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International Journal of Zoology and Animal Biology
ISSN: 2639-216X

Climate Change: Impact of Temperature on Dimethoate (OP) Toxicity and Behavior of Fish and Bivalve

Das VK*

Department of Zoology, Kamla Nehru Institute of Physical and Social Sciences, India

***Corresponding author:** Vijay Krishna Das, Former Head, Department of Zoology, Kamla Nehru Institute of Physical and Social Sciences, Sultanpur- 228118, 470 Vinamra Khand, Gomti Nagar, Lucknow - 226010, India, Email: dasvkster@gmail.com

Editorial
Volume 1 Issue 5
Received Date: October 25, 2018
Published Date: November 01, 2018
DOI: 10.23880/izab-16000128

Editorial

The term "Climate Change" is used to anthropogenic climate change (Global Warming). Anthropogenic Climate Change is created by human activity (increase in CO_2 level due to burning of fossil fuel, CO_2 released by cement factories, ozone depletion, methane produced through agricultural practices, livestock, animal husbandry etc.), contrary to the changes in climate due to Earth's Natural processes. Global warming has tremendous impact on functioning of ecosystem resulting in bio-geographical distribution of biota. Climate change is causing more havoc than geophysical happenings (earthquakes, tsunami). Recent UN report on International Disaster Day (October 13) opined that 91% of all disasters during 1998-2017 were caused by flood, storms, draught, heat waves and other extreme weather conditions. The global warming of 10C compared to preindustrial level has already altered the disaster map and during past 20 years the disasters related to climate change have doubled.

Temperature is a crucial determinant of biogeography, which directly affected in combination with salinity, ocean acidification, alters the physiology, life history and behavioral responses of the invertebrate organisms [1-4]. Ocean acidification is one of the most wide spread environmental changes leading to vulnerabilities of marine life history [1]. Reduced pH and elevated temperature affect the shell density of two gastropod species [2]. Temperature and salinity also affect the physiology of two geographically-distant Oyster populations [3]. Rising CO_2 levels reduces species ability to control the calcification process in Triton shell, leading to a threat of survival, as the impact of climate change [4].

Elevated temperature increases the acute toxicity of melathion (OP) which may increase susceptibility to disease and ultimately threaten salmon survival [5]. They studied the influence of temperature on the acute toxicity of melathion by determining 96-h LC curves at optimum (11^{0}C) or elevated (19^{0}C) temperature. Mortality was found to increase by 11.2% in Chinook salmon at elevated temperature. Laetz, et al. [6] assessed the influence of water temperature (12-21^{0}C) on toxicity of ethoprop and melathion, alone or in combination to juvenile coho salmon. Elevated temperature with mixture of OP pesticides increases their toxicity, which inhibits the brain AChE, leading to disruption in swimming ability in juvenile salmon.

Organophosphates are frequently used pesticide in farming, protecting crops and used in house hold affairs, because of their high insecticidal property, low mammalian toxicity, low persistence and rapid biodegradability in nature. Dimethoate (IUPAC Name-0,0 dimethyl S-(N methyl carbamoyl methyl) phosphoro-dithioate] CAS No. 60-51-5 is OP, available in market by the name Rogor. It is an acetylcholine esterase inhibitor, working primarily as nerve poison. These pesticides reach to aquatic ecosystem by surface runoff from application sites and enter in the aquatic organism through the food chain.

In earlier studies acute static bioassay were conducted to see mortality of fishes - Carp [7] and Catfish [8] and in bivalves [9,10] after Dimethoate exposure. Mortality data were recorded at 24, 48, 72 and 96 h and analyzed using

EPA Probity analysis Version 1.5 Software (based on Finney's Probity Analysis method) to calculate LC50 values.

At a temperature of 28 ±2 0C we studied [7] the 96 h LC_{50} after Dimethoate exposure on Cyprinus carpio (9±1.5 g) as 1.61 mg/L and observed behavioral changes – increased mucus secretion, tremors, loss of equilibrium and colour change from silvery to pale. In addition recorded decreased oxygen consumption with decreased opercula movement [7]. However, recent report from Kashmir [11] on Cyprinus carpio (wt -10 ± 2 g) at a lower temperature of 11-12^{0}C revealed 96 h LC_{50} for Dimethoate as 1.1 ppm in static bioassay. They also recorded, similar behavioral responses-excessive mucus secretion, uncoordinated movements, convulsions, imbalanced swimming ending in collapse to bottom. Prior to death clinical signs like scale eruption, pale body colour and hemorrhagic patches appear on body.

To evaluate the impact of temperature we [12] exposed the air breathing catfish (*Heteropneustes fossilis*) to organophosphate pesticide (Dimethoate) in different seasons – summer (August) and winter (January). A static non-renewal bioassay was conducted under natural photoperiod for 96h in the month of January and August. The LC_{50} values of Dimethoate exposure at temperature 17.16 ± 0.78°C (January) and 27.50 ±1.50°C (August) were found to be 14.39 mglG and 2.98 mglG respectively. The behavioral responses in fishes on Dimethoate exposure exhibited that schooling behavior, swimming pattern and reflex responses were more or less same at two different temperatures. However the surfacing, gulping air and OPM (per minute) increased at higher temperature. In addition mucus secretion, skin colour and eye condition were also studied [10,12].

For freshwater mussels the LC_{50} values were also calculated from mortality data obtained (using EPA-Probity analysis version 1.5, Statistical Software) after Dimethoate exposure [10]. The 96h LC_{50} value of mussel (*Lamellidensmarginalis*) recorded at higher temperature (in August; 28.0 ± 0.5°C) was 36.34 mg l^{-1} and at low temperature (in January: 14.9 ± 1.2°C) was 163.34 mg l^{-1} [13]. The mussel exposed to Dimethoate at higher temperature showed more sensitive behavioral responses like huge mucus secretion, sudden closure of shell valves, quick postmortem changes and increased oxygen consumption as compared to exposure at low temperature [10,13]. It indicated that increasing threat of global temperature increases the risk of pesticide toxicity in the exposed organisms.

Temperature appears a main driver of clearance rate, valve opening duration and oxygen consumption rate in *Cross ostrea virginica* [3]. Casas, et al. [3] emphasized how a species may occupy different geographical locations, will be affected by climate change, develop varied physiological patterns. They studied a direct comparison of two Oyster populations that occupied contrasting temperature and salinity habitats-New Brunswick (Canada) and Lousiana (USA). They reported variations in clearance rate, valve opening and oxygen consumption in Oyster of both populations with 3 different temperatures (10,20 & 30°C) and two salinities (15,25).

A very recent eye catching news, "Himalayan Viagra now costlier than gold, under threat by climate change" attracted my attention (TOI, October 24, 2018). Hopping, et al. [14] has reported that Himalayan caterpillar fungus (*Ophiocordycepssinensis*) has become rare and valuable, as a result of over exploitation, habitat degradation and Climate change. It is an entomopathogenic fungus that parasitizes 50 species of Thitarodes moth larvae in Himalayan region. For centauries it has been used as aphrodisiac in Tibetan and Chinese medicines. Now it is popular in different ailments including cancer. Change in climatic conditions of fungal habitat and its production have been studied from 1979-2013 which revealed that winter temperatures have warmed significantly in India, Nepal, Bhutan and Tibetan plateau, mean winter temperature increasing by 3.5-4°C across most of habitats. Based on geographical location of caterpillar fungus, they inferred that a temperature below 0°C suits the fungus, avoiding frozen soil. Hopping, et al. [14] concluded that caterpillar ecology and economy is threatened by climate change and overexploitation for traditional medicine.

Nations around the globe are coming together to fight against climate change but initiative should start by people movement. CO_2 is the worst culprit of climate change. We all should share to avoid burning of fossil fuel, start a mass movement to switchover to renewable energy (wind, solar), use energy efficient appliances, reduce electricity bills and waste of water, drive fuel efficient vehicles, adopt vegetarianism etc.

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