Epidemiology of epizoootic ulcerative syndrome (EUS) on fish in the Zambezi river system: A case study for Zambia

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Abstract

An epidemiological investigation was conducted from January to December 2011 in the Sesheke District of Zambia along the Zambezi River. The study aimed at determining factors associated with the outbreak of epizootic ulcerative syndrome (EUS), a newly confirmed disease in Southern Africa. The research also determined the prevalence, severity and distribution of EUS in the river. A total of 4,800 fish were inspected for gross EUS-like lesions while environmental factors were assessed to determined association with disease outbreak. Results of the study indicated that disease outbreak was preceded by heavy rains. The predominantly gleysol and arenosol soils of Zambezi river system resulted in low water pH (5.5 to 6.5); an ideal range for EUS causing agent to sporulate. Other factors significantly (P<0.05) associated with EUS outbreak were, low total alkalinity, water temperature, ambient temperature, month of sampling (June being significant) being associated with cold season, and site of sampling (lagoon and tributary being significant). Three percent of the smapled fish had typical characteristic lesions of EUS. Disease severity on fish ranged from mildness to healing wounds. Fifteen percent of the total sampled fish showed healing wounds while histopathological examinations showed mild infection by *Brycinus lateralis*, *Serranochromis robustus* and *Sargochromis giardii*. Participatory epidemiology revealed an upstream spread of EUS within the Zambezi river system.

Key words: Epidemiology, epizootic ulcerative syndrome, risk factors, fish, Zambezi river

Résumé

Une enquête épidémiologique a été menée de Janvier à Décembre 2011 dans le district de Sesheke en Zambie le long du fleuve Zambèze. L'étude visait à déterminer les facteurs liés à l'apparition du syndrome ulcéreux épizootique (EUS), une nouvelle maladie confirmée en Afrique australe. La recherche a également déterminé la prévalence, la gravité et la distribution de l'EUS dans le fleuve. Un total de 4.800 poissons

ont été examinés pour des lésions brutes semblables à EUS tandis que des signaux environnementaux ont été évalués pour déterminer l'association avec l'éclosion de la maladie. Les résultats de l'étude ont indiqué que l'éclosion de la maladie a été précédée par de fortes pluies. Les sols principalement Gleysol et arenosol du système fluvial du Zambèze ont abouti à un faible pH de l'eau (de 5,5 à 6,5); une plage idéale de EUS occasionnant un agent pour sporuler. D'autres facteurs significativement (P <0,05) associés à l'apparition de EUS étaient la faible alcalinité totale, la température de l'eau, la température ambiante, le mois de l'échantillonnage (Juin étant significatif) associé à la saison froide, le site d'échantillonnage (lagune et affluent étant significatifs). Trois pour cent des poissons échantillonnés avaient des lésions caractéristiques typiques de EUS. La gravité de la maladie sur les poissons allait de la bénignité aux blessures de cicatrisation. Quinze pour cent du total des poissons échantillonnés ont montré les blessures de cicatrisation tandis que les examens histo-pathologiques ont montré une légère infection par *Brycinus lateralis, Serranochromis robustus* et *Sargochromis giardii*. L'épidémiologie participative a révélé une propagation de EUS en amont dans le système fluvial du Zambèze.

Mots clés: Epidémiologie, syndrome ulcéreux épizootique, facteurs de risque, poisson, fleuve Zambèze

Background

The first case of epizoootic ulcerative syndrome (EUS) outbreak in Africa was reported in 2006. Diseased fish of a variety of species began to appear in the Zambezi Fishery leading to massive fish kill. This threatened the biodiversity of the fishery and posed food insecurity to thousands of peole in Zambia. Fish samples were collected from Sesheke District of Zambia, formalinised and sent to the University of Zambia on suspicion of poisoning from chemical or anthrax contamination (Samui *et al.*, 2007) . Similar outbreaks were reported from Botswana and Namibia and investigations showed that the levels of pesticides and heavy metals in the tissues of the fish were very low, discounting pollution as an underlying cause for the disease. In response to the epidemic, the Food and Agricultural Organisation (FAO) formed an International Emergency Disease investigation Task Force with the overall objective of assessing the fish disease outbreak in order to establish the causative agent. In May 2007 the Task Force confirmed the occurrence of *Aphanomyces invadans* in fish of the Zambezi river, a fungal pathogen which causes EUS (FAO, 2009).

Further surveillance works were conducted in 2007 by a team from the University of Zambia. It was reported that EUS prevalence could go as high as 50% in new areas of Zambezi and Chavuma districts where the disease was spreading (FAO, 2009). In 2008, the prevalence rate of 5% per catch was observed in Sesheke District where the disease was first noticed in Zambia (FAO, 2009). However, not much epidemiological research had been carried out to adequately understand factors associated with EUS outbreaks in the Zambezi river hence necessitating a retrospective study which the current research addressed. Overall, the study aimed at investigating the Epidemiology of Epizootic Ulcerative Syndrome on fish of the Zambezi River system of Zambia. The specific objectives were to: determine the environmental and biological risk factors associated with EUS outbreak, determine the prevalence and severity of EUS on different species of fish; and determine the spatial distribution of EUS in the Zambezi River system of Zambia.

Study Description

An active surveillance system and participatory epidemiology were used to sample fish for disease diagnosis while different instruments were used to measure environmental factors. Geographical Information System (GIS) was used to map the distribution of disease. Principal Component Analysis helped to reduce 14 environmental parameters to 6 , while Logistic Regression was used to test the significance of parameters.

Research Application

The study implicated a combinations of six environmental factors as risk factors associated with EUS outbreak in the Zambezi river system. Both meteorological and hydrological parameters triggered the sporulation of *Aphanomyces invadans* leading to EUS outbreak (Table 1).

Table 1.   Means for environmental cues and measures of association with disease.

Env.cue	No. of sampling	Mean	S.e	Sig [a]	Measure of association with disease
Month	321	6.028	± 0.1861	0.003	0.922
Site	321	2.996	± 0.0790	0.049	0.604
Air Temperature	321	25.85	± 0.3058	0.04	0.906
Water temperature	321	20.94	± 0.2173	0.02	0.889
Water pH	321	6.4	± 0.0199	0.016	0.782
Total alkalinity	321	45.13	± 0.0418	0.007	0.743

[a]$P<0.05$

The current research also collected rainfall data for the Zambezi river system of Zambia with evidence of 952.6mm of rainfall during 2005/2006 when EUS was reported. This figure is above 500mm, an average of the area and the highest in the past 10 years. This undoubtedly impacted on other hydrological variables such as the ones in Table 1 above and thereby favouring the sporulation of the disease causing fungus (*Aphanomyces invadans*).

Estimation of disease prevalence showed that 3% (144) of the 4,800 fish sampled had typical characteristic lesions of EUS. Of these, 11 were found to have mycotic granulomas on histopathological analysis, representing 7.6% of the initially identified through gross examination.

Disease severity on fish on the other hand ranged from mildness to healing wounds and no particular size classes were infected. Fifteen percent (720) of the total sampled fish showed healing wounds while histopathological examinations showed mild infection on samples of *Brycinus lateralis*, *Serranochromis robustus* and *Sargochromis giardii* of the 15 species sampled. Eighty two percent (3936) showed no evidence of gross lesions. (Figs.1, 2 and 3).

Figure 1.   EUS lesion on *Brycinus lateralis*.

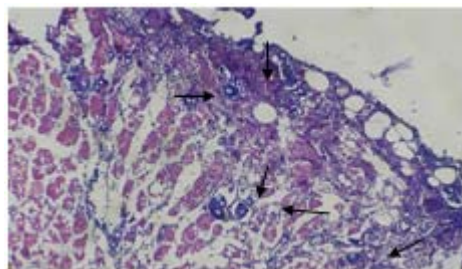**Figure 2.   Healing wound on *Serranochromis robustus*.**

Figure 3. Histopathology of EUS-infected *Brycinus lateralis* showing typical mycotic granulomas. Surrounding invasive fungal hyphae (black arrow) penetrating into muscle layer (H&E).

Both active surveillance and participatory epidemiology applied in the research confirmed upstream spread of EUS within the Zambezi river system of Zambia.Geographical Information System (GIS) was used to map disease distribution. It has been envisaged that results from the current research would have a wider application in helping to formulate strategic interventions consistent with the control and prevention of the spread of EUS to other aquatic ecosystems. This study has demonstrated that several predisposing environmental factors are associated with EUS outbreak on fish in the Zambezi river system. Although control of EUS in the wild is difficult, successful prophylactic and therapeutic treatments can generally be administered involving addition of quicklime (CaO), a relatively simple and inexpensive way of enhancing water quality. This fact only reinforces the need to overcome the environmentally degrading conditions which may predispose fish to disease. Therapeutic treatments will target mainly lagoons before they cut off from main river system.

Biosecurity of the Zambezi river system must be given attention by instituting appropriate management and policy measures such as restricting of trans-boundary fish stock transfers. Furthermore more, fish stocks earmarked for aquaculture purposes are collected from the wild and therefore observance of the restriction to fish translocation must be upheld. Epidemiologists must be assigned to formulate and reinforce legislatory measures.

Overall, the results from this research provide a multifaceted benefit to various stakeholders such as the Department of Fisheries who should device plans to preserve species diversity of the Zambezi river system in the wake of EUS epidemic. It

was hoped that fishers dependant on the river would in the long run experience increased fish yield. Furthermore fish consumers would be accessing safe and good quality fish products from the fishery. Bilateral agreements with the regional Governments must focus more on preventing the disease spread to non-affected areas such as the nearby Congo basin. Rainfall higher than 500mm must serve as a warning alarm to the recurrence of EUS outbreak and therefore governments and other stakeholders must put in place a strategic workforce to quickly react to such an indicator.

Acknowledgement

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