CHANGES IN THE BIMODAL GAS EXCHANGE AND SOME BLOOD PARAMETERS IN THE AIR-BREATHING FISH, *CHANNA STRIATUS* (BLEEKER) FOLLOWING LETHAL (Lc 50/48 Hrs.) EXPOSURE TO METASYSTOX (DEMETON)

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The extensive use of insecticides is constantly polluting freshwater, whose effects are manifold on living organisms including economically important fishes. They are also responsible for a number of physiological and biochemical disturbances[14,15]. Metasystox is probably the most widely used insecticide against paddy sucking aphids, spider mites, saw flies, etc. It is primarily a neurotoxicant inhibiting the working of the enzyme acetylcholinesterase[10]. Till now no report seems to be available on the toxic effect of Metasystox on oxygen consumption and haematology of any tropical fish. The present communication deals with the action of lethal (Lc 50/48 hrs) exposure of Metasystox on the oxygen consumption and haematology of the ubiquitous major fresh-water food fish, *Channa striatus*, which is extensively cultured in ponds and rice-fields and is frequently exposed to Metasystox during agricultural operations.

Adult *C. striatus* (10–15 g) obtained locally were allowed to acclimatize to the laboratory water which contained a dissolved oxygen level of $6 \cdot 5 \pm 0 \cdot 3$ ppm; free CO_2 $0 \cdot 3 \pm 0 \cdot 2$ ppm; pH $= 7 \cdot 2 \pm 0 \cdot 2$ and temperature of $29 \pm 1°$ C. The technical grade Metasystox (Demeton; 0-Methyl sulphoxide = 0, 0-dimethyl S-2 (sulphinyl) ethyl phosphorothioate) of 95% purity was obtained from Bayer Ltd., Bombay. Lc 50/48 hrs as calculated by probit method[4] was 5 mg/l for Metasystox.

The oxygen consumption of the fish in water without access to air (aquatic respiration) and in water with access to air (bimodal respiration) was measured[12]. Blood for white blood cell count (WBC), red blood cell count (RBC), packed cell volume (PCV) and haemoglobin content (Hb) was obtained by caudal puncture with 2·5 ml syringe and 21 gauge needle previously rinsed with 10% sodium heparin. Blood cell counts were made with Neubauer crystalline counting chamber; haemoglobin content was estimated by acid haematin method. Haematocrit determination followed the methods of Hesser[6] and Blaxhall and Daisley[2]. Heparinised capillary tubes were centrifuged for 10 minutes at 3,500 rpm and percentage packed formed elements were read on a Clay Adams haematocrit reader. The mean cell volume (MCV), mean cell haemoglobin (MCH) and mean cell haemoglobin concentration (MCHC) were calculated using formulas provided by Coburn[3].

The oxygen consumption, and blood values, namely WBC, RBC, MCV, PCV, Hb, MCH and MCHC of normal and Metasystox exposed fish are presented in Tables I and II.

The oxygen consumption of fish from water without access to air increased significantly ($+ 21 \cdot 06$; $P < 0 \cdot 01$ following Metasystox exposure. However, when the fish was allowed to respire aerially, the respiratory metabolism of the fish increased by about 32%. This might be due to the dependency on air breathing organs for respiration during severe pollution stress in the aquatic environment. The overall increase of total oxygen consumption during free access to air appears to be due to behavioral manifestations like hyperactivity, darting movements on exposure to pesticide. This may also be due to the escape behaviour of the fish from the pesticide toxicity as reflected in its aerial respiration.

Table I

Oxygen consumption of C. striatus *exposed to lethal (Lc 50/48 hrs.) concentration of Metasystox (Mean ± S.E. and expressed as cc/kg/hr) N = 15*

	O_2 consumption under water (without access to air)	O_2 obtained from air	O_2 obtained from water	Total O_2 consumption
Control	42·30	174·60	38·80	213·40
	± 2·00	± 7·30	± 1·90	± 5·86
Metasystox	51·46	230·40	30·20	260·60
	± 2·38	± 8·60	± 1·62	± 6·40
	+21·06	+ 32	−22·16	+ 21·65
	$P < 0 \cdot 01$	$P < 0 \cdot 01$	$P < 0 \cdot 05$	

N = Number of fishes used in the experiment.
The signs + or − indicate per cent increase or decrease over control.
P = '*t*' test (significant).

TABLE II

Blood parameters of C. striatus *exposed to lethal (Lc 50/48 hr) concentration of Metasystox*

Blood parameter	Control	Metasystox	% change
White blood corpuscle (WBC) (× 10^4 m/cmm)	3·10 ± 2·27	2·80[a] ± 1·82	− 9·67
Red blodd corpuscle (RBC) (× 10^6 m/cmm)	3·60 ± 0·602	3·20[b] ± 0·406	−11·11
Mean corpuscular volume (MCV) (cμ)	130·20 ± 32·52	138·62* ±20·60	+ 7
Packed cell volume (PCV) (%)	32·50 ± 2·06	30·70* ± 1·33	− 5·53
Haemoglobin concentration (Hb) (%)	14·40 ± 0·642	13·28[b] ± 0·764	− 7·77
Mean corpuscular haemoglobin (MCH) (μ μ gms)	40·10 ± 4·29	42·63* ± 6·18	+ 5·93
Mean corpuscular haemoglobin concentration (MCHC) (%)	36·40 ± 2·56	38·51* ± 2·60	− 5·73

Values expressed are mean ± S.D. for 6 individual observations. Changes after insecticide treatment are statistically significant $P < 0 \cdot 01$.

[a] $P < 0 \cdot 05$, [b] $P > 0 \cdot 02$, * Not significant.

It has been shown that lethal level of Thiodan exposure increases the aquatic respiration of *Mystus vittatus*[5] which is primarily a facultative air breather. It is already shown[18] that *C. striatus* is an obligate air breather and in pesticide free water the gills contribute significantly to CO_2 excretion. However in the pesticide containing water, the air breathing organs play a very important role, by participating in the promotion of extraction of O_2 from air during their stay in water. Greater participation of air breathing organs may be advantageous to *C. striatus* which is normally an inhabitant of CO_2 rich waters. This behaviour is also very helpful under pollution stress conditions for survival. A similar conclusion has also been arrived by Natarajan[13] in the air breathing climbing-perch, *Anabas scandens* for lethal exposure of Sumithion.

Metasystox exposure also decreased blood parameters like WBC, RBC, PCV and Hb concentration. Increase observed in other values, namely, MCV, MCH, and MCHC, however was not statistically significant. The per cent decrement of WBC (− 9·67; $P < 0 \cdot 05$) RBC (− 11·11%; $P < 0 \cdot 02$), PCV (− 5·53; $P < 0 \cdot 05$) and Hb (− 7·77%; $P < 0 \cdot 02$) was statistically significant.

Lethal level of Sevin and Sumithion treatment reduced the RBC, PCV and Hb concentration in the blood of fresh-water fish, *Sarotherodon mossambica*[14]. Acute and chronic doses of DDT and Dieldrin induced anemia in the form of low erythrocyte count, low Hb content, high MCH and high colour index in *Channa punctatus*[8]. Progressive decrease in erythrocyte count, Hb concentration and total leucocyte count is also reported in *C. punctatus* for Malathion and Methyl parathion treatment[9].

The decrease of RBC, PCV and Hb values, results in hypochromic microcytic anemia which was attributed to deficiency of iron and its decreased utilisation for Hb synthesis[1]. It is well established that glycolysis is concerned with the reduction of methemoglobin as soon as it is formed, thus maintaining the iron of the Hb in the ferrous form in which state only, it acts as an efficient oxygen carrier. *In vitro* studies of Hiltibran[7] indicate the prevailing of anaerobic segment of glycolysis in the insecticides exposed fishes. The breakdown of iron synthesising machinery due to the inhibtion of aerobic glycolysis may be the reason for the decrease of blood values in the Metasystox exposed fish.

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