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Occurrence of Parasites on African Mud Fish (*Clarias Gariepinus* Burchell, 1822) Reared in Different Scale of Operations Farming System in Lagos State, Nigeria

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ABSTRACT

Aquaculture is a potential contributor to food security, poverty alleviation and livelihood assurance. However, the positive impact is being challenge by negative factors amongst which infectious diseases is significant, causing severe loss annually. Therefore, necessitates the study of pathogenic infections to sustain fish farming in different culture systems. Fifty functional farms were randomly selected and purposively characterized into scale of operations (small, medium, large). Five fish species of respective developmental stage were harvested for parasitological examination. The organs examined were skin and gills (ectoparasites); intestine, liver and trunk kidney (endoparasites). Water parameters were monitored using standard procedures. The data obtained were analysed using descriptive, frequency, mean and bar charts. Infection rates were highest in medium scale hatcheries (63.64%) and large scale grow – out (100%) in rainy season. Fingerlings were mostly infected in both seasons. *Trichodina* sp and *Dactylogyrus* sp were highly prevalent across the culture systems in both seasons.

Key words:
Clarias gariepinus, *pathogenic infection, culture systems, sustainability*

Introduction

Aquaculture production is a fast-growing industry globally especially in Asia and Africa (IFAD, 2019) producing fish which is a high-value food that supports the nutritional needs of poor communities (Golden *et al*., 2016). In Nigeria with more than 200 million population (Pison, 2022), demand for fish is highly rising causing increase in development of peri – urban commercial aquaculture (Cai *et al.*, 2017). There are some fish species suitable for culture in Nigeria water environment (Adewumi, 2015) but *Clarias gariepinus* (Claridae) is the mostly acceptable culturable species (Froese & Pauly, 2014) which suitable attributes including easy adaptability to change in culture environment, feed acceptability, fast growth, good food conversion efficiency, high disease resistance and good rate of return on investment (Asa & Obinaju, 2014; Haylor, 1993). Several culture systems have been adopted in fish farming including water usage management (Okomoda *et al.*, 2016); intensive, semi – intensive and extensive (Offem *et al*., 2010; De Graaf & Janssen, 1996); integrated farming (Bolorunduro *et al*., 2013) and scale of operation by farm sizes (Yusuf *et al.*, 2002). Each culture system has its operational peculiarity, however most of the negative factors often manifest as disease attack that possibly stands against productivity which if earlier detected prevents further spread to safe production from losses.

Pathogenic infections are significant constraints to aquaculture production causing severe loss of revenue, public health risk and environmental distress. Parasites are characterized into protozoan (unicellular organism) and metazoans (multicellular organisms) (Bassey, 2011; Kayis *et al.*, 2009). The most common unicellular organisms in fish farming are ciliates, flagellates, microsporidians, and coccidians (Klinger & Francis-Floyd, 1998) while metazoans are monogeneans, digenean trematodes, nematodes, cestodes, acanthocephalans (NIOF, 2011) and myxozoans (Atkinsona *et al*., 2018). The effects of parasitic infections on the wild and cultured freshwater fishes can be direct (mortality) or indirect (morbidity) causing negative economic impact on production (Lagrue and Pouline, 2015). The severity of direct impact may be total loss (Meyer & Hoffman, 1974). Several researchers have reported their findings on parasitic infections in various fish species in the wild (Ejere *et al*., 2014) and culture systems (Okunade *et al.,* 2020). The culture environments are prone to severe disease outbreak compared to the natural environment, thereby necessitate more attention (Roberts, 2012). However, there was no epidemiological data on parasites from cultured *Clarias gariepinus* in scale of operation (small, medium, large) culture systems in Nigeria, thereby causing this study to identify the prevailing parasites and their infection rates in both seasons.

Materials and Methods

The study was carried out in Lagos State for the period of 18 months covering the rainy and dry season. The 3% of the functional farms were sampled across the three agricultural zone categorized by the Lagos State Agricultural Development Agency (LSADA). A multi – stage sampling technique was adopted. In the first stage, 50 functional farms were purposively selected based on fish farming efficiency. In the second stage, the farms were characterized into different scale of operations: small, medium and large based on annual productions (Okunade *et al*., 2023). The third stage involved random selection of 5 fish of same developmental stage from respective farm thereby making a total of 250 fish sampled per season. The water quality parameters were observed using Hanna digital probe (pH, temperature and Dissolved oxygen) while colorimeter kits for (ammonia, nitrite and iron). Standard procedure for water monitoring was adhered to according to (APHA, 1992). The data obtained using structured questionnaires were analysed using descriptive statistics such as frequency, percentage, mean and bar chart.

Table 1: Scale of operations in hatchery and grow – out fish farms per annum

Culture Systems	Production Capacity per annum	
	Hatchery (Numbers)	Grow out (tons)
Small Scale (SSP)	≤ 100,000	0.1 - 6
Medium Scale (MSP)	100,001 - 1,000,000	6.01 – 31.9
Large Scale (LSP)	≥ 1,000,000	≥ 32

Source: Okunade *et al*., 2023

Parasitological Analysis

The fish samples were collected with appropriate scoop nets into suitable plastic containers to the laboratory for parasitological examination. The skin and gills were examined for ectoparasites while intestine, liver and trunk kidney for endoparasites. The slime on the skin was scraped using cover slip and placed on a clean slide for microscopic view; the operculum case was raised and small portion of

the gill was incised with scissors and placed on clean slide for observation under the microscope (Noga, 2010). The abdominal cavity was cut opened to expose the visceral organ. The intestine was gently incised to reveal the content which was gently removed into a petri dish. The intestinal wall was carefully scraped with the cover slip unto a clean slide for microscopic view (Noga, 2010). The parasites were observed with the aid of scope photo attached to the computer device. The parasites were identified using the standard keys according to Lom & Dykova (1992) and Klinger & Floyd (1998). The prevalence of parasites was determine using the expression of Margolis e*t al* (1982).

$$\text{Prevalence of parasites} = \frac{\text{Number of fish infected}}{\text{Total number of fish examined}} \times 100$$

Results

The stocking density per cubic meter in each breeding/culture period per annum was presented in Table 2. The range of fish seeds in small scale hatchery were 112 – 3,750 with average being 1,880 fry/fingerlings while the medium scale hatcheries were 110 – 7,500 with average number per cycle per cubic meter stands at 3,337 fry/fingerlings. No hatchery operated on large scale basis at the time of this study. Moreover, the stocking density in small scale grow – out farms ranges between 6 – 198 fingerlings/juveniles with average of 41/m^3/cycle while medium scale (10 – 250; 64) and large scale (11 – 200; 78).

Table 2: The stocking density per cycle in hatchery and grow - out system of different culture Systems

Culture Systems	Production Capacity per annum		Stocking density/m3/cycle			
	Hatchery (Numbers)	Grow out (tons)	Hatchery Range	Average	Grow - out Range	Average
Small Scale (SSP)	≤ 100,000	0.1 - 6	112 -3,750	1,880	6 - 198	41
Medium Scale (MSP)	100,001 - 1,000,000	6.01 – 31.9	110 -7,500	3,337	10 - 250	64
Large Scale (LSP)	≥ 1,000,000	≥ 32	Nil	Nil	11 - 200	78

In rainy season, farms were operated mostly in medium scale (60%) followed by small scale (34%) whereas in dry season, small scale were mostly operated by farmers (42%) followed by medium scale (38%). Surprisingly, more farms operated large scale grow – out production in dry season (20%) compared to 6% in rainy season. In rainy season, 60% of the farms sampled operated medium scale with hatchery (22%) while grow – out 38% unlike dry season with most hatcheries on medium scale (12%) while most farmers (34%) operated on small scale mode (Table 3). Furthermore, infection rate was highest in medium scale hatcheries during rainy season (63.64%) and dry season (84.62%) with

similar trend of 100% and 90% in large scale grow – out farms respectively (Figure 1). Across the season, hatchery recorded the least of 50% infection rate each in small scale and medium scale farms. No farmer found operating large scale hatchery as at the time of this study. The least infection rate recorded in grow out was in medium scale farm during the rainy season (10.53%).

Table 3: Frequency of farms sampled with different scales of fish farming in Lagos State

Scale of operations	Rainy Season					Dry Season				
	TFS	Hatchery		Grow - out		TFS	Hatchery		Grow - out	
		TNS	%	TNS	%		TNS	%	TNS	%
Small Scale	17	2	4	15	30	21	4	8	17	34
Medium Scale	30	11	22	19	38	19	6	12	13	26
Large Scale	3	0	0	3	6	10	0	0	10	20

TFS – Total Farms Sampled; TNS – Total Number Sampled; % - Percentage

Seasonal rate of infection revealed that fingerlings were highly infected in the rainy season in small scale (80%) and medium scale (43.33%) followed by fry (50%) and juveniles (33.33%) respectively (Figure 2). The juveniles and adults in large scale farms were evenly infected at 20% infection rate. However, in dry season, the highest rates of infection were recorded on juveniles in small scale farms (58%), both fingerlings (40%) and adults (40%) in medium scale farms while fingerlings 66.67% in large scale farms. No records were obtained for fry in both seasons.

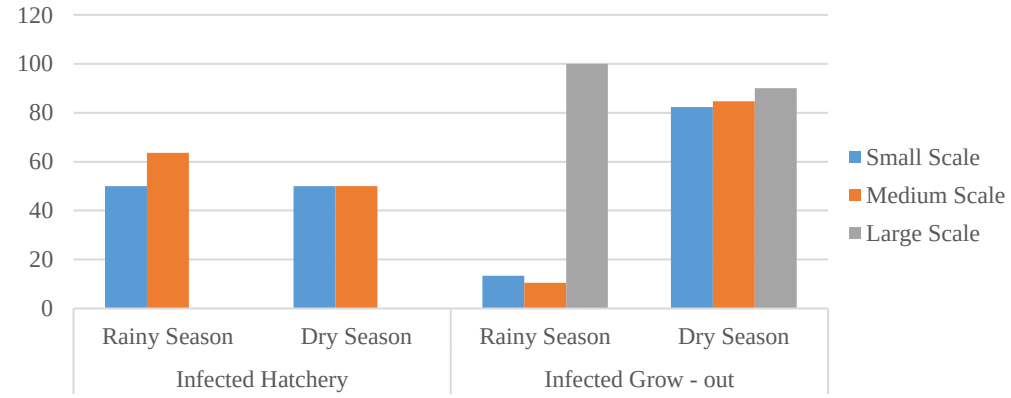

Figure 1: Seasonal rate of infected farms of the sampled sites

The rate of infected fish was highest in small scale (44.71%) during the rainy season (Table 4) and large scale (58%) in dry season (Table 5). The gills were mostly infected during the rainy season across the culture systems with small scale (81.58%), medium scale (74.51%) an large scale (33.33%) whereas both the skin (80.95%, 79.31%) and the gills (80.95%, 79.31%) were evenly infected in small and large scale respectively while highest infected site on fish reared in medium scale was recorded on the skin (66.67%). No parasitic infection was noticed on the liver and trunk kidney of *Clarias gariepinus* reared under different culture systems.

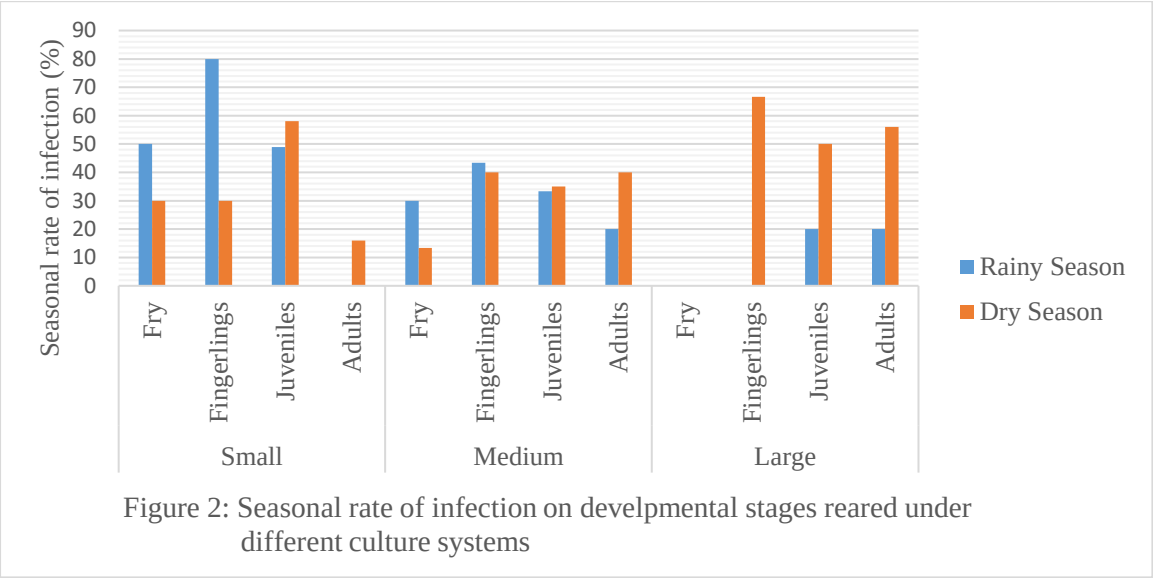

Figure 2: Seasonal rate of infection on develpmental stages reared under different culture systems

Table 4: Prevalence of parasitic infection on predilection sites of *Clarias gariepinus* reared in different scale of operations in rainy season

Scale of operation	Total Number of fish examined	Numbers of infected fish	Percentage of infected fish	Rate of infection at predilection site (%)				
				Skin	Gills	Intestine	Liver	Trunk Kidney
Small	85	38	44.71	36.84	81.58	5.26	0	0
Medium	150	51	34	78.43	74.51	5.88	0	0
Large	15	3	20	16.67	33.33	0	0	0

Table 5: Prevalence of parasitic infection on predilection sites of *Clarias gariepinus* reared in different scale of operations in dry season

Scale of operation	Total Number of fish examined	Numbers of infected fish	Percentage of infected fish	Rate of infection at predilection site (%)				
				Skin	Gills	Intestine	Liver	Trunk Kidney
Small	105	42	40	80.95	80.95	4.76	0	0
Medium	95	33	34.74	66.67	57.58	3.03	0	0
Large	50	29	58	79.31	79.31	6.9	0	0

The most prevalent parasite in small scale fish farms sampled was *Dactylogyrus* spp (63.16%) during the rainy season and both *Dactylogyrus* spp (64.29%) and *Trichodina* spp (64.29%) in dry season (Table 6). The least parasites were both *Tetrahymena* spp (2.63%) and *Argulus* spp (2.63%) in rainy season while *Ichthyobodo* spp in dry season (2.38%). In medium scale farms, *Trichodina* spp were mostly prevalent in both rainy (58.82%) and dry (57.58%) seasons whereas, the least infection rates were both *Gyrodactylus* spp (5.88%) and *Ambiphyra* spp (5.88%) in rainy season but *Tetrahymena* spp (3.03%) in dry season. *Dactylogyrus* spp (55.17%) and *Trichodina* spp (51.72%) frequently infected the fish reared in large scale farms during the dry season while the parasitic invasion during the rainy season were similar with even rate of attack of 33.33% for *Trichodina* spp, *Dactylogyrus* spp and *Chilodonella* spp respectively.

Table 6: Seasonal prevalence of individual parasites on *Clarias gariepinus* reared in different scale of operation system of farming

	Small Scale		Medium Scale		Large Scale	
Parasites	Rainy	Dry	Rainy	Dry	Rainy	Dry
Trichodina spp	31.58	64.29	58.82	57.58	33.33	51.72
Vorticella spp	13.16	16.67	9.8	36.36	0	24.14
Dactylogyrus spp	63.16	64.29	56.86	45.45	33.33	55.17
Gyrodactylus spp	0	11.9	5.88	0	0	20.69
Tetrahymena spp	2.63	4.76	0	3.03	0	0
Chilodonella spp	0	7.14	0	6.06	33.33	6.9
Ichthyobodo spp	0	2.38	0	6.06	0	3.45
Piscinoodinum spp	0	4.76	0	0	0	3.45
Ambiphyra spp	0	0	5.88	0	0	0
Argulus spp	2.63	0	0	0	0	0
Suspected Nematodes	5.26	0	0	0	0	0

The water quality recorded were pH, water temperature, dissolved oxygen, ammonia, nitrite and iron across the scale of operation (Table 7) showing seasonal values of parameters in small scale ranging from 6.66 ± 0.85 – 7.10 ±0.43; 29.58 ± 1.56 - 31.55 ± 2.70; 5.27 ± 2.65 - 5.59 ± 6.78; 2.16 ± 0.99 - 2.44 ± 0.70; 0.56 ± 0.21 - 0.71 ± 0.66; 0.82 ± 1.20 - 1.24 ± 0.55; medium scale (6.86 ± 0.80 - 6.91 ± 0.34; 29.21 ± 2.07 - 32.00 ± 2.42; 4.45 ± 3.36 - 4.85 ± 3.81; 2.20 ± 1.01 - 2.33 ± 0.86; 0.69 ± 0.80 - 0.69 ± 0.80; 0.69 ± 0.80 - 0.69 ± 0.74 and large scale 7.00 ± 0.22 - 7.89 ± 1.29; 29.43 ± 0.38 - 33.02 ± 4.38;

7.76 ± 4.71 - 8.65 ± 3.62; 2.65 ± 0.45 - 2.87 ± 0.06; 0.58 ± 0.04 - 1.51 ± 1.81; 0.37 ± 0.32 - 0.80 ± 1.02 respectively.

Table 7: Seasonal Mean Water Quality Parameter in different culture systems of fish farming in Lagos state

Culture Systems	Seasons	Water Parameters											
		pH		Water temp. (°C)		DO (mgl^{-1})		NH_3 (mgl^{-1})		NO_2 (mgl^{-1})		Iron (mgl^{-1})	
Small Scale	Rainy	7.10 ± 0.43		29.58 ± 1.56		5.27 ± 2.65		2.16 ± 0.99		0.56 ± 0.21		1.24 ± 0.55	
	Dry	6.66 ± 0.85		31.55 ± 2.70		5.59 ± 6.78		2.44 ± 0.70		0.71 ± 0.66		0.82 ± 1.20	
Medium Scale	Rainy	6.91 ± 0.34		29.21 ± 2.07		4.45 ± 3.36		2.20 ± 1.01		0.69 ± 0.80		0.69 ± 0.74	
	Dry	6.86 ± 0.80		32.00 ± 2.42		4.85 ± 3.81		2.33 ± 0.86		1.05 ± 1.10		0.39 ± 0.87	
Large Scale	Rainy	7.00 ± 0.22		29.43 ± 0.38		8.65 ± 3.62		2.87 ± 0.06		1.51 ± 1.81		0.37 ± 0.32	
	Dry	7.89 ± 1.29		33.02 ± 4.38		7.76 ± 4.71		2.65 ± 0.45		0.58 ± 0.04		0.80 ± 1.02	

Discussion

The protozoan group were mostly recorded in all the scale of operations (small, medium and large) culture systems compared to monogeneans (*Dactylogyrus* sp and *Gyrodactylus* sp) and crustacean (*Argulus* sp) unlike helminths that were reportedly found predominantly on different culture fish species in Africa (Paperna 1996; Hecht & Endemann 1998). The most prevalent parasite across the culture system was *Trichodina* sp which agreed with the report of Banu & Khan (2004) and Kolia *et al* (2021). This could be influenced by the life cycle of *Trichodina* sp in which the binary fission at cleavage divide speedily at every ½ hour and easily transmit through the water especially when having direct contact with infected fishes (Indahsari *et al*., 2019). Afifah *et al* (2014) reported that parasites found on the body surface of the fish can be as a result of fish having direct contact with the environment.

The skin and the gills of sampled fish were highly infected in all the culture systems in this study probably agreed with the suggestions that these organs secrete more mucous at chronic, sub – lethal level of infection that may enrich trichodinid and monogenean rates of infection (Khan & Kiceniuk 1988; MacKenzie *et al.* 1995). Skin infestation may be due to its direct contact with the fish environment. Gills were also highly infected across the culture systems which could be associated to its importance as organ of feed filtration and respiration. This observation agrees with the report of highest prevalence of protozoans on the gills of *Synodontis clarias* (Emere & Egbe, 2006) and *Oreochromis niloticus* (Nyaku *et al*., 2007). More so, gills were reported to possibly contribute to parasites retention by the gill raker apparatus when foods are sieved (Somerville, 1984). The intestine recorded few parasites mostly protozoans unlike helminthes which were predominantly reported in gastro-intestinal

sites of various fish species (Auta *et al*. 2019; Ejere *et al.*, 2014) probably because culture environment do not provide the necessary biotic and abiotic conditions for helminthes propagation.
Trichodina sp and *Dactylogyrus* sp were highly prevalent in both season which was partly supported with high prevalence of *Trichodina* sp (84%) and contrary to *Dactylogyrus* (7%) recorded on *Cyprinus carpio* (Prasetya & Sri, 2013). Medium scale hatcheries recorded highest infection likewise large scale grow – out farms during the rainy season which agreed to Arguedas *et al* (2017) report with higher prevalence in rainy season but contrary to Kolia *et al* (2021) in dry season. Moreover, prevalence of parasites could be higher in low stocking density (Indahsari *et al*., 2019) or high stocking density (Bwoga *et al*., 2021; Zaki *et al*.,2020) which reported to depend on parasites life cycles (Choisy *et al.* 2003) and rate of interactions between the environment, fish and the parasitic pathogens (Indahsari *et al*., 2019) Fingerlings were mostly infected in rainy season (small scale) and dry season (large scale) which could be associated with stress probably during transfer from one culture facility to another or poor handling during sorting.

Conclusion

The major parasites found on *Clarias gariepinus* reared in small, medium and large scale culture systems were protozoans with preference for the skin and gills. The negative implications if not adequately treated can cause damage to fish organs especially the skin and gills, reduce the quality and market value which may eventually result to economic losses to the farmers. This study showed the prevalence of parasites existence in culture systems in order to take precautionary measure to best aquaculture management as well as prophylactic treatment to prevent or reduce possible attack of the fish from parasitic pathogens which often be a portal entry to secondary infections.

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