AQUATIC OXYGEN UPTAKE OF THE FRESHWATER FEATHERBACK, *NOTOPTERUS CHITALA* (HAM.) IN RELATION TO BODY WEIGHT.

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ABSTRACT

The rate of metabolism in fishes is measured by determining the oxygen consumption. The present investigation has been carried out to see oxygen uptake through the gills in relation to body weight in *Notopterus chitala* at 27.5 ± 1.0ºC using continuous water flow system. In *Notopterus chitala* the oxygen uptake increased from 0.394 to 4.640 mlO $_2$ h^{-1} with gradual increase in body weight from 1.166 to 98.750g. the weight specific oxygen uptake decreased from 345.967 to 46.990 $mlO2.Kg^{-1}.h^{-1}$. for the same weight range. The log-log plot of oxygen uptake(mlO $_2$ h^{-1}) in relation to body weight gave a straight line with the slope (b) value 0.558. The estimated intercept (a) value was found to be 0.446. The relationship between oxygen uptake and body weight was found to be highly significant. However, the weight specific oxygen uptake decreased by a power of -0.444.

Key Words- Aquatic oxygen uptake, Body weight, *Notopterus chitala*.

INTRODUCTION

Fishes are generally aquatic and require oxygen to meet up theirmetabolic demand. The rate of oxygen consumption in fishes is related to the magnitude of their energy requirement per unit body weight. The relationship between the body weight and the oxygen uptake in detail has been studied by Zeuthen (1947,1953). The oxygen consumption in relation to body weight is specific for different fish species suggested by Moss and Scott (1961) and Beamish (1964). A great deal of work have been done on relationship between oxygen uptake and body weight in some purely aquatic breathing Indian fishes by Roy and Munshi (1984), Kunwar et al., (1989), Ojha and Singh (1981), Singh et

al., (1991) and Jha et al., (2008), Neelima et al., (2016). The relationship have also been studied in some Indian air-breathing fishes viz, *Anabas testudineus* (Munshi and Dube ,1973), *Colisa fasciatus* (Ojha et al., 1977), *Channa punctatus* (Pandit,2001), *Notopterus notopterus* (Kumari et al., 2010). Bimodal Oxygen uptake in relation to body weight in *Notopterus chitala* and *Notopterus notopterus* have been studied by Ghosh et al., 1986 and kumari et al., 2015 respectively. However, so far no attempt has been made to study the aquatic oxygen uptake in relation to body weight in *Notopterus chitala.* Therefore, the present work is an endeavour to establish the relationship between the aquatic oxygen uptake and body weight in *Notopterus chitala.*

MATERIALS AND METHODS

Live specimens of different weight groups (1.166 to 98.750 g) of *Notopterus chitala* were collected form river Ganga through fisherman and they were transferred to the large plastic pool of departmental Aquarium House. They were acclimatized for about two weeks feeding live shrimps and pieces of small fish with continuous aerator on. The oxygen consumption through gills was measured by using cylindrical glass respirometer of various capacity depending upon the size of the fish similar to that used by Ghosh and Munshi (1987). The respirometer was connected to large constant level water tank to maintain the water flow under constant hydrostatic pressure. The respirometer was covered over with black cloth to avoid visual disturbance to the fish. The flow of water through the respirometer was adjusted according to the size of the fish to provide stress free condition. The oxygen uptake was determined by the difference in the concentration of dissolved oxygen between inspired and expired water, the rate of water flow and the body weight of the fish using Winkler's volumetric method (Welch, 1948).

RESULTS

Aquatic oxygen uptake per unit time ($mlO_2.h^{-1}$).

The oxygen uptake of *Notopterus chitala* increased from 0.394 to 4.640 $mlO_2.h^{-1}$ with gradual increase in body weight from 1.166 to 98.75 (Tab.1). The relationship between oxygen uptake and body weight was found to be highly significant ($r=0.962$; $p<0.001$). When the data for the oxygen uptake per unit time where plotted against body weight on log-log graph, it gave a straight line with a slope 'b' value of 0.558 and intercept 'a' value of 0.446 (Tab.2, fig.2). The rate of oxygen uptake of *Notopterus*

chitala have been calculated to be 0.446, 1.612, 5.832 and 21.035 for a 1.0, 10.0, 100.0 and 1000.0 g respectively (Tab.3).

The relationship between the oxygen uptake per unit time (mlO $.h^{-1}$) and the body weight may be expressed by the following equation.

$$VO_2 = 0.446.W^{0.558}$$

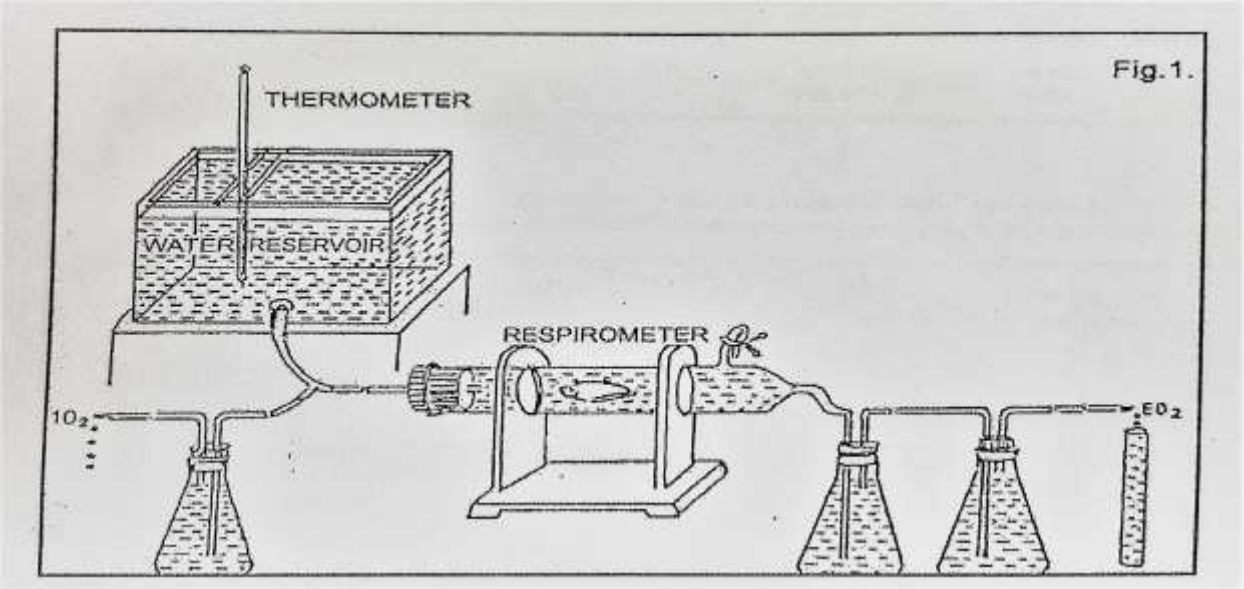


Figure 1. Experimental setup for the measurement of aquatic oxygen uptake in *Notopterus chitala*.

Aquatic oxygen uptake per unit body weight (mlO2.$Kg^{-1}.h^{-1}$)

The weight specific oxygen uptake in *Notopterus chitala* decreased from 345.967 to 46.99 mlO2.$Kg^{-1}.h^{-1}$. with gradual increase in body weight from 1.166 to 98.750 g. The log-log plot between the body weight and oxygen uptake per unit body weight gave a straight line with a slope 'b' value of -0.444 when different scores were fitted by the least square regression method (Tab.2, Fig.2). There is a negative and highly significant correlation between these two variables ($r=0.942$; $p<0.001$). The relationship between the weight specific oxygen consumption and body weight may be expressed as follows:-

$VO = 449.086 * W^{-0.444}$
2

The estimated value of a fish of 1.0, 10.0, 100.0 and 1000.0 g, the oxygen uptake per unit body weight were calculated to be 449.086, 161.661, 58.194 and 20.949 mlO2.Kg- $^{1}.h^{-1}$. respectively. (Tab.3)

DISCUSSION

In *Notopterus chitala*, aquatic oxygen uptake through continuous water flow system without access to air showed similar trend as that of *Notopterus notopterus* (Kumari et al., 2010). In *Notopterus chitala,* within the body weight range of 1.166 to 98.750 g, the oxygen uptake increased by a function power of 0.558. However, in *Notopterus notopterus*, the slope 'b' value was reported to be 0.421 for a weight range of 5.100 to 122.333 g (Kumari et al.,

2010). The slope 'b' value 0.558 is lower than most of the purely aquatic breathing fishes. In *Labeo rohita* (body weight- 16.00 to 425.0 g) and *Catla catla* (body weight- 6.50 to 240.0 g), slope 'b' value estimated by (Kunwar et al., 1989) as 0.0515 and 0.7469 respectively. Although, 'b' value of *Notopterus chitala* is slightly higher and closer to *Glossogobius giurus* (b=0.5561). Similarly, the slope 'b' value of *Notopterus chitala* is less than the values reported for many air-breathing fishes. In *Heteropneustes fossilis* the oxygen consumption through gills increased by a function power of 0.799 (Munshi et al., 1978). A slope of 0.629 has been reported by Hakim and Munshi (1983) in *Channa punctatus*. Although, the present value of (0.558) is higher than that of *Anabas testudineus* (0.526) (Munshi and Dube, 1973), the juveniles 0f *Heteropneustes fossilis* (0.475) (Munshi et al., 1978) and *Notopterus Notopterus* (0.421) (Kumari et al., 2010). The lower slope value of *N. chitala* is prob- ably due to the stress under surfacing prevented condition during experimentation. This is true to almost air-breathing fishes studied earlier. The difference in slope value among different fish species seems to be due to different growth pattern, stages of their life cycle, physiological condition of fish and changes in feeding behavior etc. (Smith, 1935 a,b; Kamler, 1972).

The slope 'b' for weight specific oxygen uptake was -0.444 in *Notopterus chitala.* Such a decreasing trend was also reported by various other workers- Munshi and Dube (1973), in *Anabas testudineus*, Hakim and Munshi (1983), in *Channa punctatus*, kumari et al.,(2010) in *Notopterus notopterus,* Kunwar et al.,(1989) in *Labeo rohita* and *Catla catla.* According to Prigogine and Wiame (1946) the weight specific oxygen consumption can only decrease with gradual increase in body weight. This is probably due to opportunities for lower cost, change in skeletal structures, economy of food utilization etc. (Jones, 1972; Schmidt-Neilson,1984). The computed value of oxygen uptake ($mlO_2 .h^{-1}$.) of 1.0 g fish of *Notopterus chitala* was found to be 0.446 which is higher than the value estimated for purely aquatic breathing fishes viz- *Labeo rohita*, 0.321 (Kunwar et al., 1989), *Glossogobius giuris,* 0.321 (Singh and Munshi, 1985) but lower than (0.532) reported by Ojha and Singh (1981). However, it is very close to *Labeo bata* (0.447) (Sinha, 1983). This value is also lower than *Notopterus notopterus* (0.508). Although, it is higher than other air-breathing fishes, viz, 0.215 in *Heteropneustes fossilis*, and 0.394 in *Channa gachua*. Thus it indicates that the rate of oxygen uptake of *Notopterus chitala* occupies an intermediate position.

Table 1. The rate of aquatic oxygen uptake (VO_2) of Notopterus chitala against body Weight at 27.5±1°C.

Body weight (g)	Oxygen consumption(VO_2)	
	$mlO_2.h^{-1}.fish^{-1}$	$mlO_2.Kg^{-1}.h^{-1}.$
1.166±0.153	0.394±0.076	345.967±103.308
2.067±0.115	0.515±0.028	249.900±21.490
2.700±0.283	0.786±0.457	282.290±137.660
3.675±0.247	1.084±0.090	304.830±54.207
6.889±0.507	1.595±0.508	228.366±55.909
10.650±0.778	1.638±0.269	153.6±12.950
15.933±2.215	2.433±0.252	154.676±30.000
20.000±0.707	3.011± 0.360	150.300±12.728
28.167±0.764	3.854±0.505	136.533±14.116
30.208±2.88	3.595±0.366	120.291±22.969
39.250	2.685	68.410
62.750	3.405	54.260
98.750	4.640	46.990
Average:24.786±0.886	2.208±0.291	176.647±46.534

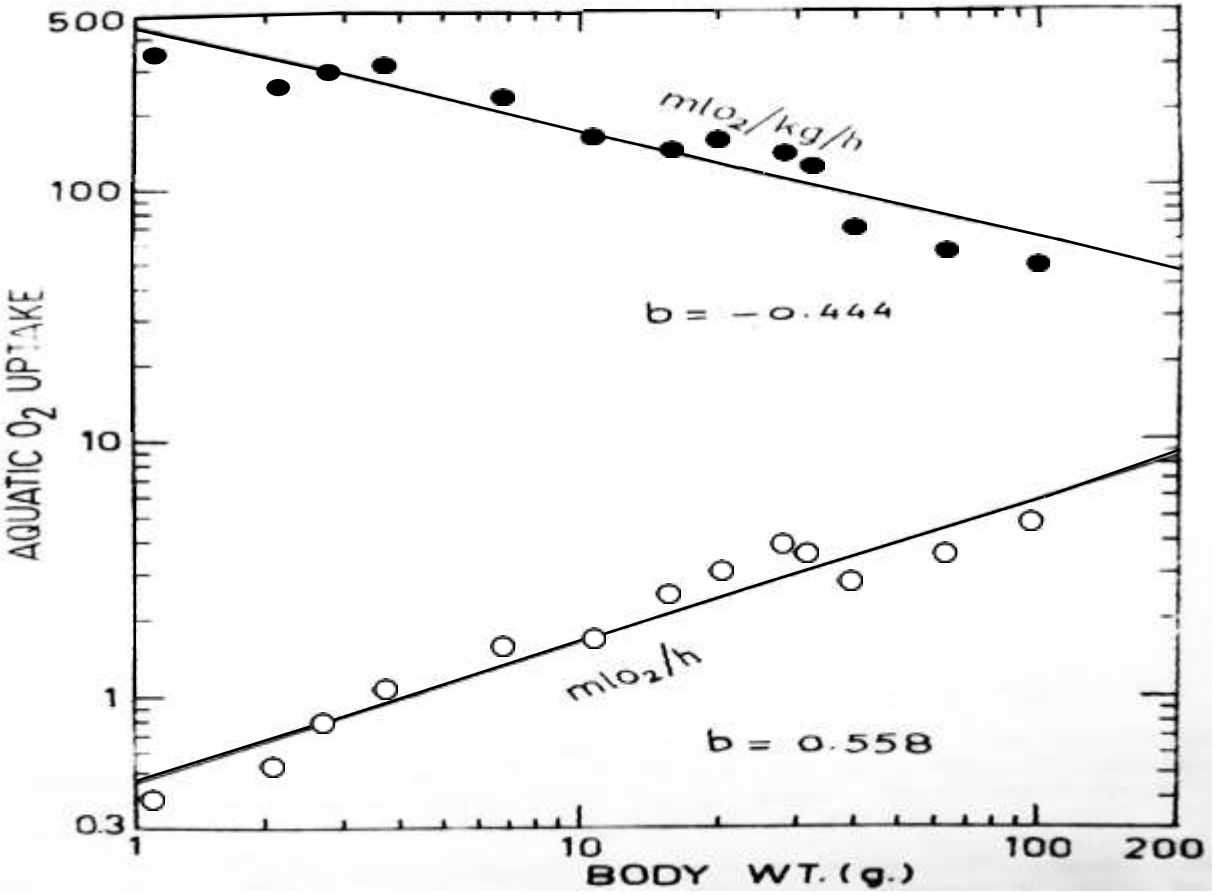
Table.2 The Allometric equation, Intercept 'a', Regression coefficient 'b' and Correlation coefficient 'r' to show the relationship between oxygen uptake VO_2 ($mlO_2.h^{-1}.fish^{-1}$ and $mlO2.Kg^{-1}.h^{-1}.$) and body weight in Notopterus chitala. Their 95% C.L. are also given.

Oxygen Uptake (VO_2)	Allometric equation $y = aw^b$	Intercept 'a'		slope 'b'		Correlation coefficient 'r'
		Value	95% C.L.	Value	95% C.L.	
$VO_2(mlO_2.h^{-1}.fish^{-1})$	$LogVO_2$=log 0.446+0.558.log W or, $VO_2=0.446.W^{0.558}$	0.446	0.322 0.576	0.558	0.476 0.690	0.962 (p<0.001)
$VO_2(mlO_2.kg^{-1}.h^{-1})$	$LogVO_2$=log 449.086-0.444.log^w or, $VO_2=0.449.086.W^{-0.444}$	449.086	334.384 603.133	-0.444	-0.548 -0.339	0.942 (p<0.001)

Table3. Statistically estimated data of aquatic oxygen uptake VO_2 ($mlO_2.h^{-1}.fish^{-1}$ and $mlO2.Kg^{-1}.h^{-1}$.) for 1.0, 10.0, 100.0 and 1000.0 g of Notopterus chitala based on regression analysis using least square method. Their 95% confidence limit are also given.

Body weight(g)	Oxygen Uptake (VO_2)			
	Value ($mlO2.h^{-1}.fish^{-1}$.)	95% C.L.	Value ($mlO2.Kg^{-1}.h^{-1}$.)	95% C.L.
1	0.446	0.323/0.691	449.086	334.384/603.133
10	1.612	0.960/2.826	161.661	94.639/276.147
100	5.823	2.826/13.862	58.194	26.785/126.435
1000	21.035	8.531/67.991	20.949	7.581/57.889

Fig.2



Log/log plots showingh relation between body weight and oxygen uptake per unit time ($mlO_2.h^{-1}.fish^{-1}$) and body weight and weight specific oxygen uptake ($mlO_2.kg^{-1}.h^{-1}$) at 27.5±1.0°C in Notopterus chitala.

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