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Effects of body size on the rate and pattern of ammonia excretion in an air-breathing fish

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Abstract. The rate and pattern of ammonia excretion of *Channa gachua* is described in relation to its body size. The food intake and rate of ammonia excretion was found to depend on the body size of the fish. The pattern of ammonia production is directly dependant on the food intake.

Keywords. *Channa gachua;* ammonia excretion; *Tubifex tubifex.*

1. Introduction

Ammonia is known to be the principal nitrogenous waste product excreted by freshwater fishes (Colt and Tohobanoglous 1976). Although freshwaters with alkaline pH are known to be highly productive and suitable for fish culture (Jhingran 1982), at 25 to 30°C, ammonia excreted by fish may accumulate to concentrations that may affect the food intake and growth of fish (Alderson 1979; Tomasso *et al* 1980; Jobling 1981). Several workers have studied the effects of temperature and meal size on the rate of ammonia excretion in fishes (Guerin-Ancey 1976a, b; Savitz *et al* 1977). Since feeding in fish is influenced by several endogenous factors including body size (Pandian 1975; Staples and Nomura 1976), the rate of ammonia excretion by fish may also be influenced by body size of fish (Jobling 1981). This paper describes the influence of food intake and body size on the rate and pattern of ammonia excretion in the freshwater air-breathing fish *Channa gachua.*

2. Material and method

Channa gachua (Ham.) were collected from a local freshwater tank and acclimated to the laboratory conditions for a week, during which they were fed on the oligochaete worms. Experimental fish were selected from this stock and based on their body size, were segregated into six series each with 5 individuals. The average body weights of fish in the six series were 0.432, 1.019, 2.878, 5.144, 9.880 and 10.975 g respectively. Each fish of a series was maintained individually in a glass aquarium (surface area: 729.95 cm^2) containing 5 litre of ammonia free water and starved for 24 hr prior to the experiment. The fish in each series were subsequently fed on a known quantity of surplus food of *Tubifex tubifex* for 1 hr. At the end of the hour, the unfed food was recovered, weighed and the exact food intake of each fish was calculated and represented as mg food intake/fish/hr. The fish was then transferred to a fresh aquarium containing 5 litres of ammonia free water. During the subsequent 8 hr period, at intervals of every 2 hr, aliquot water samples were collected from

each aquarium and the ammonia content was determined following the method of Varley (1978). The experiment was repeated for each fish on three successive days and the data analysed statistically using a computer (model: Liverpool SPSS version 5 macro).

3. Results and discussion

3.1 *Food intake*

The average daily food intake of *Channa gachua* in relation to its body size is presented in table 1. Fish weighing 0.432 g consumed 154.8 mg/hr and this value increased to a maximum of 385.3 mg/hr as the body weight of the fish increased to 9.880 g. Beyond this body size, the food intake of fish decreased. When the food intake was expressed as g/g live fish/hr (= feeding rate), it was seen that fish weighing 0.432 g exhibited the maximum feeding rate of 0.341 g, while those weighing 9.880 g could feed only 0.039 g. Figures 1, 2 illustrate the inverse linear relationship

Table 1. Food intake and feeding rate of *Channa gachua* in relation to body size

Body size of fish (g)	Food intake (mg/fish/hr)	Feeding rate (g/g fish/hr)
0.432±0.065	154.8±0.015	0.341±0.012
1.019±0.110	198.7±0.024	0.195±0.043
2.878±0.397	296.4±0.052	0.103±0.011
5.144±1.033	272.6±0.012	0.053±0.013
9.880±0.669	385.3±0.132	0.039±0.012
10.975±0.877	263.4±0.122	0.024±0.016

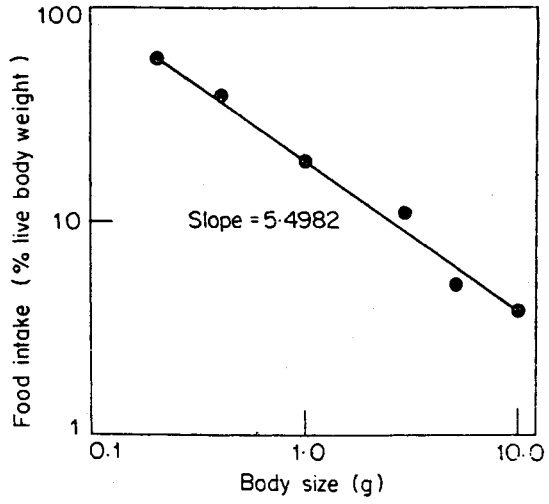

Figure 1. Relationship between the body size (X) and daily food intake (Y) in *Channa gachua*. Regression equation Y = 58.65 − 5.4982X

between food intake (expressed as percentage live body weight) and body size of *C. gachua*. It is seen that, for every 100 mg increase in the body weight of the fish, the feeding rate decreased by nearly 1%. Similar size correlated inverse feeding rates have also been observed in other channid fishes (Gerald 1976; Pandian 1967a).

Figure 2 gives the linear relationship between body weight of fish and ammonia excretion. With increase in body size of fish, the ammonia excretion was also found to increase. The rate of ammonia excretion in *C. gachua* as a function of body size is represented in table 2. From the table, it is apparent that smaller fish excrete more ammonia per g weight of the tissue than larger fish. Similar observations have also been made in the plaice *Pleuronectes platessa* (Jobling 1981). He reported that the relationship between rate of nitrogenous excretion and fish size takes the form of $M = aw^b$ (where m=rate of nitrogenous excretion, w=fish size, b is the weight exponent and a is the y-axis intercept), clearly indicating that nitrogenous

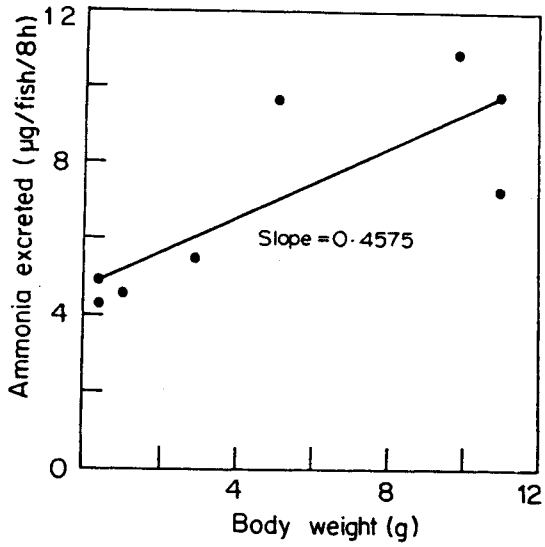

Figure 2. Relationship between the body weight (X) and rate of ammonia excretion (Y) in *Channa gachua*. Regression equation Y=4.7293+0.4575X.

Table 2. Rate of ammonia excretion by *Channa gachua* in relation to body size

Body size of fish (g)	Ammonia excretion (µg/g fish/8hr)
0.432±0.065	9.84±1.324
1.019±0.110	4.55±0.645
2.878±0.397	1.98±0.128
5.144±1.033	1.89±0.204
9.880±0.669	1.10±0.076
10.975±0.877	0.66±0.163

Table 3. Pattern of ammonia excretion in *Channa gachua* during the 8 hr period.

Body size of fish (g)	Ammonia excreted (μg/g fish)			
	2 hr	4 hr	6 hr	8 hr
0.432±0.065	5.21±0.295	2.33±0.784	0.89±0.441	1.41±0.196
1.019±0.110	1.60±0.436	1.09±0.413	0.85±0.042	1.01±0.012
2.878±0.397	0.71±0.176	0.54±0.101	0.19±0.052	0.55±0.086
5.144±1.033	0.59±0.097	0.40±0.155	0.43±0.168	0.47±0.055
9.880±0.669	0.36±0.069	0.18±0.049	0.31±0.034	0.25±0.026
10.975±0.877	0.22±0.083	0.22±0.096	0.03±0.000	0.20±0.040

metabolism and excretion could reflect general trends in the overall metabolic rate of the fish. The present results on *C. gachua* expressed in a similar way indicate that the weight exponent is 0.46. Winberg (1960) considered that a weight exponent as high as 0.81 describes the metabolic rate-size relationship of fishes. Although such values relating nitrogenous excretion to body size of fishes have been reported (von Infant 1974; Guerin-Ancey 1976a), some workers have found either higher (Savitz 1969; Iwata 1970) or lower (Gerking 1955a; Jobling 1981) values.

The pattern of ammonia excretion of *C. gachua* in relation to its body weight is represented in table 3. It is interesting to note that irrespective of the body weight of the fish, the rate of nitrogenous excretion increased markedly shortly after food intake and then declined subsequently. In the blue gill sunfish *Lepomis macrochirus*. Savitz (1971) has indicated a direct relationship between rate of nitrogen excretion and activity oxygen consumption. Since it is known that in fish the metabolic activity increases following feeding (Brett and Zala 1975) the high rate of ammonia production observed in *C. gachua* soon after feeding may be due to the increased metabolic activity, higher oxygen uptake and/or increase in the level of SDA consequent to digestive processes (see Brody 1968).

Thus it may be concluded that in *C. gachua* the rate of ammonia excretion is strongly influenced by body size and that the pattern of ammonia production is dependant on ingestion of food.

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