Environmental conditions of a drainage channel inhabited by an invasive species Melanoides tuberculatus (Muller, 1774) in southwestern, Nigeria

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Abstract:
Melanoides tuberculatus (Muller, 1774) an invasive species that serves as vector transmitting several diseases causing parasites was found inhabiting a drainage channel in University of Lagos. The prevailing environmental conditions of the drainage channel were studied between February and July 2006. Standard methods were used to collect and analyze samples. pH ranged from 6.30 to 7.70. The Air and water temperatures ranged between 29.37±2.29 ºc and 28.62±2.00 ºc respectively. Conductivity, total dissolved solid (TDS), salinity, dissolved oxygen, biochemical oxygen demand, nitrate, copper, phosphate and sulphate ranged between 37.17±13.60 µscm⁻¹, 18.50±6.75 ppm, 0.04±0.05‰, 4.28±0.34 ppm, 6.17±3.19 ppm, 1.03±0.27 ppm, 0.03±0.05 ppm, 0.20±0.36 ppm and 10.17±5.38 ppm respectively. pH significantly correlated with water temperature (r=0.891, P < 0.05); TDS significantly correlated with nitrate (r=0.845, P < 0.05) and conductivity (r=1.000, P < 0.05); nitrate correlated significantly with conductivity (r=0.834, P < 0.05) and copper correlated significantly with phosphate (r=0.987, P < 0.05). The observed environmental factors that favour colonization of M. tuberculatus in the drainage channel suggest its possible spread in several water bodies in Nigeria.

Key words: Distribution pattern, Environmental conditions, Melanoides tuberculatus, Nutrient elements.

Introduction
The invasion of freshwater by the molluscs has aptly been characterized as ‘desultory’ (Robert, 2000). Gastropods have successfully invaded freshwater where they serve as vectors transmitting several dangerous parasites (Russo, 1974; Jacobson, 1975; Murray, 1971; Dundee and Paine, 1977, Bogeа et al., 2005). M. tuberculatus Muller, 1774 from the Family Thiaridae commonly referred to as red-rimmed melania is one
such vector. The species is a small aquatic herbivorous snail which is very common to sub tropical and tropical areas of northern and eastern Africa, southern Asia, Morocco, Madagascar, Saudi Arabia, Iran, Pakistan, Indian, southern China and Gelebes (Neck, 1985; Vaz et al., 1986; Pointier and Marquet, 1990; Howells, 1992; Pointier et al., 1994; Pointier, 1999; De Marco, 1999; Watanabe et al., 1999, Thiengo et al., 2001, 2004; Duggan, 2002; Fernandez et al., 2003; Bogea et al., 2005; Giovanelli et al., 2005; Mitchell, 2006).

The thiarid snail, *M. tuberculatus* is now been monitored worldwide because of its fast growing distribution and its economic importance. The spread of the Afro-Asian *M. tuberculatus* has been associated mainly with human activities, some of which are suggested to be by direct release (Duggan, 2002) or successive accidental release from aquaria (Vaz et al., 1986; Giovanelli et al., 2005). Mitchell (2006) reported that contaminated fisheries equipment is also another way by which the snail is spread from one place to another because of the presence of operculum which slows down desiccation. The dispersion of this organism has also been associated with aquatic birds (Lassen, 1975; Boag, 1986; Duggan, 2002).

Surprisingly, few studies of this species have been published in Africa where *M. tuberculatus* is a native species. However, 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 agent of *Biomphalaria pfeifferi*. In Nigeria, the presence of *M. tuberculatus* has also been reported by a few authors, Ndifon and Ukoli (1989) examined the distribution and the habitat preference of the species in southwestern part of the country while Agbolade and Odaibo (2004) also reported its occurrence in Omi stream, Ago-Iwoye also in southwestern part of the country. Accordingly, this study investigates the prevailing environmental conditions of *M. tuberculatus* in a drainage channel in University of Lagos, Southwestern Nigeria.

**Materials and Methods**

The study site was a drainage channel located within the University of Lagos, Nigeria between latitudes 6°31'1.59"N and 6°31'06.70"N and longitudes 3°23'55.89"E and 3°23'53.93"E (Fig. 1). The water drains slowly in a unidirectional manner and does not have constant influx of water from the nearby creeklet except during heavy rains leading to partial flooding of the channel which eventually leads to stagnant water and increase in sediment deposition along the drainage. The deposition of sediment at this drainage makes it possible for several aquatic organisms to colonize the channel. The water colour was often clear but sometimes had some oil sheen
as a result of domestic discharge from the surrounding buildings connected to the drainage. This channel was usually dredged yearly prior to rainy season but was not dredged during study year for the purpose of this research.

Water samples were collected monthly between February and July 2006 at a point along the channel. Atmospheric and water temperatures were measured in-situ using dry bulb centigrade Mercury-in-glass Thermometer, 0-100°C. A transparent 250ml reagent bottle and 250ml Amber reagent bottle were used to collect water for dissolved oxygen and Biochemical Oxygen Demand respectively which were determined by Winkler’s method (APHA, 1992). Conductivity, TDS and pH were determined with Rana Instrument (Model U-10). Surface water was collected in 1 liter plastic bottle for Phosphate, Sulphate, Copper and Nitrate analysis in the laboratory. All laboratory analyses were carried out according to USEPA, 1979; SMEWW, 1985; APHA, 1992.

One-way analysis of variance (ANOVA) and correlation coefficient matrix for water quality were carried out using SPSS 10.0 packages for windows following the procedures described by Ogbeibu (2005).

**Results**

The summary of the physical and chemical characteristics of the water channel is presented in Table 1 and coefficient matrix in Table 2.
Table 1: Summary of physical and chemical parameters of surface water showing Mean±Standard deviation (S.D), Minimum and Maximum values

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mean±S.D</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Temperature (ºc)</td>
<td>29.37±2.29</td>
<td>25.70</td>
<td>32.00</td>
</tr>
<tr>
<td>Water Temperature (ºc)</td>
<td>28.62±2.00</td>
<td>26.70</td>
<td>31.50</td>
</tr>
<tr>
<td>pH</td>
<td>6.30</td>
<td>6.30</td>
<td>7.70</td>
</tr>
<tr>
<td>Conductivity (µscm⁻¹)</td>
<td>37.17±13.60</td>
<td>16.00</td>
<td>56.00</td>
</tr>
<tr>
<td>Total Dissolved Solid (ppm)</td>
<td>18.50±6.75</td>
<td>8.00</td>
<td>28.00</td>
</tr>
<tr>
<td>Salinity (%)</td>
<td>0.04±0.05</td>
<td>0.00</td>
<td>0.10</td>
</tr>
<tr>
<td>DO (ppm)</td>
<td>4.28±0.34</td>
<td>4.00</td>
<td>4.80</td>
</tr>
<tr>
<td>BOD (ppm)</td>
<td>6.17±3.19</td>
<td>2.00</td>
<td>10.00</td>
</tr>
<tr>
<td>Nitrate (ppm)</td>
<td>1.03±0.27</td>
<td>0.62</td>
<td>1.35</td>
</tr>
<tr>
<td>Copper (ppm)</td>
<td>0.03 ±0.050</td>
<td>0.000</td>
<td>0.13</td>
</tr>
<tr>
<td>Phosphate (ppm)</td>
<td>0.20±0.36</td>
<td>0.02</td>
<td>0.94</td>
</tr>
<tr>
<td>Sulphate (ppm)</td>
<td>10.17±5.38</td>
<td>5.00</td>
<td>20.00</td>
</tr>
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</table>

Air and water temperatures did not vary widely during the study period. The air temperature decreased while the water temperature increased for most part of the study period (Fig. 2). Conductivity and Total Dissolved Solid (TDS) follow similar pattern decreasing from February to April with a sharp increase in May recording the highest level attained during the period (Fig. 2). Salinity generally was less than 1‰ with mean salinity of 0.04‰ (Table 1). Nitrate and Phosphate concentration decreased from February to April and increased in May while Copper concentration showed an irregular fluctuation over the study period (Fig. 3). pH was slightly acidic, while Sulphate concentration decreased from February to April and a sharp increase was observed in May (Fig. 4). Dissolved Oxygen fluctuated irregularly over the study period but Biochemical Oxygen Demand (BOD5) was high in February and June while it maintained constant levels from March to May (Fig. 4).

The Hydrogen ion concentration (pH) significantly correlated with water temperature (r =0 .891, P < 0.05). Total Dissolved Solid (TDS) was significantly correlated with nitrate (r=0.845, P < 0.05) and conductivity (r=1.000, P < 0.05). Nitrate correlated significantly with conductivity (0.834) while copper also significantly correlated with phosphate (r= 0.987) (Table 2).
Table 2: Correlation Co-efficient Matrix for the physical and chemical parameters of the water channel.

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
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<tbody>
<tr>
<td>A</td>
<td></td>
<td>.772</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>B</td>
<td>-.332</td>
<td>.030</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>C</td>
<td>.411</td>
<td>-0.88</td>
<td>-.179</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>D</td>
<td>.612</td>
<td>.891*</td>
<td>.402</td>
<td>-.187</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>E</td>
<td>.368</td>
<td>-.097</td>
<td>.845*</td>
<td>.129</td>
<td>.154</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>F</td>
<td>.281</td>
<td>.609</td>
<td>.602</td>
<td>.122</td>
<td>.690</td>
<td>.714</td>
<td></td>
<td></td>
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<tr>
<td>G</td>
<td>-.738</td>
<td>-.558</td>
<td>.224</td>
<td>-.687</td>
<td>-.330</td>
<td>-.093</td>
<td>-.564</td>
<td></td>
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<tr>
<td>H</td>
<td>-.173</td>
<td>-.486</td>
<td>-.56</td>
<td>.621</td>
<td>-.478</td>
<td>.409</td>
<td>.103</td>
<td>-.355</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>I</td>
<td>-.338</td>
<td>.018</td>
<td>1.000*</td>
<td>-.188</td>
<td>.398</td>
<td>.834*</td>
<td>.563</td>
<td>.245</td>
<td>-.062</td>
<td></td>
<td></td>
</tr>
<tr>
<td>J</td>
<td>-.065</td>
<td>-.358</td>
<td>.003</td>
<td>.636</td>
<td>-.331</td>
<td>.456</td>
<td>.230</td>
<td>-.444</td>
<td>.987*</td>
<td>-.004</td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>-.439</td>
<td>-.403</td>
<td>-.051</td>
<td>.317</td>
<td>-.574</td>
<td>.438</td>
<td>.162</td>
<td>-.257</td>
<td>.667</td>
<td>-.070</td>
<td>.604</td>
</tr>
</tbody>
</table>

Air Temperature= A, Water Temperature= B, TDS= C, Salinity= D, Ph= E, Nitrate= F, Sulphate= G, DO= H, Copper= I, Conductivity= J, Phosphate= K, BOD=L

*.Correlation is significant at the 0.05 level (2-tailed).

Discussion

As reported by several authors, water chemistry of an aquatic 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 drainage channel which was small and shallow with a slow water flows. The decrease in atmospheric temperature could be as a result of delayed Harmattan associated with dust (Onyema et al., 2003) since the period of study was late dry season followed by rainy season. The fluctuation pattern of temperature observed in this study agreed with the pattern reported by Onyema and Nwankwo (2006) in polluted
estuarine creeks in Lagos, and this was attributed to increase in cloudy conditions and subsequent reductions in solar insulation. Iwugo et al. (2003) also reported the same pattern in Lagos with a mean temperature of 30°C which agreed with our study.

Fig. 2: Monthly fluctuation in air, water temperatures, conductivity and TDS of drainage channel

Fig. 3: Fluctuation in Nitrate, Phosphate and Copper concentration at sampled site
The range of air and water temperature observed during the study was similar to those reported for many water bodies in Southern Nigeria (Sridhar and Ademoroti, 1984; Ogbeibu and Egborge, 1995; Edokpayi and Osimen, 2001; Onyema et al., 2003; Edokpayi et al., 2004; Edokpayi and Ayorinde, 2005).

The pH (6.30 - 7.70) recorded at the drainage channel was observed to be weakly acidic for most of the study period except for May which was slightly alkaline but generally falls within ranges reported for rivers flowing through areas with thick vegetation (Awuchie, 1981; Osimen, 1997; Uwadiae et al., 2009), although the channel did not flow through thick vegetation but it received water influx from the nearby creeklet with pH (6.70-7.90) reported by Edokpayi and Ayorinde (2005) and the environment was classified as brackish. The usual pattern in which conductivity rises during dry season and falls during wet season (Ogbeibu and Victor, 1995) was not pronounced in this study. The fluctuating pattern observed agreed with the pattern observed in Ibiekuma stream studied by Edokpayi and Osimen (2002). The values of conductivity recorded during the study period were quite low when compared with those recorded in some water bodies in southern Nigeria (Edokpayi and Osimen, 2002; Edokpayi, 2005) but a similarly low conductivity result was observed by Edokpayi and Ayorinde (2005) for a brackish water swamp within the same University of Lagos and Edokpayi et al. (2004) for Kuramo water, Lagos. Although conductivity is the measure of the total ionic composition of water...
and therefore the richness of the aquatic system (Awachie, 1981), the low conductivity values observed in this study may be an indication of ionic paucity since the drainage channel construction is granite base which is composed of inert materials that do not ionize.

The variation in the values of TDS recorded during the study followed a similar pattern observed for conductivity and the values obtained were similar to that reported for Kuramo water (Edokpayi et al., 2004), but far less than that reported for different network of creeks, rivers connected to Lagos Lagoon in southwestern Nigeria (Onyema and Nwankwo, 2006).

Salinity was generally low, less than 1‰ for the study period. This shows that the channel is a fresh water environment as it is a drainage channel for runoff water and domestic water from Faculty of Engineering and Mariere Hall.

The dissolved oxygen levels (0.00–0.10 mg/l) recorded along the study channel was low and around the range (3.8 – 4.2mg/l) reported by Onyema and Nwankwo (2006) for some creeks in Lagos, but lower than those reported for some other rivers in Nigeria (Edokpayi, 1988; Edokpayi and Osimen, 2002). The low oxygen level could have been as a result of the slow flowing nature of the water which could limit oxygen diffusion and small volume of water (Edokpayi, 2005). Low oxygen observed in dry season could also be associated with increase in temperature as observed during the study period.

Biochemical Oxygen Demand (BOD$_5$) provides a measure of the effect of pollution on a receiving water body (Mason, 1991). The BOD$_5$ recorded during this study (2 - 10ppm) was slightly higher compared with 0.42 to 8.0mg/l reported for some water bodies in Nigeria (Victor and Onomivbori, 1996; Edokpayi and Osimen, 2001, 2002; Ogbiebu and Oribhabor, 2002; Edokpayi and Ayorinde, 2005) but lower than 17 - 35mg/l reported in Light House Beach, Lagos (Nwankwo et al., 2004) and polluted creeks in Lagos (Onyema and Nwankwo, 2006) and also far lower than 90.00-370.00 mg/l that was reported for water bodies exposed to urban run-off elsewhere (Mason, 1991).

The high BOD$_5$ values that were recorded during February and June could probably be associated with increase in microbial activities which led to high oxygen consumption. Nitrate concentration observed during the study was lower than some water bodies reportedly polluted from organic source in some sections of Lagos Lagoon (Ajao, 1996; Onyema and Nwankwo, 2006) and Ikpoba River (Victor and Ogbiebu, 1991; Victor and Onomivbori, 1996). The observed low level of nitrate agreed with earlier reported values for some rivers in Nigeria (Egborge and Benka-Coker, 1986; Egborge et al., 1986; Edokpayi, 1988). The low level of nitrate shows that the environment is
stable, with less pollution stress from external environment (Edokpayi, 2005). This was contrary to the high nitrate-nitrogen documented by Nwankwo (1993) in some coastal waters in southwest Nigeria which was attributed to the biodegradable wastes from surrounding hotels and residential areas around the coastal waters. The observed nitrate concentration level in the present study may be due to plants releasing nitrate as leachate along the channel (Kellman and Tackaberry, 1997; Edokpayi, 2005). Sulphate decreased gradually throughout the study period except for May which showed sharp increase up to 20 ppm although was still within the range reported for some rivers in Nigeria and followed the same pattern reported by Onyema and Nwankwo (2006). Although the values obtained in this study were much lower than those they reported, which were associated with possible waste discharges.

The copper concentration within the study channel was very low compared with the concentration reported by Edokpayi and Ayorinde (2005) for brackish water swamp within University of Lagos, although slightly higher than concentration reported for Light House Beach, Lagos, Nigeria (Nwankwo et al., 2004). The observed results indicate that the channel may be almost free of heavy metal pollution or having just a trace of them.

Phosphate usually occurs in small amount in aquatic ecosystem (Tait and Dipper, 1998). Low values generally less than 1ppm was recorded during the study period. The observed level was lower than those reported for some water bodies in Nigeria (Edokpayi and Osimen, 2001; Nwankwo et al., 2004; Edokpayi et al., 2004; Edokpayi, 2005; Edokpayi and Ayorinde, 2005) but agreed with concentrations documented for some water bodies in southwestern Nigeria (Nwankwo, 1993; Nwankwo et al., 2003). The concentration observed during this period could probably be associated with surface water run-off and precipitation (Sutcliffe et al., 1982).

The absence of lead in this channel throughout the study period and the observed low copper concentration mentioned earlier suggested that the environment was possibly free of external sources of heavy metals.

The correlation coefficient matrix obtained for the physical and chemical parameters was more significant among nitrate, phosphate, total dissolved solid and conductivity which showed chemical richness. Hydrogen ion concentration (pH) also significantly correlated with water temperature while copper correlated with phosphate.

*M. tuberculatus* has been reported to show preferences for habitat which are mainly lotic environment (Giovanelli et al., 2005). Similar observations have been reported in Nigeria where preference is given to moderately shaded habitat by *M. tuberculatus* (Ndifon and Ukoli, 1989). In this study *M. tuberculatus* was found
within a slow flowing or lotic and shallow drainage channel. This agreed with habitat preference of *M. tuberculatus* described by Duggan (2002). Similar observations have been reported (Dudgeon, 1989; Gutierrez *et al.*, 1997) where *M. tuberculatus* prefer mud and silt substrates. According to Duggan (2002), *M. tuberculatus* has been reported to be absent at temperatures 32.70 to 37.80ºC but have been found in abundance at 29.00 to 30.00ºC. Similar observation was recorded in the present study (26.00 to 31.00ºC) which agreed with those reported elsewhere: 18.00 to 25.00ºC in United States (Murray, 1971), 21.00 to 31.00ºC in the United Arab Emirates (Ismail and Arif, 1993) and 27.00 to 29.00 ºC from a thermal station in Morocco (Laamrani *et al.*, 1997). The trends of temperature changes observed in this study and those of earlier reports suggested that *M. tuberculatus* might have invaded several lotic and shallow water bodies in southwestern, Nigeria. The environmental conditions recorded along the drainage channel falls within the reported environmental conditions for most water bodies in Nigeria which favour colonization of *M. tuberculatus*. According to Agbolade and Odaibo, (2004) high population of *M. tuberculatus* was reported at Omi stream, Ago-Iwoye confirming the spread of *M. tuberculatus* in southwestern, Nigeria.

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References


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