ECOLOGICAL OBSERVATIONS ON *LYMNAEA (BULLASTRA) CUMINGIANA*

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Abstract. Field surveys conducted at Echague, Isabela and San Pablo, Laguna revealed that *Lymnaea (Bullastra) cumingiana,* the natural second snail intermediate host of *Echinostoma malayanum* in the Philippines, exhibits a moderate degree of diversity in its choice of habitats. Rice fields of all stages of development, stagnant shallow streams and springs are the main areas where the snail can be collected from at Echague, Isabela. However, they were absent in rice fields that had been extensively sprayed with molluscicides to control the "golden apple snail" *(Ampullarius canaliculatus).* In contrast, they were also very abundant in the highly eutrophic waters of Sampaloc lake, San Pablo, Laguna. *L. cumingiana* coexists with various species of insects, snails, fish and plants in these habitats. Information on ecological characteristics affecting its distribution will be useful for those who wish to collect and study this species in the future.

INTRODUCTION

The lymnaeids are freshwater snails which are found in nearly all parts of the world. Some species can tolerate a low amount of salt water, *eg Lymnaea rubiginosa* (Benthem Jutting, 1956).

They inhabit various habitats like grassfields, rice fields, ditches, canals, slow-moving streams, stagnant pools, swampy areas and other muddy places including man-made pools with aquatic vegetation (TROPMED Technical Group, 1986). Some species prefer stagnant shallow water or slow running ditches and brooks with muddy bottoms and an abundance of water plants. Other favorite abodes include backwaters of rivers and the pools or swampy depressions left behind on alluvial plains by receding floods (Bequaert, 1928).

In Indonesia, they inhabit all kinds of freshwater habitats. In Malaysia, they also thrive in slow-moving streams. In the Philippines as well as in Thailand, they prefer habitats with standing water (TROPMED Technical Group, 1986).

The ecological requirements of mollusks are such that a species is seldom uniformly distributed throughout its range. Instead, it is broken up into a number of populations between which are varying degrees of geographical isolation (Wright, 1960). This has led to the formation of races which may later lead to speciation.

Some lymnaeid species may exhibit semi-amphibious behavior. Since they are provided with "lungs" (a modified vascularized mantle cavity), certain species can survive drought for a time, especially in tropical countries where atmospheric humidity is relatively high. Some may even leave the water voluntarily. They do not always need to come to the surface to take in air through their pneumostomes as they may also respire through the skin or admit water into the pulmonary cavity or absorb the bubbles of air clinging to aquatic plants (Bequaert, 1928).

Lymnaea (Bullastra) cumingiana Pfeiffer has been established as a snail species of medical and potential public health importance in the Philippines since it has been proven to serve as natural second intermediate host of *Echinostoma malayanum* (Monzon and Kitikoon, 1989) and has likewise been incriminated in the transmission of human echinostomiasis, earlier misdiagnosed as "cathaemasiasis" (Jueco and Monzon, 1984), at Isabela province, northern Luzon (Cabrera *et al,* 1986).

The complete life cycle of *Echinostoma malayanum* in the Philippines has not yet been determined. Just as important but lacking as well is basic biological information regarding the snail host, *Lym-*

naea (Bullastra) cumingiana, which is more of an oddity among lymnaeid species in Southeast Asia due to its depressed spire, expansive foot and mantle and other unique features. Habitat preferences and other ecological parameters pertinent to its geographical distribution were therefore investigated in this paper.

Such information may contribute to future studies related to the epidemiology of echinostomiasis since not all provinces in the Philippines can support the snail's ecological requirements for establishing itself and not all those that can have local populations that consume snails raw. It will also facilitate the acquisition of living snail specimens should some investigators be interested in its collection from the field and laboratory cultivation for further experimentation.

MATERIALS AND METHODS

Lymnaea (Bullastra) cumingiana snails were collected by handpicking from all possible habitats in which they could be found in the municipality of Echague, Isabela province (Cagayan Region, northern Luzon) and at Sampaloc lake, San Pablo, Laguna (Southern Tagalog Region) during December 1988 to March 1989, January 1990 and May to June 1991.

Sampling was done purposively instead of randomly due to time and budgetary constraints as well as the potential dangers of working in communist infiltrated areas. The local people assisted in locating these habitats.

Characteristics of the collection sites were carefully observed and noted, particularly: topography, type of substrate, water depth, movement and pollution, accompanying macroscopic plant and animal species and other pertinent features related to the habitat.

RESULTS

Four distinct types of natural habitats were observed for *Lymnaea (Bullastra) cumingiana* during the course of field work studies at Echague, Isabela and Sampaloc lake, San Pablo, Laguna. Descriptions and salient features of these areas are summarized in Table 1.

At Echague, Isabela three different types of habitats were noted. The first and most common was rice fields in all stages of cultivation: early or newly plowed (with no rice planted in yet), intermediate (or with seedlings and young growing transplants) and late (or with fully mature rice plants close to harvest).

The substrate was basically muddy, soft, smooth and slippery in texture. *Lymnaea (Bullastra) cumingiana* could be found crawling above it. The water level remains low throughout the year (less than 20 cm) although it may rise slightly during irrigation and after a heavy rain or fall during the warm summer months. Correspondingly, water movement was negligible and limited to that brought about by rainfall, irrigation or strong winds. The snails could also be found abundantly inside the irrigation ditches or canals adjacent to the banks of the rice fields. They were occasionally found floating upside down on the water surface.

It was interesting to note the presence of these snails even in mature rice fields approaching harvest wherein the water level was very low. The snails could still be seen embedded in small water pockets on the muddy substrate.

During subsequent field trips, however, it became increasingly difficult to locate *L. (Bullastra) cumingiana* due to the extensive use of molluscicides to control and/or eradicate a recently imported agricultural pest, the "golden apple" snails *(Pomacea canaliculata* or *Ampullarius canaliculatus).*

The second type of habitat discovered for *L. (Bullastra) cumingiana* in Echague, Isabela was stagnant shallow streams whose depth was only slightly greater compared to that of the rice fields but whose movement was also minimal. These were bounded on the sides by diverse grasses, small shrubs, bushes and trees, providing shade along some portions of it. The substrate was also very muddy and the snails could only be located at the bottom substrate by touch due to high turbidity. The origin of the streams could not be traced exactly although it seemed to be a minor tributary of a nearby river. However, examination of the banks of the fast and flowing Cagayan river, which is the largest in the region, did not reveal this species.

The third type of habitat for this species at Echague, Isabela was in springs *("bukal")* which are natural overflows or points of escape from

Table 1

Natural habitats of *Lymnaea (Bullastra) cumingiana* in Echague, Isabela and San Pablo, Laguna, Luzon, Philippines.

Location	Description/Salient features of habitat
A. Echague, Isabela	1. rice fields in all stages of cultivation - also found in irrigation ditches or canals adjacent to rice field - muddy substrate - low water levels (<20 cm) with seasonal fluctuations - minimal water movement except during rain, irrigation and strong winds - generally high daily exposure to sunlight - water temperature: 20 - 40°C 2. stagnant shallow streams: - muddy substrate - low water levels (0.5-1.0 m) with seasonal fluctuations - minimal or slight water movement - moderate daily exposure to sunlight - water temperature: 20-35°C 3. springs *("bukal"):* - varied substrate consisting of soil, sand and small rocks - very low water level (< 5 cm) and usually constant - water movement: regular gentle trickle - generally low exposure to sunlight - water temperature: 20-25°C
B. San Pablo, Laguna	4. eutrophic freshwater lake: - varied substrate: mud, silt, sand, small and large rocks - water level moderate to high (1.0-3.0 m) - water movement present but intermittent, - light to moderate depending on wind velocity - high constant exposure to sunlight - water temperature: 18-25°C - moderate level of eutrophication

some underground reservoir of water. This rare habitat was unique and contrasted highly with the first two which were more common.

The spring was traced to its source and a slow constant trickle of water was seen emerging spontaneously from the substrate consisting of coarse soil, sand and small rocks. One had to search closely and carefully to locate the snails which blended well with the small rocks and dark greenish brown substrate. This habitat was the least exposed to sunlight due to abundant low-lying vegetation.

In San Pablo, Laguna, however, a totally different environment constituted the natural habitat of *L. (Bullastra) cumingiana.* They were collected abundantly from Sampaloc lake, a small shallow lake. Water depth ranged from moderate to high, compared to the first three habitats described, and the temperature was more or less constant throughout the day. The substrate was more heterogeneous and water movement was irregularly present due to variable wind action.

Just as in the rice fields, *L. (Bullastra) cumingiana* could sometimes be found floating upside down on the water surface or creeping on the substrate; however they were more often attached to stems, roots and undersides of leaves of various aquatic plants. Due to the presence of diverse artificial and man made structures in the lake (*eg,* nylon fish-

nets, plastics, bamboo rafts and canoes), they could also be located attached to these items which were often observed to be coated by thick growths of green algae.

The effects of human activity were evident here since fishpens, restaurants and local village houses surrounded the perimeter of the lake. A moderate level of eutrophication was observed due to the regular dumping of organic wastes by the local population. Pollution by non-biodegradable materials (plastic, styrofoam, etc) was also noted.

A slight difference in coexisting floral and faunal species was observed for *L. (Bullastra) cumingiana* collected from the two provinces which was probably due to differences in environmental conditions. The Isabela habitats were semi-terrestrial, amphibious or semi-aquatic while Sampaloc lake was purely aquatic. Floral and faunal species observed are summarized in Table 2. Microscopic plants and animals were not considered in the survey.

Coexisting snail species in both areas were very similar. Fish species were encountered only in the lake although some may have also been present in the rice fields, irrigation ditches and stagnant streams of Echague, Isabela but were unnoticed due to the turbidity of the muddy water. Various specialized aquatic insect groups as well as their larval stages were also observed.

However, the greatest difference was in the plant species encountered. The aquatic plants encountered in Sampaloc lake required perennial continuous contact with water while those from the Isabela habitats were more amphibious or terrestrial in nature. Lymnaeid egg masses were often found on the undersides of broad-leafed aquatic plants like water lilies, *Pistia stratiotes* and *Eichhornia crassipes* in contrast to the base of rice stems and on the muddy substrate in rice fields of Echague, Isabela.

DISCUSSION

There is hardly any available information in the existing scientific literature concerning the ecological distribution of *Lymnaea (Bullastra) cumingiana* in the Philippines. Although Abbott (1948) generalized that this species can be found in "small warm bodies of water among grass stems", this study revealed that it exhibits a moderate degree of diversity in its preference of natural habitats.

The four types of habitats encountered in this study (Table 1) had one common factor, namely, the generally static (lentic) nature of the body of water. Nevertheless, the snails could also tolerate a mild to moderate degree of water movement as shown by their presence in springs of Echague, Isabela and in Sampaloc lake, San Pablo, Laguna. But even then, water movement was usually nil and rarely vigorous in such habitats.

In Sampaloc lake, for example, water movement was generally slow and irregular, being totally dependent on wind action. Any disturbing effects could also be easily buffered by the thick growth of floating aquatic plants such as water hyacinth *(Eichhornia crassipes)* and water lettuce *(Pistia stratiotes)*. Laboratory acclimatization and cultivation experiments confirmed later this predilection for a calm aquatic environment since higher mortality was observed when vigorous or energetic aeration was provided (Monzon and Kitikoon, 1991).

Rice fields are the dominant habitat for this species in Echague, Isabela. This became very evident when difficulty was encountered in locating even just a few specimens during the early part of the study because of the recent heightened use of molluscicides in rice fields due to the farmers' drastic attempts to control the recently introduced but highly destructive "golden apple snails" *(Pomacea canaliculata = Ampullarius canaliculatus)* (Gastropoda: Ampullariidae), which were harming their rice crops. *Lymnaea (Bullastra) cumingiana* coexisted with these agricultural pests and was even more sensitive to the molluscicides as proven by the dramatic drops in their population density during that period. Inspite of its extreme sensitivity to these chemicals, the species nevertheless displayed some level of tolerance and adaptability to its environment.

Somehow this hardy species successfully manages to survive the heat and dessication that exist regularly during the day and especially the dry summer months. Tolerance to heat and wide fluctuations in temperature is a necessity for survival in shallow bodies of waters such as those encountered in Echague, Isabela.

Table 2

Floral and faunal species found coexisting with *Lymnaea (Bullastra) cumingiana* at Echague, Isabela and San Pablo, Laguna, Luzon, Philippines.

Location	Flora	Fauna
A. Echague, Isabela	rice *(Oryza sativa)* various grasses low lying shrubs and vines	Coleoptera: Dysticidae Hemiptera: Gerridae larval Odonata, Diptera Amphibia: Ranidae *Lymnaea (Radix) quadrasi* *Physastra hungerfordiana* *Pila luzonica* "golden apple snail" *(Pomacea canaliculata* or *Ampullarius canaliculatus)* *Bellamya philippinensis* *Indoplanorbis exustus* *Gyraulus* sp *Melanoides* sp
B. San Pablo, Laguna	*Egeria (Elodea) densa* *Nymphaea lotus* "water lilies" *Eichhornia crassipes* *Pistia stratiotes* *Ceratophyllium* sp *Cabomba* sp *Lemna* sp *Ipomoea* sp	Hemiptera: Gerridae larval Odonata and Arachnida *Tilapia* sp *Poecilia reticulata* *Ophicephalus striatus* *Lymnaea (Radix) quadrasi* *Physastra hungerfordiana* *Pila luzonica* "golden apple snail" *(Pomacea canaliculata* or *Ampullarius canaliculatus)* *Bellamya philippinensis* *Indoplanorbis exustus* *Gyraulus* sp *Melanoides* sp *Brotia asperata*

In tropical countries, the range of temperature experienced in a single freshwater habitat can be considerable as some swamp waters range from 10° to 42°C (Boycott, 1936). However, it should not be surprising if *L. (Bullastra) cumingiana* is also capable of this since Hunter (1964) noted that "the temperature range within which some freshwater molluscs can live practically corresponds to the absolute limits for metabolism in metazoan tissues". *Lymnaea peregra,* for example, exhibits phenomenal adaptability to temperature changes as it can survive up to 45° C in thermal water in the Pyrenees (Issel, 1908) but can also be found actively moving and feeding under ice in ponds in Scotland (Hunter, 1964).

After the rice is harvested, many rice fields become dry and *L. (Bullastra) cumingiana* cannot be found. However, the snails reemerge and are

once again abundant upon the arrival of the wet (rainy) season. Since it was observed that they can embed themselves in the mud when the water level is low, the possibility of estivation during summer should be considered and investigated.

Hunter (1964) reported that certain pulmonate species burrow into the surface soil before estivating, probably in order to achieve a microclimate of lower temperature. Even if conditions are good, estivation tends to occur whenever water content is low (Howes and Wells, 1934; Wells, 1944). On the other hand, it is also possible that these adult snails perish after harvest and the rice fields are once again recolonized by snails carried along by irrigation waters during the next planting season.

The versatility of this species was demonstrated in another way at San Pablo, Laguna. Sampaloc lake, which is only one out of seven lakes in the area, is moderately eutrophic due to the impact of human activities around it. Nets and bamboo enclosures surround the banks as the local people raise fish beside their houses, for personal consumption and as a source of additional income. Restaurants offering grilled fish (raised and caught from the lake), alcohol and entertainment are also plentiful. The lake also serves as their natural "latrine" since human excrement and garbage are thrown into it regularly.

As of 1976, Sampaloc lake, which has a maximum depth of 27.0 m and total surface area of 104 hectares, had 150 fishpens with an average area of 182.64 m^2. A limnological study conducted by Peace Corps volunteers showed that the general water quality of the lake was well suited for several fishes such as *Chanos chanos* (milkfish or "bangus"), *Tilapia* spp and various cyprinids (carp). However, 85% of the total lake volume is unsuitable for fish culture due to a thermocline layer extending only 10 m from the surface (Dalisay and Luna, 1978).

Inspite of all the obvious pollution, *Lymnaea (Bullastra) cumingiana* appears in abundance and reaches mature adult sizes comparable to those of specimens collected from Echague, Isabela. In general, molluscs are most plentiful in eutrophic lakes with hard water, less common in oligotrophic lakes and absent from certain dystrophic lakes with little calcium (Hunter, 1964).

However, some differences in physical and behavioral characteristics were observed for specimens collected from the two provinces. Although both seemed to be grazing for algae and other microscopic organisms on the substrate on which they crept on, those from the lake seemed to have developed a scavenging feeding habit as well. They could often be found attached and apparently feeding on decaying plant stalks. The overall color of the snail, especially when the mantle covers the entire shell, is greenish black for specimens collected from the lake but olive green for specimens collected from the rice fields of Echague, Isabela. Lastly, the movement of the lake specimens was very slow and sluggish as compared to the specimens from Echague, Isabela which were fast and active. These characteristics seem to be environmentally influenced since juvenile snails raised from eggs laid by adults from both provinces in the laboratory turned out to be similar with regards to eating habits, body color and movement.

A temporary behavioral adaptation to their habitat was their propensity for floating upside down on the water surface. De Jesus (1935) believed that *Lymnaea (Austropeplea) philippinensis* utilized this method to establish populations elsewhere. Hunter (1964) reported that *Physa fontinalis* and several species of *Lymnaea* can live temporarily as members of the "neuston". By suspending themselves upside down of the surface film, they are able to collect microscopic organisms and chains of free protein molecules from the water using their ciliated foot soles. This activity could also constitute one of its regular methods to take in atmospheric air, especially during summer conditions (Hunter, 1953, 1957).

As for the coexisting floral and faunal species in both provinces (Table 2), the main differences are that the aquatic plants in Sampaloc lake are unique and can only exist in that type of habitat; also, fish were observed only in the lake. The important role of the broad-leafed aquatic plants, to which *L. (Bullastra) cumingiana* and its eggs masses were often found attached to, can be easily overlooked. Wright (1956) suggested that microhabitats, with microclimatic differences in temperatures and oxygen tension, are more likely in tropical freshwaters and gave as an example the snail microhabitat on the underside of water lily leaves.

Bequaert and Clench (1939) stated that *L. Bullastra) cumingiana* is distributed throughout the Philippine archipelago. This limited study was not

able to support or refute this claim which was made more than 50 years ago. However, it is highly probable that this snail species is not present in all provinces of the country due to environmental modification and pollution in recent times. As has been shown, this snail is limited in distribution in the two provinces studied.

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