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Behavioral changes in *Clarias batrachus* due to exposure of endosulfan

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Abstract
Endosulfan is classified as extremely hazardous pesticide (Ganestwade *et al*. 2012) and usually toxic to non – target organisms like fish. It passes via surface runoff into natural waters, where it is accumulated in different organisms like water, especially fish, thus making it vulnerable to several prominent effects. Any change in the aquatic environment causes altered behavioural responses. The present paper therefore, was undertaken to study the behavioural changes in the teleost *Clarias batrachus*, caused by sub-acute exposure to the organochloride pesticide endosulfan.

Keywords: *Clarias batrachus*, endosulfan, behavior, physiological adjustments

Introduction
Endosulfan is an off patent organochlorine insecticide and acaricide, highly toxic, potential for bioaccumulation and is endocrine disruptor in nature. It is banned in more than 63 countries including European Union, Australia & New Zealand and other Asian and West African countries and being phased out in United states and Brazil, but it is used extensively in many other countries including India & China. India is the world's largest user of endosulfan and a major producer with three companies – Excell Crop Care, HIL & Coromandal Fertilizers, producing 4500 tons annually for domestic use and another 4000 tonnes for export.
Behavioral changes are recognised as most sensitive indicators of possible toxic effects. The behavioral and the swimming patterns of fish exposed to different insecticides include changes in feeding activities, swimming behavior, Competition, predation, reproduction and species to species, social interactions such as aggreseion (Rahman *et al*., 2016) [1]. In the present paper the behavioral changes in teleost *Clarias batrachus* due to effect of endosulfan is studied.

Materials and Methods
Fishes were collected from purni pond, situated at vill – Ghonghia, Via – Bahera, District – Darbhanga, 22 KM away from the CM Science College laboratory with the help of local fisherman. Healthy fish of 45-50 gram average weight each, were sorted out for experimental purposes and was brought to the laboratory in a plastic basket filled with water added with commercial feed. Water of the aquatic was changed on the day after feeding. Physico-chemical conditions of water i.e. PH, D.O, CO_2, Hardness, Alkalanity chloride content were estimated prior to the experiment. These were estimated by methods given by APHA, AWWA & WPCF (2005) [2].

Results and Discussion
A record of atmosphere and water temperatures was simultaneously maintained throughout the experiment (Table 1). Hence, no changes were observed in physico-chemical parameters.

Table 1: Physico-chemical characteristics of water (Sub-acute experiment).

Parameters	Values
Atmospheric Temp. (0C)	Maximum – 22 Minimum – 18
Water Temperature (0C)	Maximum – 19 Minimum – 15
PH	7 – 7.5
Dissolved Oxygen (mg/l)	6.75 – 7.5
Alkalanity (mg/l)	64 – 68
Hardness (mg/l)	15 – 18
Chloride content (mg/l)	30 – 33

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Behavioral Changes in Clariasbatrachus

Marked changes were noted in the behavior of *Clarias batrachus* during the experiment. Changes in behavior of the fish were observed every day and summarised at the intervals of 72h, 96h & 120h.

Table 2: Behavioral changes in *Clarias batrachus* after sub-acute exposure to Endosulfan

Parameters	Duration	Gr I	Gr II	Gr III
Swimming Activity	72 h	+++	+++	+++
	96h	+++	++	++
	120 h	+++	++	+
Surfacing Activity	72 h	+++	++++	++++
	96 h	+++	++++	+++++
	120 h	+++	+++++	+++++
Opercular Movements	72 h	+++	++++	++++
	96 h	+++	++++	+++++
	120 h	+++	++++	+++++
Body Color	72 h	+++	++	++
	96 h	+++	++	++
	120 h	+++	++	+

+ = Very low, ++ = Low, +++ = Moderate, ++++ = High, +++++ = Very high

In comparison to control, swimming activity declined at 96h in group II & III while it further declined at 120h in group III. In treated grounds, fish showed a tendency to settle at the bottom of the aquaria after 120h of exposure. Surfacing frequency of the fish increased and was very high in group II at 120h and in group II at 120h & in group III from 96h onwards. This mechanism indicates a hypoxic condition as the fish rise to the surface to engulf air from the environment. Simultaneously, an increase in opercular movements was also observed in both the treated groups (II & III) for 72j. In group III very high movements were observed at 96h & 12h. This increase can be correlated with the surface frequency of the fish. The color of the body surface became pole in group III at 120h.

In the present study, a dose and duration dependent decrease in swimming activity has been observed in the treated group. This may be due to endosulfan uptake by the gills and altered gill structure which led to the respiratory stress (Harit & Srivastava 2017a) [3] and this way possibly increase the metabolic reactions resulting in energy depletion (Harit & Srivastava, 2007) [4]. Similar correlative observations have been recorded in behavior& protein content in muscles of fish Labeorohita exposed to endosulfan for 96h (Ullah *et al*., 2016) [5]. On the other side high opercular movements & surfacing frequency observed in Channapunctatus is indicative of its slow metabolic activity.

Under endosulfan stress (Harit & Srivastava, 2017b) [6]. Progressive poling of body color has been observed in the present study along with an increase in dose and duration of the experiment. It has been suggested that stimulation of adrenal glands & hypersecretion of during stress condition inhibits the action of MSH, resulting in pole body color (Tyagi, 2004) [7].

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