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Oxygen uptake in relation to group size in the juveniles of a climbing perch, *Anabas testudineus* (Bloch)

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Abstract: *The present work reports oxygen uptake in relation to group size in the juveniles (body weight : 0.70 to 1.30 g) of a climbing perch, Anabas testudineus (Bloch). The experiments were conducted at 21.5 ± 1.0^{0}C using a cylindrical glass respirometer having continuous water flow system. With an increase in the number of fish at an interval of 5 from 5 to 40 in each fourth subsequent experiment, the weight specific aquatic oxygen uptake of a fish decreased from 0.192± 0.030 to 0.800± 0.006 ml $O_2 g^{-1} h^{-1}$. When compared with a controlled fish, there was a reduction of 27.80% in the oxygen uptake in a group of 5 but 58.39% in a group of 40. A negative and significant correlation (r=0.8411, p<0.01) was calculated between oxygen uptake and group size of fishes. The investigation showed that probably due to shoaling behaviour, the aquatic oxygen uptake in the juveniles of A. testudineus always remained high in controlled fish or a fish in isolation than when they were in a group*

Key words: *Oxygen uptake, Group effect, Juvenile, A. testudineus*

Introduction

Oxygen uptake of individuals is affected by various abiotic and biotic factors. The variation in oxygen uptake when animals of either similar or different genera or species are kept together is known as group effect (Allee,1931). Different aspects of grouping have been studied to describe the phenomenon in fishes. Kennedy and Pitcher (1975) explained the concept of shoaling behaviour. The shoaled fishes get bounded to a school during swimming which results in their synchronized and polarized behaviour at that time to sooth them. The soothing reduces the excitability of fish and consequently their metabolic rate (Shlaifer, 1938).

Oxygen uptake of purely aquatic fishes in relation to group size was determined by Singh and Munshi (1985) and Jana and Das (1996) respectively in *Glossogobius giuris* and *Labeo rohita* in India. Such experiments with Indian air breathing fish were conducted by Ghosh and Pandit (1992) in *Channa punctatus* and Ghosh *et al*. (1994) in *Heteropneustes fossilis*. An attempt has been made here to study the effect of group size on oxygen uptake in the juveniles of *Anabas testudineus* (Bloch) which might be applied during the packing of live specimens of *A. testudineus* for transportation and other related purposes.

Materials and Methods

Isomorphic juveniles (body weight : 0.7 to 1.30g and total length : 3.5 to 4.0 cm.) of *A. testudineus* were segregated from a large plastic pool in which they were bred artificially by administration of heteroplastic pituitary extract. The segregated juveniles were brought to laboratory for a fortnight acclimatization. During the later period juveniles were fed with trash fishes, goat liver *etc.* on alternate day but feeding was checked 24 hr before the experiment.

A continuous water flow system of cylindrical glass respirometer (capacity 0.5 to 1.0 litre) was used for this experiment. The respirometer was connected to a water reservoir and uniform water flow was maintained. The juveniles were taken in the respirometer and further acclimatized for 2 hr to avoid effect of handling. Each experimental set up was repeated four times and from each set three readings were taken. The number of juveniles was increased from 5, 10 and 15 up to 40. The rate of water flow through the respirometer was increased accordingly from 10-220 ml min^{-1}. A black cloth was used to cover the respirometer so that the juveniles do not get exposed to external disturbances. All the experiments were conducted in morning hours (8 to 10 am) at temperature of 21.5 ± 1.0^{0}C.

Initial physico-chemical characteristics such as pH (7.4±0.2), temperature (21.5± 1.0^{0}C), dissolved oxygen (7.2± 0.8mgl^{-1}), free carbon dioxide (1.5±0.5mgl^{-1}) and total alkalinity (107± 07 mgl^{-1}) of experimental water were recorded. The concentration of dissolved oxygen in inspired and expired water was determined by Winkler's volumetric method (Welch, 1948). The rate of oxygen uptake was calculated from the difference between amount of dissolved oxygen, rate of water flow and body weight of the juveniles. The variation in oxygen uptake due to group size in *A. testudineus* was calculated by following formula (Itazawa *et al.,* 1978).

$$\text{Group effect: } \frac{VO_2 \text{ in a smaller group} - VO_2 \text{ in a large group}}{VO_2 \text{ in a smaller group}} \times 100$$

The regression analysis using logarithmic transformation and t-test was made on a Pentium IV 550mHz. based computer to establish relation between oxygen uptake and group size.

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Results and Discussion

The oxygen uptake by juveniles of *A. testidineus* in relation to group size was compared in term of per unit body weight (ml $O_2 g^{-1} h^{-1}$). A controlled juvenile of *A. testudineus* (body weight 0.92±0.19g) consumed 0.192±0.030 ml $O_2 g^{-1} h^{-1}$ (Table 1). With successive increase in group size from 5 to 40 fishes at an interval of 5 individuals, the weight specific oxygen uptake of one specimen in a group decreased from 0.140± 0.026 to 0.080 ± 0.006 $mlO_2 g^{-1} h^{-1}$ (Fig. 2). There exists a significant correlation between oxygen uptake and group size (r=0.8411, p<0.01). The slope was calculated to be –0.2647 and the estimated value of aquatic oxygen uptake for a fish of 1g was found to be –0.6716. The relationship between two variables can be expressed as:

$$VO_2 = -0.6716 GS^{-0.2647}$$

The equation expresses that for a unit increase in group size, the rate of aquatic oxygen uptake of a fish decreased by a functional power of –0.2647.

A reduction of 46.0 ± 16.0% (21.80 to 69.79%) in comparison to a control fish was calculated and found to be significant when fishes were in a group of 20 onwards. While working with medaka (*Oryzias latipes)* of body weight 0.484 ± 0.027g, Itazawa *et al*. (1978) reported a reduction of 14.99 ± 1.75% in weight specific oxygen uptake. Similarly, Ghosh and Pandit (1992) obtained a lowering of 48.01 ± 19.0% in weight specific oxygen uptake in *C. punctatus* (body weight 0.83 ± 0.20g) from 5 to 40 fishes at 21.5 ± 1.0°C. Jana and Das (1996) also reported a reduction of 38 to 81% in grouped *L. rohita* as compared to specimen in isolation. These findings corroborate with present observation. But conversely, Ghosh *et al*. (1994) observed an increase of 127.44 ± 60.0% in weight specific oxygen uptake while working with *H. fossilis* of body weight 1.8± 0.2g at 24.0 ± 1.0°C. Therefore, it seems that standard metabolic rate (SMR) or routine metabolic rate (RMR) of aggressive fishes (*eg. H. fossilis)* get increased either to active metabolic rate (AMR) or maximum metabolism of sustained activity (MMSA) in grouping by which they became excited and consequently their oxygen uptake got increased (Fry, 1971 ; Ghosh *et al.,* 1994). On the other hand, the shoaling fishes (*eg. A. testudineus)* get soothed under association which results in reduction of their oxygen uptake.

It was analysed that the oxygen uptake of *A. testudineus* sharply decreased in a group of 5 and then there was a gradual reduction in later group of fishes (Table 1, Fig. 2). In other work, it was observed that juveniles of *A. testudineus* prefer to remain in a shoal of 2 to 4 isomorphic individuals (Fig. 1). Besra (1996) also reported that the group of four is an ideal group of *A. testudineus.* Therefore, these investigation support the present analysis.

Dutta and Munshi (1985) have explained that oxygen uptake of a fish is regulated by their behaviour which mutually contribute towards total oxygen uptake. *A. testudineus* is basically predatory in nature, so it is expected that the oxygen uptake should increase due to grouping as reported by Brett and Sutherland (1965) in *Lepomis gibbosus* and Ghosh *et al.* (1994) in *H. fossilis. A. testudineus* did not show schooling behaviour even during their early developmental stages due to their predatory nature. However, their juveniles behaved homogeneously in a shoal of 2 to 4 individuals (Fig. 1) suggesting changes in behaviour by the fish during life cycle. Umezawa *et*

Teble - 1: Effect of group size on the aquatic oxygen uptake in juveniles of *Anabas testudineus* at 21.5 ± 10°C

No. of fish	Average wt. of a fish (g)	$mlO_2.h^{-1}$	$mlO_2.g^{-1}.h^{-1}$	Aquatic oxygen uptake 95% CL	% decrease due to GE
01.	0.92 ± 0.19	0.177 ± 0.027	0.192 ± 0.030	0.1094	
			(0.2178)	0.4146	
05	0.90 ± 0.12	0.126 ± 0.023	0.140 ± 0.026*	0.0798	27.08
			(0.2190)	0.2426	
10	0.74 ± 0.06	0.111 ± 0.013	0.150 ± 0.018	0.0677	21.80
			(0.2307)	0.1981	
15	0.98 ± 0.10	0.124 ± 0.004	0.127 ± 0.004	0.0609	33.85
			(0.2141)	0.1776	
20	1.04 ± 0.07	0.102 ± 0.019	0.098 ± 0.018*	0.0563	48.96
			(0.2108)	0.1651	
25	1.18 ± 0.08	0.068 ± 0.009	0.058 ± 0.008**	0.0528	69.79
			(0.2039)	0.1563	
30	1.05 ± 0.16	0.093 ± 0.078	0.089 ± 0.008*	0.0500	53.64
			(0.2103)	0.1498	
35.	1.12 ± 0.10	0.097 ± 0.008	0.087 ± 0.007*	0.0478	54.68
			(0.2067)	0.1446	
40	0.90 ± 0.12	0.072 ± 0.005	0.080 ± 0.006*	0.0459	58.39
			(0.2190)	0.1404	

(* = p<0.05, ** = p , 0.01) (Data in parenthesis = Estimated value) (CL = Confidence limit , GE = Group effect)

Log a = -0.6716 (SE = 0.0792)
b = -0.2647 (SE = 0.0643)
r = 0.8411 (p< 0.01)

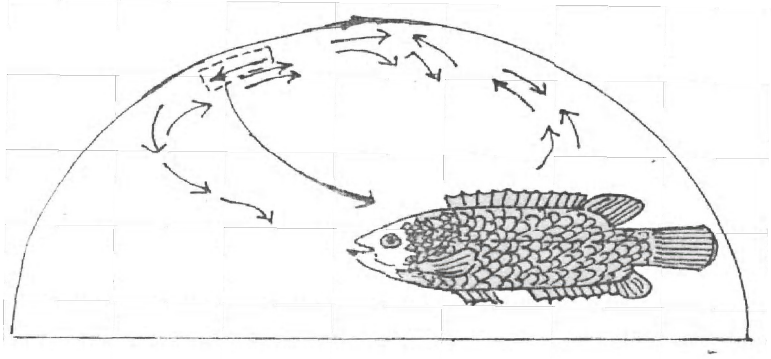

Fig. 1: Showing shoaling behaviour in the juveniles of *Anabas testudineus*

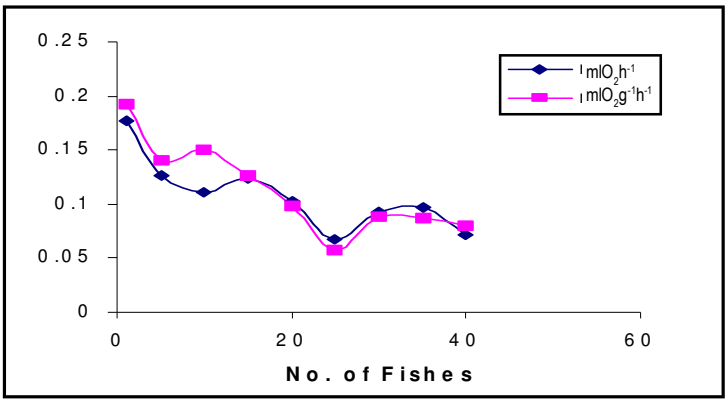

Fig. 2: Showing aquatic oxygen uptake in relation to group size in the juveniles of *Anabas testudineus*

al. (1983) also reported that *Plecoglossus altivelis* exhibits changes in behaviour with growth. They observed schooling behaviour in the juveniles and adults stages but aggressive behaviour during their young stages.

It may be concluded that *A. testudineus* showed a reduction in their aquatic oxygen uptake, beyond exception, is probably a result of shoaling behaviour which created a soothing or calming effect.

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