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ORIGINAL RESEARCH ARTICLE

The Survival Out Of Water And Evaporative Water Loss In *Anguilla bengalensis* Related To Relative Humidity

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ABSTRACT

Oxygen availability in aquatic habitats is a major ecological factor influencing the distribution of fish. The fish has limited potentialities to survive out of water. Higher humidity enhances the survival rate and minimizes evaporative water loss. Humidity plays an important role in the survival capacity of fish. At 35 % - 40 % relative humidity an *A. bengalensis* survive at 3 h - 5 h.

Key Words: *A. bengalensis,* oxygen, relative humidity, survival out of water.

INTRODUCTION

In general, decrease in O_2 content of water elicits increased surfacing activity in air-breathing fish. When the air-breathing fish are kept in air-saturated water, the facultative air-breathers rarely, comes to the surface because its gills are very efficient in exchanging both O_2 and CO_2. But the obligate air-breathers have to surface at regular intervals even in air-saturated water because of their reduced gill size. Air-breathing fish are often found out of water. *Anabas* sp. and eel, *Heteropneustes* sp. and *Channa* sp. migrate from one body of water to another through damp grass (Das, 1927). They can live out of water for extended periods if their skin is kept moist (Hora, 1935). *Anabas* sp. is even said to migrate from one pond to another during rainy season for spawning (Natarajan, 1972). Therefore, the foundation which became the basis of investigations reported herein was established.

MATERIALS AND METHODS

Group of *A. bengalensis* of both sexes (Weight 12 g – 100 g; length 16 cm – 75 cm) were collected and acclimated to the laboratory conditions; temperature 28 °C, pH 7.7, hardness 104 mg L^{-1} as calcium carbonate, alkalinity 106 mg L^{-1} as calcium carbonate, dissolved oxygen > 7.0 mg L^{-1}, Cl^- 36.4 mg L^{-1}, NO_2 and ammonia < 0.01 mg L^{-1}. *A. bengalensis* were taken from the aquaria and lightly blotted on paper towels to remove excess water. Care was taken to make sure that no water was retained in the branchial chambers or the buccopharynx of any fish. They were placed individually in a 1-liter volume plastic box, each covered with a piece of plastic window screen. The fish in the boxes were then exposed to the experimental environmental conditions, with determinations of survival and body weight made at intervals. These fish were immediately transferred to big glass desiccators containing 250 mL of following solutions for desired humidity levels using graded solutions of KOH as outlined by Solomon (1951).

Three experimental conditions were studied:

Water giving 96 % to 97 % relative humidity (RH); $\bar{x}$ 95 %

Sodium chloride giving 72 % to76 % relative humidity (RH); $\bar{x}$ 75 %

Calcium chloride 28 % to 31 % relative humidity (RH); $\bar{x}$ 35 %

Faster equilibration of the humidity level was achieved by the use of stirrer for 5 min to agitate the solution at the bottom. The humidified chamber was then placed in an incubator at a constant temperature of 28 °C ± 1 °C with determinations of survival and body weight made at intervals. Serial weighings were made to determine rates of evaporative water loss. The containers were weighed at intervals to the nearest 0.1 mg^{-1} and weight loss was assumed to equal

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water loss. Criteria for life used in survival studies were either visible small spontaneous movements or recovery of life when placed in water within a few minutes.

RESULTS AND DISCUSSION

A. bengalensis adopts a number of ecophysiological "tactics" to changing environmental conditions. The fish has limited potentialities to survive out of water. Humidity plays an important role in the survival capacity of fish. At 35 % – 40 % RH, fish in the weight range 12.35 g – 22.0 g (x = 17.57 g) survive 3 h - 5 h. The total mean percentage loss of body weight is 20 –23% and the mean loss of weight in mg g^{-1} h^{-1} is 41.17 % (**Table 1**). The regression equations computed for the fish weight Vs various parameters are:

Survival time: Y = +34.45 – 4.22 x (r = 0.96; P < 0.01)

Total Percentage: Y = +64.73 – 2.33 x (r = 0.86; P < 0.05)

Loss of weight: Y = +71.05 – 1.30 x (r = 0.91; P < 0.05)

Table 1. Survival time (h) out of water and percentage loss of body weight in *Anguilla bengalensis* at 35 % – 40 % RH

	Fish weight(g)	Survival Time (h)	Total percentage loss of body weight	Loss of weight in mg g^{-1} h^{-1}
	12.35	5	22.10	44.10
	14.10	5	21.00	43.22
	16.40	4	20.00	42.06
	19.20	4	21.06	41.12
	21.34	3	19.06	40.10
	22.00	3	18.17	36.40
$\bar{x}$	17.57	4	20.23	41.17
SD	03.59	0.82	01.32	02.50
SE	01.47	0.33	00.54	01.02

Fish weight vs Survival time r = 0.96; t = + 8.25
Fish weight vs total percentage loss of body weight r = -0.86; t = - 1.56
Fish weight vs loss of weight r = -0.91; t = -12.64

A. bengalensis often encounters unfavorable environmental conditions and their survival out of water is limited by the various factors. A critical factor for survival in terrestrial biotopes is the animal's ability to maintain water balance. EWL is a major avenue of losing water to the environment. In ectotherms (lizards and snakes) evaporation occurs mainly at the skin surface rather than through the respiratory system (D mile, 2001). Any adaptation (behavioral morphological or physiological) leading to minimize EWL could be of a significant survival value to *Anguilla*. Quite a few studies have shown that, indeed, fishes from tropical countries are often exposed to the vagaries of the environment. The skin resistance to water loss reflects the intrinsic (biochemical and structural) properties of the skin.

When *Anguilla* leaves the water and emerges on to land for long periods it faces a number of problems which ultimately can be solved only be return to the water. These problems are O_2 uptake and CO_2 loss, ammonia loss and desiccation.

Oxygen acquisition is not a great problem since *Anguilla* can make use of the moist skin and Swim-bladder for aerial gas exchange. Smith *et al.* (1983) corroborated this suggestion for eels and stated that cutaneous O_2 uptake supplied only the skin tissues demand. However, air-breathing enables *Anguilla* to survive out of water for certain period and enables them to make terrestrial progression.

Air-breathing fish are known to survive out of water for different durations and this is mainly limited by humidity (**Table 2**). Daldrof (1797) reported the overland movement and climbing habit of *Anabas scandens*. The fish is known to leave water and spend sometime in air or migrates even when there is no danger from drought (Carter, 1957). The fish survives 22 h to 25 h out of water (Hora, 1935). Amputation of the labyrinthine organ limits the survival to 13 h to 16 h (Natarajan, 1972). Gorden *et al.* (1970) have reported survival of the cling-fish *Skicyases sanguinus* out of water for a day and half when not exposed to severe dehydration or thermal stresses. Low tide emersed fishes can

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survive many hours out of water (Martin, 1991). The limited survival *Anguilla* out of water is linked with the O_2 uptake, CO_2 excretion, NH_3 loss and desiccation.

Table 2. Survival out of water in a few air-breathing fish

Species	Survival out of water (h)	Reference
Synbranchus marmoratus	5 – 10	Bicudo and Johansen,1979
Trichogaster pectoralis	4 – 6	Burggren, 1979
Amphipnous cuchia	60	Das,1927
Anabas scandens	72 – 96	Das,1927
Clarias batarachus	18	Das,1927
Mystus punctatus	3.5	Devika,1999
Anabas testudineus	6 – 10	Hughes and Singh,1970a
Clinocothus analis	24	Martin,1991
Amia calva	72 – 120	Mc Kenzie and Randall,1991
Channa punctatus	7	Munshi,1980
Macropodus cupanus	12	Natarajan,1987
Erepetoichthys calabaricus	6 – 8	Petiff and Beitinger,1985
Channa gachua	18	Ramaswamy and Reddy,1978b
Channa striata	6 – 14	Rani,1994
Mystus gulio	2 – 6	Raveendran, 2000
Anabas scandens	22 – 25	Reddy and Natarajan,1970
Clarias batrachus	5 – 6	Singh and Hughes, 1971
Lepisosteus oculatus	7.8 – 60	Smatresk and Cameron,1982
Notopterus notopterus	3 - 7	Vijayalakshmi,1996

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