NEW DATA ON THE MORPHOLOGY OF *ELECTROTAENIA MALOPTERURI* (CESTODA: PROTEOCEPHALIDAE) AND THE ATTENDANT HISTOPATHOLOGICAL CONSEQUENCES ON *MALAPTERURUS ELECTRICUS* (SILURIFORMES: MALAPTERURIDAE) FROM LEKKI LAGOON (NIGERIA)

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A parasitologic investigation was carried out on *Malapterurus electricus* from Lekki Lagoon, Nigeria. The proteocephalidean cestode, *Electrotaenia malopteruri* (Fritsch, 1886) (Cestoda: Proteocephalidae: Gangesiinae) which is the type and only species of *Electrotaenia* Nybelin, 1942 was the dominant parasites species recovered. The parasite is specific to the fish host. Scanning electron microscopy (SEM) revealed sharp differences in the scolex morphology of the parasite with the existing species of *Electrotaenia malopteruri*. The new sub-species have a wider spherical scolex, the four uniloculate suckers groove are bean shaped and not spherical in the existing species. The suckers of this species are not widely closed to one another but distinctly large with a wider external surface and a wider groove. The disc shaped rostellum-like organ is also wider. There is no median line in-between the uniloculate suckers. The overall incidence of infection was 30.2% with higher incidence of infection in the male (n = 210 (31.7%) and (n = 130 (27.6%) in the female specimens. A total of 254 helminthes were recovered from the three hundred and forty specimens examined of the fish hosts. The tissue sections of the fish host revealed diffuse oedema of epithelium with sloughing of epithelium into lumen, marked shortening and matting of villi with diffuse lymphocytic propria together with thickened wall of the intestine and the observation of the localized area of calcification.

Key words: Malapterurus, *Electrotaenia*, rostellum, suckers, microtriches, histopathology.

INTRODUCTION

More than 3.000 species of freshwater fishes have been identified in Africa (Skelton, 2001). In Nigeria, the parasitic fauna of freshwater fishes has been studied by a number of workers (Awachie, 1965; Aderounmu & Adeniyi, 1972; Okaka, 1991; Akinsanya & Hassan, 2001 a, b; Akinsanya & Otubanjo, 2006; Akinsanya *et. al*., 2007; Akinsanya *et al*., 2008). The host-parasite checklist of Khalil & Polling (1997), documented the Proteocephalidean tapeworms, *Electrotaenia malopteruri* (Fitsch, 1886) (Proteocephalidae: Gangesinae) in *Malapterurus electricus* (Woodland, 1925; Khalil, 1963) in Sudan. *E. malopteruri* have also been reported by several authors (La Rue, 1911, 1914; Janicki, 1928; De Chambrier *et al*., 2004; Akinsanya *et al*., 2007).

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In Nigeria there is a dearth of information on fish helminthology. There are only few ichthyoparasitologists as reported earlier on the parasitic helminth fauna of fishes. Most of the work done in Nigeria has been on incidence and prevalence. There have been not much work done on pathology of infections or on loss of condition factor due to the infections. Most of the fish parasites recorded have not been thoroughly studied with regard to their identifications and using modern techniques of scanning electron microscopy to establish their correct features. Most identifications in some recent publications are fashioned after previous studies.

Histopathological investigations are necessary because the impacts exerted by parasites on their host could be mechanical, physical or chemical. Ford (2002) reported that the histopathological examination remains the best general approach for simultaneous evaluation of a wide range of parasitic diseases and pathologies. The SEM description of *E. malopteruri* in Nigeria most especially from *Malapterurus electricus* of Lekki Lagoon has not been reported by any author.

The present study therefore projects the first scientific report of detailed morphological description of *E. malopteruri* from *M. electricus* of Lekki Lagoon, Lagos, Nigeria.

MATERIAL AND METHODS

STUDY AREA

Lekki Lagoon supports a major fishery in Nigeria. The lagoon is located in Lagos State Nigeria and lies between longitudes $4^0$00’ and $4^0$15’E and between latitudes $6^0$25’ and $6^0$37’ N. It has a surface area of about 247 km^2 with a maximum depth of 6.4 m; a greater part of the lagoon is shallow and less than 3.0 m deep. The Lekki lagoon is part of an intricate system of waterways made up of lagoons and creeks that are found along the coast of south-western Nigeria from the Dahomey border to the Niger Delta stretching over a distance of about 200 km. It is fed by the River Oshun and Saga discharging into north-western parts of the lagoon.

Lekki lagoon experiences both dry and rainy seasons typical of the southern part of Nigeria. The vegetation around the lagoon is characterized by shrub and *Raphia* palms, *Raphia sudanica* and oil palms, *Elais guinensis*. Floating grass occurs on the periphery of the lagoon while coconut palms *Cocos nucifera* are widespread in the surrounding villages. The rich fish fauna of the lagoon includes *Heterotis niloticus, Gymnarchus niloticus, Clarias gariepinus, Malapterurus electricus, Synodontis clarias, Chrysichthys nigrodigitatus, Parachanna obscura, Mormyrus rume, Calabaricus calamoichthys, Tilapia zilli, T. galilaeus, Hemichromis fasciatus* and *Sarotherodon melanotheron*.

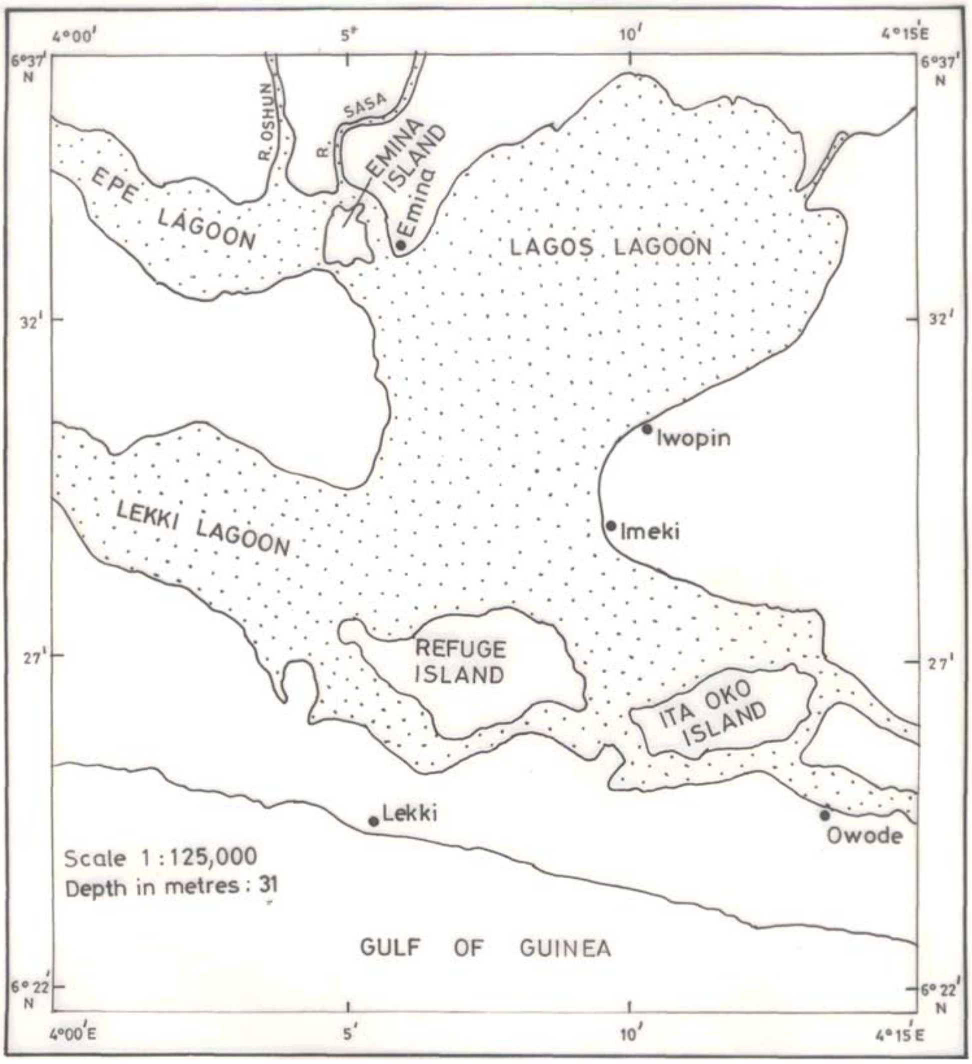

Fig. 1. The map of Lekki Lagoon, Lagos, Nigeria.

COLLECTION AND PARASITOLOGICAL EXAMINATION OF FISHES

Three hundred and forty specimens of the fish species were procured from Lekki lagoon, landing centre's at Oluwo market Epe, Lagos, Nigeria. The fish species were allowed to stabilize initially and were later dissected for parasitological examination. One hundred and thirty females (n = 130) and two hundred and ten males (n = 210) were examined. The fishes were later dissected for parasitological examinations. The recovered specimens of *Electrotaenia malopteruri* were counted, recorded and fixed in 2.5% glutaldehyde solution in 0.1m phosphate and kept in a refrigerator. Some of the parasites were also fixed in 70% alcohol and sent to the parasitic worms Division Natural History Museum, United Kingdom for their identification to species level.

SCANNING ELECTRON MICROSCOPY

For scanning electron microscope the cold temperatures were used to decrease extraction and provides a slower rate of autolysis. The cestode were later rinsed in the same buffer solution 3 times at 15 minutes interval to remove debris and to hold pH (7.4%) steady during the fixation process. Post fixation was done in 1% osmium tetra oxide for 2 hours. The samples were later dehydrated through a graded ethanol series. After dehydration, the trematodes were dried to the critical point in liquid CO_2. The CO_2 were brought above critical point (31.1 C and 1.073 Psd) and becomes dense vapour phase. The samples were later sputter coated and examined with the Tescan SEM VEGA of the Rhodes University, scanning electron microscope of the Central Michigan University, U.S.A.

HISTOPATHOLOGICAL ANALYSIS

For histopathological analysis, intestine samples of the fish host were fixed in Bouins fluids for 7 hours. They were later preserved in 10% phosphate buffered formalin and embedded in paraffin wax – blocked, sectioned with the rotary Leitz Wetzlab Microtome at 4-5 microns and stained with haematoxylin and eosin. The stained tissues were washed off in tap water and the over stained ones destained in 1% acid alcohol. The tissues were mounted using DPX mountant, dried and examined under the microscope.

RESULTS

DESCRIPTION OF *ELECTROTAENIA MALOPTERURI* (Fritsch, 1886)

The SEM examination of the cestode revealed important morphological features not previously reported or described. The proteocephalidean cestode is the type and only species of the genus *Electrotaenia* Nybelin, 1942 and specific to the electric catfish *Malapterurus electricus*. The fish species was obtained from Lekki Lagos, Lagos, Nigeria. The scolex is spherical, 168744.15 nm long and 100333.26 nm wide. The external and internal surface of the scolex is covered with filiform microtriches. Fig. 2 A shows the scolex of the proteocephalidean cestode. Some of the microtriches are small and tiny while some are long (Fig. 2 D). There was an evenly growth of the mictotriches on the scolex. The postero-lateral lobes are unique bearing the antero-lateral uniloculate suckers as shown in Fig. 2 B. In the Fig. 2 C, D the uniloculate sucker is shown with the zone of proliferation of proglottids. The lobes are distinct from each other having an external bulge with no median line between them. The suckers groove is bean-shaped in contrast to the rounded groove of the existing *E. malopteruri*. They are with tuft of microtriches on its surface some of which grow erect while some grow singly. The microtriches are broad beneath and tapered toward the anterior region (Fig. 2 E). The scolex is with four uniloculate suckers in the postero-laterally directed lobes. The postero-laterally lobes bearing the suckers has a length of 75290.11 nm and a breadth of 88506.02 nm the bean-shaped sucker has a groove with a length of 22676.11 nm and a breath of 40713.14 nm as shown in Fig. 2 D. The bean shaped structure of the sucker makes the species differ from the original one described with circular shaped sucker (Fig. 2 D). The circumference of the lobe measures 275658.46 nm while the circumference of the sucker groove measures 116252.97 nm. The sucker cavity is covered with filiform microtriches (Fig. 2 D).

The rostellum-like apical organ is well developed, muscular and disc-shaped. It also bears tuft of numerous microtriches both inside and on its side. Rostellum-like apical organ measures 109750.01nm (Fig. 2 B).

The strobila of *E. malopteruri* is acraspedote as shown in Fig. 2 F (configuration of the strobila-proglottids, in which the posterior portion of the proglottids does not overlap the anterior portion of the next proglottids and anapolytic (mode of strobila development characterized by the non-detachment of gravid proglottids).

The neck of the proteocephalidea cestode measures 92906.66 nm. The first proglottid measures (immature) 79019.81 nm while the second proglottid measures 78922.60 nm. There is an inward lateral extension and depression at the proglottids. The lateral strobilar extension measures 11042.80 nm. The lateral strobilar extension did not however continueous throughout the entire strobilar. There are alaes on top of the strobilar. The proglottids number ranges between 50- 60. The lateral strobilar extension connects one proglottid to the other. The breadth of the proglottids becomes smaller at the termination of the lateral strobilar extension. The proglottids measure 46934.76 nm, 44983 nm and 58951.26 nm. The lateral strobilar extension joins the lengthened proglottids together and ensures non-overlap of both the posterior and anterior proglottids. The length and breadth of the proglottids reduced after the termination of the lateral strobilar extension.

The mature proglottid measures 76483.07 nm. The gravid proglottid measures 236512.33nm with a length of 5976.91 nm. There is an inward lateral depression on the last gravid proglottid of *E. malopteruri* which measures 85568.27 nm. The tegument is smooth with marked diagonal lines. There is no interception of the lines on one another.

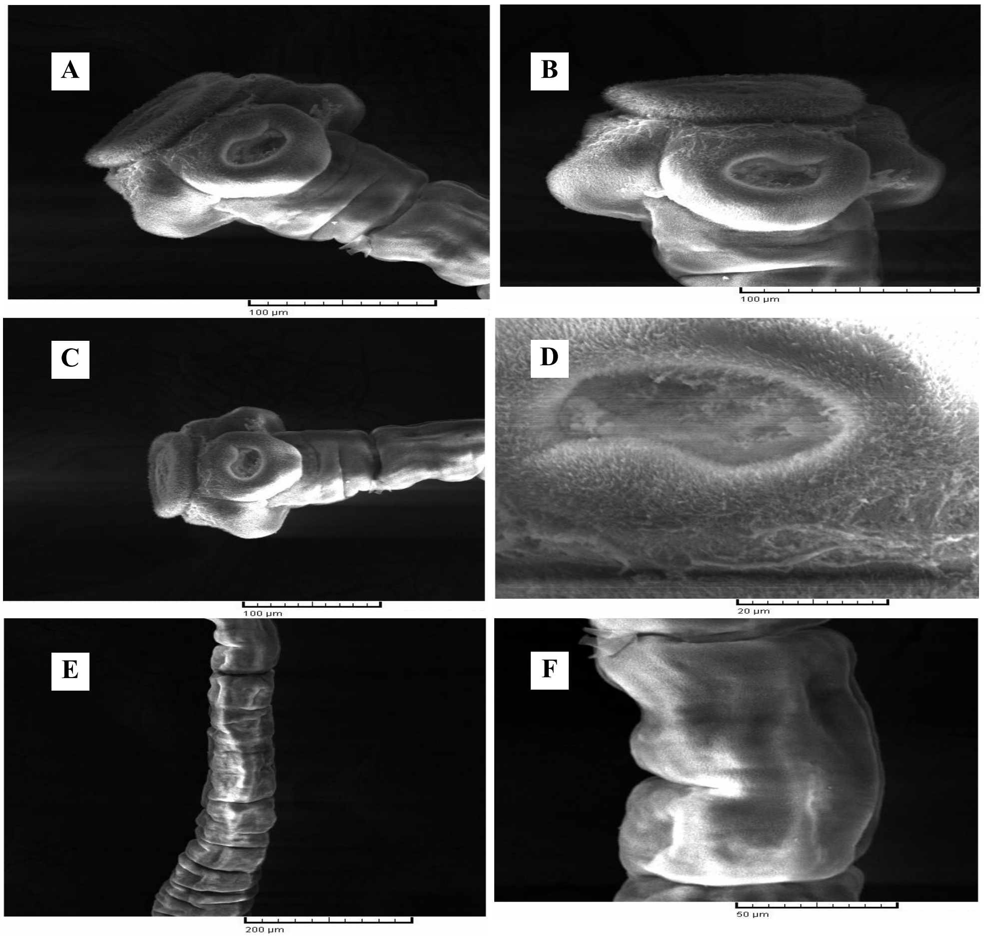

Fig 2. SEM Micrograph of *Electrotaenia malopteruri*.
A – Cephalic end of *Electrotaenia malopteruri*; B – Subapical view showing the disc shaped organ and the uniloculate sucker; C – Cephalic end of *E. malopteruri* showing the uniloculate sucker and the zone of proliferation of proglottids; D – Sub apical view showing the microtriches on the disc – shaped rostellum like organ; E – Acraspedote strobila of *E. malopteruri*; F – immature proglottids.

HISTHOPATHOLOGICAL RESULTS

The results of the histologic analysis of the tissue sections in *Malapterurus electricus* are shown in Fig 3 (A-D). They revealed diffuse oedema of epithelium with sloughing of epithelium into lumen. Marked shortening and matting of villi with diffuse lymphocytic propria were also observed. All the parasites were recovered from the intestine. Thickened wall of the intestine and the localized area of calcification were observed.

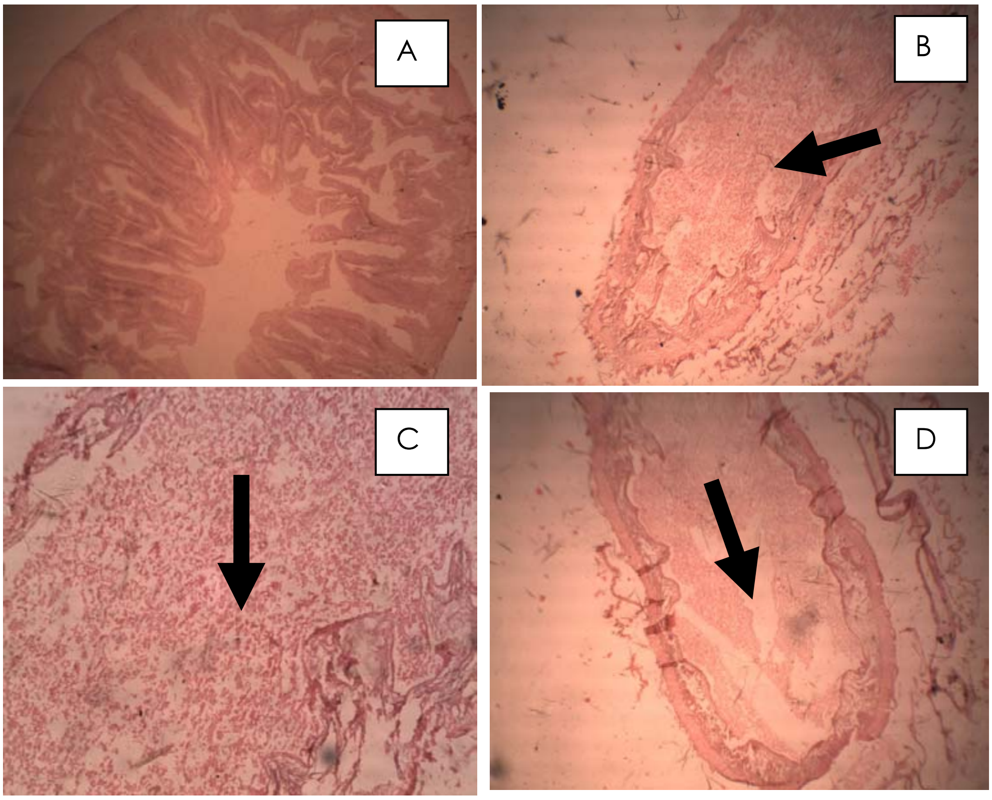

Fig. 3. Section through the Intestine of *Malapterurus electricus* showing different pathological conditions
(A) – Normal section; (B), a – Marked thinning of intestinal wall with sloughing and necrosis of the surface epithelium; (C), b – Severe mucosal necrosis with accumulation of necrotic debris in lumen; (D), c – Thinning of intestinal wall and accumulation of necrotic debris in lumen (× 100).

The sections also revealed generalized and diffuse matting of villi and villous collapse with presence of intraluminal parasites with thick fibrous capsule together with thinning of intestinal wall with sloughing and necrosis of the surface epithelium (Fig. 3 B). There was also minimal inflammation associated with the circumscribed parasite together with moderate thickening of the mucosa with severe mocosa necrosis (Fig. 3 C) There was also accumulation of necrotic debris in the lumen (Fig. 3 D).

DISCUSSION

The scanning electron microscopy of *Electrotaenia malopteruri* (Fitsch, 1886) (Proteocephalidae: Gangesiinae) was undertaken. The scolex morophology of the cestode conform with the existing descriptions by different authors such as: La Rue 1911, 1914; Woodland, 1925; Nybelin, 1942; Khalil, 1963, 1971, 1973; Schmidt, 1986; Ibraheem, 1998; De Chambrier *et al*., 2003.

The cestode was recovered from the intestine of the electric fish species *Malapterurus electricus*. Akinsanya *et al*. (2007) reported the proteocephalidean cestode from *M. electricus*.

This present study revealed some new data not previously reported on the description of *Electrotaenia malopteruri*. De Chambrier *et al*. (2004) on the redescription of *E. malopteruri* from Egypt confirmed the validity of *Electrotaenia* and some unique characters of this genus such as the internal morphology of a rostellum-like apical organ which is disc-shaped with a flat or slightly concave apex the structure of the ovary and the cirrus sac, the presence of a medio-dorsal band of muscle fibres, and the morphology of the vagina and eggs. This present study however only focused on the SEM of the proteocephalidean cestode.

The specimens of *E. malopteruri* observed with SEM in this study differ morphologically with the already ones described in having a wider spherical scolex with the growth of the filiform microtriches which grows externally and internally on the scolex. The scolex of the existing species is smaller compared with the present described specimen of the proteocephalidean cestode. The uniloculate suckers also differ markedly with the existing species in having a groove with a bean-shaped and not spherical as reported by various authors such as De Chambrier (2004) being one of the recent authors on the redescription of *E. malopteruri* from Egypt. The uniloculate suckers in comparison with the existing species are distinctly separated from one another having a wider external surface and a wider bean-shaped groove with tuft of filiform microtriches on their surface. The disc-shaped rostellum-like organ in this present study is also wider than that of the already described species. The neck is also wider with no median line in-between the uniloculate suckers. The comparison of *E. malopteruri* of this present study made it possible to describe previously unreported features of the morphology of *E. malopteruri* and in which *Electrotaenia* differs markedly from other gangesiine genera as defined by Rego (1994). The presence of lateral strobilar extension in and lateral groove at the last gravid proglottid of this new description was not reported by De Chambrier *et al*. (2004) on the redescription of the Proteocephalidaen cestode. The lateral body extension is not however continuous throughout the entire strobilar of this new description but may be of taxonomic value to the entire gangesiinae considering the length and point of termination.

De Chambrier *et al*. (2004) reported a narrow longitudinal groove along the median line of the body of *E. malopteruri*. In this present study, however, streaks of diagonal lines with little inward strobilar depression were observed. The lines run from both sides of the strobilar crossing each other while some terminated without crossing each other. The lines are not straight but clear and distinct to distinguish one part of the strobilar from another.

The species of *Electrotaenia malopteruri* recovered from the intestine of *Malapterurus electricus* from Lekki Lagoon demonstrated congruency with the originally described species but it has some previously unreported features such as bean-shaped uniloculate suckers, wider spherical scolex, distinct separation of the uniloculate suckers from one another, wider rostellum-like organ and lateral strobilar extension which may be of taxonomic value.

De Chambrier *et al*. (2004) reported the importance of re-evaluation of the usefulness of morphological characters for the systematics of the genus *Electrotaenia*. They also reported that as a result of the weakness of the present classification as reported by several authors such as Zehnder & Mariaux, 1999; Kodedova *et al*., 2000; Mariaux & Olson, 2001; Olson *et al*., 2001. Then the re-evaluation of the genus considering the present study which reported some morphological features not previously reported is very significant. Several alae and papillae were also observed on the strobilar of *Electrotaenia malopteruri* which either were omitted or not previously reported by several authors. The microscopic study of the fish host revealed different pathological effects on the examined tissues. *E. malopteruri* scolex with four uniloculate suckers may penetrate deeply through the intestinal layers of the fish host which may cause or lead to serious mechanical injury to the mucosa. Villous collapse sloughing of epithelium into the lumen and localized area of calcification and other serious pathological consequences observed in this study may also lead to destruction of intestinal architecture and inability of adequate absorption for normal growth of the fish host.

Parasites are normal and natural in any ecosystem but they may indicate the relative health of any ecosystem. The observation of different pathological conditions in the fish host are clear evidence of the mechanical damage by the attachment organs of *E. malopteruri*. This is also with an inflammatory response at the site of attachment and also in the adjacent tissue.

Histological lesions such as sloughing of epithelium into the lumen, villous collapse, and hyperplasia of the epithelium is an indication of the depth to which the parasites penetrate the gut wall. Abowei *et al*. (2011) in a review of some viral, neoplastic, environmental and nutritional diseases of African fish reported epithelioma, proliferative epithelium from the mouth region, where only Malpighi cells are involved.

In this study diffuse oedema of the epithelium, moderate thickening of the mucosa and hyperplasia of the epithelium are also reported. Several interrelating factors such as spawning behavior, feeding time, temperature and exposure to antigens may also contribute to pathological consequences observed in the fish host as reported by Doggett & Harris (1987). Holmes & Zohar (1990) reported important host behavioural changes as a result of pathology to host tissues caused by the attachment of parasites, as well as movement, growth or development. The behavior of *Malapterurus electricus* as a result of parasite infections of *Electrotaenia malopteruri* is not however studied in this present study.

CONCLUSIONS

Conclusively, it has been shown in this study that new taxononomically important morphological data has been added for *Electrotaenia malopteruri* which may be regarded as a subspecies of the original already described species.

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