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PARASITIC PROFILE AND ZOONOTIC RISK OF *Ethmalosa fimbriata* CONSUMED IN THE ESCRAVOS ESTUARY, DELTA STATE, NIGERIA

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ABSTRACT
This study was carried out to examine the parasite population structure, diversity indices, and infection risk, of Ethmalosa fimbriata and associated water quality indicators at the Escravos Estuary. A total of 300 E. fimbriata specimens were examined for parasites from two fishing communities along the Estuary (150 in Kurutie and 150 in Okerenkoko). Results obtained showed that a total of six parasite species, belonging to three taxonomic groups including protozoans (Trichodina sp. and Protozoan cysts), monogeneans (Gyrodactylus sp. and Dactylogyrus sp.), and nematodes (Contracaecum sp. and Camallanus sp.), were identified. A total of 9 individuals (6.00%) were infected in Kurutie, while 11 individuals (7.33%) were infected in Okerenkoko, with 30 recovered parasites in Kurutie and 47 in Okerenkoko. The mean intensity (MI) of infection was 3.33 in Kurutie and 4.27 in Okerenkoko, whereas the mean abundance (MA) was 0.20 and 0.31, respectively. Species dominance was slightly higher in Okerenkoko (0.46) compared to Kurutie (0.35). Conversely, diversity indices including Simpson's Index of Diversity, Shannon-Wiener index (H'), Margalef's index and evenness (e^H/S) suggested a more balanced distribution of parasite species in Kurutie. Risk assessment analysis showed an odds ratio (OR) of 1.24 and a risk ratio (RR) of 1.22, suggesting a slightly increased likelihood and relative risk of parasitic infection among the examined fish population. The water quality parameters in the study correspond with a typical tropical estuary, although, with notable fluctuations in BOD, which influenced parasite prevalence. Overall, the findings underline the necessity for regular monitoring and careful fish handling, consumption of hygienically prepared fish and properly cooked fish in the Estuary to protect public health.

Keywords: Fish parasites, Bonga Shad, Zoonosis, Prevalence, Public health, Species Diversity Indices

INTRODUCTION
Transmission of parasitic infections from fish to humans has been a significant public health issue increasingly over the past few years, especially in areas where fish constitutes the main diet (Ibiwoye *et al.,* 2006; Ekanem *et al.,* 2011). These zoonotic infections that originate from aquatic animals and affect humans are very dangerous when humans consume infected or undercooked fish (Micheal *et al.,* 2024). Some of the zoonotic diseases that are associated with parasitic infestations in fish include opisthorchiasis, intestinal trematodiasis, diphyllobothriasis, and anisakidosis, which are usually associated with parasites like digeneans, cestodes, and nematodes (Ekanem *et al.,* 2014). The affected fish usually experience stunted growth, metabolic disruption, tissue damage, and, in extreme conditions, actually die. Parasites not only pose a risk to the health of fishes but also compromise their defense systems, predisposing them to reinfection, which can have far-reaching economic consequences in terms of high mortality rates (Onyedineke *et al.,* 2010). Moreover, parasites have multifaceted ecological functions, regulating host populations, and acting as pointers to the general status of ecosystems. Pandemics of zoonotic diseases often result from the consumption of raw or inadequately cooked fish, or contact through unhygienic handling and processing (Ekanem *et al.,* 2014). Parasitology of fish remains relevant for monitoring aquatic animal health and transmission routes of these pathogens, with particular reference to seasonal patterns and human exposure (Novotny *et al.,* 2004). A number of surveys have reported protozoan and metazoan parasites in food fish of economic importance, indicating their zoonotic potential and public health implications (Aladetohun *et al.,* 2013). Interestingly, parasites are not only causative agents of foodborne risks but also serve as biological indicators for assessing environmental quality, heavy metal pollution, pollution levels, and climate change impacts, in addition to fish stock health and trophic interactions (Quiazon, 2015). One such economically and nutritionally valuable species is *Ethmalosa fimbriata*, or bonga shad. The clupeid, ray-finned fish has a wide distribution off the West African coast and in adjacent brackish aquatic environments such as rivers, estuaries, and lagoons. It is an integral component of artisanal fisheries in the Escravos Estuary, for instance, in Okerenkoko and Kurutie towns, where it constitutes a significant proportion of local fish landed catches. *E. fimbriata*, which on average grows to 25 cm and can reach 45 cm, is a pelagic-neritic and catadromous species (Soyinka *et al.,* 2012). Inshore small-scale fishers utilize seine and gill nets to catch it. The species prefers shallow coastal waters and has been observed to travel 300 km upstream in rivers. The bonga shad, aside from being economically feasible and well consumed, is also highly nutritious. It is rich in proteins, fats, and bioactive elements like vitamin E, zinc,

selenium, and omega-3 and omega-6 fatty acids that have been shown to enhance immunity and combat infectious diseases (Eyo *et al.,* 2023; Naeem and Selamoglu, 2023). Morphologically, *E. fimbriata* is laterally compressed with a deep body shape and 16–19 dorsal soft rays (Eriegha and Eyo, 2023). It has a distinct notch on the upper jaw for the reception of the tip of the lower jaw, long lower gill rakers that are abruptly curved upwards, and V-shaped pelvic fin rays (1 unbranched, 7 branched). Its caudal fin is pointed and elongated, and a weak dark spot is visible behind the gill cover. The tip of the dorsal fin is marked with black pigmentation. *E. fimbriata* reproduces continuously throughout the year across a wide salinity range (3.5–38 ppt), with spawning activity being enhanced in estuaries, marine environments, and freshwater watercourses. Its adaptability to different ecological conditions and its trophic relevance render it a species of considerable interest to both fisheries management and public health monitoring, particularly in parasite-host interaction studies. However, despite its extensive distribution and relevance in local cuisine, a considerable knowledge gap still exists regarding the parasitic fauna infecting *E. fimbriata.* The research focuses on *E. fimbriata* in the Escravos Estuary and specifically addresses the zoonotic potential and ecological significance of the parasites involved. Thus, the current study aims to fill the existing knowledge gap by evaluating the parasitic community composition, diversity indices, infection risk, and associated water quality criteria of *E. fimbriata* between two fishing communities, Kurutie and Okerenkoko, of the Escravos Estuary. The results are designed to offer better management practice regarding the health of fish, assist in improved monitoring of food safety, and increase the knowledge of zoonotic disease risk in local fisheries.

MATERIALS AND METHODS

Study Area

This parasitological study was carried out at the Escravos Estuary, Delta State, Nigeria, which spans about 50 kilometers in length and 4 to 15 kilometers in width, with salinity range of 14 to 39ppt (Abowei, 2009; Eriegha and Eyo, 2023). *E. fimbriata* specimens were caught from two fishing communities (Kurutie and Okerenkoko) along the Escravos Estuary between May 2024 and April, 2025 with gill net. Kurutie and Okerenkoko communities are located at 44°12'07.9"N 22°41'27.0"E and 44°12'07.9"N 22°41'27.0"E respectively (Figure 1).

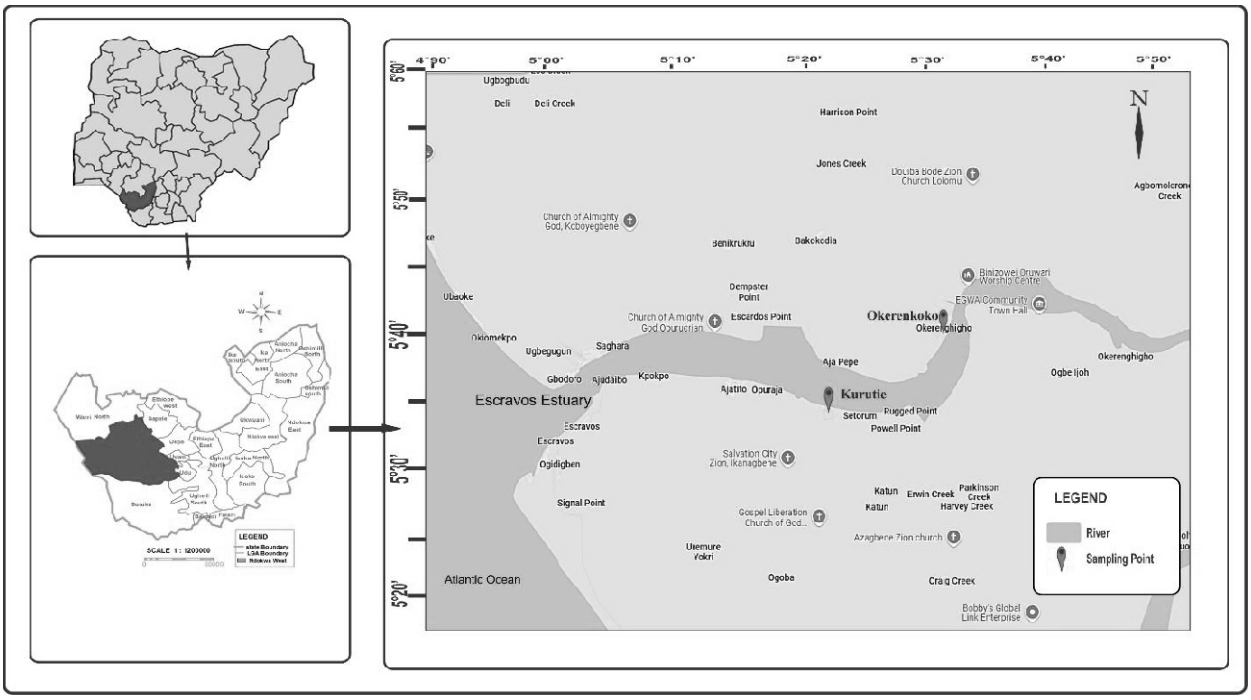

Fig.1: Map of the Study Area showing Sampling collection points (Kurutie and Okerenkoko)

Fish Collection and Parasitological Analysis

A total of 300 *E. fimbriata* specimens were caught from the two fishing communities (150 per community) in the rainy season (April to October) and dry season (November to March). The specimens were identified using morphological description given by Idodo-Umeh (2003) and Adeyeye (2010) such as body shape, fin morphology, and color patterns. After capture, the specimens were immediately transported to the Fisheries and Aquaculture laboratory, Nigeria Maritime University, Okerenkoko, for biometric data collection and parasitological examination. In the laboratory, the body weight (BW) of the *E. fimbriata* specimen was measured in grams with an OHAUS SPX622 electronic balance, and the total length (TL) was measured with a measuring board in centimeters (Table 1). The fishes were grouped into four length classes including 5.00 – 9.90 cm, 10.00 – 14.90 cm, 15.00 – 19.90 cm and 20.00 – 24.90 cm. For ectoparasite examination, biopsy was prepared from the eye, fin, gills and skin of each specimen following the techniques of Eyo *et al.,* (2015) and Roohi *et al.,* (2014) and examined under MEDICA OLYMPUS binocular microscope. The gills of each specimen was examined for protozoan cyst using MSC-ST45 stereo microscope. For endoparasites, the internal organs of each specimen were dissected and examined for the presence of endoparasites using MSC-ST45 stereo microscope following the methods described by Paperna (1996). Parasites isolated from the examined specimens were preserved by fixing and storing them in 70% ethyl alcohol. Microscopic preparations including temporary and permanent preparations, were prepared to identify the isolated parasite species (Eyo *et al.,* 2015).

Calculation of parasite indices

Parasite indices were calculated according to Upadhyay *et al.,* (2012) as follows:

Mean abundance (MA) = Total number of parasite recovered/Total number of fish examined

Mean intensity (MI) = number of collected parasites/number of infested fish

Prevalence (P-%) = Number of fish infected/Total number of fish examined*100

Calculation of Risk Characterization Metrics

This was calculated using the formulas given by McHugh (2009) as follows:

Odds Ratio (OR) = (A/C)/(B/D)

Risk Ratio (RR) = A/(A+B)/C/(C+D)

Where:

A: Number of infected fish in Okerenkoko

B: Number of uninfected fish in Okerenkoko

C: Number of infected fish in Kurutie

D: Number of uninfected fish in Kurutie

Measurement of water quality parameters

Water samples were collected in duplicates from key locations within two fishing communities during both the rainy season (April to October) and the dry season (November to March). Sampling was done using airtight plastic containers that had been sterilized with ethylene oxide gas. The samples were refrigerated immediately after collection and transported on ice to the laboratory for further analysis. Physicochemical parameters were analyzed following the standard procedures outlined by the American Public Health Association (APHA, 2017). Temperature was measured using a thermometer; turbidity was assessed using the spectrophotometric method; pH using a pH meter; and electrical conductivity with a conductivity meter. Total dissolved solids (TDS) were determined by the evaporation method, total hardness by the EDTA titrimetric method, and total alkalinity through acidimetric titration. Dissolved oxygen (DO) was measured using a DO meter, while salinity was determined by titration with potassium iodide. Nitrate levels were assessed using the sodium salicylate method, and cyanide concentration was measured using the direct spectrophotometric method with picric acid reagent. Heavy metals such as magnesium (Mg), cadmium (Cd), nickel (Ni), iron (Fe), aluminum (Al), copper (Cu), lead (Pb), chromium (Cr), and zinc (Zn) were analyzed using flame atomic absorption spectrometry (FAAS). Phosphate was determined using the molybdenum blue spectrophotometric method, while sulphate was analyzed using the turbidimetric method.

RESULTS

Biometric Data and Condition Factor (K) of *Ethmalosa fimbriata* from from the Escravos Estuary

A total of 150 specimens of *E. fimbriata* were sampled from each of the two fishing communities: Kurutie and Okerenkoko. The body weight (BW) of fish from Kurutie ranged from 6.48 to 30.2 g, with a mean ± standard deviation (SD) of 12.92 ± 0.60 g. The total length (TL) varied between 9.21 and 16.93 cm, averaging 11.80 ± 0.18 cm. The condition factor (K) for these fish ranged from 0.61 to 0.88, with a mean of 0.75 ± 0.10. In Okerenkoko, the body weight of *E. fimbriata* ranged from 6.42 to 36.4 g, with a mean of 13.02 ± 0.55 g. Total length ranged between 9.02 and 16.45 cm, with an average of 11.90 ± 0.19 cm. The condition factor in this group ranged from 0.63 to 0.94, with a mean of 0.74 ± 0.08. Table 1 shows the biometric data and condition factor (K) of specimens of *E. fimbriata* studied.

Table 1: Biometric data and condition factor (K) of specimens of *E. fimbriata* from the Escravos Estuary

Fishing community		BW (g)	TL (cm)	K
Kurutie	Min - Max	6.48 – 30.2	9.21 – 16.93	0.61 – 0.88
(N = 150)	Mean ± SD	12.92 ± 0.60	11.80 ± 0.18	0.75 ± 0.10
Okerenkoko	Min - Max	6.42 – 36.4	9.02 – 16.45	0.63 – 0.94
(N = 150)	Mean ± SD	13.02 ± 0.55	11.90 ± 0.19	0.74 ± 0.08

*BW = Body weight in grams and TL = Total length in centimeters

Parasitic Fauna Identified in *E. fimbriata* from the Escravos Estuary

A total of six parasite species, spanning three major taxonomic groups, were identified in *E. fimbriata* collected from the Escravos Estuary. These include protozoans (*Trichodina sp*. and protozoan cysts), monogeneans (*Gyrodactylus sp*. and *Dactylogyrus sp*.), and nematodes (*Contracaecum sp.* and *Camallanus sp*), with varying localization and life cycle types. Table 2 shows the parasitic fauna identified in *E. fimbriata* from the Escravos Estuary.

Table 2: Parasitic fauna identified in *E. fimbriata* from the Escravos Estuary

Taxon	Parasite Species	Endoparasite	Ectoparasite	Monoxenous	Heteroxenous
Protozoan	*Trichodina sp*	–	+	+	–
	Protozoan cysts	–	+	+	–
Monogenea	*Gyrodactylus sp*	–	+	–	+
	Dactylogyrus sp	–	+	–	+
Nematoda	*Contracaecum sp*	+	–	–	+
	Camallanus sp	+	–	–	+

Ecological Indices and Parasite Diversity in *E. fimbriata* from the Escravos Estuary

The ecological indices and parasite diversity in *E. fimbriata* from the Escravos Estuary are presented in Table 3. A comparative analysis of the parasite component communities in *E. fimbriata* from Kurutie and Okerenkoko revealed variations in infection rates, diversity, and ecological indices. Out of 150 fish examined from each site, 9 individuals (6.00%) were infected in Kurutie, while 11 individuals (7.33%) were infected in Okerenkoko. The total number of parasites recovered was 30 in Kurutie and 47 in Okerenkoko. The mean intensity (MI) of infection was 3.33 in Kurutie and 4.27 in Okerenkoko, whereas the mean abundance (MA) was 0.20 and 0.31, respectively. In terms of species dominance, a slightly higher value was recorded in Okerenkoko (D = 0.46) compared to Kurutie (D = 0.35). Conversely, Simpson's Index of Diversity (1-D) was higher in Kurutie (0.65) than in Okerenkoko (0.55), suggesting a more balanced distribution of parasite species in Kurutie. The Shannon-Wiener index (H'), which accounts for both abundance and evenness, was also higher in Kurutie (1.07) compared to Okerenkoko (0.93), indicating greater diversity. Similarly, Margalef's index and evenness (e^H/S) were higher in Kurutie (0.59 and 0.98, respectively) than in Okerenkoko (0.52 and 0.84, respectively). Equitability (J), which measures how evenly individuals are distributed across species, was slightly higher in Kurutie (0.98) than in Okerenkoko (0.86).

Table 3: Ecological Indices and Parasite Diversity in *E. fimbriata* from the Escravos Estuary

Taxon	Kurutie	Okerenkoko
Number of fish examined (N)	150	150
Number of fish infected (n)	9	11
Total number of parasites (p)	30	47
Prevalence (%)	6.00	7.33
Mean intensity (MI)	3.33	4.27
Mean abundance (MA)	0.20	0.31
Dominance (D)	0.35	0.46
Simpson (1-D)	0.65	0.55
Shannon Wiener (H')	1.07	0.93
Margalef (D)	0.59	0.52
Evenness (e^H/S)	0.98	0.84
Equitability (J)	0.98	0.86

Risk Characterization Metrics of *Ethmalosa fimbriata* from the Escravos Estuary

Risk assessment analysis of *E. fimbriata* from the Escravos Estuary (Table 4) yielded an odds ratio (OR) of 1.24 and a risk ratio (RR) of 1.22.

Table 4: Risk characterization metrics of *E. fimbriata* from the Escravos Estuary

Metrics	Values
Odds Ratio (OR)	1.24
Risk Ratio (RR)	1.22

Relative Proportion of Parasite Taxa in *Ethmalosa fimbriata* from the Escravos Estuary

The relative abundance of parasite taxa infecting *E. fimbriata* varied between the two sampling locations—Kurutie and Okerenkoko. In Kurutie, a total of 30 parasites were recovered, with monogeneans representing the highest proportion (12 parasites), followed by nematodes (11 parasites) and protozoans (7 parasites). In contrast, fish from Okerenkoko harbored a total of 47 parasites, with protozoans being the most prevalent group (29 parasites), while nematodes and monogeneans accounted for 10 and 8 parasites, respectively.

Table 5: Relative proportion (%) of parasite taxa infecting *E. fimbriata* sampled from the Escravos Estuary

Taxon	Kurutie	Okerenkoko
Protozoan	7	29
Monogenea	12	8
Nematoda	11	10
Total	**30**	**47**

Physicochemical Parameters of Water Samples from Okerenkoko and Kurutie Stations Across Seasons

Physicochemical analysis of water samples collected from Okerenkoko and Kurutie during the rainy and dry seasons revealed notable variations across sampling sites and seasons, with most parameters remaining within the typical ranges for estuarine systems. Temperature increased during the dry season in both locations, rising from 26.28 ± 0.04 °C to 30.13 ± 0.01 °C in Okerenkoko and from 26.80 ± 0.02 °C to 30.19 ± 0.01 °C in Kurutie. Turbidity was slightly lower in the dry season at both sites, with values ranging between 2.30–2.39 NTU in Okerenkoko and 2.32–2.40 NTU in Kurutie. pH remained near neutral, with a marginal seasonal increase in Okerenkoko (7.21 to 7.26) and a slight decrease in Kurutie (7.17 to 7.14). Electrical conductivity and total dissolved solids (TDS) were higher in Kurutie than in Okerenkoko in both seasons, suggesting greater ionic content in Kurutie waters. Total hardness and total alkalinity decreased from rainy to dry season at both sites. Alkalinity was higher in Okerenkoko (240.00–234.50 mg/L) than in Kurutie (218.50–203.50 mg/L). Dissolved oxygen (DO) levels ranged from 4.21–4.40 mg/L, while biological oxygen demand (BOD) was markedly higher in Okerenkoko (5.39–6.46 mg/L) compared to Kurutie (2.98–3.08 mg/L), indicating possible organic load differences. Salinity was higher in Okerenkoko (5.23–5.28 ppt) than in Kurutie (4.82–4.94 ppt), aligning with conductivity trends. Nutrient levels such as nitrate and phosphate showed slight seasonal reductions, with phosphate marginally increasing in Kurutie during the dry season (0.62 mg/L). Sulphate and magnesium levels were consistently higher in Okerenkoko, while cadmium, nickel, and iron were detected in both stations, with Kurutie showing slightly higher levels for cadmium and iron. Aluminium, copper, lead, chromium, zinc, and cyanide were not detected (ND) in any of the samples.

Table 6: The mean physicochemical parameters studied in the different sampling stations

Parameters	Okerenkoko		Kurutie	
	Rainy Season	Dry Season	Rainy Season	Dry Season
Temperature (°C)	26.28 ± 0.04	30.13 ± 0.01	26.80 ± 0.02	30.19 ± 0.01
Turbidity (NTU)	2.39 ± 0.01	2.30 ± 0.02	2.40 ± 0.01	2.32 ± 0.03
pH	7.21 ± 0.02	7.26 ± 0.01	7.17 ± 0.01	7.14 ± 0.01
Electrical conductivity (µ/cm)	12464.00 ± 22.00	12491.00 ± 7.00	13821.50 ± 53.50	13894.00 ± 8.00
Total dissolved solid (mg/L)	8944.50 ± 20.50	8882.50 ± 9.50	9277.00 ± 12.00	9183.50 ± 47.50
Total Hardness (mg/L)	990.00 ± 4.00	975.00 ± 4.56	967.00 ± 2.16	954.00 ± 2.00
Total Alkalinity (mg/L)	240.00 ± 1.00	234.50 ± 1.50	218.50 ± 4.50	203.50 ± 2.50
Dissolved oxygen (mg/L)	4.40 ± 0.08	4.29 ± 0.02	4.32 ± 0.04	4.21 ± 0.02
Biological oxygen demand (mg/L)	5.39 ± 0.07	6.46 ± 0.12	2.98 ± 0.04	3.08 ± 0.40
Salinity (ppt)	5.23 ± 0.02	5.28 ± 0.02	4.82 ± 0.04	4.94 ± 0.02
Nitrate (mg/L)	2.41 ± 0.02	2.29 ± 0.03	2.15 ± 0.03	2.14 ± 0.02
Phosphate (mg/L)	0.57 ± 0.01	0.54 ± 0.01	0.60 ± 0.01	0.62 ± 0.01
Sulphate (mg/L)	171.50 ± 1.50	175.50 ± 2.50	160.00 ± 2.00	158.00 ± 1.00
Magnesium (mg/L)	855.00 ± 3.00	872.50 ± 3.50	795.00 ± 3.00	806.50 ± 5.50
Cadmium (mg/L)	0.10 ± 0.002	0.11 ± 0.001	0.13 ± 0.002	0.14 ± 0.002
Nickel (mg/L)	0.11 ± 0.002	0.11 ± 0.003	0.12 ± 0.003	0.12 ± 0.001
Iron (mg/L)	0.21 ± 0.004	0.20 ± 0.003	0.12 ± 0.004	0.13 ± 0.003
Aluminum (mg/L)	ND	ND	ND	ND
Copper (mg/L)	ND	ND	ND	ND
Lead (mg/L)	ND	ND	ND	ND
Chromium (mg/L)	ND	ND	ND	ND
Zinc (mg/L)	ND	ND	ND	ND
Cyanide (mg/L)	ND	ND	ND	ND

*ND: Not detected.

DISCUSSION

Fish-borne parasites constitute a category of food-borne zoonotic illnesses and are frequently endemic in specific geographical areas (Cong and Elsheikha, 2021). The findings of this study gives valuable insights into the parasitic fauna of *E. fimbriata* from the Escravos Estuary, highlighting potential zoonotic risks associated with consumption of infected fish. The condition factor (K), which is a reflection of the general well-being and fatness of fish showed values that were very close in Kurutie and Okerenkoko. The closeness of the mean values in the two sampling stations is an indication of the fact that in both communities, fish are in relatively similar physiological condition, which further suggests that environmental factors are also similar. According to Akamse amd Eyo (2018) and Eriegha and Eyo (2023), condition factor values ranging between 0.7 to 1.0 are generally indicates fish populations in healthy state. The observed means which were slightly below 0.8 in the two communities may reflect moderate fluctuations in environmental conditions or seasonal variations which may slightly affect fish condition. In this study, the occurrence of both endoparasites (nematodes) and ectoparasites (protozoans and monogeneans) signifies a complex parasitic structure associated with *E. fimbriata i*n the Escravos Estuary. Protozoan parasites such as protozoan cysts and *Trichodina sp.* Are ectoparasites which have monoxenous life cycles, and are commonly known to disrupt the health of fish by attaching to the gills and skin (Parpena, 1996). The detection of *Trichodina* sp. externally aligns with previous findings that this genus is a widespread ectoparasite in freshwater and estuarine fishes (Eyo and Effanga, 2018; Eyo *et al.,* 2025). *Gyrodactylus* sp. and *Dactylogyrus* sp. found in *E. fimbriata* are monogeneans and also ectoparasitic that have monoxenous life cycles, completing their developmental stages on a single host (Asuquo and Eyo, 2023). Their presence on *E. fimbriata* from the Escravos Estuary suggests a stable parasite–host interaction, as monogeneans usually exhibit host specificity and may be used as indicators of environmental conditions. In this study, endoparasites including *Contracaecum* sp. and *Camallanus* sp. which are nematodes with heteroxenous life cycles that requires intermediate hosts to complete their developmental stages, were identified. This is in line with their already documented biology, where they live in smaller fish or aquatic invertebrates as intermediate hosts before infecting the definitive fish host (Paperna, 1996; Ibor *et al.,* 2016; Effanga and Eyo, 2018). The existence of these nematodes reveals complicated trophic interactions within the estuary and suggests that *E. fimbriata* plays a function in the parasite life cycle as a definitive host. The range of parasite taxa and life cycles identified in *E. fimbriata* reflects the ecological complexity of the Escravos Estuary. The coexistence of monoxenous and heteroxenous parasites reflects a well-structured ecosystem with diverse trophic levels and habitat niches supporting parasite transmission (Dzikowski *et al.,* 2003). Moreover, the parasite assemblage can serve as bioindicators of environmental health, as changes in parasite diversity and prevalence often correspond with water quality and habitat variations (Scott, 2023; Ayodele, 2025). Out of 150 fish evaluated per sampling location, overall prevalence was slightly greater in Okerenkoko (7.33%) compared to Kurutie (6.00%). Although the prevalence of parasites recorded in this study is low, it may still be of concern, particularly for public health since it involves a zoonotic parasite. Correspondingly, the number of isolated parasites was higher in Okerenkoko (47) than in Kurutie (30), with mean intensity (MI) and mean abundance (MA) likewise lower in Kurutie (MI = 3.33, MA = 0.20) than in Okerenkoko (MI = 4.27, MA = 0.31). The significantly low prevalence of protozoan cysts compared to *Trichodina sp.* may imply differences in the response of the host immunity or tolerance to the environment. These data suggest that in Okerenkoko, the parasite burden is higher compared to Kurutie and this may be linked to several factors including the host population density, local environmental indices, or habitat metrics which favors parasite transmission (Santoro *et al.,* 2020). Irrespective the higher parasite burden in Okerenkoko, Kurutie had more parasite species variety that were distributed more evenly. This is indicated by higher values of Simpson's Index of Diversity (Kurutie – 0.65, Okerenkoko – 0.55), Shannon-Wiener index (Kurutie – 1.07, Okerenkoko – 0.93), Margalef's index (Kurutie – 0.59, Okerenkoko – 0.52), evenness (Kurutie – 0.98, Okerenkoko – 0.84), and equitability (Kurutie – 0.98, Okerenkoko – 0.86). Apart from the species richness, these indices also represent evenly distribution of individual species, demonstrating that the parasite community in Kurutie is more diversified and balanced (Dzikowski *et al.,* 2003). The higher dominance index (D) recorded for Okerenkoko (0.46) compared to Kurutie (0.35) shows that a few parasitic species dominate Okerenkoko, potentially lowering total diversity. This trend could indicate habitat degradation or environmental stressors that supports opportunistic or resistant parasite species, leading to diminished community evenness. Conversely, the more evenly and diverse parasite community in Kurutie may reflect a less disturbed and more stable environment that favors a greater range of parasite species and ecological interactions that are more complicated. The analysis of risk assessment for *E. fimbriata* in the Escravos Estuary suggests a moderately elevated risk of parasite infection, as shown by an odds ratio (OR) of 1.24 and a risk ratio (RR) of 1.22. Odd Ratio of 1.24 implies that the likelihood of parasite infection in the Estuary are 24% greater compared to a less exposed water body. Risk Ratio of 1.22 implies that fish in the Escravos Estuary suffer a 22% higher likelihood of infection than unexposed fishes. These metrics provide vital insights into the parasite-host dynamics within this estuary and also suggest a slightly increased likelihood and relative risk of parasitic infection among the examined fish population, indicating a moderate level of parasitic exposure within the estuarine environment. In this study, the notable differences between parasites prevalence in Kurutie and Okerenkoko could be attributed to several factors including water quality, which impacts parasite –host relationship. The water quality parameters in both Okerenkoko and Kurutie corresponds with typical estuarine system although, there were some notable fluctuations that may influence the prevalence of parasites. In Okerenkoko, the organic load was higher with BOD which translates to a higher organic pollution, with the tendency to favor intermediate hosts such as copepods for nematodes, elevating the transmission of parasite transmission. This finding corresponds to the higher prevalence and mean abundance observed in Okerenkoko compared to Kurutie Salinity and Conductivity also followed the same trend with higher values recorded in Okerenkoko compared to Kurutie which may favor parasites that adapt to salinity such as monogeneans, thereby supporting its higher prevalence (El-Naggar *et al.,* 2017). Metals including cadmium and iron were slightly higher in Kurutie than in Okerenkoko which may possibly expose the fish immunity to stress, potentially increasing susceptibility of the host, irrespective the lower organic load (Authman *et al.,* 2015). Temperature was approximately ~30°C in the dry-season in both stations, favoring parasite development in both stations, although, higher organic load in Okerenkoko amplified parasite prevalence **(**El-Naggar *et al.,* 2017).

CONCLUSION

Findings of this study demonstrates that *E. fimbriata* in the Escravos Estuary hosts a range of parasites with possible zoonotic concerns, especially in Okerenkoko where higher parasite prevalence is associated to increased organic pollution. In comparison, Kurutie showed increased parasite diversity and ecological equilibrium. Although the prevalence of parasites recorded in this study is low, it may still be of concern, particularly for public health, since it involves a zoonotic parasite. Overall, the findings underline the necessity for regular monitoring and careful fish handling, consumption of hygienically prepared fish and properly cooked fish to protect public health.

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AUTHORS CONTRIBUTION

VOE wrote the draft of the manuscript, designed the study and examined the fishes; OJE collected the fishes and water samples; AM collected and analysed the data. All authors approved the manuscript for submission.

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