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Conditions of Eleyele dam in Ibadan Nigeria inhabited by *Melanoides tuberculata*

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ABSTRACT

Melanoides tuberculata is now been monitored worldwide because of its fast growing distribution and its economic importance. *M. tuberculata*, a freshwater mollusc that is an invasive species of freshwater snail, serves as vector transmitting several diseases causing parasites, was found inhabiting Eleyele dam in Ibadan, Nigeria. The prevailing environmental conditions of Eleyele dam were studied between May and October, 2013. Standard methods were used to collect and analyze water samples for physico-chemical variables at four different points on the dam. Conductivity, total solid, water temperature, water depth, dissolved oxygen, biological oxygen demand, nitrate, calcium, alkalinity, total hardness, total suspended solids ranged between 123.95 ± 100.66 mg/L, 143.34 ± 73.21 mg/L 28.42 ± 1.05 °C, 25.73 ± 6.70 cm, 2.71 ± 1.33 mg/L, 0.85 ± 0.90 mg/L, 1.44 ± 1.86 mg/L, 30.70 ± 27.56 mg/L, 43.12 ± 45.04 mg/L, 25.33 ± 23.71 mg/L, 63.15 ± 50.71 mg/L respectively. Calcium significantly correlated with alkalinity ($r = 0.864$, $P < 0.05$), total hardness correlated with calcium concentration ($r = 0.86$, $P < 0.05$) and alkalinity ($r = 0.984$, $P < 0.05$), conductivity with total dissolved solids ($r = 0.97$, $P < 0.05$). The observed environmental conditions that favor colonization of *M. tuberculata* in the Eleyele dam suggest its possible spread in several water bodies in Nigeria. Great precaution must be taking when introducing new aquatic plants into water bodies because this provides a likely route for introduction of nonnative snails as small snails can easily be overlooked on leaves and also during the introduction of *M. tuberculata* as biocontrol of snails, particularly hydrobes that may carry Schistosoma.

1. Introduction

Invasions of ecosystems by non-native species are increasing, especially in aquatic environments (Byers, 2000). The consequences of these invasions include biodiversity loss and changes in ecosystem structure (Pimentel, 2002). Specifically, the establishment of non-native freshwater snails has been associated with changes in ecosystem function (Arango et al., 2009), community structure (Kerans et al., 2005) and the introduction of non-native parasites (Madsen and Frandsen, 1989).

The genus Melanoides is evidently restricted to the Old World tropics and about 30 species occur in Africa of which only *Melanoides tuberculata* (Müller, 1774) is wide-spread. *M tuberculata* was described from the Coromandel Coast of India in 1774 and its present-day distribution is the Indo-Pacific region, Southern Asia, Arabia, Northern Australia, Near East and

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much of Africa (Appleton, 1978) and was also introduced into the Caribbean area. *M. tuberculata* has proved to be a compatible intermediate host for several trematode species elsewhere in the world and shedding of cercariae of a number of trematode families has also been recorded for this snail species elsewhere in Africa (Frandsen and Christensen, 1984). It has become invasive after its introduction into new territories such as Martinique Island (Pointier, 2001) and Brazil (Rocha-Miranda and Martins-Silva, 2006) but has also proved to be an efficient and sustainable bio-control agent of *Biomphalaria glabrata* the intermediate host snail of the intestinal schistosomiasis in these areas (Pointier, 2001).

Surprisingly, little studies of this species have been published in Africa the acclaimed native of this species *M. tuberculata*. Although, it has been reported in Morocco from a thermal stream (Laamrani et al., 1997). In Kenya, Mkoji et al. (1992) reported the possibility of using it as a biological control of *Biomphalaria pfeifferi*. In Nigeria, the presence of *M. tuberculata* has also been reported by few authors, Ndifon and Ukoli (1989) examined the distribution and the habitat preference of the species in south western part of the country while Agbolade and Odaibo (2004) also reported its occurrence in Omi stream, Ago-Iwoye also in south western part of the country and Bolaji et al. (2012) reported their presence in some drainage channels located within the University of Lagos, Nigeria.

In fact, *M. tuberculata* has been introduced in areas where schistosomiasis was prevalent in the hopes of reducing populations of vector snails such as *B. glabrata* and *Biomphalaria straminea*, and thereby reducing the incidence of the disease (Pointer and Guyard, 1992).

A major concern with the introduction of exotic snails is the potential parasites that they may carry and their effects on native fauna. Nonnative trematodes have been documented to negatively affect native communities by infecting vertebrate hosts lacking the co-evolved defense mechanisms to keep densities of parasites at a low level (Taraschewski, 2006).

M. tuberculata serves as the first intermediate host to several species of digenetic trematodes, including the gill trematode *Centrocestus formosanus* (Ben-Ami and Heller, 2005; Tolley-Jordan and Owen, 2008). *C. formosanus* infects some vertebrate hosts, such as aquatic migratory birds (e.g. the green heron *Butorides virescens* and great egret *Ardea alba* (Mitchell et al., 2005) as well as a wide variety of fish hosts, including several endangered spring species e.g. the fountain darter, *Etheostoma fonticola* (Mitchell et al., 2000). The presence of *C. formosanus* produces inflammatory responses in the gills of many freshwater fishes that can lead to respiratory stress and eventual mortality (Mitchell et al., 2000, 2005). *M. tuberculata* also serve as first intermediate host for the human lung fluke *Paragonimus westermani* (Dundee and Paine, 1977; Harasewych, 1998).

In the past, food, health and safety were assumed to be the key issues, while environmental and ecological aspects of human existence were often taken for granted. This trend started to change due to some environmental disasters occurring in different places in the world as a result of negligence of the state of the non-human elements of the biosphere such as water bodies, during which human health was endangered and more environmental awareness started to grow (Goethals and Volk, 2016).

This study investigates the prevailing environmental conditions that favor the thriving of *M. tuberculata* in Eleyele dam in Ibadan, Southwest Nigeria.

2. Materials and methods

2.1. Study area

The study was conducted on Eleyele dam which is located in north-eastern part of Ibadan, south-western Nigeria within longitude 07°025′00″N and 07°027′00″N and Latitude 03°050′00″E and 03°053′00″E. The study site is surrounded by Eleyele community toward the south, Apete community toward the east and Awotan community toward the north. The water from the dam serves as a very important source of domestic water supply, transportation, farming, fishing and recreation to the community.

2.2. Water quality sampling

Water samples were collected fortnightly from four sampling points between July and December 2013 on the dam. The coordinates of these points are Point A- Latitude 07°25′23.7″N and Longitude 003°51′26.6″E; Point B- Latitude 07°25′22.9″N and Longitude 003°51′29.4″E; Point C- Latitude 07°25′30.4″N and Longitude 003°51′31.1″E; Point D- Latitude 07°25′30.4″N and Longitude 003°51′36.6″E.

2.2.1. Physical parameters

The physical parameters measured during each sampling include temperature, conductivity, pH, water depth. Temperature, conductivity and pH values were measured using Consort C933-chemical analyzer. The values were displayed on its screen and recorded when its probe was inserted into the water. Water depth was measured using the meter rule calibrated in centimeters. Water temperature was determined in-situ by inserting a mercury-in-glass thermometer into the water at a depth of 10 ml and allowed to stabilize horizontally for five minutes and readings were taking in degree Celsius (°C).

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2.2.2. Chemical parameters

Surface water samples were collected twice in a month at the four sampling points in Eleyele dam in 2L plastic containers by simple dip method (Owojori et al., 2006). Total dissolved solids, total solids, total suspended solids, and total hardness were determined. The cadmium reduction method (Pillows or AccuVaeAmplus) was used to determine the nitrate level in water. Calcium ion concentration in the water was determined with a buck scientific Atomic Absorption Spectrometer (Model 210/211 VGP), nitrate ion concentration was determined by using Phenoldisulfonic method. Total alkalinity was determined by titration with standard sulfuric acid (N/50 H_2SO_4) using mixed indicators (methyl red and bromocresol green). Dissolved Oxygen was determined titrimetrically using Winkler's method described by (APHA, 1994). Water samples were collected in a glass stoppered light reagent bottles and immediately fixed with Wrinkler's reagent (KI and $MnCl_2$) in the field and titrated in 0.0125 N sodium thiosulphate (APHA, 1994). Samples for Biological oxygen demand were determined in the same way except that it was collected in dark reagent bottles and fixed after incubation in the dark for 5 days.

One-way analysis of variance (ANOVA) and coefficient matrix for water quality were carried out using SPSS 22.0 packages for windows.

3. Results

It was observed that water temperature and pH at the dam was fairly constant during the sampling period. There was a wide variation in the values recorded for other physico-chemical parameters during the sampling. Air and water temperatures did not vary widely during the study period (Table 1).

Total hardness was significantly correlated with calcium ($r = 0.864$, $P < 0.05$) and alkalinity ($r = 0.984$, $P < 0.05$). Total suspended solids correlated significantly with alkalinity ($r = 0.687$, $P < 0.05$) and Total hardness ($r = 0.674$, $P < 0.05$) while conductivity significantly correlated with total solids ($r = 0.658$, $P < 0.05$) and total dissolved solids ($r = 0.967$, $P < 0.05$) (Table 2). The mean water temperature was recorded to be constant across the sampling months likewise water depth but a sharp decrease in water depth was observed in the month of June (Fig. 1). Conductivity and total solids show almost the same pattern of variation (Fig. 2). Dissolved Oxygen, biochemical oxygen demand (BOD5) and nitrate ion concentration fluctuated irregularly over the study period (Fig 3). It was observed that TDS and TSS followed almost same pattern of variation expect in the month of June when we have the least recorded TDS concentration and peak of TSS concentration (Fig. 4). pH was observed to be fairly constant while calcium ion and alkalinity ion concentration shows the same pattern of variation during the sampling periods (Fig. 5). An increase in total hardness was recorded between June and July and a very sharp increase was recorded between August and September (Fig. 6).

4. Discussion

Water chemistry of an ecosystem is dependent on the physical and geological features of its drainage basin (Victor and Al-Mahrouqi, 1996; Edokpayi et al., 2004). Similar phenomenon might be responsible for the recorded physical and chemical parameters studied in the Eleyele dam. Temperature is known to affect the abundance, distribution and spread of freshwater snails (Appleton, 1978; Sturrock, 1993). A temperature range of 26–30 °C was recorded in Eleyele dam during the course of study and this appears to be favorable to the vector snails. The fluctuation pattern of temperature observed in this study agreed with the pattern reported by Onyema et al. (2003). Iwugo et al. (2003) also reported the same pattern in Lagos with a mean temperature of 30 °C which agreed with this study. The range of water temperature observed during this study was similar to those reported for many water bodies in Southern Nigeria (Ogbeibu and Victor, 1995; Edokpayi and Osimen, 2001; Onyema et al., 2003; Edokpayi et al., 2004; Edokpayi and Ayorinde, 2005; Owojori et al., 2006; Bolaji et al., 2012). The relatively high temperature recorded could be as a result of the time and season (late raining season-beginning of dry season-mid of dry season) of sample collection and also because similar observation are from the same geopolitical zones in Nigeria (Bolaji et al., 2012).

Table 1
Summary of physical and chemical parameters of Eleyele dam showing the mean, standard deviation, and range values.

Physical parameters	Mean value ± S.D	Minimum	Maximum
Conductivity (mS/cm)	123.949 ± 100.660	46.70	292.00
pH	8.01 ± 0.570	6.94	8.88
Water temperature (°C)	28.417 ± 1.048	26.00	30.00
Water depth (cm)	25.729 ± 6.699	8.00	43.00
Dissolved oxygen (mg/L)	2.707 ± 1.327	0.51	7.62
Biological oxygen demand (mg/L)	0.849 ± 0.894	0.00	4.06
Nitrate (mg/L)	1.436 ± 1.860	0.01	7.60
Calcium (mg/L)	30.701 ± 27.559	5.02	98.85
Alkalinity (mg/L)	43.117 ± 45.041	3.00	126.00
Total hardness (mg/L)	25.335 ± 23.710	2.37	65.00
Total suspended solids (mg/L)	63.146 ± 50.715	8.90	156.05
Total solids (mg/L)	143.341 ± 73.215	40.95	285.00
Total dissolved solids (mg/L)	82.547 ± 59.610	6.00	194.00

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Table 2
Correlation co-efficient matrix for the physical and chemical parameters of the water body.

pH	TEMP	WATER DEPTH	D O	BOD	NITRATE	CALC	ALK (mg/L)	TH (mg/L)	T S S (mg/L)	T S (mg/L)	T D S (mg/L)	COND. (mS/cm)
	−0.045	0.015	−0.215	−0.057	−0.158	0.018	−0.029	−0.009	−0.100	−0.208	−0.183	−0.172
Temperature		0.395*	−0.260	−0.336*	−0.004	0.084	0.078	0.039	0.385	0.416	0.093	0.139
Water depth			−0.231	−0.358*	−0.251	0.263	0.108	0.136	0.351	0.112	−0.263	−0.240
D.O				0.652*	−0.139	−0.060	0.119	0.113	0.174	0.211	0.193	0.180
B.O.D					−0.077	−0.070	−0.015	−0.061	−0.102	0.037	0.271	0.241
Nitrate						−0.382*	−0.397*	−0.453*	−0.352*	0.186	0.545*	0.521*
Calcium							0.864*	0.864*	0.526*	0.005	−0.478*	−0.604*
Alkalinity								0.984*	0.687*	0.101	−0.492*	−0.580*
TH									0.674*	0.033	−0.569*	−0.648*
TSS										0.642*	−0.108	−0.112
TS											0.680*	0.658*
TDS												0.967*
Conductivity												

KEYS: CAL, calcium; D.O, dissolved oxygen; B.O.D, biological oxygen demand; TH, total hardness; TSS, total dissolved solid; TS, total solid; TDS, total dissolved solid; COND, conductivity; TEMP, temperature.
* Correlation is significant at the 0.05 level.

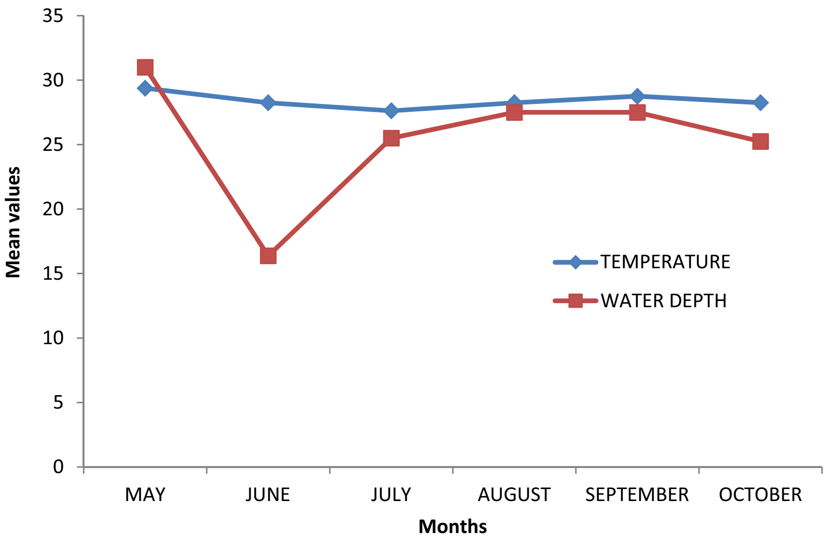

Fig. 1. Mean monthly variation in temperature (°C) and water depth (cm) in Eleyele dam.

A low pH value may be harmful to freshwater snails, as it may result into coagulation of the snails' exposed skin surface affecting respiration and movement and consequently lead to their death (Jordan and Webbe, 1982). The pH range during the course of this study was 6.94–8.88. The pH during of water samples ranged from slightly acidic value of 6.94 to basic 8.88. This range is in accordance with Owojori et al. (2006) and Sharma et al. (2013). The range recorded was similar to those observed by Hyeladi and Nwagilari (2014) during their study on Alau dam in Maiduguri, Borno State, Nigeria. However, this range is slightly higher than those recorded by Ewa et al. (2011) in Omoku Creek, River State that recorded pH range of 5.4–6.8 during the study because of high salinity recorded at Omoku Creek or as a result of deposition of organic matter into water from run-off or partial decomposition of organic matter by bacteria and fungi that produces various organic acids that are capable of lowering the pH.

Water conductivity is the measure of the total ionic composition of water and therefore the richness of the aquatic system (Awachie, 1981). The usual pattern in which conductivity rises during dry season and falls during wet season (Ogbeibu and Victor, 1995) was pronounced in this study. The conductivity range recorded was 46.70–290 ms/cm. This range agrees with Owojori et al. (2006), Adefemi et al. (2007) on the study of Egbe and Itajpaji dam in Ondo State. The conductivity range observed in this study is higher than those ranges recorded by Martins-Silva and Barros (2001) at Riacho Fundo Creek Basin, Brasilia, Brazil, Yirenya-Tawiah et al. (2011) in Kpong Head pond and Oyakhilome et al., 2012 in Owena multi-purpose dam, Ondo, Southwestern, Nigeria. The high water conductivity values recorded during this study could be as a result of excessive evaporation of water from the dam during the dry season which in return can lead to increase the concentration of dissolved soluble salts in the dam (Ewa et al., 2011).

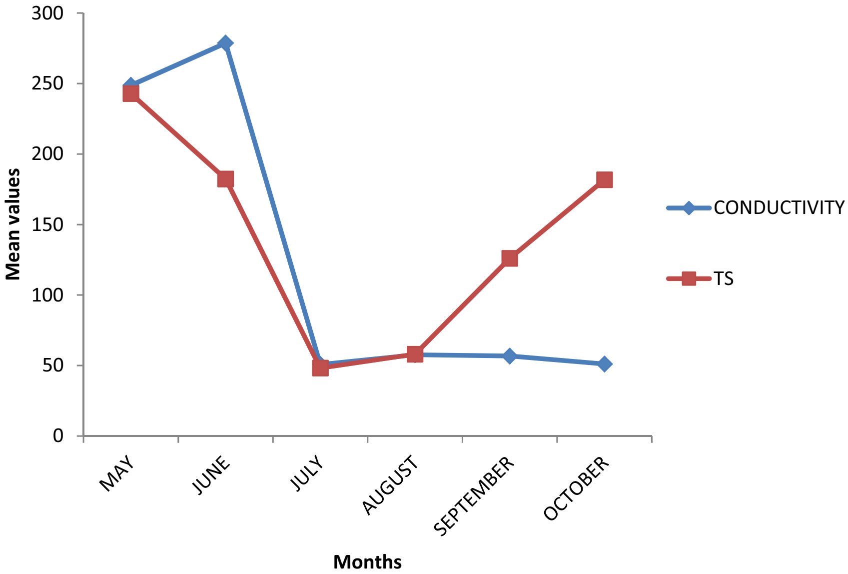

Fig. 2. Mean monthly variation in conductivity (mg/L) and total solid (mg/L) in Eleyele dam.

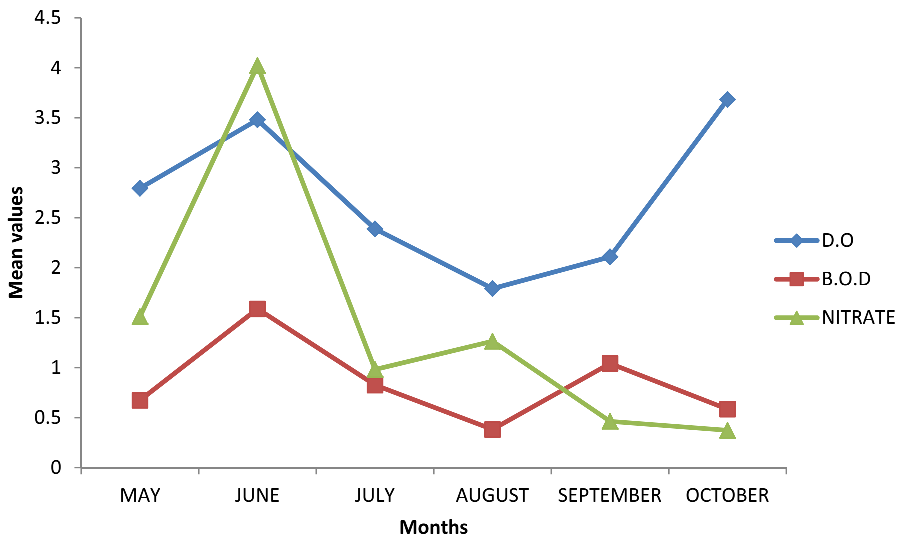

Fig. 3. Mean monthly variation in D.O (mg/L), B.O.D (mg/L) and nitrate (mg/L) in Eleyele dam.

Snails need oxygen for their metabolic activities (WHO, 1965). The dissolved oxygen range of 0.51–7.62 mg/L was recorded during this study. This suggests that the amount of dissolved oxygen in the water is favorable for the snail host. This range of oxygen dissolved in the water was probably due to the oxygen produced by aquatic plants by photosynthesis (Owojori et al., 2006). This finding is in consonance with other findings that desired concentration of dissolved oxygen for freshwater snails is 0.40–16.00 mg/L (Harman and Berg, 1971). This study is in accordance with studies by Owojori et al. (2006) that recorded D.O range of 2.8–14.2 mg/L at Opa reservoir and D.O range of 2.4–8.6 mg/L at research farm ponds in Obafemi Awolowo University Ile-Ife and also with Hussein et al. (2011) and Yirenya-Tawiah et al. (2011) that recorded a D.O range of 4.8–12.5 mg/L and 0.9–7.3 mg/L at their respective sampling stations. However, Sharma et al. (2013) recorded a D.O range that is 4.4–22.0 mg/L in Manhasan stream, Jammu which doesn't agree with the D.O range from this study. Bolaji et al. (2012) observed that D.O values are usually low for most rivers, drainages and creeks.

Alkalinity range at the sampling points in Eleyele dam was 3.00–126 mg/L which is in accordance with alkalinity range recorded by Owojori et al. (2006) during the study of Opa reservoir and farm ponds in Obafemi Awolowo University, Ile-Ife and also with Oyakhilome et al. (2012). However, the range recorded were greater than those recorded by Adefemi et al. (2007) at Ero and Egbe dam in Ondo State and Hyeladi and Nwagilari (2014) at Owena multi-purpose dam, Ondo State,

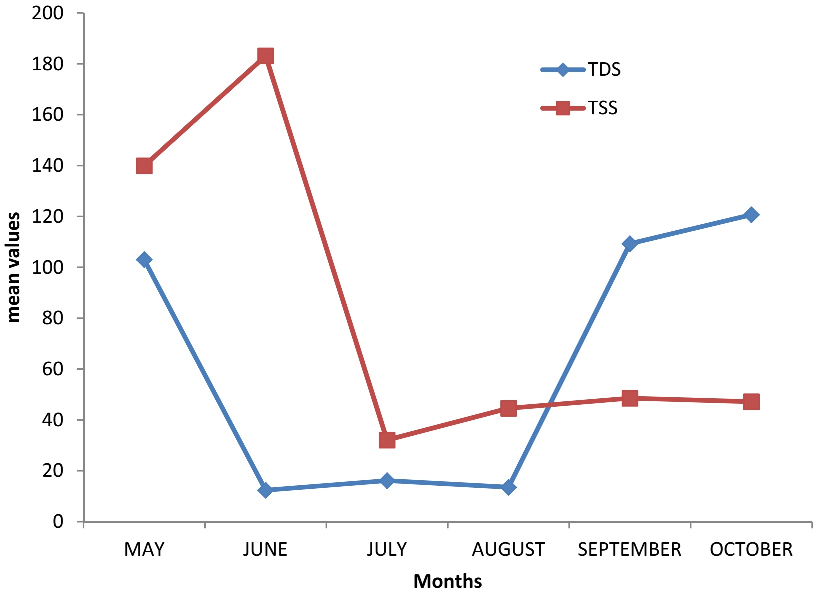

Fig. 4. Mean monthly variation in T.S (mg/L), T.D.S (mg/L) in Eleyele dam.

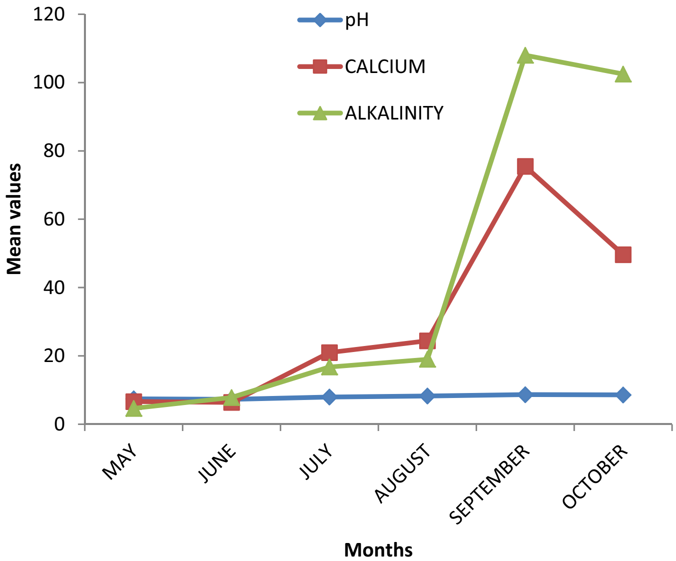

Fig. 5. Mean monthly variation in pH, calcium (mg/L) and alkalinity (mg/L) in Eleyele dam.

Nigeria. The values recorded during this study agrees with the fact that alkalinity of water increases as we tend toward dry season and the sampling took place from late raining season to early and mid-dry season.

One of several arbitrary classifications of waters by hardness include: Soft up to 50 mg/L $CaCO_3$; Moderately Soft 51–100 mg/L $CaCO_3$; Slightly Hard 101–150 mg/L $CaCO_3$; Moderately Hard 151–250 mg/L $CaCO_3$; Hard 251–350 mg/L $CaCO_3$; Excessively Hard over 350 mg/L $CaCO_3$ (IEPA, 2001). Abd El-Malek (1958) observed that waters of very low hardness showed reduction in individual number and shells become relatively thin. The total hardness range of 2.37–65.00 mg/L was recorded in Eleyele. The values recorded from the dam lake were within the soft classification. This range agrees with the range recorded by Adefemi et al. (2007) and Hyeladi and Nwagilari (2014) but those not agree with Hussein et al. (2011) that recorded total hardness value range of 79.9–437.8 mg/L at Qena Governorate, Upper Egypt. Hardness in water comprises the determination of calcium and magnesium as the main constituents and the widespread abundance in rock often to very considerable hardness levels in surface waters.

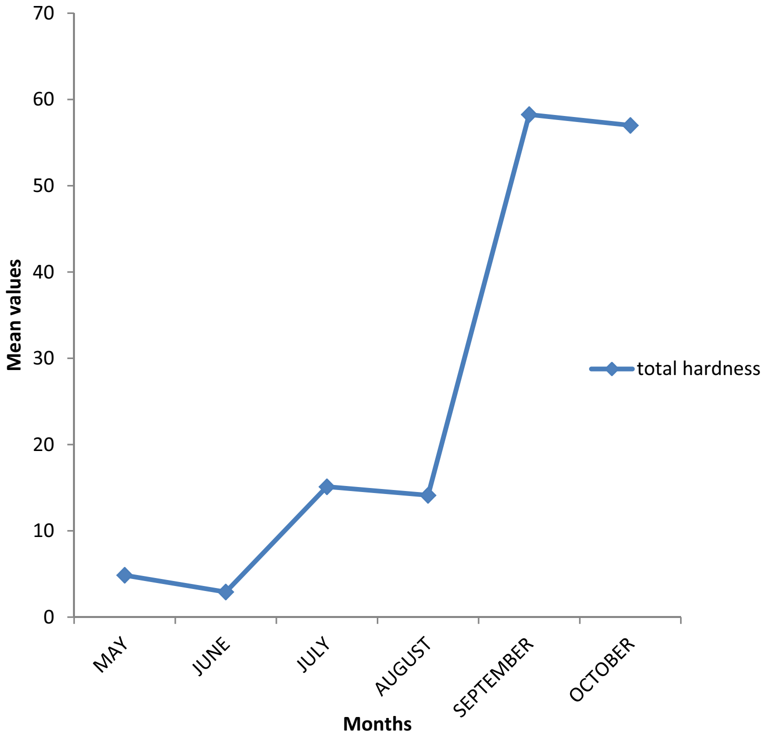

Fig. 6. Mean monthly variation in total hardness (mg/L) in Eleyele dam.

Water depth range at the four sampling points was recorded to be 8–43 cm. This agrees with the work of Owojori et al. (2006) that recorded the water depth range at seven sampling points in Opa reservoir in Obafemi Awolowo University Ile-Ife to be 27–76 cm and also with Sharma et al. (2013) that observed that the range of water depth during the sampling period was 8.8–48 cm Gho-Manhasan stream, Jammu. However, Hussein et al. (2011) at Qena Governorate, Upper Egypt recorded water depth value range 55–160 cm and also Yirenya-Tawiah et al. (2011) observed 31–246 cm in Kpong Head Pond, Ghana, as studies where taking during the peak of raining season by these authors compared to readings taking in this study during late raining season. Several authors have shown that calcium concentration is an important factor in controlling the abundance and distribution of molluscs in freshwater (Boycott, 1936; Macan, 1950; Mckillop and Harrison, 1972; Dussart, 1976, 1979; Mckillop, 1985; Supian and Khwanuddin, 2002). Supian and Khwanuddin (2002) reported that the strongest constraint is the amount of dissolved calcium in the water, since calcium is an essential constituent of the shell. The range of calcium ion at the sampling points during the study period was 2.31 and 98.85 mg/L, which agrees with works by Hussein et al. (2011) who reported calcium ion range of 16.03–77.5 mg/L from sampling points at Qena Governorate, Upper Egypt and Sharma et al. (2013) who reported the calcium ion range to be 8.82–64.96 mg/L in Gho-Manhasan stream, Jammu (Jammu and Kashmir). However, the range recorded in this study is higher than those recorded by El-Kady et al. (2000), Martins-Silva and Barros (2001) and Hyeladi and Nwagilari (2014). The low to moderately high calcium ions recorded from this study was as a result of the softness of the water body. It is known that calcium ion contributes more to water hardness, that is, there is a positive correlation between calcium ion concentration and water hardness (McCuen, 2002).

The total suspended solids range of 8.9–156.05 mg/L was recorded in Eleyele dam during the study period. This is in line with El-Kady et al. (2000) who reported total suspended solids range of 32.95–125 mg/L at the irrigation sampling sites and 44.48–180.0 mg/L at the Drainage channel sampling sites in newly settled areas of the Sinai Peninsula at El-Abtal Village. Martins-Silva and Barros (2001) recorded the range of suspended solids at Riacho Fundo Creek Basin to be 18–62 mg/L. This study does not agree with Nnaji et al. (2010) in River Galma, Zaira, Nigeria and by Oyakhilome et al. (2012) that recorded a lower total suspended solid range during their studies. The lower total suspended values recorded by these authors could be as a result of dilution of water bodies as a result of rainfall during raining season when evaporation is lesser.

The nitrate ion concentration range of 0.01–6.55 mg/L was recorded during the study period. This range is in accordance with the value recorded by Yirenya-Tawiah et al. (2011) in the KpongHead Pond; Ghana (0.9–1.4 mg/L). The relatively high value of nitrate ion in the dam is an indication of organic and inorganic pollution which could be from numerous sources including sewage waste discharges and run off from nearby farms and also fixing of nitrogen by aquatic plants present at the dam can increase nitrate level of water (Viala, 2008). A positive correlation was observed between nitrate ion concentration and water conductivity. This implies that an increase in nitrate ion concentration leads to increases in conductivity

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and a decrease in nitrate ion concentration leads to decrease in conductivity. This is in accordance with Bolaji et al. (2012) that reported a positive correlation between nitrate and conductivity.

M. tuberculata has been reported to show preferences for habitat such as reservoirs, ponds (El-Kady et al., 2000; Giovanelli et al., 2005; Owojori et al., 2006). Similar observations have been reported in Nigeria where preference is given to moderately shaded habitat by *M. tuberculata* (Ndifon and Ukoli, 1989; Owojori et al., 2006). In this study *M. tuberculata* was found within a slow flowing or lotic and shallow drainage channel. This agreed with habitat preference of *M. tuberculata* described by Duggan (2002). Similar observations have been reported (Dudgeon, 1989; Gutiérrez et al., 1997) where *M. tuberculata* prefer mud and silt substrates. According to Duggan (2002), *M. tuberculata* has been reported to be absent at temperatures 32.70–37.80 °C but have been found in abundance at 29.00–30.00 °C.

Similar observation was recorded in the present study (26.00–31.00 °C) which agreed with those reported elsewhere: 18.00–25.00 °C in United States (Murray, 1971), 21.00–31.00 °C in the United Arab Emirates (Ismail and Arif, 1993) and 27.00–29.00 °C from a thermal station in Morocco (Laamrani et al., 1997), in Nigeria 26.70–31.50 °C (Bolaji et al., 2012). The trends of temperature changes observed in this study and those of earlier reports suggested that *M. tuberculata* might have invaded several water bodies in southwestern, Nigeria. According to Agbolade and Odaibo (2004) high population of *M. tuberculata* was reported at Omi stream, Ago-Iwoye confirming the spread of *M. tuberculata* in southwestern, Nigeria. The environmental conditions recorded along the dam falls within the reported environmental conditions for most water bodies in Nigeria which favor colonization of *M. tuberculata.*

5. Conclusion

The potential of *M. tuberculata* to invade new habitats and quickly establish populations may be the result of its high population growth rate and favorable environmental conditions. The observed high population of *M. tuberculata* in this dam may indicate an organic pollution of water because *M. tuberculata* strives excellently mostly in organically polluted water bodies indicating that human populations carrying out different activities at this dam are highly predisposed to diseases transmitted by this freshwater snail.

Government should make policies to regulate the rate at which aquatic plants are introduced to new water bodies because this provides a likely route for introduction of nonnative snails as small snails can easily be overlooked on leaves and also during the introduction of *M. tuberculata* as biocontrol of snails, particularly hydrobes that may carry Schistosoma.

The population growth of *M. tuberculata* may be checked by introduction of local predators such as crayfish and perhaps species of loaches like the Zebra Loach and raccoons that feed predominantly on this specie of freshwater snail as suggested by Kirsten and Cody (2013).

Further research can be conducted to determine if *M. tuberculata* present in Eleyele dam has already introduced the exotic trematodes *C. formosanus* and *P. westermani* into the water body. Studies can be carried out on the dam to know the level at which the dam is polluted organically. An all year sampling of freshwater snail population can also be conducted to determine the period of the year with the highest population of *M. tuberculata* before introducing the control measures in order to reduce the population of this freshwater snail.

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