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# Prevalence of *Schistosoma japonicum* infection of *Oncomelania quadrasi* snail colonies in 50 irrigated and rain-fed villages of Samar Province, the Philippines

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**Abstract**

A cross-sectional survey of *Oncomelania quadrasi*, the intermediate host for *Schistosoma japonicum*, was conducted between 2004 and 2005 in 50 villages of the Province of Samar, the Philippines. The villages were classified as rain-fed (25) or with some man-made irrigation system (25). The primary objective was to identify all snail colony sites in the 50 villages and to compare snail population density and *S. japonicum* infection prevalence between the two types of villages. The presence of snail colonies was surveyed along streams, springs, various canals and swampy areas or grass land. A total of 198 colony sites were identified out of the 845 sites surveyed. Of these, a sufficient number of *O. quadrasi* snails were identified to measure density and infection in 147 sites. Density of *O. quadrasi* was remarkably uniform across habitats and there were no significant differences across habitats and between village type. The prevalence of infected snails showed more variability among habitats. Indeed, there was an interaction between the type of habitat and the type of village with irrigated villages being associated with a prevalence proportion ratio of 5.76 (1.31, 25.42) as compared to rain-fed villages among streams and springs. No such association was found among other habitats. The results suggest that once a suitable habitat exists, *O. quadrasi* populations establish and reach a plateau density. These results are discussed in light of possible ecological measures of control.


*Keywords:* *Oncomelania*; Schistosomiasis; Irrigation; The Philippines

## 1. Introduction

Schistosomiasis due to *Schistosoma japonicum* remains a public health concern in parts of the Philippines (Leonardo et al., 2002). Despite regular and ongoing attempts to keep the prevalence of *S. japonicum* infection at a low level, the infection persists in some areas of the Philippines, such as Samar. This is believed to be partly due to the zoonotic nature of transmission (McGarvey et al., 2006). The prevalence of infection in animals and humans is very heterogeneous across villages and infection has been found in cats, cattle, dogs, goats, pigs, rats and water buffaloes (Fernandez et al., 1982; Carabin et al., 2005; McGarvey et al., 2006; Fernandez et al., 2007). It has been reported that intensified water usage through creation of water distribution systems may result in creation of new habitats for the intermediate hosts and subsequently increase transmission (Yasuraoka, 1979).

The intermediate host, *Oncomelania quadrasi* was considered as a subspecies of *O. hupensis* but allozyme variation suggests that it should be recognized as a full species (Viyanant et

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al., 1987; Woodruff et al., 1988). *O. quadrasi* are small, amphibious and dioecious snails (Pesigan et al., 1958). Females tend to be larger than males, and eggs are laid singly on solid objects mostly above the water line (Pesigan et al., 1958). Hatching occurs after 10–25 days, depending on the temperature, and the newly hatched snails pass through an aquatic stage of 1–2 weeks. Snails reach sexual maturity after 10–16 weeks and may live for 24–35 weeks (Pesigan et al., 1958). The pristine habitat of *O. quadrasi* is flood plains, forests and swamps (Pesigan et al., 1958; Yasuraoka, 1979). Man-made habitats resulting from agricultural development, such as drainage channels, roadside ditches and small canals and drainage canals of irrigation works, are thought to be especially important habitats. Snails are found primarily on the banks but some are also found in very shallow water (i.e. depth less than 20 cm). Habitats preferred by *O. quadrasi* are shaded by vegetation, where the temperature is relatively constant and cool. Rice fields do not constitute an optimal habitat for *O. quadrasi* because they are rather unstable (Pesigan et al., 1958; Lipayon et al., 2002).

In Samar Province, a great variability in agricultural practices exists ranging from entirely rain fed to primarily irrigated culture with well-developed canal system. The prevalence of human infection was recently estimated to range from village-to-village between 0% (95% Bayesian credible interval (BCI): 0–3.1%) and 45.2% (36.5–53.9%) and between 0% (0–1.6%) and 23.0% (16.4–31.2%) for lightly and at least moderate intensity of infection, respectively (Tarafder et al., 2006). The area provided an opportunity to compare the density of the intermediate host snail, *O. quadrasi* and the prevalence of infection in the colonies between rain-fed and irritated villages.

## 2. Material and methods

### 2.1. Study area

A total of 50 villages, 25 with some man-made irrigation systems and 25 with mostly rain-fed culture, in Samar Province (Fig. 1) were selected on basis of irrigation infrastructure or absence of such, accessibility and location. More details on the selection of villages can be found elsewhere (McGarvey et al., 2006; Tarafder et al., 2006).

### 2.2. Mapping of the villages

Selected villages were carefully mapped before snail surveys were initiated. All water courses (natural streams, springs, irrigation canals of various types and drainage canals), ponds and swamps were traced by walking the entire distance along these and regularly taking GPS records. Maps were printed and brought to the field.

### 2.3. Snail sampling

Based on our preliminary surveys and literature (Pesigan et al., 1958), we established a list of criteria to where snail colonies should be searched. These criteria included the presence of well-shaded areas along streams, springs or various canals (drainage canals and others) and swampy areas or grass land (often currently unplanted rice fields). Areas of seepage and affluents and swampy sections next to streams wider than 1–2 m were also included. The following sites were excluded: streams wider than 1–2 m with steep banks which are very unlikely habitats (and usually very difficult to access) and rice fields which do not constitute an optimal habitat for *O. quadrasi*. Data collection took place between September 2003 and September 2004.

A team of three technicians walked the entire perimeters of all mapped major water bodies and systematically checked for potential snail sites meeting the above-mentioned criteria. These sites were then inspected for the presence of snails. For each snail site identified, a sample of 10 voucher specimens of *O. quadrasi* (if possible) was preserved in 70% ethanol (stored at Research Institute for Tropical Medicine). Quantitative sampling (see below) was done in sites where the 10 voucher specimens could be collected within 10 min. Sites where less than 10 voucher specimens were found were recorded as snail positive sites but were considered as newly established sites and no quantitative estimates of snail density and infection were conducted. Such sites with few snails were considered as temporary due to small habitat patches and the likely interference from agricultural activities leading to snail habitat destruction. Each site inspected was positioned on the map. For habitat sites with snails, the extension (length and width) of the snail-infested area was estimated.

### 2.4. Quantitative snail sampling

To get a reliable estimate of density within a sampling site, 30 ring samples were taken. The ring was 13.5 cm in diameter and all snails found within this area were collected. The sampling techniques were used according to the type of habitat and on the extension of the snail site. For streams, canals or other water courses where snails were found in a relatively narrow zone along which a 100-m stretch could be chosen, three ring samples 1 m apart were taken every 10 m along every transect. If a 100-m stretch could not be found, samples were spaced more closely. In more extensive habitats, such as swampy area, seepage or grassland, a 100-m stretch was selected and three ring samples 1 m apart (across transect line) were taken. The 100 m stretch usually covered the entire length of the snail colony (only three sites exceeded 100 m in length and in those cases the most accessible stretch was sampled). If a 100 m stretch could not be chosen, ring samples were placed more closely. In irregular habitats such as swamp or grassland, ring samples were placed so as to cover the entire area of the snail colony. For more extensive swamps, however, sampling was done along the periphery because it could be difficult to access the interior part. Snails collected within one ring sample were transferred to a pre-labelled envelope. A note indicating which plants provided shading was taken at the location of each ring sample.