

	<u>Page</u>
List of Tables	xi
List of Figures	xiv
List of Photographs	xx
Summary	si
1. <u>INTRODUCTION</u>	1
2. <u>LITERATURE REVIEW</u>	7
2.1 General	8
2.2 Pesticides and Insecticides	8
2.3 Fertilizers and other chemicals	10
2.4 Industrial Pollutants	11
2.5 Metals	12
2.5.1. Lead and its compounds	12
2.5.2 Chromium and its compounds	14
2.5.3 Other metals	15
2.5.4 Mercury and its compounds	16
2.5.5 Cadmium and its compounds	19
2.5.6 Nickel and its compounds	21
3. <u>EXPERIMENTAL PROGRAMME</u>	23
3.1 Material and methods	24
3.2 Material	24
3.2.1 Chemicals	24
3.2.2 Equipments	25
3.3. Methods	26
3.3.1 Test fish and their collection	26
3.3.2 Acclimatization	26
3.3.3 Preparation of stock solutions	27
3.4 Toxicity tests	27
3.4.1 Screening test	27
3.4.2 Bioassay test	27
3.4.3 Cadmium treatment	28
3.4.4 Mercury treatment	28
3.4.5 Nickel treatment	29

3.5	Physico chemical analysis of water	29
3.6	Respiratory frequency	29
3.7	Mortality	30
3.8	Analysis of results of toxicity tests	30
	3.8.1 Lethal threshold concentration	30
	3.8.2 Median lethal concentration	30
	3.8.3 Toxicity curve	31
3.9	Histopathology	31
	3.9.1 Stains	31
3.10	Growth rate	31
3.11	Determination of accumulation of metals in organs	33
	3.11.1 Digestion of gills, liver and kidney	33
	3.11.2 Determination of cadmium	34
	3.11.2.1 Dithizone method	34
	3.11.3 Determination of mercury	38
	3.11.3.1 Dithizone method	38
	3.11.4 Determination of nickel	41
	3.11.4.1 Heptoxime method	41
3.12	Statistical analysis	44
	3.12.1 Analysis of variance	44
	3.12.2 Regression analysis	45
4.	<u>OBSERVATIONS AND RESULTS</u>	46
4.1	Toxicity of metallic pollutants	47
	4.1.1 Acute toxicity of cadmium sulphate	47
	4.1.2 Acute toxicity of mercuric chloride	49
	4.1.3 Acute toxicity of nickel sulphate	50
4.2	Physiological changes	52
	4.2.1 Alterations in respiratory frequency due to cadmium sulphate	52
	4.2.2 Alterations in respiratory frequency due to mercuric chloride	53
	4.2.3 Alterations in respiratory frequency due to nickel sulphate	54
4.3	Alterations in behavioural pattern	55

4.4	Effects of toxicity of metals on growth	56
4.4.1	Changes observed due to cadmium sulphate	56
4.4.2	Changes observed due to mercuric chloride	57
4.4.3	Changes observed due to nickel sulphate	58
4.5	Histological studies	59
4.5.1	Structure of gill	60
4.5.1.1	Histological changes in gills due to cadmium sulphate	60
4.5.1.2	Histological changes in gills due to mercuric chloride	61
4.5.1.3	Histological changes in gills due to nickel sulphate	63
4.5.2	Structure of liver	63
4.5.2.1	Histological changes in liver due to cadmium sulphate	63
4.5.2.2	Histological changes in liver due to mercuric chloride	64
4.5.2.3	Histological changes in liver due to nickel sulphate	65
4.5.3	Structure of kidney	66
4.5.3.1	Histological changes in kidney due to cadmium sulphate	66
4.5.3.2	Histological changes in kidney due to mercuric chloride	66
4.5.3.3	Histological changes in kidney due to nickel sulphate	67
4.6	Bioaccumulation of Heavy metals	68
4.6.1	Bioaccumulation of cadmium in fish, <i>H. fossilis</i>	68
4.6.1.1	Bioaccumulation of cadmium in gills of <i>H. fossilis</i>	68
4.6.1.2	Bioaccumulation of cadmium in liver of <i>H. fossilis</i>	69
4.6.1.3	Bioaccumulation of cadmium in kidney of <i>H. fossilis</i>	70
4.6.2	Bioaccumulation of mercury in fish, <i>C. mrigala</i>	70
4.6.2.1	Bioaccumulation of mercury in gills of <i>C. mrigala</i>	71

4.6.2.2	Bioaccumulation of mercury in liver of C. mrigala	72
4.6.2.3	Bioaccumulation of mercury in kidney of C. mrigala	72
4.6.3	Bioaccumulation of nickel in fish, H.fossilis	73
4.6.3.1	Bioaccumulation of nickel in gills of H. fossilis	73
4.6.3.2	Bioaccumulation of nickel in liver of H. fossilis	74
4.6.3.3	Bioaccumulation of nickel in kidney of H.fossilis	75
5.	<u>DISCUSSION</u>	76
5.1	General	77
5.2	Acute toxicity of the metallic pollutants	78
5.2.1	Acute toxicity of cadmium sulphate to the fish	78
5.2.2	Acute toxicity of mercuric chloride to the fish	79
5.2.3	Acute toxicity of nickel sulphate to the fish	80
5.3	Physiological changes	83
5.3.1	Effect of cadmium sulphate on respiratory frequency of H.fossilis	83
5.3.2	Effect of mercuric chloride on respiratory frequency of C.mrigala	84
5.3.3	Effect of nickel sulphate on respiratory frequency of H.fossilis	86
5.4	Change in behaviour of the fish	87
5.5	Effect of heavy metals on growth of fish	88
5.6	Histopathology	90
5.6.1	Histological changes in gills due to cadmium mercury and nickel	91
5.6.2	Histological changes in liver due to cadmium mercury and nickel	93
5.6.3	Histological changes in kidney due to cadmium mercury and nickel	94

5.7	Accumulation of metals in the fish	96
5.7.1	Accumulation of cadmium in gills, liver and kidney of <i>H. fossilis</i>	96
5.7.2	Accumulation of mercury in gills, liver and kidney of <i>C. mrigala</i>	99
5.7.3	Accumulation of nickel in gills, liver and kidney of <i>H.fossilis</i>	101
5.8	Conclusion	103
5.9	Further scope of research	105
6.	BIBLIOGRAPHY	106
7.	TABLES	128
8.	FIGURES	149
9.	PHOTOGRAPHS	220
