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The Fishery of the Freshwater Oyster *Etheria Elliptica* (Etheriidae) in Northern Ghana: Its Distribution and Economic Importance

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Abstract. A survey was conducted for seventeen months in 1998 and 2008 to record indigenous knowledge on the freshwater oyster *Etheria elliptica* in the north of Ghana, with emphasis on its distribution and economic importance. The study showed natural occurrence of the oyster in the major rivers and their tributaries that form the northern Volta Basin: River Oti in the north-east serving as the international boundary between Ghana and Togo, the Black Volta River in the north-west serving as the international boundary between Ghana and La Cotê d'Ivoire, and the White Volta River running through the central portion. Apparently, the oyster is fairly widespread in the north. Biochemical analysis of fresh meat samples showed nutritional values that suggest that the White Volta and Oti stocks are the same. The oysters are sessile organisms and are usually collected from the riverbeds mostly by women and during low water levels in the dry season, using locally manufactured implements like hoes, chisels and hammer to dislodge them from the hard substrates to which they are attached. The oyster fishery constitutes a major source of livelihood, providing employment, income and nutritious food for the local inhabitants.

Keywords: *Etheria* sp., Freshwater oyster, Bivalves, Volta Basin, Ghana.

1. Introduction

In most tropical and subtropical countries, shellfishes including oysters(bivalves) and crustaceans are a major source of much needed protein for rural communities and they are not considered as luxury food items as in the temperate zones (Quayle,1980). The exploitation of bivalve resources in developing countries is mostly done on subsistence levels (Vakily, 1994; Bogan, 2008). Many species of bivalves are often found in dense aggregations or colonies filtering out large quantities of blue-green algae, diatoms, bacteria, fine-particulate organic matter as well as silt and heavy metals (Bogan, 2008).

The taxonomy of Etheriidae has been in some confusion for a long time (Yonge, 1962; Van Damme, 1984; Mandahl-Barth, 1988: Bogan and Hoeh, 2000). However, recent classification using DNA sequence analysis considers the family Etheriidae occurring in Africa and northern Madagascar as representing a single genus *Etheria* and a single species *elliptica* (Bogan, 2008; Bogan and Roeh, 2008). Thus, the freshwater oyster in Ghana is *Etheria elliptica*.

Traditional knowledge indicates that this freshwater oyster is of considerable socio-economic importance to some rural communities in the north of Ghana, but there is no documentation on its distribution, fishery and nutritional value. This work was therefore undertaken to report on the range of distribution and economic importance of the freshwater oyster populations in the north of Ghana to serve as a source of baseline reference for future studies.

2. Materials and Methods

2.1. Study Area

The study was conducted in the north of Ghana for a total period of seventeen months in three phases: January to May 1998, the same period in 1999 and January to July 2008. The study area lies between latitudes 8^0 and 11^0N, and longitudes $2^0$45'W and $0^0$30'E. Within this area flow the Oti, Black Volta and White Volta Rivers and their tributaries including Nasia, Kulpawn and Sisile

Rivers (Fig 1). The villages of Nawuni on the White Volta, Bamboi on the Black Volta and Sabari on Oti were chosen for detailed study of the oyster fishery.

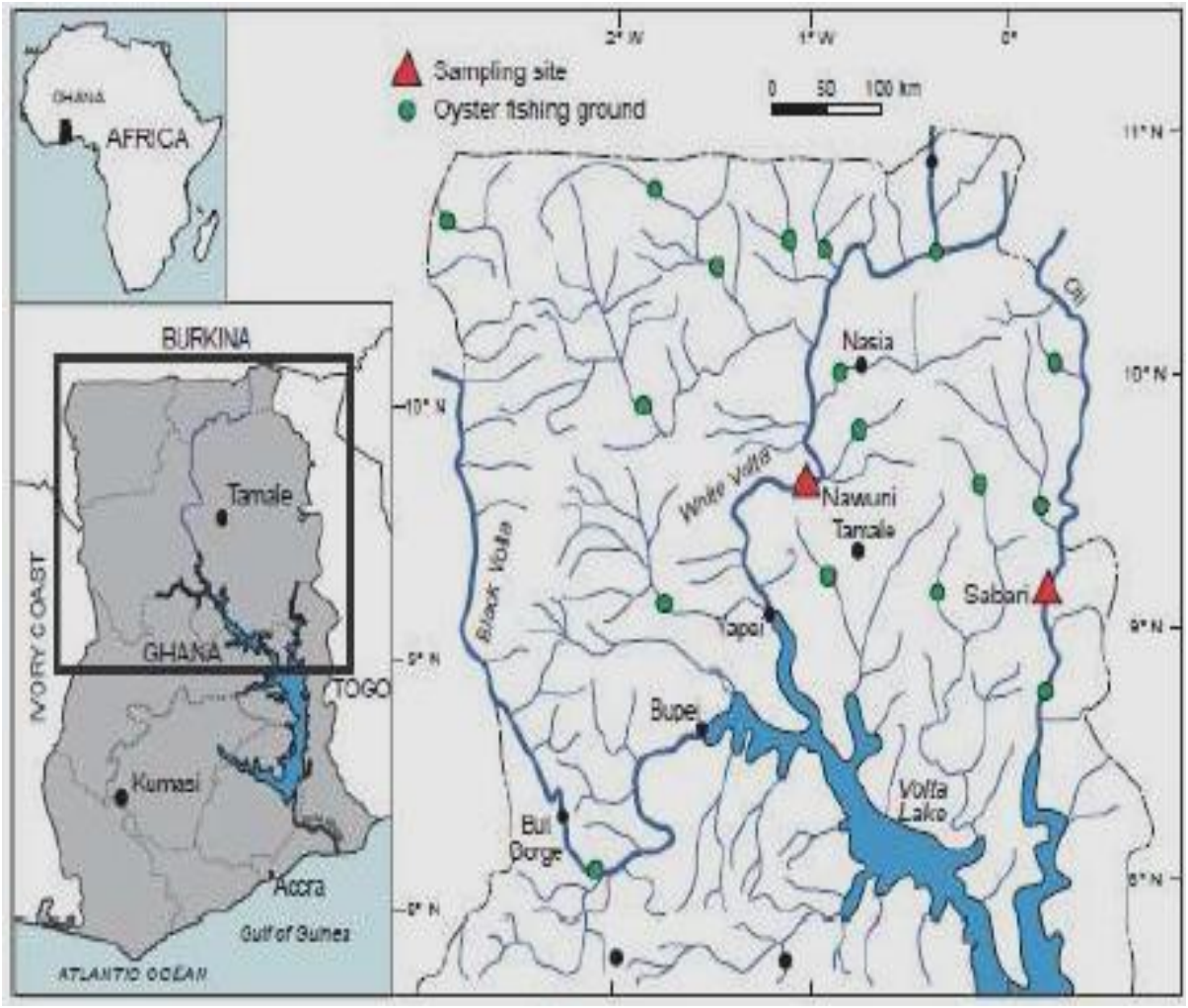

Figure 1. Map of northern part of Ghana showing the major fishing grounds (green spots) and sampling sites (red spots) of the freshwater oyster (*Etheria elliptica*) in the northern Volta basin (adapted from Ampofo-Yeboah *et al*, 2009)

2.2. Assessment of the Distribution and Economic Importance of the Oyster fishery

Indigenous knowledge on the distribution and economic importance of the freshwater oyster fishery was collected using interviews granted by local inhabitants and the administration of a well-designed semi-structured questionnaire. Personal observations were also made to collect primary data on the subject.

2.3. Biochemical analysis of the nutritional value of the oyster

The biochemical composition of fresh meat samples of the White Volta and Oti stocks of the oyster was determined at the Council for Scientific and Industrial Institute (CSIR)-Food Research Institute (FRI). The meat samples were minced in a Hobart mincer and 5 g sub-samples taken to determine the proximate composition and mineral contents according to the procedures outlined in/the American Organization of Analytical Chemists (AOAC, 1970, 11th Edition). The meat of the Black Volta strain was not analysed for lack of funds.

Moisture content was determined by oven drying the minced samples at 105 $\pm$ 1^0C to a constant weight and subtracting the dry weight from the wet weight. Protein content was determined by estimating the total nitrogen using the macro Kjeldahl procedure and multiplying the value by a conversion factor of 6.25. Fat was extracted by the continuous Soxhlet extraction procedure while ash content was determined by igniting the dry meat to ash in a muffle furnace at 550^0C. Carbohydrate was obtained by subtracting the protein, fat and ash values from 100. The concentration of iron was determined by reducing a portion of the ash solution with ascorbic acid. A solution of dipyridyl was then added and the colour intensity measured with a colorimeter (Coleman Model 8). The iron content was read from a standard curve. Calcium was precipitated as oxalate by dissolving a portion of ash in hydrochloric acid (HCl). The oxalate was then dissolved in sulphuric acid (H_2SO_4). The liberated oxalic acid was titrated against potassium permanganate ($KMnO_4$) solution to give the calcium content.

3. Results

3.1. Distribution

The freshwater oyster, *Etheria elliptica* was found to occur in all the major rivers in the north of Ghana namely; the Black Volta, White Volta, Red Volta, Nasia, Oti and Daka and their tributaries that flow into the Volta Lake (Fig. 1). The oyster was also found in the main canals of the Tono Irrigation Dam built on the Tono River. Apparently, the oyster has a fairly extensive range of distribution in the north. The oyster colonies were usually found attached to rocks or stones in

the shallow or deep riverbeds (Fig 2a, 2b). The Black Volta stock at Bamboi and the White Volta stock at Nawuni usually possessed long hollow tube-like projections on the upper valve and occurred in dense clusters (Fig 3a). In contrast, the Oti stock at Sabari had smooth shells and usually occurred in comparatively small, sparse colonies (Fig 3b).

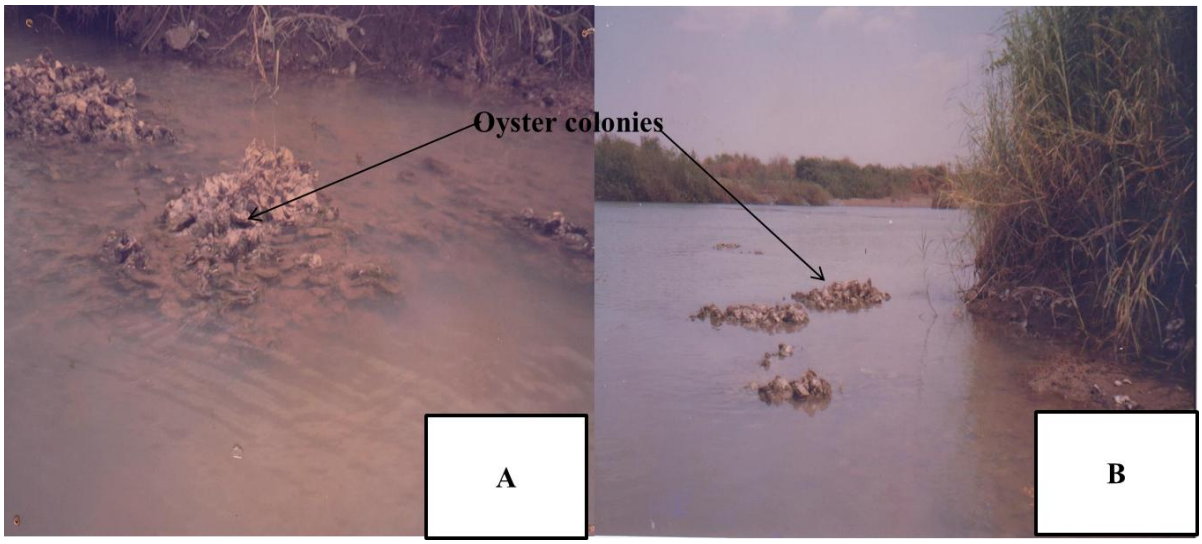

Figure 2. Freshwater oyster *Etheria elliptica* colonies in the shallow bed of the White Volta at Nawuni **(A)** and in the deep portion of the river forming small islands**(B)**

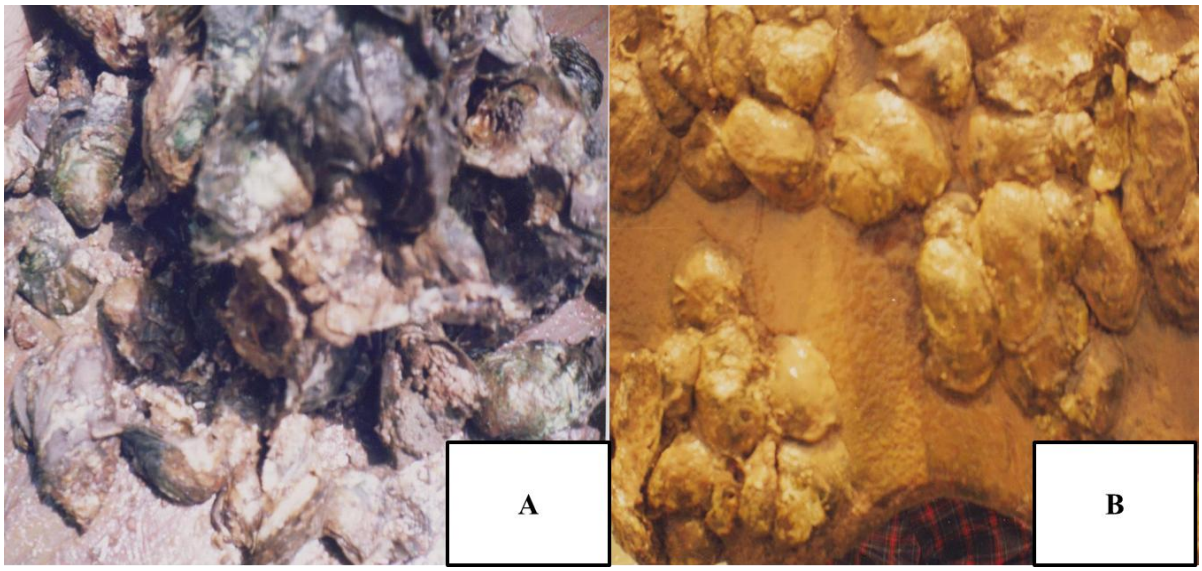

Figure 3. White Volta stock of the freshwater oyster *Etheria elliptica* showing animals with rough shells in a dense cluster **(A)** and Oti River stock showing animals with smooth shells in sparse clusters **(B)**

3.2. Economic Importance of the Oyster Fishery

3.2.1 Oyster fishery as a livelihood

The *Etheria elliptica* fishery is an important source of livelihood for the rural communities in the north of Ghana. It involves subsistence level of harvesting, processing, preservation and marketing. Simple manufactured implements including small hoes, chisel-like metals and hammer are used to dislodge the sessile animals from the hard substrates to which they are attached.

The oyster is harvested mainly during the dry season (January to April) when the water levels are low. Where it is difficult to see the oysters, the harvesters (mostly women) use their feet to locate them on the riverbeds as they wade through the rivers. In very deep waters where it is not possible to wade through the rivers and diving is necessary, the women engage the men as divers. Harvesting starts from early morning and ends at dusk.

The catch is sent to the riverbanks or sandbars, where the women remove and process the meat for the local markets. The meat is scooped fresh when the shells open by themselves or the oyster is boiled until the shells open. The meat is smoked over an earthen kiln and sun-dried. Well-smoked or sun-dried oyster meat can be stored whole or as powdered meal for up to one year. Revenue from the sale of harvested oysters is the main source of income for many women in the study area.

3.2.2 Oyster as a source of food

Results of the interviews indicated that the oyster has been a popular delicacy for the major tribes in the north for many centuries. The meat is eaten in one of three forms: cooked, smoked or sun-dried, and is served in different kinds of stew or soup. The average nutritional values determined for the fresh oyster meat were 12.5% protein, 4.8% carbohydrate, 1.8% fat, 1031.8mg/100 g calcium, 58.0 mg/100g iron, 3.8% ash and 77.2% moisture and 74.8 (kcal/100g) energy (Table 1).

Table 1. Comparison of the nutritional value of fresh meat of the White Volta and Oti stocks of *Etheria elliptica*

Ingredients	White Volta River stock	Oti River stock	Average values
Moisture	78.1 %	76.3%	77.2%
Ash	3.8 %	3.8 %	3.8 %
Fat	1.6 %	1.9 %	1.8 %
Protein	12.4 %	12.6 %	12.5 %
Carbohydrate	4.1 %	5.4 %	4.8 %
Energy	70.4 (kcal/100g)	79.1 (kcal/100g)	74.8(kcal/100g)
Iron	57.6 (mg/100g)	58.3 (mg/100g)	58.0 (mg/100g)
Calcium	1144.4 (mg/100g)	919.2 (mg/100g)	1031.8 (mg/100g)

3.2.3 Uses of the Shell

Traditionally the oyster shell has limited economic importance in the north of Ghana, judging by the heaps of shells abandoned along the banks of the rivers forming the northern Volta Basin (Fig 4a, 4b). However, in some communities along the White Volta near Tamale the powdered shell is used on a small scale as poultry feed additive to supply minerals to the birds. The powder is also soaked in water and used as paint (white wash) by some communities along the Oti River.

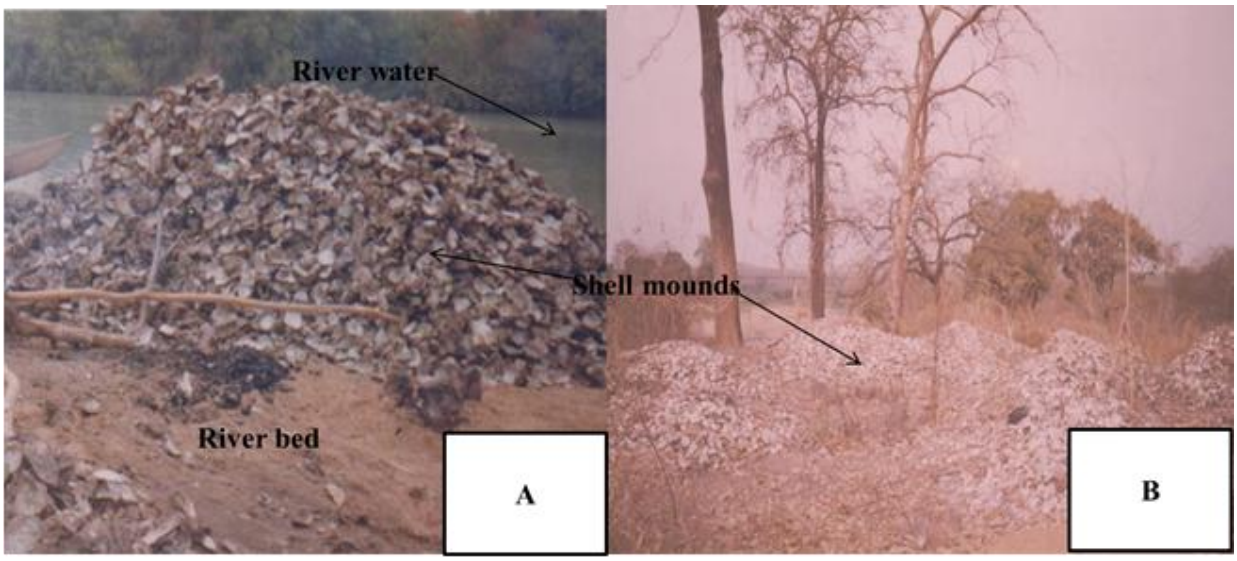

Figure 4. Mounds of freshwater oyster *Etheria elliptica* shells on the banks of the White Volta at Nawuni **(A)** and River Oti at Kpalba **(B)**

4. Discussion

This study has shown that the oyster is widespread in the north of Ghana, occurring predominantly in the major rivers and tributaries that form the northern Volta Basin.

Like the Volta clam *Galatea paradoxa* (formerly *Egeria radiata*), *Etheria elliptica* is exclusively freshwater (Purchon, 1977; Bogan, 2008). It differs from all other freshwater bivalves by possessing an irregular, unequivalve shell: the left valve is cemented to firm substrates from which it takes its shape (Pilsbry and Bequaert, 1927; Yonge, 1962; Bogan and Hoeh, 2000). Fishers operating on the White and Black Volta Rivers complained that "high rise" oyster colonies and mounds impede navigation and fishing activities at low water levels. This was not the case in the Oti River because the oyster stocks there occurred in very small, low colonies.

The freshwater oyster has long been exploited for food by the fishing communities in the Congo Basin where it occurs in the rapids (Pilsbry and Bequaert, 1927). Mounds of empty oyster shells have been found in the lower Nile Basin, suggesting extensive exploitation of the animal for food (Van Damme, 1984). In this study, it was revealed that indigenous tribes in rural northern Ghana have also used the freshwater oyster as food for centuries. In this part of the country oyster meat is consumed fresh, dried or smoked but the latter is preferred. Analysis of the nutritional composition of fresh oyster meat samples in the present study suggests that the White Volta and Oti stocks are the same. In general the nutritional quality of *Etheria elliptica* as determined in this study was fairly comparable to that of any of the other bivalves: *Galatea paradoxa* (Kwei, 1965), *Crassostrea tulipa* (Obodai, 1990; Yankson *et al*., 1994). Kintin and Cesarani (1996) have described shellfish in general and oysters in particular as constituting a good body-building food containing a lot of protein, vitamins and minerals such as calcium, iron and phosphorus (Pyke, 1989).

Oyster shells are known to have some economic importance where the organism occurs. In some communities of the northern Volta Basin of Ghana, specifically along River Oti, the shells are used to manufacture local paint (white wash). In the Congo Basin, the early Belgian settlers are also reported to have used oyster shells as a source of lime to produce paint because of the scarcity of limestone (Pilsbry and Bequaert, 1927). Additionally, the shell is used as a source of mineral supplement in poultry feeds in some communities near Tamale.

Conclusions

The study has shown that the freshwater oyster *Etheria elliptica* occurs in all the major rivers and tributaries forming the northern Volta Basin in Ghana. The nutritional value of the oyster meat is high and has been used as a staple delicacy by rural households in the north for centuries. The shell is used as a source of mineral supplement in poultry feeds and a source of lime in local preparation of paint. The oyster fishery is a renewable natural resource that has a great potential to provide livelihoods for many more rural communities in the north of Ghana, if it is developed commercially.

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References

[1] Ampofo-Yeboah A, Owusu-Frimpong M, Yankson K. 2009. Gonad development in the freshwater oyster *Etheria elliptica* (Bivalvia: Etheriidae) in northern Ghana. *African Journal of Aquatic Science* 34(2): 195–200.

[2] AOAC. 1970. Official Methods of Analysis.11th Edition Association of Official Analytical Chemist, Washington D.C.

[3] Bogan, AE. 2008. Global diversity of freshwater mussels (Mollusca, Bivalvia) in freshwater. *Hydrobiologia*, 595:139-147.

[4] Bogan, AE, Hoeh WR. 2000. On becoming cemented: evolutionary relationships among the genera in the freshwater bivalve family Etheriidae (Bivalivia: Unionoidae). In Harper, E.M.,

Taylor, J.D. and Crame, J.E. (eds). The Evolutionary Biology of the Bivalvia. Geological Society, London, Special Publications, 177, p159-169.

[5] Bogan, AE, Roe KJ. 2008. Freshwater bivalve (Unioniformes) diversity, systematics, and evolution: status and future directions. Journal of the North American Benthological Society 27 (2): 349-369

[6] Kinton R, Cescrani V. 1996. Theory of Catering. English Language Book Society, Low Priced Edition. 325pp

[7] Kwei EA. 1965. The Spawning and the Growth of the Volta Oyster, *Egeria radiata* (Lam).Ghana *Journal of Science* 5 (2): 150 – 160

[8] Mandahl-Barth G. 1988. Studies on African Freshwater Bivalves. Danish Bilharziasis Laboratory, Charlottenlund, Denmark, 161 p.

[9] Obodai EA. 1990. Aspect of Ecology and Biology of the West African Mangrove Oyster, (*Crassostrea tulipa*), Lamarck occurring in some coastal waters of Ghana, West Africa. M.Sc. Thesis. University of Cape Coast, 82 pp.

[10] Pilsbry HA, Bequaert J. 1927. Article II. The Aquatic Mollusks of the Belgium Congo. With a geographical and Ecological Account of Congo Malacology. Bulletin of the American Museum of Natural History. Vol. L. III. 69-906; 446-602.

[11] Purchon RD. 1977. The Biology of the Molluscs. 2nd Edition. Pergamon Press. New York. NY, USA 560 pp.

[12] Pyke M. 1986. Success in Nutrition. London: John Murray (Publishers) Ltd.

[13] Quayle DB. 1980. Tropical Oysters: Culture and Methods. International Development Center, Ottawa, Canada, T.S. 17e.80 pp.

[14] Vakily JM. 1994. Determination and comparison of bivalve growth, with emphasis on Thailand and other tropical areas. ICLARM, Manila. 125p.

[15] Van Damme D. 1984. The Freshwater Mollusca of Northern Africa. Distribution, Biogeography and Paleoecology.Dr. W. Junk Publishers. Dodrecht. The Netherlands, 164 p

[16] Yankson K, Plahar WA, Obodai EA. 1994. Seasonal Changes in the Biochemical Composition of the Mangrove Oyster, *Crassostrea tulipa* occurring in two coastal water bodies in Ghana. *Ghana Journal of Science*. 31-36(1991-1996), 37 - 43

[17] Yonge CM. 1962. On *Etheria elliptica* Lam. and the course of evolution, including the Assumption of monomyarianism in the family Etheriidae (Bivalvia: Unionacea). Philosophical Transactions of the Royal Society of London. Series B244(715), 423 - 458