A comparative study of the gill anatomy of *Clarias anguillaris*, *Chrysichthys longifilis* and *Synodontis membranaceus* from Asa reservoir and Kainji reservoir, Nigeria

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Abstract

Some morphometric and meristic features of the gills of 3 tropical freshwater air breathing fishes, *Clarias anguillaris*, *Chrysichthys longifilis* and *Synodontis membranaceus* from Asa reservoir and Kainji reservoir were investigated. *Synodontis membranaceus* had the largest number and size of gill filaments while the largest number of secondary gill lamellae was recorded in *Chrysichthys longifilis*. The distance between the secondary gill lamellae was the narrowest in *C. longifilis*. The gill features of *S. membranaceus* were significantly affected by its body weight, while *C. longifilis* and *C. anguillaris* were affected though not significantly by surface area and standard length respectively. A clear relationship existed between the gill features and presumed activity and habitat of the 3 air breathing species. [Life Science Journal. 2008; 5(1): 85 – 87] (ISSN: 1097 – 8135).

Keywords: gill morphology; air breathers; Nigeria

1 Introduction

Several investigations abound on the gills of fish, these include studies on gill structure (Morgan & Towell, 1973; Laurent, 1982), gill morphometry and osmoregulation (Laurent & Hebibi, 1989), gill dimensions of Teleostan fish (Hughes, 1966; Hughes and Morgan, 1973), dimension of fish gills in relation to their function (Hughes, 1966), gill morphology and acid base regulation (Goss *et al*, 1992a) and changes in gill morphology and acclimation (Balm, 1996; Dunel-Erb, 1996).

Early investigations into the comparative studies of gill anatomy include those of Schottle (1931) on gobiform fishes and Gray (1954) on 31 species of Marine teleost fishes.

Reports on gills of fresh water fishes include Perry & wood (1985), Avella *et al* (1987), Perry & Laurent (1989), Brown (1992) and Goss *et al* (1992a, b, 1994). This present investigation was initiated to compare the gill anatomy of 3 tropical freshwater air breathers, *Clarias anguillaris*, *Chrysichthys longifilis* and *Synodontis membranaceus*.

Asa reservoir is located approximately 4 kilometres south of Ilorin Township. It is located between latitudes 8º 28´ and 8º 52´ N and longitudes 4º 35´ and 4º 45´ E. Asa reservoir has a surface areas of 302 ha (Ita *et al*, 1985), with a maximum length of 18 kilometres and a maximum depth of about 14 metres at the dam site.

The Kainji reservoir is located between latitudes 9º 50´ N – 10º 55´ N and longitudes 4º 25´ E – 4º 45´ E. The Kainji reservoir has a surface area of 1300 km^2, with a maximum length of 136.8 kilometres and a maximum depth of 60 metres.

2 Materials and Methods

50 Specimens of *Clarias anguillaris* and 100 of *Chrysichthys longifilis*, were collected from Asa reservoir. Simultaneously 50 specimens of *Syndontis membranaceus* were collected from Kainji reservoir.

The fishes were caught using gillnets of 2.50 and 5.00

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cm mesh sizes. Their total weights (± 0.5 g) and standard lengths (± 0.5 cm) were recorded. Body surface estimates of each fish was made by outline drawings around the fish, allowing for body thickness and omitting dorsal, and paired fins and determining the area of the outline with a planimeter.

The gill arches of right side were dissected out carefully, separated and placed in dishes of freshwater; one arch to each disc. The number of filaments on each side of each arch was counted under a dissecting microscope. The average length of the filaments was determined by measuring every tenth filament with Vernier calipers. From this measurement the average length of the filaments was established.

The spacing of the secondary lamellae was measured on several filaments from each of the gill arches, using an eye piece graticle graduated to the nearest 0.1 mm. The average number of secondary gill lamellae was counted under the light microscope from which the total number of secondary gill lamellae was estimated. The relationship of the different parameters were determined by plotting a graph of their $\log_{10} y$ values against that of $\log_{10} x$.

3 Results and Discussion

Obvious differences existed in the morphometric and meristic features of the gills amongst the 3 species (Table 1). *Synodontis membranaceaus* had the largest number and size of filaments amongst the 3 species while the largest number of secondary gill lamellae was recorded in *Chrysichthys longifilis*. The distance between the secondary gill lamellae was the narrowest in *Chrysichthys longifilis*.

The gill feature of *Synodontis membranaceaus* was significantly affected by its body weight (Table 2). However, *Chryischthys longifilis* and *Clarias anguillaris* were affected, though not significantly by surface area and standard length respectively. The morphometric and meristic features of the gills of the 3 species were found to be dependent on the level of activity of the fish.

The larger number (average and total) of secondary lamellae on a single gill of *Chrysichthys longifilis* and the narrower distance between its secondary lamellae as compared to the other two are in response to an active mode of life. *Chrysichthys longifilis* is an active swimming cat fish while *Synodontis* and *Clarias* are more sluggish forms, occupying, benthic zones. .

Synodontis membranaceaus a benthic form like *Clarias anguillaris* is a more active swimmer. Due to this higher level of activity, it possesses larger number and size of filaments.

The number and spacing of the secondary lamellae has also affected the ability of the fishes to stay out of water. *Chrysichthys longifilis* cannot stay out of water for long, this is because the delicately close spaced lamellae adhere together when removed from an aquatic medium and the functional surface is then reduced. However the widely spaced secondary lamellae of Synodontis and Clarias allow them to stay for longer periods outside water.

It was only *Synodontis membranaceaus* that had its gill dimensions affected significantly by its body weight. This could probably be due to its large head size, which contributes to the bulk of its body weight. Hakim *et al* (1977) reported that increase in body weight of an ani-

Table 1. Gill dimensions of *Clarias anguillaris*, *Synodontis membranaceaus* and *Chrysichthys longifilis* from Asa and Kainji reservoir

Species	Fish size gill dimensions										
	Morphometric							Meristics			
	Total body weight (s)	Standard length (mm)	Head length (mm)	Body surface area (mm2)	Average length of filament (mm)	Total length of filament/gill (mm)	Distance between secondary gill lamellae (mm)	Mean No. of filament/gill	Average No. of secondary gill lamellae/gill	Total No. of secondary gill lamellae/gill	Gill raker gill filament ratio
Clarias anguillaris	41.85	16.97	4.02	482.05	1.07	117.70	0.04	110	21.52	2367.20	1 : 1
Synodontis membranaceaus	174.74	18.45	9.21	1087.47	2.72	386.24	0.04	142	64.56	9167.52	2 : 1
Chrysichthys longifilis	36.21	12.36	3.75	360.59	0.86	223.20	0.02	120	75.10	9492.00	1.5 : 1

Table 2. Relationship between gill dimension and size of *Clarias anguillaris*, *Synodontis membranaceaus* and *Chrysichthys longifilis* from Asa reservoir and Kainji reservoir

Species	Average filament length: head length relationship	Total filament length: standard length relationship	Total No. of secondary gill lamellae: body weight relationship	Total No. of secondary gill lamellae: body surface area relationship
Clarias anguillaris	0.06	0.26	0.11	0.33
Synodontis membranaceaus	0.37	0.36	0.70*	0.14
Chrysichthys longifilis	0.12	0.14	0.22	0.25

*Significantly different, *r*-values at 5% probability and 3 degrees of freedom

mal is accompanied by an increase in the living materials requiring oxygen for its metabolic process and that it is associated with a larger gas exchange surface. For *Chryisichthys longifilis* however the gill dimension was more related to the surface area than the body weight.

This paper has shown that in air breathing species, a clear relationship exist between the gill dimensions and presumed activity of the fish and also the habitat.

References

1. Avella M, Masoni A, Bornancin M, Mayer-Gastan N. Gill morphology and sodium influx in the rainbow trout (*Salmo gairdneri*) acclimated to artificial freshwater environments. J Expl Biol 1987; 241: 159 – 69.
2. Balm PHM. Trycophrya intermedia on the gills of rainbow trout acclimating to low ambient pH. J Fish Biol 1996; 48: 147 – 50.
3. Brown P. Gill chloride cell surface area is greater in freshwater adapted adult sea trout (*Salmo trutta* L.) than those adapted to sea water. J Fish Biol 1992; 40: 481 – 4.
4. Dunnel-Erb S. Morphological changes induced by acclimation to high pressure in the gill epithelium of the freshwater yellow eel. J Fish Biol 1996; 48: 1018- 22.
5. Goss GG, Laurent P, Perry SF. Gill morphology and acid base regulation during hypercapnic acidosis in the brown bull head. Ictalurus nebulosus. Cell Tissue Res 1992a; 268: 539 – 52.
6. Goss GG, Perry SF, Wood CM, Laurent P. Mechanisms of ion and acid base regulation at the gills of freshwater fish. J Exp Zool 1992b; 263: 143 – 59.
7. Goss GG, Laurent P, Perry SF. Gill morphology during hypercapnia in brown bullhead (*Ictalurus nebulosus*): role of chloride cells and pavement cells in acid-base regulation. J Fish Biol 1994; 45: 705 – 18.
8. Gray IE. Comparative study of the gill area of marine fishes. Biol Bull Woods Hole 1954; 107: 219 – 25.
9. Hakim A, Hughes GM, Datta JSM. Morphometrics of the respiratory organs of the Indian green snake-headed fish (*Channa punctata*). J Zool Lond 1977; 184: 519 – 43.
10. Hughes GM. The dimension of gill in relation to their function. J Exp Biol 1966; 45: 177 – 95.
11. Hughes GM, Morgan M. The structure of fish gills in relation to their respiratory function. Biol Rev 1973; 48: 419 – 75.
12. Ita EO, Sado EK, Balogun JK, Pandogari A, Ibitoye R. Inventory survey of Nigerian inland waters and their fishery resources. I. A preliminary checklist of inland water bodies in Nigeria with special reference to ponds, lakes, reservoirs and major rivers. Kainji Lake Research Institute Technical Paper Series 1985; 14: 51.
13. Laurent P. Structure of Vertebrate Gills. Cambridge University Press, New York. 1982; 25 – 43.
14. Laurent P, Hebibi N. Gill morphometry and fish osmoregulation. Can J Zool 1989; 67: 3055 – 63.
15. Morgan M, Towell PWA. The structure of the gill of the trout (Salmo gairdneri, Richardson). Zelforch Mikrost Anal 1973; 142: 147 – 62.
16. Perry SF, Laurent P. Adaptational responses of rainbow trout to lowered external Nacl: Contribution of the branchial chloride cell. J Exp Biol 1989; 147: 147 – 68.
17. Perry SF, Wood CM. Kinetics of branchial calcium uptake in the rainbow trout. Effects of acclimation of various external calcium levels. J Exp Biol 1985; 116: 411 – 34.
18. Schottle E. Morphologie und physiologie der Atmung bei wasser Schlamm – und – landibenderi Gobiformes. Zeitschr Fwiss Zool 1931; 140: 1 – 115.