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Full Length Research Paper

Copepoda parasites in economically important fish, Mugilidae (*Mugil cephalus* and *Liza falcipinnis* from Lac Nokoue Lagoon in Republic of Benin, West Africa

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Fish parasitology is an indispensable tool in aquatic health studies and a basic understanding of richness of a community parasitism in many localities is essential for instituting control. Many copepod parasites are ecto-parasites which negatively affect the appearance and reduced production of species of economically important fish, both from the wild and fish farms, thus making them difficult to market. In this study, copepod parasitic investigation was carried out in gills of 856 fish mugilidae (*Mugil cephalus* and *Liza falcipinnis*) in three stations (Ganvie, Djdje and Zogbo) of Lac Nokoue lagoon. In the three stations, three species of parasitic copepod were found: *Nipergasilus bora, Ergasilus latus* and *Ergasilus lizae*. The highest total percentage copepod prevalence was found in Ganvie (86.23%) and the least in Djdje (63.14%). There is significant difference (P<0.05) in the rate of infestation of *L. falcipinnis* at Djdje than the other two stations, where as *M. cephalus* shows no significant difference in the rate of infestation in the three stations. The research reveals higher number of parasite copepods during the rainy season.

Key words: Copepod parasites, Mugilidae fish, Lac Nokoue Lagoon.

INTRODUCTION

Even though spawning can be induced on an environmental basis, mullet farming still depends on fry or fingerlings stocked from natural water. This fact combined with behaviour of mullets, promotes disease including parasite infestation (Paperna and Overstreet, 1981). This results in constant dissemination of disease-causing agent between cultured and natural population of mullet. Transmission can occur through water and intermediate host. Thus there is need for comprehensive study of parasites from natural stocks.

Lake Nokoue is the largest coastal lagoons and the most productive brackish water body in Republic of Benin (Laleye and Moreau, 2004). Lake Nokoue was formally a lake until 1185 when it was artificially linked with the ocean through a channel (Lang and Paradis, 1977). Majority of fish production (fish mugilidae inclusive) come

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from the lagoon (Laleye et al., 2003; Niyonkuru et al., 2010).

The Ganvie area is located near the floating village of Ganvie, where the water is characterised by a high level of organic pollution (Niyonkuru et al., 2003). The fishing technique used by the fishermen from whom samples were obtained included gill nets, cast nets and acadjas (a traditional fish harvesting system using nets to encircle man-made brush packs of branches placed in the lagoon (Gnohossou et al., 2009).

Fish mugilidae are economically important and are important food fishes. The euryhalinity, eurythermality and their simple diet as well as their rapid growth, have made them the object of aquaculture in many parts of the world (Oren, 1981). In Republic of Benin, these *(Mugil cephalus* and *Liza falcipinnis*) constitute important proportion of catches by artisanal or subsistence fishermen (Laleye et al., 2003; Gnohossou, 2009). They are of economic importance to the country.

Parasites have recently been highlighted as serious pathogenic problems in cultured mullet fish in marine and brackish water. Among the parasites, copepode family is commonly found on fishes cultured in brackish water (Noor El- Deen et al., 2012), and therefore a threat to the developing industry of finfish mariculture (Ru¨ckert et al., 2008).

Copepods are aquatic crustaceans which are diverse and are the most numerous metazoans in the water community with habitats ranging from fresh water to hypersaline conditions. Some copepods parasites of fishes all over the world may cause lesions that negatively affect the fisheries and aquaculture economies (Barreiro and Francnete, 2003).

Some studies have been carried out to discover the richness of community parasitic in many localities (Poulen and Rode, 1997; Sures and Street, 2001; Kimpela et al., 2006; Boualleg et al., 2011)

In Republic of Benin, many researchers have worked on parasites of fish (Doussou, 1985; Sakiti et al., 1991; Sakiti, 1997; Gbankoto et al., 2003) but no work has been carried out on parasites of mugilidae fish in Repulic of Benin.

The objective of this study is to determine copepod parasites in economically important fish *Mugil cephalus* and *Liza falcipinnis* in some major fishing areas of the largest fishing lagoon in Republic of Benin.

In determining the copepods parasite species of this world economically important fish with high commercial and environmental attributes will provide better culture condition for them, especially in mariculture. This will also help to solve some of the problems of fish diseases that can perturb their health and productivity, both in the wild and fish culture.

MATERIALS AND METHODS

The study site, Lake Nokoue (Figure 1) is the largest lagoon (Moreau, 2004), is a shallow, sub-tropical coastal lagoon (6°25N, 2°36E) (Table 8) with surface of 150 km and stretches 20 km in its east-west direction by 11 km in the north-south direction (Laleye et al., 2003). Lake Nokoue opens directly into the Atlantic Ocean through channel at cotonou which is about 24.5 km long.

For the purpose of this study, three stations were considered as sampling areas within the lagoon: Ganvie, Djdje and Zogbo (Figure 1). The Ganvie area is located at the northern part of the lake Nokoue lagoon, near the floating village of Ganvie where the water is characterised by a high level of organic pollution (Laleye et al., 2003). The Djdje and Zogbo areas are located at the southern part of the lake and are partly influenced by Atlantic Ocean waters. Sampling was carried out at each station both in the dry (December-March, 2011) and the rainy season (April-July, 2012).

Collection and analysis of water samples

Water samples were collected with 1 dm 3 water samplers and stored in 1 L water bottles and analysed in the laboratory for pH, conductivity, salinity and turbidity using a multi-meter water checker (Horiba U- 12). Water sample was collected in 250 ml dissolved oxygen bottle and fixed with Winkler solution at each station. This was followed by dissolved oxygen estimation using Iodometric Winkler's method. Water temperature was measured *in situ* using mercury-in-glass thermometers.

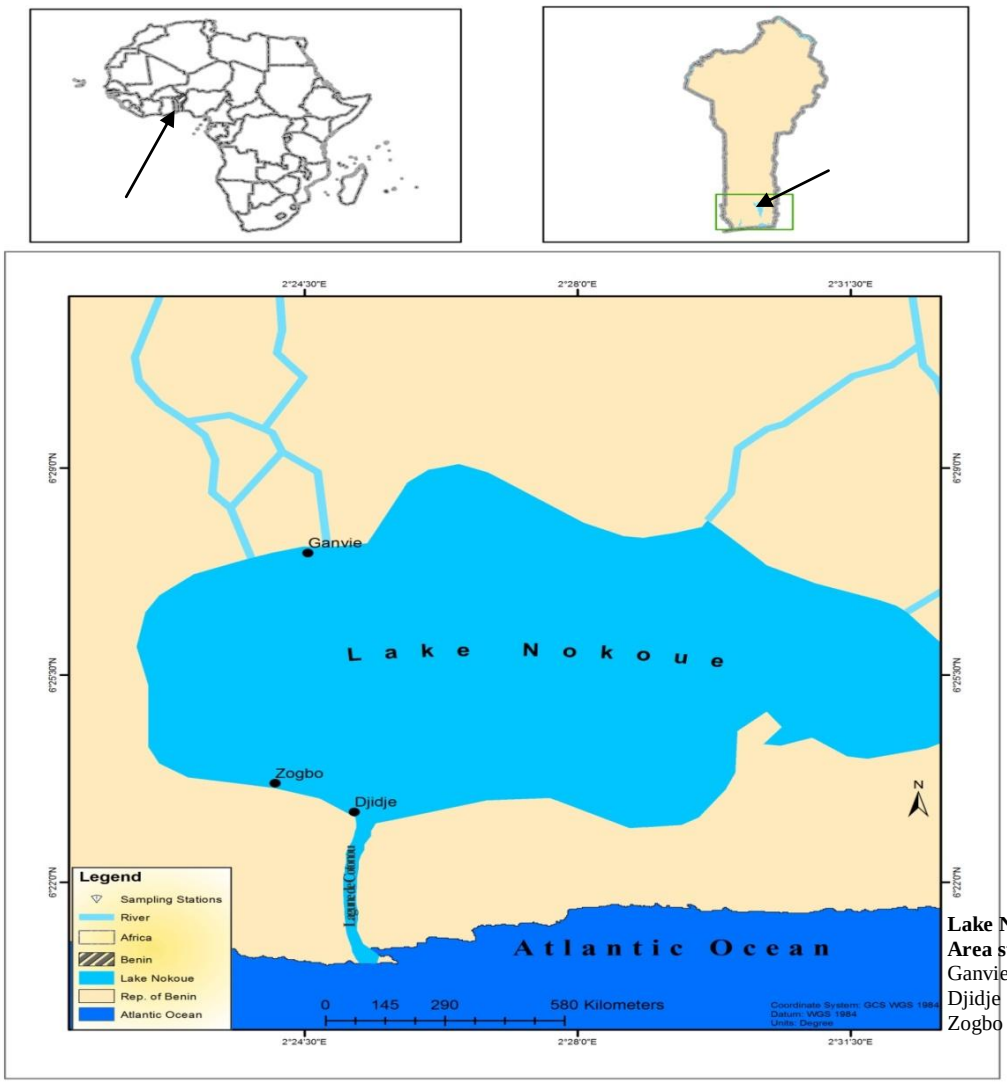
Sampling of the fish specimen and parasitological examination

M. cephalus and *L. falcipinnis* from the three stations were obtained by the assistance of fishermen. A total number of 856 fish specimen, *M. cephalus* and *L. falcipinnis* were examined for copepods parasites. In Station 1 (Ganvie) number of fish examined was (MC - 115, L.F - 132), in Station 2 (Djdje) it was (MC - 181, LF - 226) and station 3 (Zogbo) it was (MC - 96 and LF - 106). The collected fish were transported in ice boxes to the laboratory and examined for parasites. The weight of the fish were taken using digital weighing balance and recorded. The standard length (SL), the total length (TL) and the fork length (FL.) were measured with the aid of meter rule.

After dissection, stereo-microscopic observation was made on gills, for the presence of copepod parasites. Checking of prepared slides for parasites for better observation was carried out using light microscope. The standard length (SL), the total length (TL) and the fork length (FL) were measured with the aid of meter rule. The host species was identified using Fisher et al. (1987). The standard length (SL), the total length (TL) and the fork length (FL) were measured with the aid of meter rule. The host species was identified using Fisher et al. (1987). Collected copepods were fixed and preserved in ethanol (70%). Copepods on gills were studied using stereo and light microscopy. Parasites species identification was based on morphological features according to Yamaguti (1963), Vassiliades, (1975), Kabata (1979) (Skryabin et al., 1982), Ben-Hasseine (1983), Kabré (1997), Kabre et al. (1997), Ho and Kim (2004) and Moravec (2007).

Data analysis

The parasitological terms follow Bush et al. (1997): prevalence (P)



Lake Nokoue area

Area stations	Longitude	Latitude
Ganvie	20 24'32.615"E	6027'33.77"N
Djidje	20 25'8.393"E	6023'11.077"N
Zogbo	20 24'7.512"E	6023'40.162"N

Figure 1. Location of Lake Nokoue showing fish sampling stations.

is the number of fish infected with one or more individuals of a particular parasite species (or taxonomic group) divided by the number of hosts examined (expressed as a percentage):

$$Prevalence = \frac{No\ of\ hosts\ \text{inf}\ ested}{No\ of\ hosts\ exa\ \text{min}\ ed} X\ 100$$

Intensity (of infection, I) is the number of individuals of a particular parasite species in a single infected host (expressed as a numerical range); mean intensity (of infection, mI) is the average intensity, or the total number of parasites of a particular species found in a sample divided by the number of infected hosts:

$$\text{Mean intensity} = \frac{Total\ number\ of\ a\ particular\ parasite}{Number\ of\ \text{inf}\ ected\ hosts}$$

ANOVA test, using statistical software (SPSS) was also done on MC and LF to know the significant difference of copepod parasites infestation in each station.

RESULTS

Physicochemical parameters of the study area

The physicochemical parameters recorded at the three stations during rainy and dry seasons are presented in Table 1. Both in the rainy and dry season, the salinity levels were lowest in station 1 (Ganvie) with 0 and 11.4 parts per thousand, but highest in station 2 (Djdje) with 0.8 and 29.5 parts per thousand salinity levels respectively. The highest salinity recorded at Djdje is because of its proximity to the sea. The lowest salinity value obtained

Table 1. Spatial and seasonal distributions of the physico-chemical parameters in some parts of Lake Nokoue.

Station	WT (°C)		PH		Cond. (mScm^{-1})		Turb. (NTU)		Sal. (ppt)		DO (Mg/l)	
	RS	DS	RS	DS	RS	DS	RS	DS	RS	DS	RS	DS
Ganvie	29	28	8.1	8.5	0.18	19.5	78	10	0	11.4	11.2	8.0
Djdje	29	27	8.9	8.0	1.0	46.5	366	10	0.8	29.5	13.6	13.2
Zogbo	28	28.5	9.0	8.1	0.8	45.8	126	10	0.5	27	18.4	8.4

WT: Water temperature; Cond: conductivity; Turb: turbidity; Sal.: salinity; DO: dissolved oxygen; RS: rainy season; DS: dry season.

Table 2. Copepods for eight months in Benin.

Month	La Ganvie		Djdje		Zogbo		
	M.C	L.F	M.C	L.F	M.C	L.F	
Dec	7	19	10	26	10	11	
Jan	18	10	16	29	9	18	
Feb	14	22	12	28	10	5	
Mar	5	8	8	19	11	17	
Apr	16	20	7	18	6	10	
May	11	13	13	20	7	7	
June	10	11	16	15	13	13	
July	12	17	14	6	10	10	
Total	93	120	96	161	76	91	637

M.C*: M. cephalus,* L.F: *L. falcipinnis*.

Table 3. Percentage fish infested and percentage parasite prevalence in Benin.

Location	No. of fish examined		Total	No. of infested fish		Number of fishes infested (%)	No. of copepod parasite		Parasite prevalence (%)		Total parasite prevalence (%)
	MC	L.F		M.C	L.F		M.C	L.F	M.C	L.F	
Ganvie	115	132	247	90	110	80.97	93	120	43.66	56.34	86.23
Djdje	181	226	407	150	201	86.24	96	161	37.35	62.65	63.14
Zogbo	96	106	202	71	89	79.21	76	91	45.51	54.49	82.67
Total	392	464	856	311	400	246.42	265	372	126.52	173.48	232.04

can be explained by the proximity of the So River to the station (Laleye et al., 2003).

Generally low conductivity levels were recorded from all stations during rainy season, whereas relatively high levels which ranged from 19.5 mScm^{-1} in station 1 to 46.5 mScm^{-1} at station 2 were obtained in the dry season (Table 1). On the other hand, every station had higher turbidity, pH and DO levels during rainy than dry season (Table 1).

A total number of 637 copepods parasites were found in the three stations (Table 2): station 1 (MC- 93, LF - 120), station 2 (MC-96, Lf - 161 and station 3 (MC 76, L F- 91). Total % copepod prevalence was highest in Ganvie 86.23% followed by Zogbo (82.67%) and Djdje with 63.14% (Table 3).In all the three stations Liza falcipinnes (LF) has the highest percentage copepods parasite infestation. Station 1(MC-43.66%, LF-56.34%), Station2(MC-37.35%, LF-62.65%) and the third station (MC-45.51, L F-54.49).

In all the three stations, percentage of copepod para-

Table 4. Prevalence rate of copepod during dry and rainy season.

Season	Location	No of fish examined		No of copepods		Parasite prevalence (%)		Total parasite prevalence (%)
		M.C	L.F	M.C	L.F	M.C	L.F	
Dry	Ganvie	63	71	44	59	0.4272	0.5728	0.7687
	Djide	92	114	46	102	0.3108	0.6892	0.7185
	Zogbo	49	53	40	51	0.4396	0.5604	0.8922
Rainy	Ganvie	52	61	49	61	0.4455	0.5545	0.9735
	Djije	89	112	50	59	0.4587	0.5413	0.9732
	Zogbo	47	53	36	76	0.4737	0.5263	0.6184

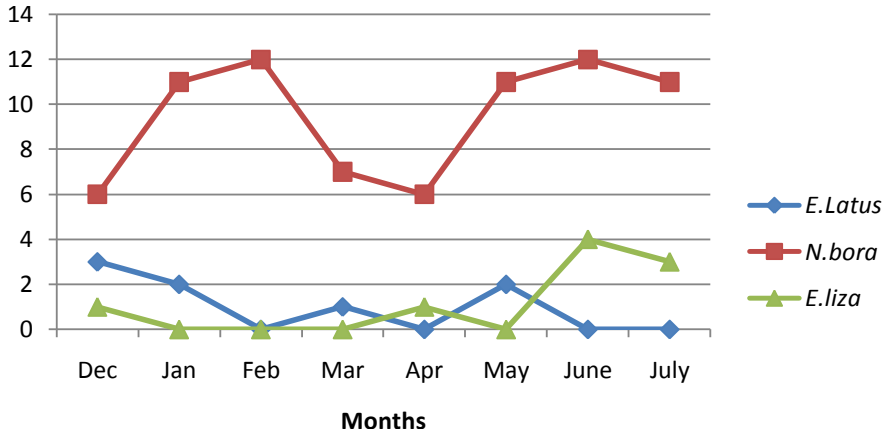


Figure 2. M.C copepod species at Djdje.

sites prevalence was much higher in *L. falcipinnis* than in *M. Cephalus*: In Ganvie (MC 43.66%, LF 56.34%), Djide (MC 37.35%), (LF 62.35%) and in Zogbo (MC 45.51%, LF 54.49%). Total percentage copepod parasites was highest in Ganvie (86.23%) and least in Djidje (63.14%) (Table 3).

Further analysis was carried out to investigate the prevalence rate of copepods during dry and raining season (Table 4). The prevalence rate during dry season; shows Ganvie (0.769), Djide (0.719) and Zogbo (0.892). The prevalence rate during the rainy season is Ganvie (0.974), Djide (0.973) and Zogbo (0.618). It is clearly shown in the analysis that the prevalence rate is higher in the rainy season than dry season. Zogbo shows highest percentage of parasite prevalence during dry season, while Ganvie shows highest copepod parasite prevalence during rainy season.

Figures 2 to 7 shows graphs of parasitic copepod species (*E. latus*, *N. bora* and *E. lizae*) found in both LF and MC in all the stations.

In Ganvie, *N. bora* shows the highest percentage prevalence both in the dry season and rainy season in both (MC 9.813%, LF 16.822%) and (MC 16.355, LF 28.972) (Table 5). Also in Djdje, *N. boras* shows highest percentage prevalence in dry season (MC 14.173, LF 21.2598) and at rainy season (MC 15.148, LF, 38.189 (Table 6), the same in Zogbo, *N. bora* also shows highest percentage rate both in the dry season MC (19.162 and LF, 15.569), and in rainy season (MC 16.767% and LF, 28.7437%) (Table 7).

DISCUSSION

Generally low conductivity levels were recorded from all stations during rainy season, whereas relatively high levels which ranged from 19.5 $mScm^{-1}$ in station 1 to 46.5 $mScm^{-1}$ in station 2 were obtained in the dry season (Table 1). On the other hand, every station had higher turbidity, pH and DO levels during rainy season than dry season (Table 1). This report coincides with that of Yakub et al. (2011).

Copepod parasites are common on fish hosts in

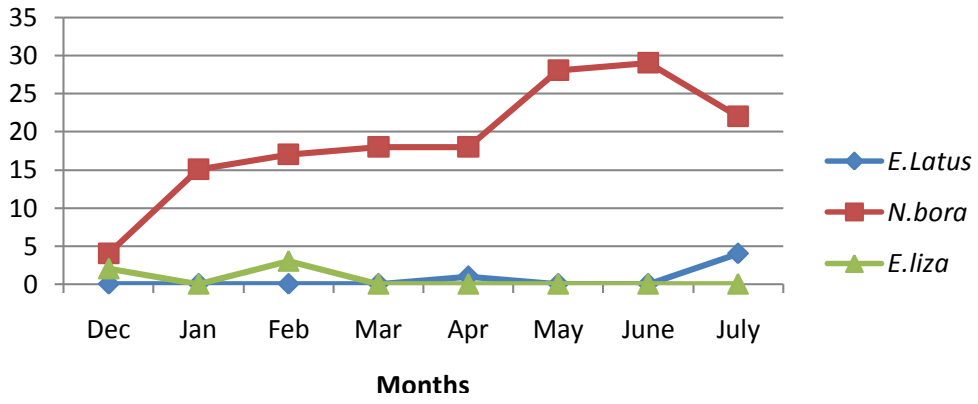


Figure 3. L.F copepod species at Djidje.

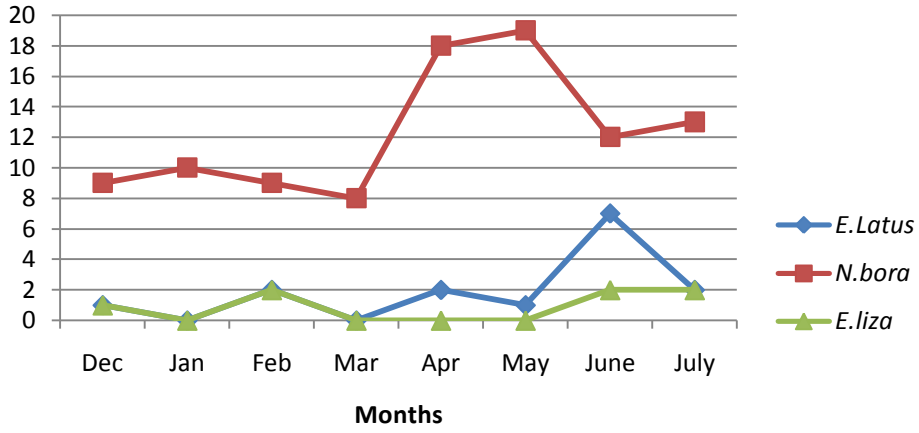


Figure 4. L.F copepod species at Ganvie.

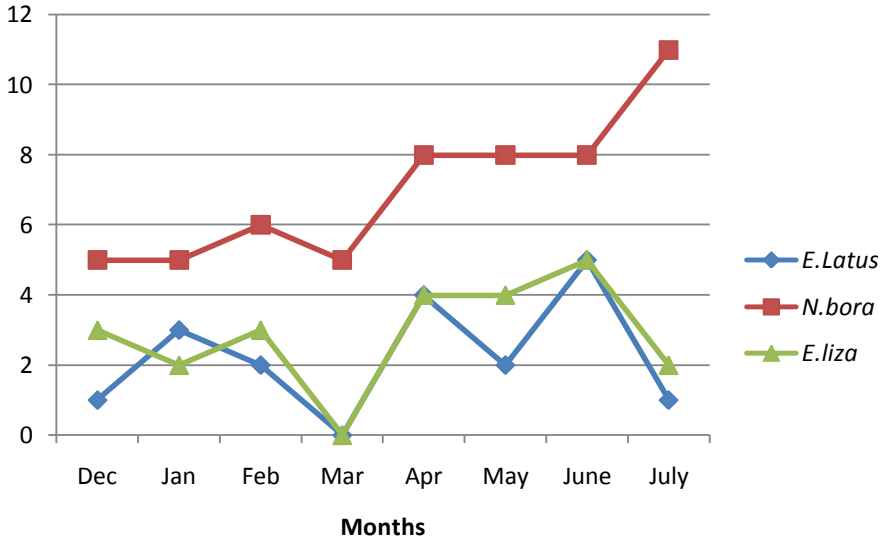


Figure 5. M.C copepod species at Ganvie.

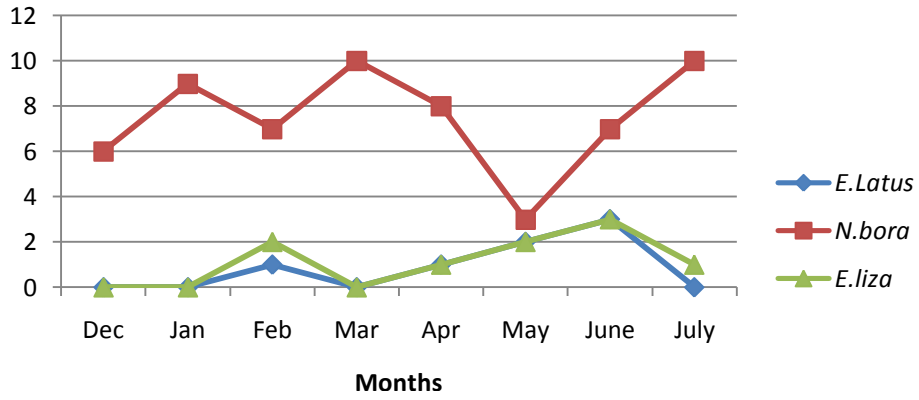


Figure 6. M.C copepod species at Zogbo.

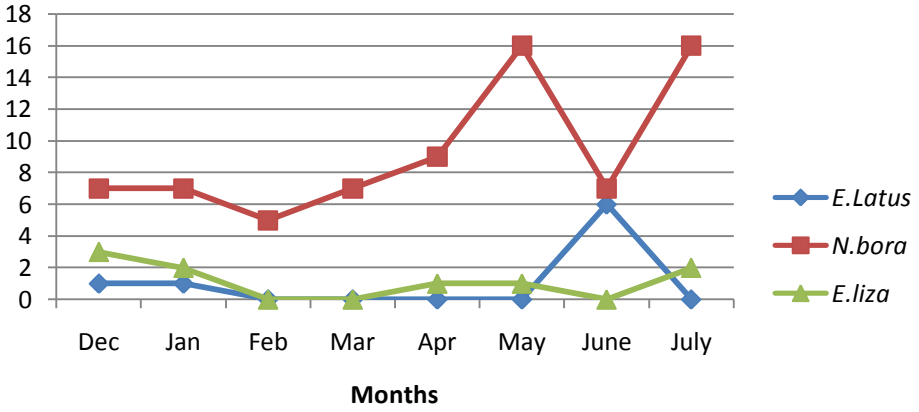


Figure 7. L.F copepod species at Zogbo.

Table 5. Prevalence rate of copepod species of Ganvie.

Ganvie	*E. latus*	*N. bora*	*E. lizae*	*E. Latus*	*N. bora*	*E. lizae*
	MC	MC	MC	LF	LF	LF
Dry	2.804	9.813	2.336	1.402	16.822	1.402
Rain	5.607	16.355	7.009	5.607	28.972	1.869

Table 6. Prevalence rate of copepods species of Djdje.

Djdje	*E. latus*	*N. bora*	*E. liza*	*E. latus*	*N. bora*	*E. liza*
	MC	MC	MC	LF	LF	LF
Dry	2.362	14.173	0.394	0	21.260	1.969
Rain	0.788	15.748	3.150	1.969	38.189	0

coastal, marine and brackish waters (Vinoth et al., 2010; Noor El - Deen et al., 2012). According to Vinoth et al., 2010 Infestation can result in serious loss and damage of gill rakers and gill lamella which hinders respiration and

Table 7. Prevalence rate of copepods species of Zogbo.

Zogbo	*E. latus*	*N. bora*	*E. liza*	*E. latus*	*N. bora*	*E. liza*
	MC	MC	MC	LF	LF	LF
Dry	0.599	19.162	1.198	1.198	15.569	2.994
Rain	3.593	16.767	4.192	3.593	28.742	2.400

N. bora: *Nipergasilus bora, E. latus: Ergasilus latus* and *E. lizae*: *Ergasilus lizae*.

Table 8. Geographical coordinate of sampling stations

Lake Nokoue area		
Area stations	**Longitude**	**Latitude**
Ganvie	2° 24'32.615"E	6°27'33.77"N
Djidje	2° 25'8.393"E	6°23'11.077"N
Zogbo	2° 24'7.512"E	6°23'40.162"N

and eventually result in the death of fish and significant economic loss. In his work he also reported maximum copepoda parasite infestation was noticed in *M. cephalus* and *Lates calcarifer* (P. Vinnobaba 2007). The result of this work agrees with that of Barreiro and Fancinete, (2003), who worked on parasite copepod from fishes of Santa Cruz Channel and Suape area of Pernathatmbico, Brazil. He discovered that, 66% family mugilidae were infested with copepod parasite

The highest total percentage copepod parasites recorded in Ganvie might have been caused by organic pollution resulting from the human settlement. Aladetohun et al. (2013, awating publication), in a similar work on copepod parasites of these species of mugilidae fish from Lagos lagoon, Nigeria also shows that ,*Liza falcipinnis* had more copepod parasites than *Mugil cephalus.*

In this work, *genuss Nipergasilus bora* copepods had the highest frequency of occurrence and relative abundance than genus ergasilus. This agrees with Morella and Garippa (2001) in his work on parasites of grey mullets from Mistras lagoon, Western meditarranean, also reported Caligus apolus and Nipergasilus bora to be the most prevalent crustaceans.

Ben-Hassin (1983) in his work on copepod parasites of mugilidae from the meditarrranean of France and Tunisia, reported *Nipergasilus bora.* Although *Ergasilus lizae* and *Ergasilus latus* were also found in all the three stations. Perperna and Lahav (1971), also discovered copepod parasite (*Ergasilus lizae*) in grey mullets in Israel.

Tores and Bareiro (2003) in his work also revealed higher no of copepod parasites during rainy season which also agrees with the result of this present work Yashouv, 1972, reported reduction in the number of harvested fish was about 50% of those stocked, rather than the expected 90% as a result of this infestation. Even though *M. capito*, *Tilapia aurea* and carp accompanied *M cephalus*, only *M cephalus* was involved in mortalities. Individual *M. capito* had about nine copepods compared with 100 to 120 on the emaciated *M. cephalus*.

In conclusion, high level of copepod parasites infestation of mugilidae fish *(Mugil cephalus* and *Liza falcipinnis*) in Lac Nokoue can cause serious health problems, fish mortalities and consequent production loss.

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