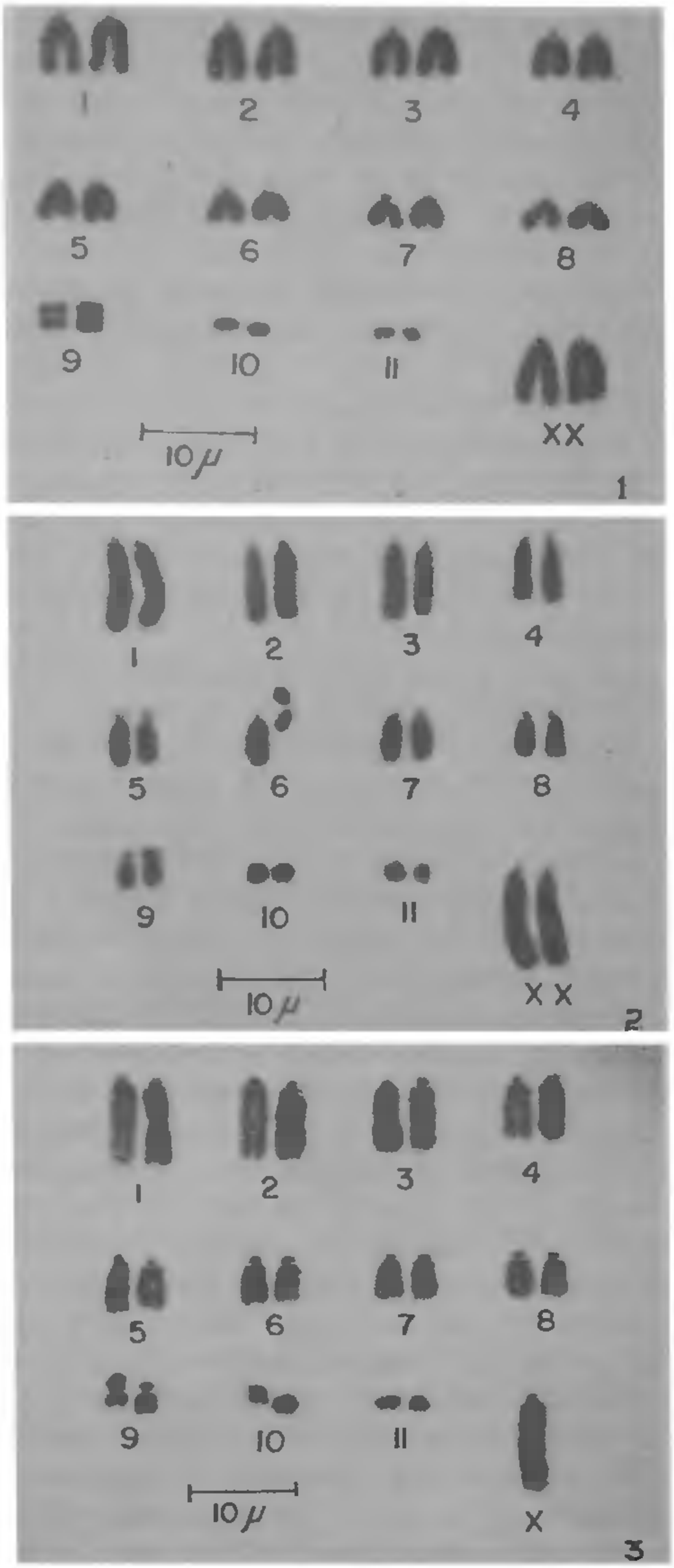

Figures 1–3. 1. Female karyotype showing the metacentric chromosomes of the 9th pair; **2.** Female karyotype with heteromorphic 6th (meta-/acro-) and homomorphic 9th (submeta-/submeta-) pairs of chromosomes; and **3.** Male karyotype with heteromorphic 9th (meta-/submeta-) and 10th (meta-/acro-) pairs.

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COMPARATIVE STUDIES ON THE TOXICITY OF ENDOSULPHAN IN SOME FRESHWATER FISHES UNDER DIFFERENT pH AND HARDNESS OF WATER

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ENDOSULPHAN [Hildan 35 EC, LB-1,2,3,4,7, 7-hexachlorobicyclo (2,2,1)-heptene-(2)-bis-hydroxy-methylene(5,6) sulphite] is a registered fish toxicant[1]. It is used extensively to control undesirable organisms. In the present study, an attempt has been made to study the toxicity of endosulphan by determining the LC_{50} values in 3 species of exotic carps viz *Ctenopharyngodon idella*, *Hypophthalmichthys molitrix* and *Puntius javanicus* and 2 species of Indian major carps viz *Catla catla* and *Labeo rohita* under 3 different pH and hardness of water.

Fish (fingerling) specimens were obtained from Naihati Fish Farm, West Bengal. The experiments were conducted following the methods suggested earlier[2–4].

Fishes exposed to endosulphan were excited and swam around erratically and rapidly. Subsequently the fishes lay several hours on their sides on the bottom of the container. When such fishes attempted swimming they moved erratically often making somersaults. The bottom surface of fishes after some hours of exposure specially at higher concentration became very soft to the touch. Fishes that were about

Table 1 *The 24 hr, 48 hr, 72 hr and 96 hr-LC_{50} values (ppb or µg/lit) of endosulphan to 5 species of fishes under 3 different pH and hardness of water*

					pH (range)		
					8.25	7.9	7.5
					Hardness (mg/lit) $CaCO_3$ (range)		
					700	430	250
Species	Time (hr)	Average size (cm)	Average weight (g)	D.O. (ppm) (range)	LC_{50} values (range) ppb		
C. idella	0	6.3–7.1	2.7–3.1	7.2–8.1	0	0	0
	24			6.8–7.8	5.741–5.791	4.122–4.167	2.799–2.830
	48			6.6–7.7	5.697–5.724	4.100–4.113	2.523–2.571
	72			6.3–7.5	4.201–4.258	3.701–3.778	1.872–1.893
	96			6.3–7.4	4.078–4.113	3.766–3.712	1.711–1.767
H. molitrix	0	4.5–6.0	1.15–2.5	7.2–8.1	0	0	0
	24			6.9–8.0	4.302–4.341	2.671–2.717	1.331–1.367
	48			6.7–7.8	4.083–4.112	2.613–2.652	1.076–1.105
	72			6.6–7.7	2.600–2.653	2.239–2.313	0.382–0.427
	96			6.4–7.5	2.428–2.498	2.272–2.300	0.261–0.301
L. rohita	0	5.0–6.1	1.8–2.9	7.2–8.1	0	C	0
	24			7.0–8.0	4.341–4.381	2.722–2.754	1.387–1.419
	48			6.8–7.9	4.299–4.331	2.601–2.671	1.121–1.159
	72			6.7–7.7	2.801–2.861	2.303–2.349	0.433–0.493
	96			6.6–7.6	2.688–2.721	2.298–2.333	0.356–0.371
C. catla	0	5.8–6.4	2.3–2.7	7.2–8.1	0	0	0
	24			7.1–8.1	4.892–4.919	3.251–3.295	1.921–1.961
	48			7.0–7.9	4.811–4.854	3.101–3.151	1.673–1.704
	72			6.8–7.8	3.336–3.388	2.786–2.815	1.020–1.026
	96			6.5–7.7	3.199–3.239	2.795–2.833	0.891–0.902
P. javanicus	0	5.1–5.5	1.4–2.1	7.2–8.1	0	0	0
	24			6.7–7.8	10.372–10.403	8.722–8.779	7.361–7.402
	48			6.5–7.6	10.303–10.336	8.688–8.725	7.111–7.143
	72			6.4–7.4	8.821– 8.876	8.327–8.389	6.422–6.467
	96			6.1–7.3	8.689– 8.729	8.335–8.375	6.308–6.341

to die had their ventral sides much bloated. Another characteristic behavioural change observed was violent quivering of the body followed by convulsions and paralysis.

Table 1 summarizes the results of the toxicity tests. *H. molitrix* and *L. rohita* were most susceptible to endosulphan while *P. javanicus* was the most tolerant. With the increase of pH and hardness of water the lethal dose (LC_{50}) also increased gradually with exposure to 24, 48, 72 and 96 hr respectively.

Within a few seconds of application of pesticides, the abnormal behavioural manifestations could be seen in the fishes as noted by number of workers in different types of invertebrates[5] and fishes[6–9].

In the present study the behavioural symptoms as well as the change in shape of the body following application of endosulphan were almost similar to those noted in the channel catfish *Ictalurus punctatus* by Mount and Putnicki exposed to endrin[10] and also in *Mystus cavasius* following treatment with methyl parathion and fenosulphothion[11].

The toxicity of endosulphan based on static tests to several freshwater and marine fishes has been studied[12–14] but not the impact of this pesticide on fishes under different pH and hardness of water. The present results revealed that the pH and hardness of water do play a role and therefore their fractions also have to be considered during application of endosulphan in freshwater. It is clear that a higher pH value along with high amount of $CaCO_3$ demand more pesticides.

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LACTIC ACIDOSIS IN DIFFERENT TISSUES OF *SAROTHERODON MOSSAMBICUS* (PETERS) EXPOSED TO SEVIN

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ONSET of oxygen debt[1] resulting in utilization of stored glycogen[2,3] and a shift from aerobic to anaerobic mode of energy release[4,5] have been reported in fishes following exposure to different kinds of pesticides. Animals, which pay off an oxygen debt, tend to accumulate more lactic acid during anaerobiosis[6]. Lactic acid is the end product of anaerobic glycolysis and its accumulation in different tissues above normal levels is indicative of a shift from aerobic to anaerobic metabolic pathway under hypoxic conditions. Changes in lactic acid levels of different tissues following pesticide exposure have not been investigated in detail in fishes except the studies of Shaffi[7] and Verma *et al*[8]. In the present investigation, the patterns of changes in lactic acid levels of different tissues of *Sarotherodon mossambicus* (Peters) following exposure to a carbamate pesticide sevin have been studied.

The carbamate pesticide, sevin (1-Naphthyl N-Methyl carbamate), widely applied in the eradication of cotton pest in Coimbatore District, was used in the present study. Samples of *S. mossambicus* (5–9 g), obtained from local ponds in and around Coimbatore City, were acclimatized to laboratory conditions (29 ± 1°C) in large cement tanks and regularly fed with cooked rice. A stock solution of 1 gram of sevin (available as 10% dust) in 100 ml of distilled water was used to prepare the required concentrations of pesticide-water. The sublethal and lethal concentrations of sevin were assessed by repeated exposure experiments employing the static bioassay method and Probit analysis[9]. Fishes were exposed to 3 ppm (sublethal) of sevin for 48 hr and to 25 ppm (lethal concentration) of sevin for 6 hr in glass jars. A batch of 10 fishes were exposed to each concentration for the prescribed period. Control fishes were also maintained in similar glass jars with pesticide-free tap water.

Lactic acid levels were estimated in blood, liver, muscle and heart of control and pesticide-exposed fishes (after 48 hr of sublethal exposure and after 6 hr of lethal exposure) following the method of Barker and Summerson[10]. Blood sample was collected by cardiac puncture using a pre-chilled hypodermic syringe rinsed with cold heparin. Tissue samples of liver, muscle and heart were dissected by keeping the stunned (by a blow on the head) fish in an iced trough. Lactic acid levels in blood were expressed in mg/100 ml of blood and those of liver, muscle and heart in mg/g of tissue. The lactic acid levels in blood, liver, muscle and heart of control and sevin-exposed *S. mossambicus* are presented in table 1. Data on lactic levels of blood are represented in figure 1 and those of liver, muscle and heart in figure 2.

A perusal of table 1 reveals increased accumulation of lactic acid in the blood of sevin-exposed *S. mossambicus* above normal level resulting in severe 'lactic acidosis'. This probably indicates the operation of anaerobic glycolysis in different tissues and channelling of the final product (lactic acid) into blood. Lactic acidosis in blood appears to be more severe under lethal exposure than sublethal exposure in *S. mossambicus* (table 1). A similar increase in the

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