



# Acute Toxicity of Endosulfan, Malathion and Carbaryl, and their Sublethal Effects on Growth of *Channapunctatus* bloch in Cachar District, Assam, India

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Available online at: [www.isca.in](http://www.isca.in), [www.isca.me](http://www.isca.me)

Received 7<sup>th</sup> August 2013, revised 13<sup>th</sup> September 2013, accepted 13<sup>th</sup> October 2013

## Abstract

The 24, 48, 72 and 96 h  $LC_{50}$  values of endosulfan, malathion and carbaryl for the fish *Channapunctatus* Bloch were estimated by log-probit analysis. These were 0.0182, 0.0025, 0.0011, and 0.0007  $mg\ l^{-1}$ , respectively, for endosulfan; 5.5, 2.3, 1.6, and 0.9  $mg\ l^{-1}$ , respectively, for malathion; and 10.9, 8.3, 8.0, and 7.5  $mg\ l^{-1}$ , respectively, for carbaryl. When *C. punctatus* was exposed to 1/3 and 1/10 of the 96 h  $LC_{50}$  values of these three pesticides for 21 days, the body weight of fishes decreased in both sublethal concentrations of the three pesticides when compared with those in the control, which gained weight during the experiment. The reductions in growth were statistically significant as revealed by one-way ANOVA and Tukey tests.

**Keywords:** Pesticides,  $LC_{50}$ , mortality, reduction in body weight.

## Introduction

Indiscriminate use of pesticides in agriculture poses an ever-increasing risk to biodiversity and human health. Among the three pesticides tested in the present study, endosulfan is a broad-spectrum<sup>1</sup> that is known to be highly toxic to fish, amphibians and crustaceans<sup>2,3</sup>. Endosulfan is highly resistant to microbial bioremediation and persists as a xenobiotic in the agricultural soils also<sup>4</sup>. Malathion, (AChE) inhibitor, is also known to cause harmful effects to non-target organisms<sup>5</sup>. Carbaryl (n-naphthyl, 1-methyl carbamate) is a carbamate pesticide that is used to control a variety of pests of different crops. Though carbaryl and 1-naphthol are not considered as toxic to fish as many organochlorine and organophosphate pesticides, their toxicity is severe enough to make them environmental hazards. 1-Naphthol, the main degradation product of carbaryl, was found to be more toxic than the parent compound to two size groups of the carp *Labeorohita* (Ham)<sup>6</sup>. Carbaryl is also an important AChE inhibitor<sup>7</sup>. Water bodies support all life forms and contamination of the water bodies will affect health, lifestyle and economic well being of the society<sup>8</sup>. Water functions as a solvent for a large number of chemical substances<sup>9</sup>. Both point and non-point pollution of water are among the various anthropogenic causes for perturbations in the ichthyofaunal distribution in some of the major rivers of north east India<sup>10</sup>. The fish selected for the present study, viz., *Channapunctatus* Bloch is widely distributed throughout India and southeast Asia. This hardy, air-breathing species has been identified for rearing in paddy fields, swamps and marshes, as they comprise a relatively cheap source of protein<sup>11</sup>. Incidentally, these ecosystems are also vulnerable to pesticide contamination from agricultural fields, tea plantations and

similar sources. The polluted water will cause death of the fishes<sup>12</sup> and other aquatic organisms bringing an ecological imbalance.

## Material and Methods

**Procurement and maintenance of fishes:** Live and healthy *C. punctatus* were procured from local fishermen in and around Silchar, Cachar district, Assam, India (figure 1). They were doused with weak potassium permanganate solution for two minutes to treat existing fungal or bacterial infections, if any, and to ward off further infections. The fishes were reared in glass aquaria containing aerated water and were fed commercial fish food 'Tokyu' which is fortified with vitamins, minerals and carotenoids, etc. The fishes were acclimatized for two weeks before subjecting them to experiments.

**Acute toxicity tests:** Commercial grade endosulfan (Hildan: 35% EC), malathion (Kunamala: 50% EC), and carbaryl (Sevin: 50% WDP) were purchased from a pesticide dealer in Silchar, Assam, India. Eight randomly selected fishes (length: 14-15 cm) were placed in each test container having graded endosulfan concentrations ranging from 0.56 - 56  $\mu g\ l^{-1}$ ; malathion concentrations from 0.5 - 5  $mg\ l^{-1}$ ; and carbaryl concentrations from 5 - 28  $mg\ l^{-1}$  in unchlorinated tap water. All pesticide concentrations were calculated on the basis of active ingredients. The test solution was changed every alternate day. Range-finding tests were initially conducted to find out the toxic range of the pesticide in order to economize on pesticide use and minimize the number of fish sacrificed. The median lethal concentrations ( $LC_{50}$  values) for *C. punctatus* was calculated by log probit analysis<sup>13</sup> with the help of SPSS 20 statistical software for Windows.

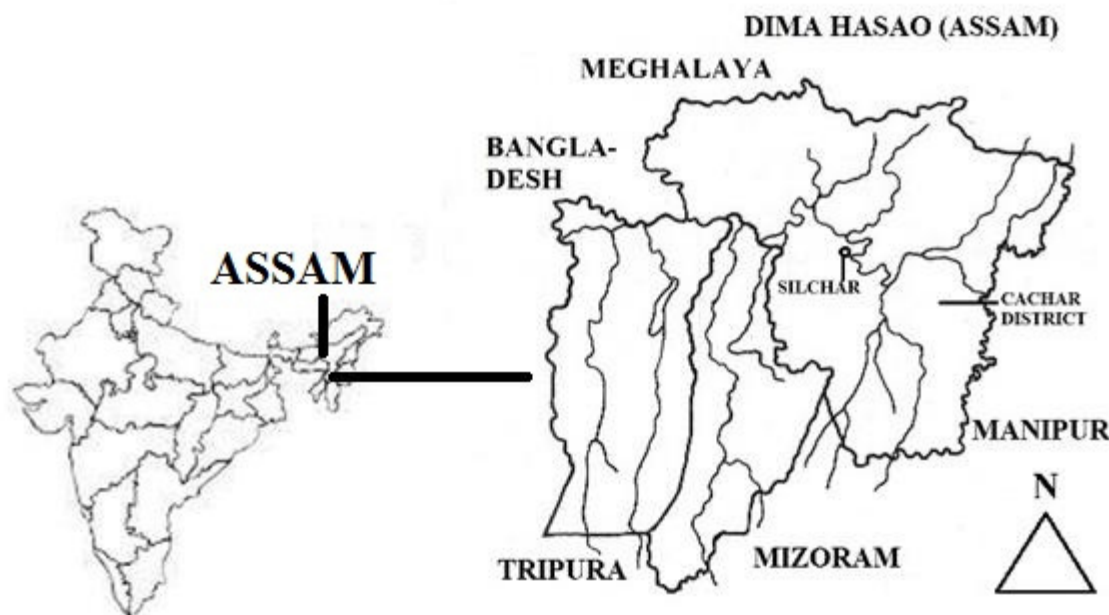


Figure 1  
Map showing the study area near Silchar in Cachar district, Assam

**Measurement of growth:** The fishes were exposed to 1/10 and 1/3 of the 96 h LC<sub>50</sub> values of the pesticides (endosulfan: 0.07 and 0.23 µg l<sup>-1</sup>; malathion: 0.09 and 0.3 mg l<sup>-1</sup>; and carbaryl: 0.75 and 2.5 mg l<sup>-1</sup>) for 21 days. Growth was measured at the end of 21 day, and the difference between the initial and the final weight was noted in control and pesticide-exposed fish. Utmost care was taken to avoid any stress to the fishes during weighing.

## Results and Discussion

**Acute toxicity:** Acute toxicities of endosulfan, malathion and carbaryl (active ingredients of each pesticide) in terms of median lethal concentrations (LC<sub>50</sub>) at 24, 48, 72 and 96 hours along with their confidence limits are presented in table 1. The 24, 48, 72 and 96 h LC<sub>50</sub> values of endosulfan in the present study were found to be 18.2, 2.5, 1.1 and 0.7 µg l<sup>-1</sup>, respectively. In an earlier study, LC<sub>50</sub> values of endosulfan for *Channapunctatus* were recorded to be 19.67, 12.95, 10.15 and 7.75 ppb at 24, 48, 72 and 96 h, respectively<sup>14</sup>. The 24 h LC<sub>50</sub> of both the studies are comparable, although those at 48-96 h are much lower in our study. A sharp increase in mortality could be observed between 24 and 48 h, which resulted in a low 48 h LC<sub>50</sub>. The 24 LC<sub>50</sub> value for endosulfan was estimated to be 2.6 and 1.6 µg l<sup>-1</sup> in *Brachydaniorerio* and *Hyphessobrycon bifasciatus* respectively, indicating higher sensitivity of these two species than that of *C. punctatus*<sup>15</sup>. On the contrary, fishes like *Gambusia affinis*, *Heterandria formosa*, *Poecilia latipinna* and *Pimephales promelas* were less sensitive, having 96 h LC<sub>50</sub> values of 2.1 to 3.5 µg l<sup>-1</sup>.

The LC<sub>50</sub> values of malathion at 24, 48, 72 and 96 h were found to be 5.5, 2.3, 1.6, and 0.9 mg l<sup>-1</sup>, respectively. The 96 h LC<sub>50</sub>

value for malathion was found to be 0.25 ppm in a study conducted on *Clarias batrachus*, indicating its higher sensitivity when compared to *C. punctatus*<sup>17</sup>.

Table -1  
Showing LC<sub>50</sub> values and confidence limits of endosulfan, malathion and carbaryl for *Channapunctatus*

Pesticide	Mean LC <sub>50</sub> (Confidence Limit)			
	24 h	48 h	72 h	96 h
Endosulfan µg l <sup>-1</sup>	18.2 (15-34)	2.5 (0-8)	1.1 (0-4)	0.7 (0-4)
Malathion mg l <sup>-1</sup>	5.5 (4-11.6)	2.3 (1.9-2.7)	1.6 (1.4-1.8)	0.9 (0.8-1.0)
Carbaryl mg l <sup>-1</sup>	10.9 (8.5-24.4)	8.3 (7.1-18.9)	8 (7-18.5)	7.5 (5-17)

Carbaryl was the least toxic of the three pesticides with 24, 48, 72 and 96 h LC<sub>50</sub> values of 10.9, 8.3, 8.0, and 7.5 mg l<sup>-1</sup>, respectively. *Mystus vittatus* (Bloch) (72 h LC<sub>50</sub>: 17.5 ppm) was found to be more tolerant to carbaryl than *C. punctatus*<sup>18</sup>.

Further, when the toxicity of these pesticides were compared with the 96 h LC<sub>50</sub> values of some other chemicals for *C. punctatus*, those of Cypermethrin and λ-cyhalothrin were 0.4 mg l<sup>-1</sup> and 7.92 µg l<sup>-1</sup> respectively<sup>19</sup> indicating that these chemicals had relatively high toxicity to this species when compared to those of malathion and carbaryl, but less than that of endosulfan. Atrazine had 24-96 h LC<sub>50</sub> ranging from 42.38-64.05 mg l<sup>-1</sup>, and was, therefore, less toxic than all the three pesticides<sup>20</sup>. The present study also shows that endosulfan had 2-3 orders of magnitude higher toxicity to *C. punctatus* than those of malathion and carbaryl, indicating the high vulnerability of the fish to this pesticide.

**Reduction in body weight:** Body weight decreased in fishes in both the sublethal concentrations of all three pesticides when compared with those in the control, which gained weight during the whole experiment (figure 2-4). The decrease in body weight was proportionate to the concentration of the pesticides and statistically significant at  $p < 0.05$  in both sublethal concentrations of the three pesticides. Endosulfan is known to have acted as a growth suppressant in *Danio rerio*<sup>21</sup>; it led to decrease in body weight in *Cyprinionwatsoni* at a concentration

of 1ppb<sup>22</sup>. The decrease in weight could be due to excessive expenditure of energy on metabolism that otherwise could have been utilized in fish growth. Malathion also suppressed growth in zebra fish<sup>23</sup> and *Clarius batrachus*<sup>17</sup>. Carbaryl was also found to suppress growth in *Mystus vittatus* at 12.5 ppm<sup>18</sup>, and in the air-breathing fish *Macropodus cupanus* at 1-2.5 ppm<sup>24</sup>. Growth reduction was likely to be due to the expenditure of more energy on maintenance, thereby identifying this pesticide as a metabolic stressor.

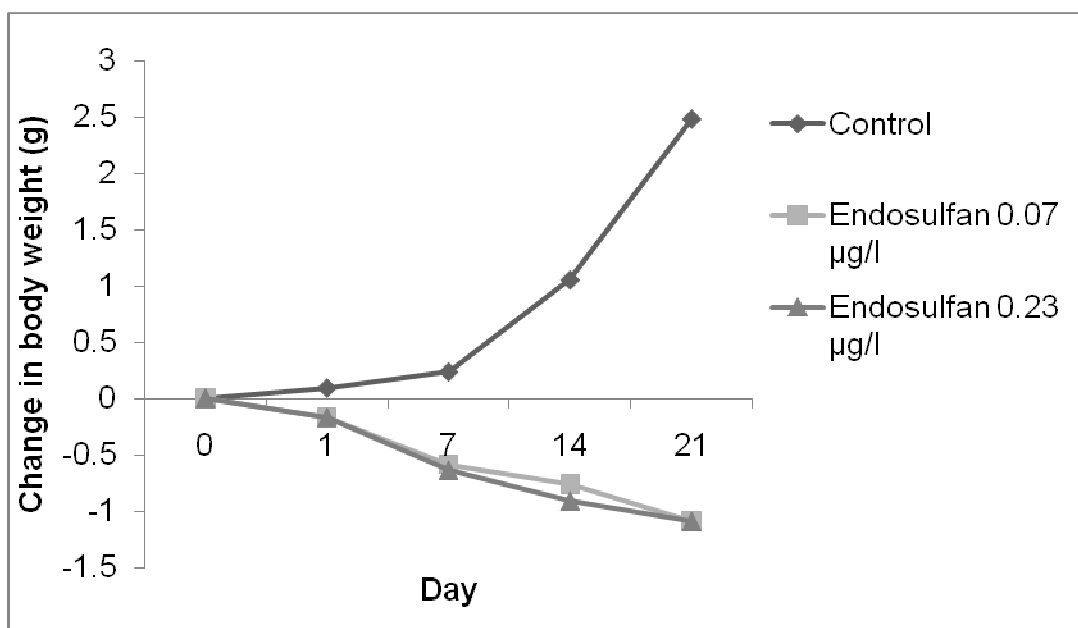


Figure – 2  
Showing changes in body weight (g) in control and endosulfan-exposed *C. punctatus*

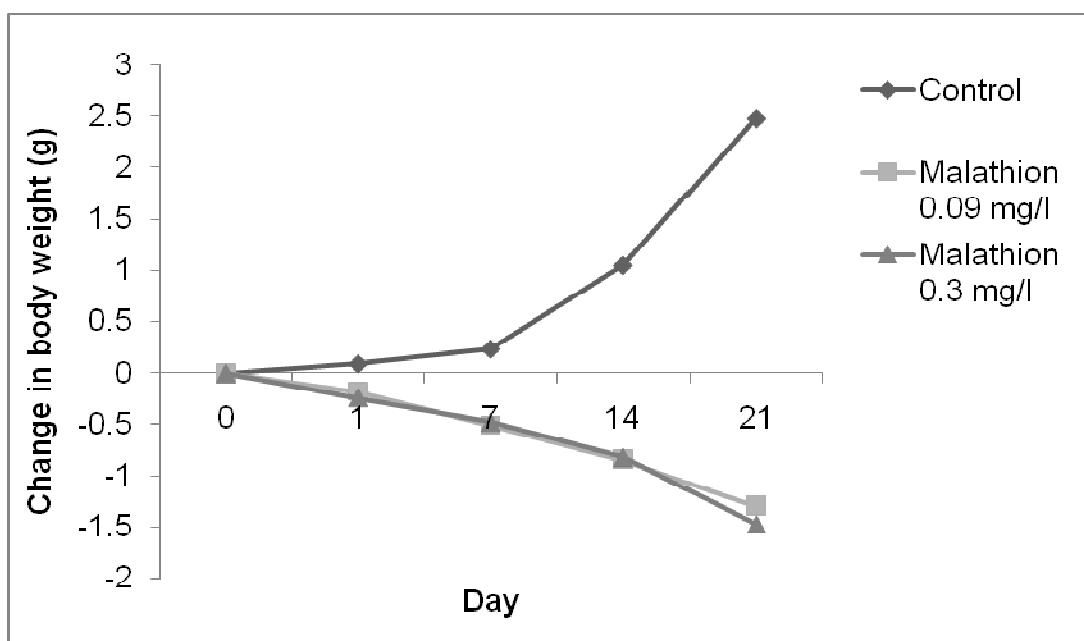


Figure – 3  
Showing changes in body weight (g) in control and malathion-exposed *C. punctatus*

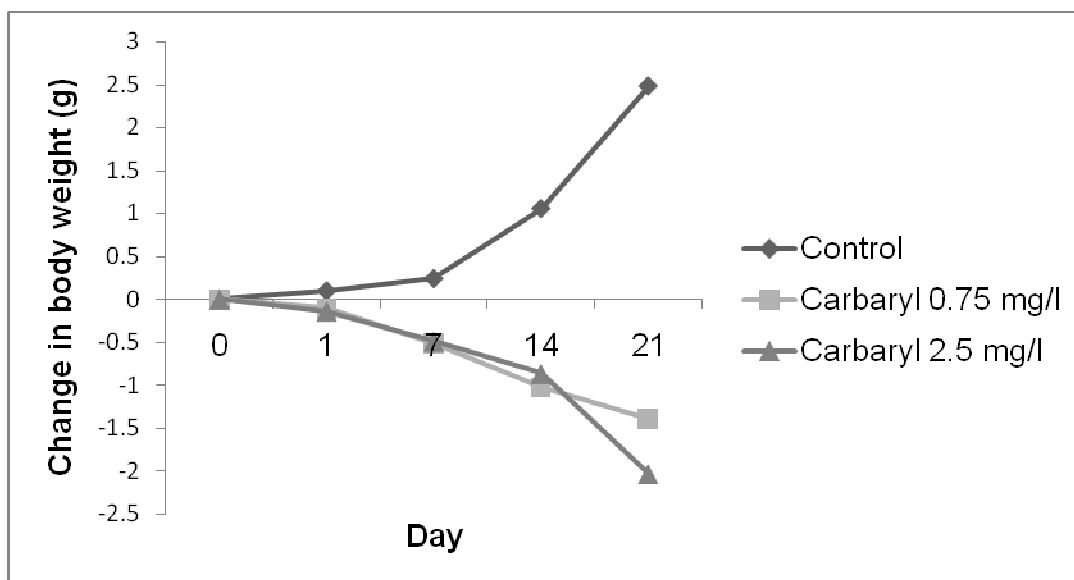


Figure – 4  
Showing changes in body weight (g) in control and carbaryl-exposed *C. punctatus*

## Conclusion

From the present study it could be concluded that indiscriminate use of pesticides not only results in the extermination of the target organisms but also of a large number of non-target organisms are killed or affected in such a way that their normal physiological mechanisms are hampered. This could result in the death of the fishes thereby decreasing their number and bringing an ecological imbalance. Thus this study could be used as a tool for bringing awareness among the local farmers so that the use of these deadly pesticides could be minimized.

## Acknowledgements

Sharmila Naosekham is thankful to the University Grants Commission, New Delhi, India, for award of a UGC-AUS fellowship.

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