



Available online  
wjbr.interscholar.org

World Journal of Biological Research  
Revue Mondiale de la Recherche Biologique

World Journal of Biological Research 004: 2

Published: 27 September, 2011

## Morphological characteristics and Salinity tolerance of *Melanoides tuberculatus* (Muller, 1774).

Bolaji D.A<sup>1</sup>., Edokpayi C.A<sup>2</sup>., Samuel O. B<sup>2</sup>., Akinnigbagbe R.O<sup>1</sup>.and Ajulo A.A<sup>1</sup>

<sup>1</sup> Nigerian Institute for Oceanography and Marine Research. Victoria Island, Lagos. Nigeria.

<sup>2</sup> Department of Marine Sciences, Faculty of Science, University of Lagos. Akoka- Yaba, Lagos, Nigeria.

### Abstract

*Melanoides tuberculatus* has an elongated shell with regular increasing whorls, weakly curved ribs and much fine striation with reddish brown stripes on the shell. The lost of apex or last whorl are common among adult and a protective operculum in the aperture which is used to seal the snail in case of any disturbance or if it sensed any toxic chemical in the environment and this greatly slow down desiccation. There is strong significant correlation between whorl number and increase in shell length ( $r = 0.625$ ,  $P < 0.01$ ), suggesting that the higher the shell length the more whorls an individual possess. A bioassay of *M. tuberculatus* was carried out in the laboratory to determine the salinity tolerance of the invasive species at different salinity concentrations 25‰, 26‰, 27‰, 28‰, 29‰, 30‰. The analysis of variance showed significant difference ( $P < 0.05$ ) in the mortality of *M. tuberculatus* at different salinity concentration but Student Newman Keul's (SNK) test at ( $P=0.05$ ), showed no significant difference in the percentage mortality exposed to salinity of 25‰ to 28‰ and control for 24 hours. The salinity exposure of *M. tuberculatus* at 96hLC<sub>50</sub> (24.42‰) was 1.7 times more toxic than in 24hrs, 48hrs and 72hrs exposure. This suggests that *M. tuberculatus* might not be able to survive in marine waters due to salinity tolerance level that is not more than 25‰.

Keywords: *Melanoides tuberculatus*, Shell length, Whorl, Salinity tolerance, Biological control.

\*Corresponding author: Bolaji Dunsin A.

Email- [bdunsin@yahoo.com](mailto:bdunsin@yahoo.com)

Tel: 234-803-334-1739.

## Introduction

*Melanooides tuberculatus* is now been monitored worldwide because of its fast growing distribution and its economic importance. A freshwater mollusk that is a native of Africa and Asia has been reported to serve as intermediate host of several dangerous disease causing parasites (Russo, 1974; Jacobson, 1975; Murray, 1971; Dundee and Paine, 1977, Boguea *et al.*, 2005).

Surprisingly, little studies of this species have been published in Africa the acclaimed native of this species *M. tuberculatus*. 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. tuberculatus* has also been reported by few authors, Ndifon and Ukoli (1989) examine 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.

In the course of worldwide monitoring, *M. tuberculatus* has been reported to invade brackish and even marine water bodies of up to 33‰ salinity and under experimental condition survive extreme high condition of salinity up to 45‰.

This study considered the morphology of *M. tuberculatus* found within a quadrant and determines the salinity tolerance based on LC<sub>50</sub> that can influence survival in brackish and marine environments.

## Materials and Methods

Live specimens of *M. tuberculatus* were collected monthly from a quadrant of 200cm x 53cm in University of Lagos between lat. 6° 30' N and log. 3° 23' E, for morphological study and salinity tolerance. *M. tuberculatus* found within the quadrant were collected by scooping the drainage sediment with hand net 1mm mesh size and sieved within the overlaying water column. The collected *M. tuberculatus* retained within the sieve were poured into a plastic container, counted, measured with Vanier calipers and recorded Boguea *et al.*, (2005).

The shell length was obtained with the use of a divider and a meter ruler measuring from the apex to the topmost edge of the aperture and the number of whorls on each was counted, further observation was done under microscope and a magnifying lens. *M. tuberculatus* used for the anatomy studies were hand-picked from the laboratory control tank that was initially set up. The *M. tuberculatus* was anesthetized for 24 hours prior to the time they are used. They are

placed in small plastic dishes which contain water that covered just above the shell.

The snail was placed in a C-clamp and pressure was applied gradually until the shell cracked. Immediately the shell gave first sound of a crack, the pressure on the C-clamp was stopped and gradually the snail was released from the clamp. A pair of forceps was used to gradually remove the broken shells. The process was repeated until all the shell was removed and the soft body viewed. *M. tuberculatus* was then gradually turned or wound from its shell until the columella was broken and the animal was completely free from the shell. The removed soft body of *M. tuberculatus* was then placed in Petri dish for further observation. The morphological study of *M. tuberculatus* was according to Ruppert *et al.*, (2004).

The collected samples were transported to the laboratory and kept in a glass tank (22 x 14 x 17cm) acclimatized to laboratory and experimental conditions for a minimum of seven days before using them in laboratory bioassays in accordance with guidelines for bioassay technique (APHA 1992; Chukwu and Ogunmodede, 2005). Water and sediment from the natural environment were also collected so as to be able to simulate the natural environment. The sample used in the laboratory were hand-picked from the tank according to Chukwu and Ogunmodede (2005) in order to collect sizeable *M. tuberculatus* ranging from 22mm to 32mm in length.

Sediment collected from the study site was prepared after Otitoloju (2002), sun dried to allow for accurate monitoring of the number of organisms introduced into each tank during the experiment. The prepared sediment was spread out to form a thin bottom layer in each bioassay tank to serve as substrate in the test since the presence of substrate increased sensitivity of benthic organisms (Otitoloju and Don-Pedro, 2002). A total of 30 individuals of *M. tuberculatus* were used for salinity tolerance test for 96 hours to determined lethal concentration (LC<sub>50</sub>). The sample size used to test for salinity tolerance ranged from 22mm to 32mm in length. Different salinity range was prepared in triplicates using a salinometer (Model SR-6). The salinity range were prepared by diluting sea water with distilled water in the following order 25‰, 26‰, 27‰, 28‰, 29‰, 30‰ into a plastic tanks (26 x 17 x 15cm<sup>3</sup>) which contained 100g of dried sand collected from the natural environment.

## Assessment of Quantal Response (Mortality)

The *M. tuberculatus* was assumed dead if it failed to retreat its propodial foot into its shell upon prodding with glass rod or failure to protrude out of its shell

during the period of observation. Mortality was monitored and recorded every 24 hours for 96 hours. Statistical analysis for whorl and shell length measurement was carried out using SPSS package and the followings was determined mean, standard deviation, minimum, maximum and ANOVA following the procedures described by Ogbeibu (2005). Pearson correlation of whorl and shell length, LC50 using computed probit analytical method for student to Newman Keul's (Finney, 1971).

**Results**

A total of 283 individuals were collected within the quadrat throughout the period of sampling with mean shell length of 21.6mm. The minimum shell length was 1.0mm and maximum is 36mm while the dominant shell length was 23 mm. Shell length significantly correlate with number of whorls on *M. tuberculatus* ( $r = 0.625, P < 0.01$ ). The mean whorl was slightly above 8 while minimum whorl observed on the *M. tuberculatus* was 3 and the maximum was 11. The populations of *M. tuberculatus* within the quadrat generally fluctuate during the period of sampling. The minimum population of 20 individuals was observed in February and the maximum of 99 in July (Table 1). Shell length distribution over the period of study is presented in fig. 1.

The shell of *M. tuberculatus* is brownish and has an elongated body with increasing whorl size which terminates at the aperture. The whorl has much finer spiral groove and weakly transverse ribs most prominent near the top most whorl. The whorl of the organism is mainly 3 for a young one of about 1mm – 2mm while that of adult is about 8 – 11 whorls (Plate 1). Some of the individuals collected during this study were observed to have lost the last posterior whorl or apex; however a good number have their shell complete. When holding the shell with the spire pointing up the aperture is on the right side (Plate 2). On cleaning off the detritus and mud on the shell of *M. tuberculatus* new features was observed. Vertical lines of rusty brown spots which were more pronounced in the younger ones than adults (Plate 2). When active *M. tuberculatus* protrude its flattened head out, with mouth at the anterior part and a pair of tentacles at the base of the head from the posterior end where the tentacle protrudes is the eyes spot (Plate 3a) and it also posses an operculum and papillae attached to the mantle edge (Plate 3b). On cracking the shell open the visible structures were observed without dissection. The *M. tuberculatus* has partially retracted into the mantle cavity and the following were visibly identified mantle cavity, mantle collar, head, folded foot, operculum, columellar muscle, rectum line and digestive cecum (Plate 4).

Table 1: Summary of monthly measurement of size distribution within the quadrant from February to July 2006

Months	Parameters	Mean ± S.D	Min.	Max.	Total Number	Correlation
February	Length	27.2600±5.8095	15.00	33.00	20	0.703**
	Whorl	9.2000 ± 1.1517	6.00	11.00		
March	Length	23.3200±3.9552	19.00	35.00	25	0.025
	Whorl	9.8800 ± 0.8327	8.00	11.00		
April	Length	21.2917±3.4196	16.00	33.00	24	-0.229
	Whorl	8.7273 ± 1.1282	6.00	11.00		
May	Length	19.0938±2.8156	10.00	28.00	64	0.290*
	Whorl	8.0313 ± 0.8723	6.00	10.00		
June	Length	22.9412±3.0621	10.00	34.00	51	0.389**
	Whorl	8.6275 ± 0.8709	7.00	10.00		
July	Length	21.1111±7.2519	1.00	36.00	99	0.795**
	Whorl	7.7475 ± 1.5276	3.00	10.00		

\*\* Correlation is significant at the 0.01 level

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

**Salinity tolerance**

The results on the salinity tolerance of *M. tuberculatus* based on mortality response at 24hrs, 48hrs, 72hrs and 96hrs exposure are presented in Tables 4 and 5 and Appendices 4 and 5. The concentration that will cause 50% mortality of the *M. tuberculatus* (LC<sub>50</sub>) at

24hrs, 48hrs, 72hrs and 96hrs were 42.61‰, 33.26‰, 25.97‰ and 24.42‰ respectively (Table 2).

The analysis of variance showed that there was significant difference ( $P < 0.05$ ) in the mortality of *M. tuberculatus* at different salinity concentrations. Further analysis using the student to Newman Keul's (SNK) test at ( $P=0.05$ ), showed that there were no

significant difference in the percentage mortality of *M. tuberculatus* exposed to salinity of 25‰, 26‰, 27‰, 28‰ and the control for 24 hours (Table 3). At 48hrs of exposure the mortality of test animal to 29‰ showed significant difference from the control, 25‰, 26‰, 27‰ and 28‰. At 72hrs of exposure there were no significant differences in the mortality response of *M. tuberculatus* exposed to 25‰, 26‰ and 27‰ while a similar pattern was observed in 26‰, 27‰ and

28‰. However, *M. tuberculatus* exposed to 29‰ showed a significance difference ( $P < 0.05$ ) in their response when compared to those exposed to all other concentrations (Table 3). At 96hrs of exposure, *M. tuberculatus* exposed to 29‰ showed significant difference in its mortality from those exposed to all other concentrations. No significance difference was observed in the response of *M. tuberculatus* exposed to 27‰ and 28‰.

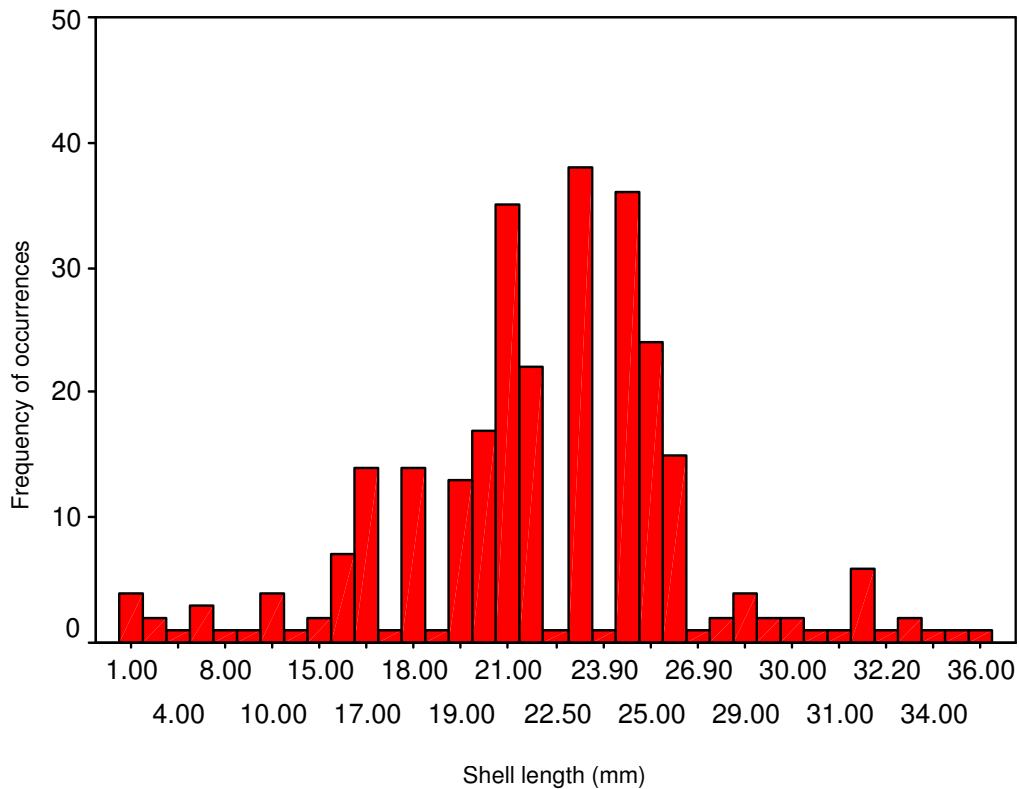


Fig. 1: Shell length distributions of *M. tuberculatus* over the period of sampling.

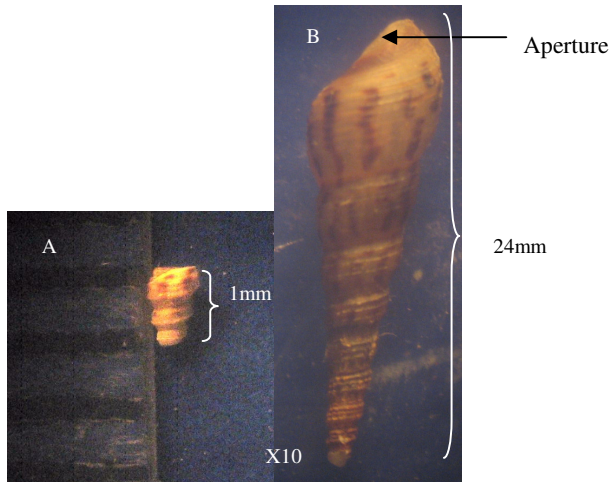


Plate 1: Shell length and whorl (A) Young one of 1mm with 3 whorls (B) Adult 24mm with whorl 9.

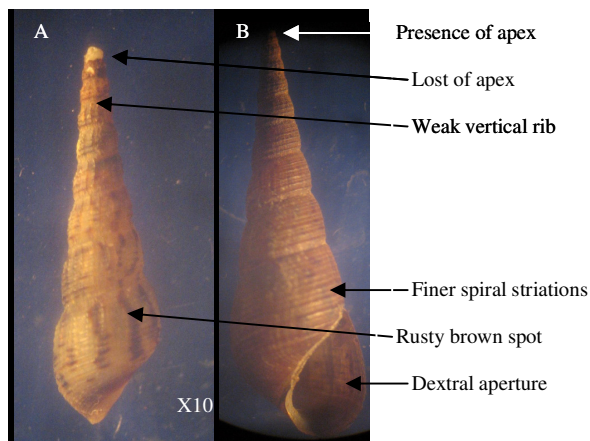


Plate 2: (A) Shell of *M. tuberculatus* with lost whorl or apex and (B) a shell with complete whorls and the position of the aperture as dextral

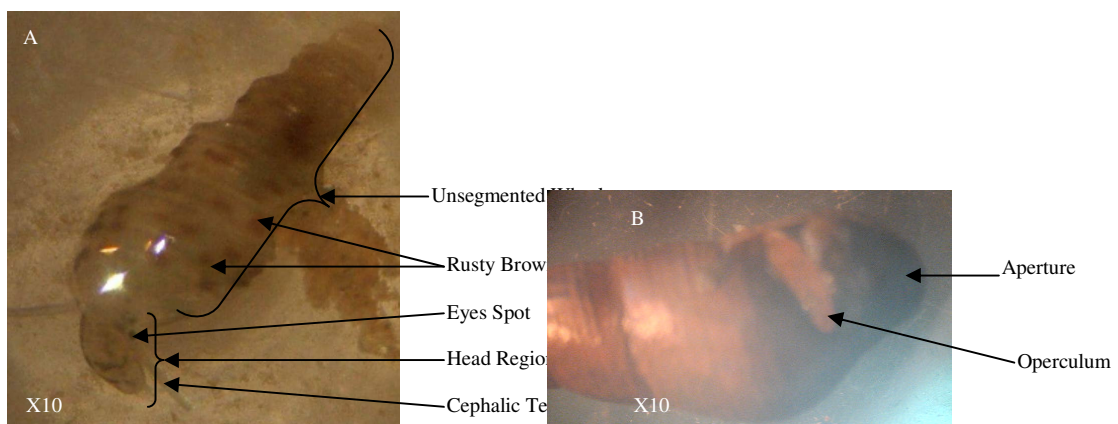


Plate 3: (A) External morphology of young *M. tuberculatus* and (B) Presence of operculum used to block the aperture when withdrawn

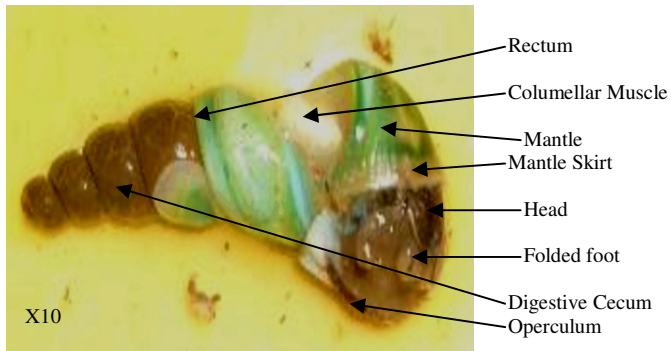


Plate 4: An adult *M. tuberculatus* after removed from shell

Table 2: Acute LC50, LC95, LC5 value for salinity tolerance of *M. tuberculatus* at 24, 48, 72, and 96 hours exposures

Time (Hrs.)	LC <sub>50</sub> (95% CL) ml/L	LC <sub>95</sub> (95% CL) ml/L	LC <sub>5</sub> (95% CL) ml/L	Slope ± S.E	D.F	Probit Equation	T.F
24	42.61 (----)	34.25 (----)	27.54 (----)	17.35 ± 9.41	3	Y = -21.63 + 17.35X	1.0
48	33.26 (29.95- 76.22)	46.56 (35.65 - 85.25)	23.76 (0.12 - 25.66)	11.26 ± 5.60	3	Y = -12.12 + 11.26X	1.3
72	25.97 (23.40- 26.94)	34.76 (31.15 - 63.78)	19.41 (8.98 - 22.27)	13.00 ± 4.66	3	Y = -13.39 + 13.00X	1.6
96	24.42 (21.40-25.42)	30.22 (28.68 - 36.32)	19.72 (12.86- 22.10)	17.75 ± 5.30	3	Y = -19.63 + 17.75X	1.7

LC = Lethal concentration CL = Confidence limit  
 D.F = Degree of freedom T.F = Toxicity factor

$$T.F = \frac{LC_{50} \text{ 24 hours}}{LC_{50} \text{ at any other period of time}}$$

Table 3: Percentage Mortality of *M. tuberculatus* exposed to different salinity concentration

Concentration (‰)	Number of <i>M. tuberculatus</i>	Percentage Mortality / (‰) Time (hrs)			
		24	48	72	96
Control	30	0.0 <sup>a</sup>	0.0 <sup>a</sup>	0.0 <sup>a</sup>	0.0 <sup>a</sup>
25	30	0.0 <sup>a</sup>	10.0 <sup>b</sup>	30.0 <sup>b</sup>	60.0 <sup>b</sup>
26	30	0.0 <sup>a</sup>	10.0 <sup>b</sup>	50.0 <sup>bc</sup>	66.6 <sup>b</sup>
27	30	3.3 <sup>ab</sup>	13.3 <sup>b</sup>	56.6 <sup>bc</sup>	76.6 <sup>c</sup>
28	30	6.6 <sup>ab</sup>	20.0 <sup>c</sup>	63.3 <sup>c</sup>	83.3 <sup>c</sup>
29	30	10.0 <sup>b</sup>	23.3 <sup>d</sup>	76.6 <sup>d</sup>	93.3 <sup>d</sup>

Values with same superscript letter in a column are not significantly different in the SNK test (P=0.05).

## DISCUSSION

The dominant shell length observed was 23.00mm which closely agrees with Duggan (2002), who reported 25.00mm as the dominant size and a shell length of 0.5 - 32.00mm in New Zealand. The shell range obtained in present study is slightly higher (1.00 – 36.00mm) and this agrees with Thompson (1984) who reported 30.00 – 36.00mm as the typical shell size, although larger specimens, 70.00 -80.00mm have been reported (Murray, 1975).

Using the dominant shell length and the mean length observed the highest population range, 21-25mm could be as a result of slow growth pattern following a parthenogenesis reproduction which allows long generation time and therefore group domination could arise.

Some authors have described *M. tuberculatus* as typically having 5 whorls (Lee, 1973). Result obtained from the present study shows that there is strong significant correlation between whorl number and increase in shell length ( $r = 0.625$ ,  $P < 0.01$ ), suggesting that the higher the shell length the more whorls an individual will possess as against the notion of typical 5 whorl as if this is maintained irrespective of the shell length. The minimum whorl observed consistently for all shell size 1mm was 3 whorls and the mean whorl over the period was 8 whorls which does not agree with the typical description adopted by some authors describing *M. tuberculatus* has having 5 whorls. *M. tuberculatus* has also been reported to attain 25mm length before reproduction which could be the possible reason why the dominant shell length observed is around this range.

The morphology observed agrees with reported descriptions of *M. tuberculatus* by several authors. Lee (1973) reported the shell to be elongated with regular increasing whorls, weakly curved ribs and much fine striation, which agrees with the observed description in the present study. An exact description was also reported by Duggan (2002) who also pointed out the red or reddish brown base, although Duggan (2002) did not report reddish brown stripes on the shell. The lost of apex or last whorl in some specimens observed in the present study has earlier been reported by Lee (1973). Mitchell (2006) reported the presence of operculum in the aperture which is used to seal the snail in case of any disturbance or if it sensed any toxic chemical in the environment and this greatly slows down desiccation.

This probably could explain the survival of *M. tuberculatus* along this channel that is dredge yearly. Since they can greatly slow down desiccation, that means they could stay out of the water, among the dredged mud till some are washed back into the channel. Another possible reason that could be

associated to continuous colonization of the channel is the ability of *M. tuberculatus* to attach itself to water surface and float as observed in the present study. This could also allow many to remain in the water column even if the mud sediment dredged and sediment later settle down, although this phenomenon is presently not fully understood.

Several authors have used *M. tuberculatus* in biological assessment (bioassay) in view of its competitive ability observed with *Biomphalaria glabrata* an intermediate host of *Schistosoma mansoni*. In order to increase the efficiency of controlling *B. glabrata* using *M. tuberculatus* some molluscicides are been combine with *M. tuberculatus* to determined the LC<sub>50</sub>. Giovanelli *et al.* (2002) tested the susceptibility of *M. tuberculatus* to Niclosamide and reported the same range of LC<sub>50</sub> and LC<sub>90</sub> for *M. tuberculatus* and *B. glabrata* which suggested a disadvantage when *M. tuberculatus* is combined with Niclosamide in a biological control.

The salinity tolerance of *M. tuberculatus* in present study showed a gradual decrease in tolerance as exposure time increases. Although *M. tuberculatus* has been reported to survive salinity as high as 30‰ (Russo, 1973; Roessler *et al.*, 1978), the observation from the present study showed a complete deviation from this as 100% mortality was recorded within 48hrs of introduction into salinity of 30‰, suggesting intolerance of *M. tuberculatus* to this salinity. This could possibly be a limiting factor to the spread or invasion of *M. tuberculatus* into some brackish or marine environment.

The acute toxicity level based on the 96hLC<sub>50</sub> value (24.42‰) was found to be more toxic on *M. tuberculatus* exposed for 96hrs, than each of the other exposure period (24hrs, 48hrs, and 72hrs). Analysis of variance (ANOVA) showed a significant difference ( $P < 0.05$ ) in the mortality response of *M. tuberculatus* to different salinity level at 24, 48, 72 and 96 hours of exposure. The salinity exposure of *M. tuberculatus* at 96hLC<sub>50</sub> was 1.7 times more toxic than in 24hrs, 48hrs and 72hrs exposure. This suggests that *M. tuberculatus* might not be able to tolerate salinity more than 25‰ which agrees with the report of Danielle and Daniel (2005) of tolerance level of less than 26.4‰ for some group of invasive species in New Zealand, however, the laboratory experiment might not translate to actual natural environment situation.

## ACKNOWLEDGEMENT

I wish to thank the member of staff of Postgraduate Marine Sciences Laboratory, University of Lagos for providing the needed materials and equipment to aid this study as well as all reviewers.



## REFERENCES

- Agbolade, O.M. and Odaibo, A.B. (2004).** Dockovdia cookarum infestation and the prosobranch gastropod *Lanistes libycus* host in Omi stream, Ago-Iwoye, South-western, Nigeria. *African Journal of Biotechnology*, **3(3)**: 202-205
- American Public Health Association (APHA) (1992).** *Standard Methods for the Examination of Water and Wastewater* 18th edn. Washington D. C, American Public Health Association, 1268pp.
- Bogea, T., Cordetro, F.M. and Gouveja, J.S. (2005).** *Melanooides tuberculatus* (Gastropoda: Thairidae) As Intermediate Host of Heterophyidae (Trematoda: Digenea) In Rio Janeiro Metropolitan Area, Brazil. *Rev. Inst. Med. Trop. S. Paulo* **47(2)**: 87-90.
- Chukwu, L.O. and Ogunmodede, O.A (2005).** Toxicological response and sensitivity of estuarine macro-invertebrates exposed to industrial effluents. *Journal of Environment Biology*. **26(3)**: 323-327.
- Duggan, I.C. (2002).** First record of a wild population of the tropical snail *Melanooides tuberculata* in New Zealand natural waters. *New Zealand Journal of Marine and Freshwater Research* **36**: 825-829.
- Dundee, D.S. and Paine, A. (1977).** Ecology Of The Snail *Melanooides tuberculata* (Müller), Intermediate Host Of The Human Liver Fluke (*Opisthorchis Sinensis*) In New Orleans, Louisiana. *The Nautilus* **91(1)**:17-20.
- Finney, D.J. (1971).** *Probit analysis* 3<sup>rd</sup> Ed. Cambridge University Press, London. 318pp.
- Giovanelli, A., Coelho da Silva, C. L.P.A., Medeiros, L. and Vasconcellos, M.C. (2002).** The Molluscicidal Activity of Niclosamide (Bayluscide WP70®) on *Melanooides tuberculata* (Thiaridae), a Snail Associated with Habitats of *Biomphalaria glabrata* (Planorbidae). *Mem Inst Oswaldo Cruz, Rio de Janeiro* **97(5)**: 743-745.
- Jacobson, M.K. (1975).** The Freshwater Prosobranch, *Tarebia granifera*, In Oriente, Cuba. *The Nautilus* **89(4)**:106.
- Laamrani, H., Khallayoune, K., Delay, B., Pointier, J. P. (1997).** Factors affecting the distribution and abundance of two prosobranch snails in a thermal spring. *Journal of Freshwater Ecology* **12**: 75–79.
- Lee, V. (1973).** Some Common Snails Of Vegetable Fields In Hong Kong. *Agriculture Hong Kong* **1(2)**:123-129.
- Mitchell, A.J. (2006).** The effect of chemical treatments on *Melanooides tuberculatus*, a snail that vectors an important fish trematode. *Aquaculture America*. 190.
- Mkoji, G.M., Mungai, B.N., Koech, D.K., Hofkin, B.V., Loker, E.S., Kihara, J.H., Kageni, F.M. (1992).** Does the snail *Melanooides tuberculata* have a role in biological control of *Biomphalaria pfeifferi* and other medically important African pulmonates? *Ann Trop Med Parasitol* **86**: 201-204.
- Murray, H.D. (1975).** *Melanooides Tuberculata* (Müller), Las Morras Creek, Bracketville, Texas. *Bulletin Of The American Malacological Union, Inc.*:43.
- Murray, H.D. (1975).** *Melanooides Tuberculata* (Müller), Las Morras Creek, Bracketville, Texas. *Bulletin Of The American Malacological Union, Inc.*:43.
- Ndifon, G. T. and Ukoli, F. M. A. (1989).** Ecology of freshwater snails in south-western Nigeria. I. Distribution and habitat preferences. *Hydrobiologia* **171**: 231–253.
- Ogbeibu, A.E. (2005).** *Biostatistics-A practical Approach to Research and Data Handling*. Mindex Press, Ugbowu, Benin City. 264pp.
- Otitoloju, A.A. (2002).** Evaluation of the joint actiontoxicity of binary mixture of heavy metals against the mangrove periwinkle *Typanotomus fuscatus* var *radula* (L.). *Ecotoxicology and Environmental Safety*. **53**: 404-415.
- Otitoloju, A.A. and Don-Pedro, K.N. (2002).** Establishment of the toxicity ranking order of heavy metals and sensitivity scale of benthic animals inhabiting the Lagos Lagoon. *West Africa Journal of Applied Ecology* **3**: 31-41.
- Roessler, M.A., Beardsley, G. L. and Tabb, D. C. (1978).** New records of the introduced snail, *Melanooides tuberculata* (Mollusca: Thiaridae) in south Florida. *Florida Scientist* **40**:87-94.
- Ruppert, E. E., Fox, R. S. and Barnes, R. B. (2004).** *Invertebrate Zoology, A functional*

*evolutionary approach*, 7<sup>th</sup> ed. Brooks Cole  
Thomson, Belmont CA. 963 pp.

**Russo, T. N. (1974).** Discovery Of The Gastropod  
Snail *Melanoides* (Thiara) *tuberculata*  
(Miiller) In Florida. *Florida Scientist* **36(2-  
4)**:212-213.

**Thompson, F. G. (1984).** *The freshwater snails of  
Florida: a manual for identification.*  
University of Florida Press, Gainesville. 94  
pp.

#### **E-REFERENCE**

**Danielle, M.C. and Daniel, P.M. (2005).** New Zealand  
Mudsnail- *Potamopyrgus antipodarum*.

<http://www2.montana.edu/nzms/>