THE EFFECT OF SALINITY STRESS ON BUCCAL VENTILATORY RATE IN THE AFRICAN LUNGFISH, *Protopterus annectens* OWEN

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ABSTRACT

The buccal ventilatory rate of the African lungfish, Protopterus annectens (Owen) following acclimation to diluted seawater was investigated under laboratory conditions for six days. Healthy adult specimens of African lungfish, Protopterus annectens (Owen) (mean weight 299.4g and mean length 38.9 cm) procured from Anambra river at Otuocha were subjected to the following concentrations of dilute seawater: 0%, 5% (s = 1.8%oo), 10% (s = 3.5‰), 15% (s = 5.3‰), 20% (s = 7.0 ‰), 30% (s = 10.5 ‰) and 40% (s = 14.0 ‰) respectively. The results revealed that increase in salinity had a significant positive correlation (r = 0.92, p < 0.05) with increase in buccal ventilatory rate. The mean least and highest buccal ventilatory rates were 5.32 and 12.26 times per hour at 1.8‰ and 14.0‰ salinities respectively. The implications of the findings for the culture of this fish species in estuarine ecosystems are discussed.

Keywords: Salinity Stress, Buccal Ventilation, *Protopterus annectens*

INTRODUCTION

The African lungfish, *P. annectens* lives in shallow parts of West African rivers and lakes Their range of distribution spreads from Nigeria to Senegal and beyond on the West African coast line. (Dupe and Godet, 1969; Dupe, 1973; Daffala *et al.,* 1985; Otuogbai and Ikhenoba, 2001; Okafor and Odiete, 2002 a, b). Recent studies show that it can tolerate seawater up to a maximum of 30% (Okafor, 2004). Thus, the fish has got the potential of being cultured in brackish water. When some fresh water fish species are cultivated in brackish water, they exhibit enhanced hatching, growth and survival rates (Canagaratnam, 1959; Otto, 1971; Nwigwe, 1985; Sugiyama, 2002). Consequently, there is the need to evaluate the physiological adjustments which *P. annectens* can make whilst subjected to brackish water regimes. The paper therefore determines changes in buccal ventilatory rate of *P. annectens* subjected to different concentrations of diluted seawater. The information obtained may serve as guidelines for studies on the osmoregulatory abilities of the species in estuarine ecosystems.

MATERIALS AND METHODS

Live fish specimens of the African lungfish *P. annectens* procured from Anambra river at Otuocha in Anambra State of Nigeria were transported to the Zoology laboratory of the University of Lagos, Lagos, Nigeria and acclimated at room temperature for 28 days inside eight glass tanks that measured 0.54 x 0.30 x 0.30 m which were neither covered nor aerated. Each tank contained 3 litres of dechlorinated water. The fish were fed daily on fish feed obtained from the Nigerian Institute of Oceanography and Marine Research (NIOMR), Victoria Island, Lagos *ad libitum* until used for the experiment.

The water in all tanks was changed twice weekly to prevent the accumulation of waste materials, uneaten food and the fish's mucous secretions. Seawater was collected at high and low tides from the Bar Beach (Atlantic Ocean) at Victoria Island, Lagos and filtered through a fine 0.5 mm sieve.

Three litres of each of the percentages of the seawater were prepared thus: 0%, 5% (s = 1.8 ‰), 10% (s = 3.5 ‰), 15 % (s = 5.3 ‰), 20% (s = 7.0 ‰), 30% (s = 10.5 ‰) and 40 % (s = 14.0 ‰) by diluting seawater of 100% salinity (s = 35 ‰) with an appropriate volume of dechlorinated water. The salinity of each prepared diluted seawater was determined using a salinometer (Table 1).

Seawater above 40 % in concentration was not prepared since *P. annectens* tolerates 30% seawater indefinitely and 40% seawater for only about 4 to 5 days (Okafor, 2004).

Fourteen specimens of *P. annectens* chosen from amongst those that survived acclimation were now introduced into seven glass tanks containing the above concentrations of

Table 1: The salinities (%o) of the various concentrations of dilute seawater that were prepared

Prepared seawater Concentration (%)	Corresponding salinity (%o)	Volume of dechlorinated Water (litres)	Volume of100 % seawater (35 %o)
40	14.00	1.80	1.20
30	10.50	2.10	0.90
20	7.00	2.40	0.60
15	5.30	2.55	0.45
10	3.50	2.70	0.30
5	1.80	2.85	0.15
0	0.00	3.00	0.00

diluted seawater at a stocking rate of two specimens per tank.

Buccal Ventilatory Rate: Only healthy and active fishes with no external signs of disease or physical injuries were selected for the experiment. The buccal ventilatory rate was estimated as the number of times each fish would remove its head out of the water, opened its mouth in order to breathe atmospheric oxygen, closed it and dipped its head back into the water, within an hour. This was repeated five times and the mean values noted.

RESULTS

Increase in salinity was directly correlated with increase in buccal ventilatory rate Coefficient of linear correlation r = 0.9162767 at 0.05 probability (Figure 1). At 0 %, 5%, 10 %, 15 %, 20 %, 30% and 40 % salinities, the mean buccal ventilatory rates were 4.04, 5.32, 6.39, 7.50, 9.86, 10.16 and 12.26 respectively.

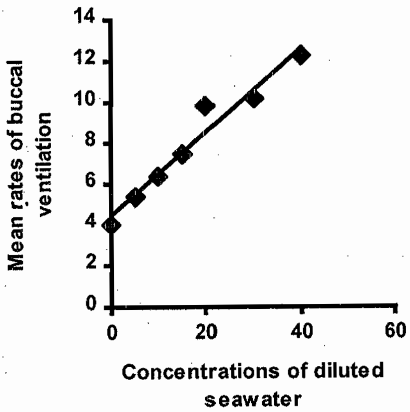

Figure 1: The mean rates of buccal ventilation at various concentrations of diluted seawater

DISCUSSION

The result clearly indicates a positive linear correlation between salinity and buccal ventilatory rate. Holliday (1969) reported reduction in oxygen content of saline waters. The present study opined that the increased buccal ventilatory rate when immersed in saline water could be a means of increasing the total amount of oxygen that would reach the tissues via the lungs since the amount received from the saline water via the gills was highly reduced.

Similar findings have been documented by Enajekpo (1989), Ebele *et al.* (1990), Onusiriuka and Ufodioke (1994), Chukwu (2001) and Chukwu and Ugbeva (2003). For example, Enajekpo (1989) reported an increase in respiration rate (opercular ventilation) in *Tilapia zilli* and *Oreochromis niloticus* exposed to sublethal concentrations of water soluble fractions of Bonny light crude.

Thus in the attempt to culture *P. annectens* in brackish or estuarine waters, farmers should put into consideration the increased demand for atmospheric oxygen in the new habitats. Since this process requires the expenditure of energy, this may be compensated by increasing the rate of feeding.

There is no lungfish that naturally inhabits brackish or estuarine waters within this Cenozoic era. However, fossil records have established that lungfishes that lived during the Permian, Carboniferous and Devonian periods such as *Gnathorhiza, Megapleuron* and *Soederberghia* were estuarine and shallow marine dwellers (Carroll, 1988; Ahlberg, *et al.,* 2003). *Soederberghia* gulped air and probably inhabited a shallow near-shore marine environment (Ahlberg, et al., 2003). The occurrence of *Soederberghia groenlandica* in the Famennian old red sandstone of North America, Greenland and Australia respectively thus furnishes evidence of contact or close proximity between North and South Pangaea during the Palaezoic era (Ahlberg *et al.,* 2003). In fact the evolution of air breathing by lungfishes has traditionally been associated with their entry into freshwaters (Carroll, 1988).

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