

Dedicated to my Parents

Declaration

I declare that the thesis entitled “**Molecular and biochemical assessment of agricultural pesticide(s)-related toxicity in *Pethia conchoni* (Hamilton, 1822), a resident fish of the river Teesta in the northern region of West Bengal**” has been prepared by me under the guidance of **Professor Min Bahadur, Department of Zoology, University of North Bengal**. No part of this thesis has formed the basis for the award of any degree or fellowship previously.

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CERTIFICATE

This is to certify that **Mr. Debojit Dutta** has prepared the thesis entitled “Molecular and biochemical assessment of agricultural pesticide(s)-related toxicity in *Pethia conchoni* (Hamilton, 1822), a resident fish of the river Teesta in the northern region of West Bengal” for the award of Ph.D. degree of the University of North Bengal, under my guidance. He has carried out the work at the Department of Zoology, University of North Bengal. The content of the thesis has not been submitted elsewhere for any degree.

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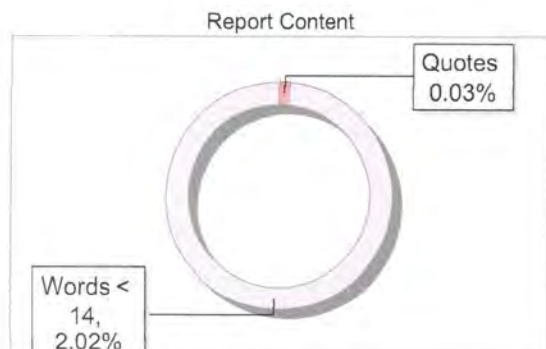
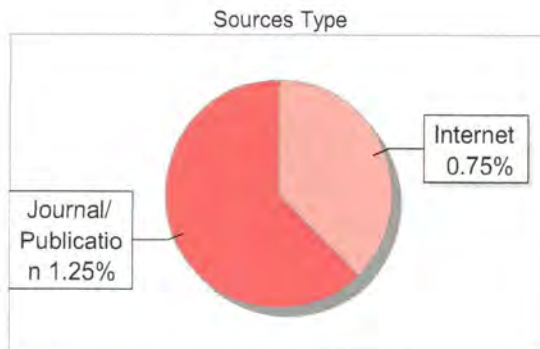
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Preface

The effects of agricultural pesticides on aquatic ecosystems have emerged as a major source of concern. The inappropriate use of pesticides in agricultural fields to control pest populations has adversely affected the aquatic bodies due to chemical runoff via air and water. Pesticide bioaccumulation endangers fish survival by altering the aquatic environment. The Teesta, which runs through the northern area of West Bengal, provides a lifeline for locals. Its tributaries are subjected to increasing human interference due to fast population increase, untreated sewage discharge, and the indiscriminate use of pesticides and fertilizers in agriculture, all of which have affected water chemistry. *Pethia conchonius*, often known as the Rosy Barb, is a resilient and ecologically valuable fish species in this complex ecosystem.

This study evaluates the **effects of agricultural pesticides, imidacloprid, and cypermethrin on *Pethia conchonius*, a fish species found in the River Teesta in the northern part of West Bengal**. The aim is to assess the genotoxicity caused by these insecticides. A significant quantity of pesticides from agricultural fields consistently contaminates river water through surface runoff, causing detrimental effects on non-target creatures, particularly fish commonly consumed by humans. The data generated on the effects of harmful pesticides, such as **imidacloprid and cypermethrin**, on fish in the Teesta River will raise awareness about the importance of minimizing chemical insecticides and refraining from consuming contaminated fish. This precaution is crucial as it can prevent serious health risks in near future. In this context, a research plan has been designed to investigate the genotoxic effects of these pesticides on the vertebrate system under both natural and laboratory conditions to evaluate the harmful consequences of synthetic insecticides. This study has been conducted in the Genetics & Molecular Biology Laboratory, Department of Zoology, University of North Bengal. The thesis is comprised of five chapters. **Introduction, Review of literature, and Objectives are included in Chapter 1. Chapter 2** encompasses the **Materials and Methods** used in the study. **Chapter 3** embodies the **Results** of the entire study, such as sampling, analysis of pesticide residue, acute toxicity bioassay, assessment of DNA and nuclear damage, biochemical changes, and the gene expression in various tissues. **Chapter 4** provides a detailed **Discussion** on the findings and a **conclusion**. **Chapter 5** includes **Appendix** consisting Publications, **list of Seminars and conferences** attended, and an elaborate **Bibliography and Index**.

Abbreviations

FAO: Food and Agriculture Organization	GST: Glutathione-S-transferase
EPA: Environmental Protection Agency	SOD: Superoxide Dismutase
GOI: Government of India	CAT: Catalase
USD: United States Dollars	GSH: Glutathione
kg/ha: kilograms per hectare	MDA: Malondialdehyde
WHO: World Health Organization	L: liter
UTs: Union Territories	NGRBA: National Ganga River Basin Authority
GDP: Gross Domestic Product	HCH: Hexachlorocyclohexane
US: United States	DDT: Dichlorodiphenyltrichloroethane
mm: million	PCB: Polychlorinated Biphenyls
µg: microgram	OCP: Organochlorine Pesticides
µL: microliter	CPCB: Central Pollution Control Board
LD₅₀: Median Lethal Dose	FID: Flame Ionization Detector
LC₅₀: Median Lethal Concentration	µg L⁻¹: micrograms per liter
ROS: Reactive Oxygen Species	ng: nanogram
ATPs: Adenosine Triphosphatases	g: gram
AChE: Acetylcholinesterase	mg: milligram
SCGE: Single-Cell Gel Electrophoresis (Comet Assay)	IMI: Imidacloprid
MN/MNi: Micronuclei	CP: Cypermethrin
DNA: Deoxyribonucleic Acid	ACT: Acetochlor
RNA: Ribonucleic Acid	TBZ: Tebuconazole
ENVIS: Environmental Information System	AO: Acridine-orange
EROD: 7-ethoxyresorufin-O-deethylase	ppm: Parts Per Million

pH: Potential of Hydrogen

NaAsO₂: Sodium Arsenite

MMS: Methyl Methanesulfonate

PUFAs: Polyunsaturated Fatty Acids

LOOH: Lipid Hydroperoxide

LPO: Lipid Peroxidation

MDA: Malondialdehyde

ENAs: Erythrocytic Nuclear Abnormalities

DMP: Dimethyl Phthalate

TBARS: Thiobarbituric Acid Reactive Substances

ATPase: Adenosine Triphosphatase

nAChRs: Nicotinic Acetylcholine Receptors

ACh: Acetylcholine

THM: Thiamethoxam

AChE: Acetylcholinesterase

GABA: γ -aminobutyric acid

***fosab*:** FOS homolog

***glsa*:** Glutaminase A

***grin1b*:** Glutamate Ionotropic Receptor 1b

***gad1b*:** Glutamic Acid Decarboxylase

***gad2*:** Glutamic Acid Decarboxylase 2

***gabrg2*:** Gamma-aminobutyric Acid Receptor Gamma 2

***gabral1*:** Gamma-aminobutyric Acid Receptor Alpha 1

***slc6a1a*:** Solute Carrier Gene Family 6 Member 1a

***slc6a1b*:** Solute Carrier Gene Family 6 Member 1b

***abat*:** Aminobutyrate Aminotransferase

RNS: Reactive Nitrogen Species

HO•: Hydroxyl radicals

O₂•-: Superoxide anions

HOO-: Perohydroxy radicals

NO: Nitric oxide

DMP: Dimethyl Phthalate

GR: Glutathione Reductase

***il-1 β* :** Interleukin-1 beta

***il-8*:** Interleukin-8

***il-10*:** Interleukin-10

***tnf- α* :** Tumor Necrosis Factor-alpha

***ifn- γ* :** Interferon-gamma

HSP70: Heat Shock Protein 70

IGF-I: Insulin-like Growth Factor I

IGF-II: Insulin-like Growth Factor II

CYP450: Cytochrome P450

ZSI: Zoological Survey of India

PBS: Phosphate Buffered Saline

***PcSV*:** *Pethia conchonius* specimens from site I (Sevok)

***PcGB*:** *Pethia conchonius* specimens from site II (Gajoldoba)

PcDM: *Pethia conchoni* specimens from site III (Domohoni)

KMnO₄: Potassium permanganate

OECD: Organisation for Economic Co-operation and Development

LC-MS/MS: Liquid Chromatography-Tandem Mass Spectrometry

GC-MS/MS: Gas Chromatography-Tandem Mass Spectrometry

SD: Standard Deviation

AOAC: Association of Analytical Communities

TQ8040: Model of triple quadrupole mass spectrometer manufactured by Shimadzu Corp., Japan

HPLC: High-Performance Liquid Chromatography

RT-qPCR: Reverse Transcription quantitative Polymerase Chain Reaction

IUPAC: International Union of Pure and Applied Chemistry

CAS: Chemical Abstracts Service

APHA-AWWA-WPCF: American Public Health Association-American Water Works Association-Water Environment Federation

SPSS: Statistical Package for the Social Sciences

IBM: International Business Machines Corporation

***p*:** Probability value

Welch correction: A statistical method to adjust for unequal variances

SEM: Standard Error of the Mean

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