Winkel W (2001) Birds and climate change. In Climate of the 21st century: changes and risks (ed. J. L. Lozan, H. Grassl & P. Hupfer), pp. 278–282. Hamburg: Wissenschaftliche Auswertungen.
[21] Menzel A, Estrella N (2001) Plant phenological changes. In “Fingerprints” of Climate Change — Adapted Behaviour and Shifting Species Ranges, Walther G-R, Burga CA, Edwards PJ (eds). Kluwer Academic/Plenum Publishers: New York; 123–137.
[22] Thomas CD, Cameron A, Green RE, Bakkenes M, Beaumont LJ, Collingham YC, Erasmus BFN, Siqueira MFD, Grainger A, Hannah L (2004) Extinction risk from climate change. Nature 427 (6970): 145–148.
[23] Bernardo J, Spotila J (2006) Physiological constraints on organismal response to global warming; mechanistic insights from clinally varying populations and implications for assessing endangerment. Biol. Lett. 2, 135–139.
[24] Parmesan C, Ryrholm N, Stefanescu C, Hill JK, Thomas CD, Descimon H, Huntley B, Kaila L, Kullberg J, Tammaru T, Tennent WJ, Thomas JA, Warren M (1999) Poleward shifts in geographical ranges of butterfly species associated with regional warming. Nature, 399: 579–583.
[25] Hellmann JJ, Byers JE, Bierwagen BG, Dukes JS. 2008. Five potential consequences of climate change for invasive species. Conservation Biology 22(3):534-543
[26] Phillips, B.L., Brown, G.P., Webb, J.K., and Shine, R. (2006). Invasion and the evolution of speed in toads. Nature 439, 803.

[27] Conversely, for some species there may be a reduction in suitability as climate factors begin to exceed mortality and development tolerances. Examining the potential changes in abundance and distribution of pest species due to climate change is vital from economic and food-security perspectives (Ziska et al., 2011).

[28] Easterling DR, Meehl GA, Parmesan C, Changnon SA, Karl TR, Mearns LO (2000) Climate extremes: observations, modeling, and impacts. Science, 289, 2068–2074.

[29] Parsons PA (1991) Biodiversity conservation under global climate change: the insect Drosophila as a biological indicator? Glob Ecol & Biogeo Lett 1:77-83.
[33].Davis MB (1981) Quaternary history and the stability of plant communitites. In:

West DC, Shugart HH, Botkin DB, editors. Forest Succession: concepts and application. New York: Springer-Verlag. p. 132–53.

[30] Kellermann V, Loeschcke V, Hoffmann AA et al. (2012a) Phylogenetic constraints in
[31] key functional traits behind species' climate niches: patterns of desiccation andcold resistance across 95 drosophila species. Evolution, 66, 3377–3389.

[32] Schneider SH (1993) Scenarios of global-warming. Pages 234-250 in P. M. Kareiva, J. G. Kingsolver, and R. B. Huey, editors. Biotic interactions and global change. Sinauer Associates, Sunderland, Massachusetts, USA.
[33] 13. Kennington, W.J., Partridge, L., and Hoffmann, A.A. (2006). Patterns of diversity and linkage disequilibrium within the cosmopolitan inversion In(3R)Payne in Drosophila melanogaster are indicative of coadaptation. Genetics 172, 1655–1663.
[34] Dobzhansky TH (1947) Adaptive changes induced by natural selection in wild populations of Drosophila. Evolution 1: 1–16
[35] Kirkpatrick, M., and Barton, N. (2006). Chromosome inversions, local adaptation and speciation. Genetics 173, 419–434.
[36] Krimbas CB, Powell JR (eds) (1992) Drosophila inversion polymorphism. CRC Press, Boca Raton, FL
[37] Krimbas CB (1992) The inversion polymorphism of Drosophilasubobscura. In: Krimbas CB, Powell JR (eds) Drosophila inversion polymorphism. CRC Press, Boca Raton, FL, p 127–220
[38] Menozzi P, Krimbas CB (1992). The inversion polymorphism of Drosophila subobscura revisited: Synthetic maps of gene arrangement frequencies and their interpretation. J Evol Biol 5: 625–641.
[39] Rodríguez-Trelles F, Alvarez G, Zapata C (1996) Time-series analysis of seasonal changes of the O inversion polymorphism of Drosophila subobscura. Genetics 142:179 187
[40] Umina PA, Weeks AR, Kearney MR, McKechnie SW, Hoffmann AA (2005) A Rapid shift in a classic clinal pattern in Drosophila reflecting climate change. Science 308: 691-693.
[41] Rodríguez-Trelles F, Rodríguez MA (1998) Rapid microevolution and loss of chromosomal diversity in Drosophila in response to climate-warming. Evol Ecol 12: 829-838.
[42] MarcaEL, MastersKL, Merino-ViteriA, PuschendorfR, RonSR, Sánchez-AzofeifaGA, StillCJ, YoungBE (2006) Widespread amphibian extinctions from epidemic disease driven by global warming. Nature 439: 161–167
[43] Rajpurohit S, Parkash R, Ramniwas S (2008) Climatic changes and shifting species boundaries of Drosophilids in the Western Himalaya. Entom Sinica 51: 328-335.
[44] Langille AB, Arteca EM, Ryan GD, Emiljanowicz LM, Newman JA. 2016. North American invasion of Spotted-Wing Drosophila (Drosophila suzukii): a mechanistic model of population dynamics. Ecological Modelling 336:70-81
[45] Tochen S, Dalton DT, Wiman N, Hamm C, Shearer PW, Walton VM. 2014. Temperature-related development and population parameters for Drosophila suzukii (Diptera: Drosophilidae) on cherry and blueberry. Environmental Entomology 43(2):501-510
[46] Hoffmann AA (2010) Physiological climatic limits in Drosophila: patterns and implications. J Exp Biol 213: 870-880.
[47] Saura A (1994) Genetic load and population size in northern populations of Drosophila subobscura. In: Levine L (ed). Genetics of Natural Populations: The

Continuing Importance of Theodosius Dobzhansky. Columbia University Press: New York. pp 173–187.

[48] Feder ME, Cartano NV, Milos L, Krebs RA, Lindquist SL (1996) Effect of engineering Hsp70 copy number of Hsp70 expression and tolerance of ecologically relevant heat shock in larvae and pupae ofDrosophila melanogaster. J Exp Biol 199:1837-1844.

[49] Sawyer LA, JM Hennessy AA, Peixoto E, Rosato HP, Parkinson, Costa R, Kyriacou CP (1997) Natural variation in Drosophila clock gene and temperature compensation. Science 278:2117-2120.