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Full Length Research Paper

Snail abundance in freshwater canals in the eastern province of Saudi Arabia and acute toxicity studies of copper sulphate in *Biomphalaria arabica* and *Lymnaea auricularia*

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The present study aimed to investigate the distribution of three species of freshwater snails, namely; *Biomphalaria Arabica*; Planorbidae, *Lymnaea auricularia*; Lymnaeidae and *Melanoides tuberculatus*; Thiaridae in two different parallel canals (the concrete irrigation and the earthen drainage canals) in the eastern province of Saudi Arabia and the effect of copper sulphate pentahydrate ($CuSO_4.5H_2O$) on mortality of the first two species after 24 h of exposure. The physico-chemical properties of the water especially, temperature and pH were determined as important factors for snail distribution. The results show that the water temperature and the pH of the two canals were almost the same. The range of water temperature was 25.8 to 28.3°C, while the water pH was 6.6 to 6.8. The two canals were occupied by three species of aquatic snails viz. *B. arabica*, *L. auricularia* and *M. tuberculatus*. The bioassay of $CuSO_4.5H_2O$ on only two snail species showed 24 h–LC_{50} as 5.7 ppm for *B. arabicus* and 7.8 ppm for *L. auricularia*. This result reveals that $CuSO_4.5H_2O$ was highly effective in snail eradication. On the basis of the present study, it is recommended that some further studies on the canals including all environmental factors should be investigated for their role in aquatic snail distribution. However, the chronic effect of lower lethal dose of $CuSO_4.5H_2O$ on the snails mortality and their effects on developmental stages should be investigated, and some local plant extract should also be tried for their potency on snail mortality.

Key words: *Biomphalaria*, *Lymnea, Melanoides*, distribution, freshwater snails, copper sulphate, Saudi Arabia.

INTRODUCTION

The phylum Molluska comprises animals of diverse shapes, and sizes occupying different habitats (SubbaRao 1993). Mollusks are divided into aquatic and terrestrial communities. The role of mollusks in the dynamics of the aquatic ecosystem and their contribution to biomass production is not well understood. The freshwater habitat is relatively poor in comparison to the marine habitats. Marine mollusks have received more attention because their shapes and colors been more attractive and more edible than freshwater mollusks (Supian and Ikhwanuddin, 2002). The existing freshwater snails are approximately 5.000 species that occupy lakes, ponds and streams worldwide (Abbott, 1950). Fluctuation of water levels and summer draught negatively affect the population dynamics of the freshwater snails as well as the trematode parasites, both of which are replenished when conditions are improved (G´erard, 2001).

Snails in the *Biomphalaria* genus are used as the intermediate host of *Schistosoma mansoni*. Schisto-somaiasis or bilharzia is one of the serious health problems. This disease is transmitted by some freshwater mollusks like *Biomphalaria arabica*, *Bulinus globosus* and *Onclomelana hupensis. Schistosomiasis* is the disease that affects more than 200 million people in the tropical and subtropical areas of the world. The fight against bilharzia is one of the most important challenges in

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tropical countries (Aladesanmi, 2007). The distribution of the disease is determined, to a large extent, by the presence or absence of *Biomphalaria* sp. snails (Opisa et al., 2011). *S. mansoni* causative agent of intestinal bilharzia is transmitted by snails of the genus *Biomphalaria*. Shistosomiasis is controlled through disrupting its life cycle. Snails, which are intermediate host of *S. mansoni*, the trematode that causes the disease, once destroyed, will prevent miracidium from changing into the infective stage, the cerecaiae (Ali, 2011). One of the methods used in control of this disease is the use of molluscicides (Aladesanmi, 2007). Extracts obtained from different parts of plants such as leaves of *Solanum nigrum* and *Sarcophrynium villosum* were used against *Biomphalaria alexandrina* (El-Sherbini et al., 2009). Sharf El-Din et al. (2010) found a positive correlation between cadmium concentration and infection rate of *B. alexandrina* snails, while they found negative correlation between the infection and concentrations of copper, lead and mercury in Egypt. Bakry (2009) used plant extract to eliminate *B. alexandrina* snails. Rawi et al. (2011) used flowers and leaves extract of *Ammi majus* and *Canna indica* to test mortality of *B. alexandrina* and compared their toxic potential with $CuSO_4.5H_2O$. Many plant extract are under test for their potent effects on the snail mortality.

The snail *Lymnaea auricularia* (Muller) is the intermediate host of *Fasciola hepatica* (Linnaeus, 1758). Exposure of the freshwater pulmonate snail, *Lymnaea luteola* to Cu at concentrations of 100 to 320 mg L^{-1} for 168 h caused serious effects on embryonic development of snails such as: malformation of foot and eyes, thinness and incomplete formation of shell, growth retardation and slow rotation of embryo within the egg (Khangarot and Das, 2010). *F. hepatica* is capable of infecting a wide range of mammals including sheep and cattle. Rabbits act as reservoir hosts. Fascioliosis is distributed worldwide and the amphibious snail *Lymnnaea trunculata* plays an important role in the epidemiology of fasciola infection (Gasniera et al., 2000). A comparison of environmental associations shows that the majority of common freshwater gastropods (e.g. *L. auricularia and Bathyomphalus contortus*) preferred dam reservoirs and old river beds and avoid the fish ponds (Michalik-Kucharz, 2008). Breeding of the amphibious snails such as *L. truncalata* is very difficult under laboratory conditions, since they require suitable conditions for their growth. Several sources of food have been proposed to obtain higher production of metacercariae. Most of these methods are based on the culture of microalgae as food for snails, while others use a food composed of dried leaves of several plant species and calcium salt (Rondelaud et al., 2002).

Bilharziasis rate in Saudi Arabia (KSA) was 2.78/ 100,000 (Bin-Dajem et al., 2011). The genetic fingerprint (RAPD-PCR) may be helpful for the identification of *B. arabica*, the causative agent of bilharziasis. The present work aimed to find out whether $CuSO_4.5H_2O$ can be used for eradication of the freshwater snails from Saudi Arabia.

MATERIALS AND METHODS

Freshwater snails of *B. arabica* (Melvill and Ponsonby, 1896), *L. auricularia* (Linaeus, 1758) and *Melanoides tuberculatus* (Muller, 1774*)* were collected from four sites of two different types of canals: the concrete irrigation canal and the earthen drainage canal of Al-Hassa (the eastern Province of Saudi Arabia). The drainage canal network runs parallel to the irrigation canals (Siddiqui, 1981). They are shallow small water bodies with slow current and covered by aquatic vegetations. The water temperature and pH were measured at four sites in irrigation and drainage canals from where the snails were collected. The pH and temperature were determined using a pH meter with a glass electrode and a temperature probe. The snails were stocked in tanks in the laboratory and fed with tilapia feed. A stock solution of $CuSO_4.5H_2O$ was prepared in double distilled water. 20 specimens of *B. arabica* and *L. auricularia* were placed in different concentrations (2, 4, 6, 8, 10 and 12 µg/l) of $CuSO_4.5H_2O$ prepared from stock solution. Two replicates of each species were maintained under the same experimental conditions as control. After 24 h, the heart beat of the snails was observed under the binocular microscope in order to determine whether the snails were dead or alive.

Statistical analysis (ANOVA) was used to compare the abundance of the snails in irrigation and drainage canals, the differences in water quality (pH and temperature) and the effect of $CuSO_2.5H_2O$ on snail mortality.

RESULTS

The physico-chemical characteristics of the water

The most important physico-chemical characteristics for the distribution of freshwater snails are temperature and pH. The temperature of the earthen drainage canal was found to be 27.5°C (25.8 to 28.3) and 27.75°C (25.8 to 28.3) in the concrete irrigating canal (Table 1). The pH of the water was found to be 6.75 (6.6 to 6.8) in the earthen drainage canal and 6.83 (6.6 to 7) in the concrete irrigating canal. The difference in the water temperature and pH values between the two canals was insignificant (P>0.05)

Identification and distribution of snails

A total of 1072 freshwater snails (Figure 1) were collected from four sampling sites of the drainage canal and irrigating canal. Three species, *B. arabica* (18.6%), *L. auricularia* (42.8%) and *M. tuberculatus* (38.6%) of the snails were identified to belong to the families: Planorbidae, Lymnaeidae and Thiaridae, respectively. Table 1 shows the average number of snails per sample in the drainage canal as 21.25 (1- 49) specimens of *B. arabica*, 34.5 (1-78) specimens of *L. auricularia* and 93.75 (10 -240) specimens of *M. tuberculatus.* The number of snails per sample in the concrete irrigating

Table 1. Distribution of *B. arabica*, *L. auricularia* and *M. tuberculatus*, and physico-chemical characteristics of water of drainage and irrigation canals.

Snail species	Earthen drainage canal	Irrigation concrete canal
Biomphalaria arabica	21,25 (1- 49)	28.5 (1-64)
Lymnaea auricularia	34.5 (1 -78)	81.25 (4-280)
Melanoides tuberculata	93.75 (10 -240)	91.0 (12-260)
Physico-chemical characteristics		
Water temperature C^{o})	28.5 (25.8 – 28.3)	28.75 (25.8 – 28.3)
Water (PH)	6.75 (6.6 -6.8)	6.83 (6.6 -7)

Mean values and range in parentheses.

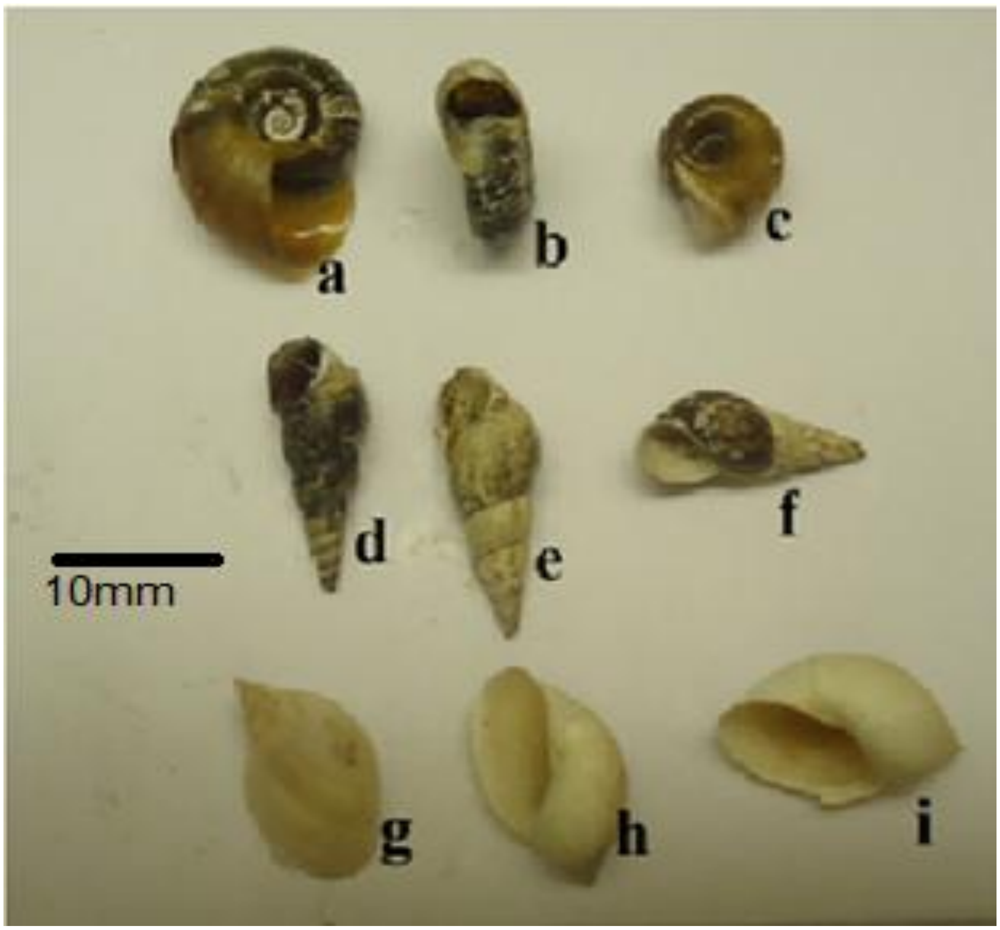

Figure 1. Freshwater snails from the eastern province of Saudi Arabia; a, b, c, *B.arabica*; d, e, f, *L. tuberculatus*; g, h, I, *M.auricularia*.

canal was 28.5 (1 to 64) specimen of *B. arabica*, 81.25 (4 to 280) specimens of *L. auricularia* and 91.0 (12 to 260) specimens of *M. tuberculatus*. The *P* values indicated that there were no significant differences (P>0.05) in the distribution of snails in the two canals and between the different samples.

Bioassay of copper sulphate

The 24 h LC_{50} of $CuSO_4.5H_2O$ for *B. arabica* and *L. auricularia* was determined as shown in Figures 2 and 3, respectively. LC_{50}-24 h for *B. Arabica* was registered as 5.8 ppm and 7.8 ppm for *L. auricularia*. The difference

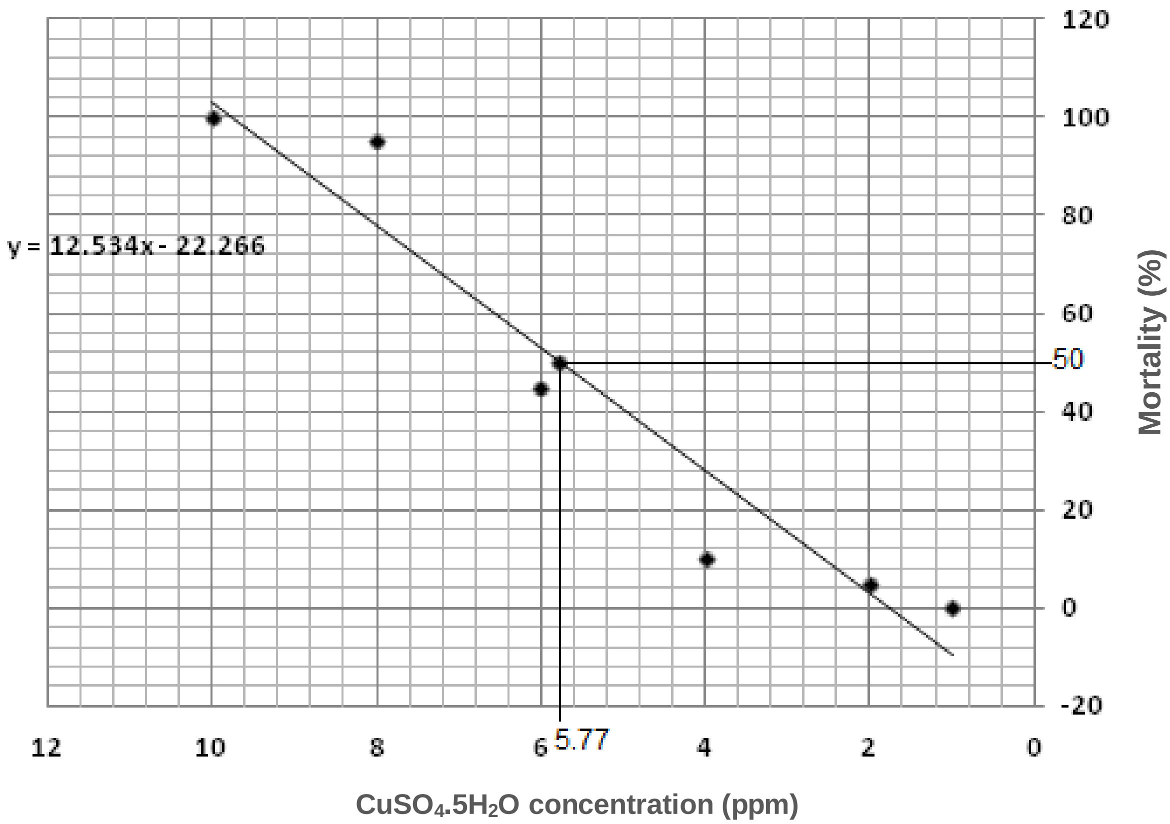

Figure 2. Sublethal concentration (LC_{50}) of copper sulphate ($CuSO_4.5H_2O$) in the freshwater snail, *B. arabica* after 24 h of exposure.

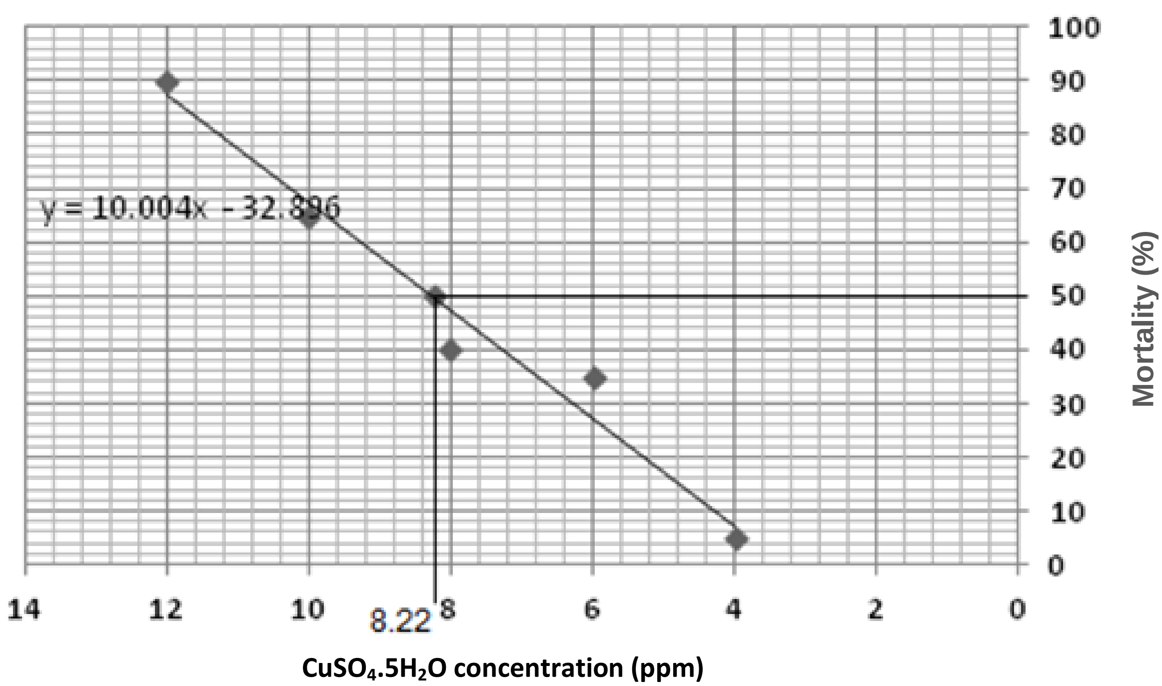

Figure 3. Sublethal concentration (LC_{50}) of copper sulphate ($CuSO_4.5H_2O$) in the freshwater snail, *L. auricularia* after 24 h of exposure.

between the two values for the two species of snails was not significance (P> 0.05)

DISCUSSION

Water quality studies of temperature and pH of the canals revealed that there is no significant difference between the drainage canal and irrigating canal of the eastern province of Saudi Arabia (P>0.05). It seems that freshwater snail distribution depends mainly on the physico-chemical properties of the water, especially temperature and pH. The present study revealed that the three species of snails viz. *B. arabica* (intermediate host of *Schistosoma mansoni)*, *L. auriculria* (intermediate host of *Fasciola hepatica*) and *M. tuberculatus* (intermediate host of several species of digenetic trematodes, (Ben-Ami and Heller, 2005) were dominant in both drainage and irrigation canals. The distribution pattern was tested with ANOVA which showed neither significant difference in distribution between the canals nor between the snail species. The present work revealed that $CuSO_4.5H_2O$ induced potent toxic effect on aquatic snails. The 24 h LC_{50} of $CuSO_4.5H_2O$ was found to be 5.8 ppm for *B. arabica* and 7.8 ppm for *L. auricularia.*

Pitchford (1958) stated that the occurrence of species in habitat is regulated by many environmental factors acting together in combination. These factors are size, volume and depth of the water. The richness of the water body, that is, rich (eutrophic) or poor (oligotrophic) is of great importance to aquatic animal distribution. Pitchford (1958) also mentioned that swamps, canals and ditches are always shallow enough to permit eutrophic conditions when they are favored by other factors such as water movement, plant shelter, temperature and nutrient availability. In this study, both canals shared many similar factors. Both canals are shallow small water bodies of slow current and covered with aquatic vegetations, and have similar temperatures. So, the three species of aquatic snails: *B. arabica*, *L. auricularia* and *M. tuberculatus* were found in both canals. Siddiqui (1981) studied the distribution of snails in the irrigation canal and the swamps. The irrigation canal was occupied by *M. tuberculatus*, *L. auricularia* and *Planorbis* sp. The present study shows that the irrigation and drainage canals were both occupied by *B. arabica*, *L. auricularia* and *M. tuberculatus*; a similar finding to that of Brown and Wright (1980). However, future studies are encouraged to show all the factors that may contribute to the aquatic snail distribution in the canals.

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