The Golden Apple Snail Infestation on the Rice Bowl Capitals of the Philippines

Ernesto looked at his newly planted rice seedlings. Half of his field was infested with golden apple snails. He had tried commercial molluscicides,[1] which were substances that killed snails or other mollusks species, prior to planting the rice but the pest had persisted. In two weeks, Ernesto's field would be entirely wiped out if no effective intervention was done. He talked to Mario, his son who studied biology at a local university, about how to eradicate the pest. Mario had researched, inquired with professors, and interviewed agriculturists on effective methods to remove the snail. From the information gathered, Mario learned that in order to test the efficacy of killing the golden apple snail with indigenous plants, a bioassay was required.

The Snail Origin, Dispersion, and Havoc[2]

The golden apple snail was native to South America, but unlike in the Philippines, the snail was not considered a chronic pest. It was introduced to the Philippines ecosystem in three identified ways. The first was from Taiwan via the port of Batangas. The next was from Argentina through the port of Cebu and, lastly, from Florida through Makati, Metro Manila. The intended goal for introduction into the Philippines was to enhance livelihood, augment the food supply of the country, and provide an enriching protein source to the human diet.

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At first, the reception of the golden apple snail was positive by farmers, but later the snail spread to farms and became a ubiquitous pest to rice plants. Its spread was unregulated and spanned to different regions of the Philippines, bringing tremendous losses to rice farmers. As of 2014, the perennial and persistent problem of the invasion remained despite efforts to reduce and remove the golden apple snail from Philippine farms.

The Deeper Impact of Snail Infestation

Year in and year out, farmers were plagued with the golden apple snail infestation on their farms. Ernesto observed that the snail dug deeper into the ground during the summer and came out in rain-fed rice plots during rainy days. This occurred most often when the onset of farming land was prepared for rice farming. This dilemma was prevalent in major regions of the country, especially in Northern Luzon and Western Visayas, which were both considered the rice granaries of the Philippines. Farmers in different regions reported annually about the infestation and the losses ensued from the snails. It was estimated that around 800,000 hectacres (ha) of rice farms were infested with the snails out of the roughly 3 million ha planted with rice in the Philippines.[3]

Interventions, Controls, and Strategies to Contain the Pest

Various interventions and control methods were used to decimate the pest. This included the use of chemicals, biological organisms, cultural, mechanical, manual, and the use of botanicals. The quick effect that pesticides had was popular among farmers. They used triphenyl compounds like Brestan, Aquatin, Torque, and Telustan. These chemicals posed hazards to the environment and human health, though. Thus, the use of pesticides was a double-edged sword due to its positive and negative implications. In biological controls, the use of ducks, birds, fire ants, rats, mites, snakes, and other reptiles was an effective bio-control method used to reduce snail population in rice paddies. Some of the cultural methods, which were directly employed by farmers to reduce the golden apple snail's impact, were the use of screens, older seedlings, higher density planting, and handpicking. The use of attractants to lure the snails from rice fields included the papaya leaves, kangkong, sweet potato, cassava, and taro, all of which were easily handpicked and employed as a chemical free agent to combat the invasion.[4]

Studies on the botanicals with molluscicidal efficacy in the market were a tannin-glycoside-sterol-flavonoid with the brand name, Protek. Protek was developed with low mammalian toxicity and a high biodegradability. Research on botanicals was still being conducted to find a natural extract(s) that had no adverse effects to humans and were ecofriendly to use. There were 16 plants in the Philippines actively tested for the potential to reduce golden apple snail populations. Some of these plants were *Azadirachta indica*, *Calotrophis gigantean, Citris mitis, Conyza balsamifera, Croton tiglium, Derris elliptica, Dioscorea hispida, Entada phaseoloides, Glericidia sepium, Jatropha curcas, Menispermum cocculus, Mikania cordata*, and *Nicotiana tabacum*.[5]

One plant seemed promising to use as a botanical against the intruding snail. This was the *Derris* plant, a known source of rotenone, which was effective against removing the invasive snail, but toxic to fish populations.[6] In the U.S., rotenone was a registered fish toxin with the Environmental Protection Agency (EPA).[7] Premna odorata (alagaw) was not included in the list of published botanicals tested against the golden apple snail. In general, botanical molluscicides were believed to be more environment friendly as compared to commercial ones. Botanicals could be easily degraded and left no residues in the environment, which made their use ideal.

Bioassay

A bioassay, shorthand for biological assay, was a type of scientific experiment that used live animals or plants (in vivo) or tissue or cells (in vitro) to determine the biological activity of a substance such as botanical extracts. It was also used to identify the concentration of a particular constitution of a mixture that may cause harmful effects on organisms or the environment.[8]

Impelled by his father's dilemma, Mario conducted a bioassay using native Philippine alagaw plant leaves. Alagaw, a small hairy tree, was known to grow between 3 to 8 meters high. Its leaves were ovate with a broad, rounded or heart-shaped base leading to a pointed end and measured between 10 to 20 centimeters long. The leaves were known to be covered in short hairs and were aromatic when crushed.[9]

This plant was abundant in the Maasin Watershed where Mario lived. Mario collected alagaw leaves from a single tree that was healthy and full of green leaves. A sack of leaves was gathered and pounded with the use a mortar and pestle. The crude extract was a pure juice squeezed from the leaves, then collected and placed in a beaker. Another extract, a pepper juice, was prepared from fruits that were not readily available locally, but the Philippines Department of Agriculture had recommended as effective.[10] Mario used the pepper extract at a 15% concentration as the positive control for his experimental bioassay. The crude extract of the alagaw leaves was testing the effectiveness of killing the golden apple snail.

Mario conducted the experiment in his school laboratory, bringing the prepared alagaw extract with him. He gathered snail specimens from his father's rice field. The snails were transported to the school in the early morning, where they were placed in a big basin that allowed them to acclimatize for four hours before the experiment began. The resting of the snails allowed them to recover from travel stress and adapt to their new environment. Snails were then segregated by size; only snails of medium size (5-7 cm) were used in Mario's experiment. Three treatments with three replications were done with the positive and negative controls. The extracts were diluted to 50%, 25%, and 12.5% concentrations.

Table 1
Mario's Bioassay Results

Treatment	Replication 1	Replication 2	Replication 3	Average
50% Extract	12	10	13	11.67
25% Extract	10	9	11	10.00
12.5% Extract	4	5	2	3.67
15% Pepper (+ control)	9	7	4	6.67
Water (- control)	0	0	0	0

The data found within the table represents the number of deceased snails.

Source: Mendoza J.T., R.M. Amorte, P.L. Artieda, and M.E. Lorca. Molluscicidal Effect of Alagaw (Premna odorata Blanco) Leaves Extract to Golden Apple Snail. 2013. TS. Collection of Saint James Catholic High School, Maasin, Iloilo, Philippines.

Mario used the pepper extract as the positive control and distilled water served as the negative control. Mario selected the snails randomly and placed 15 snails per basin, for a total of 225 snails tested. Extracts of different concentrations were sprayed in the basins until the snails were submerged. A uniform volume of liquid (150 ml) either of the extracts or controls was placed in the basins. The snail mortality rate was recorded after 12 hours of observations. **Table 1** shows that the highest snail mortality incurred after 12 hours of observation at the 50% extract treatment, with an average of 11.67 deceased snails. The second most effective concentrations were observed at 25% extract potency.

Table 2
Duncan's Multiple Range Test (DMRT)

Treatment	1	2	3	4
Water	0			
12.5% Extract		3.67		
Pepper Control			6.67	
25% Extract				10.00
50% Extract				11.67
Sig Figure	1	1	1	0.217

Please note: the subset for alpha is .05

Source: Mendoza J.T., R.M. Amorte, P.L. Artieda, and M.E. Lorca. Molluscicidal Effect of Alagaw (Premna odorata Blanco) Leaves Extract to Golden Apple Snail. 2013. TS. Collection of Saint James Catholic High School, Maasin, Iloilo, Philippines.

Duncan's Multiple Range Test (DMRT) was used as a post hoc tool in determining which concentrations were most effective. The DMRT validated how the treatments significantly differed from each other. As revealed in **Table 2,** both 25% and 50% concentrations of alagaw did not differ significantly from each other in effectiveness. Since both concentrations had a higher amount of the extract, they were more effective in eradicating the golden apple snail as compared to the 12.5% concentration, the positive control, and the pepper extract.

Eradicating the Golden Apple Snail

The results of Mario's experiment showed that the pepper extract was surpassed in its successful mortality rate by the extract from alagaw leaves. The need to conduct more thorough screening on the potentials of botanicals in decimating the golden apple snail was of paramount importance to help many farmers and families. By eliminating the golden apple snail from rice farms, the livelihood for many Filipinos would again be profitable, unshackling several farmers from the contingencies of poverty.

Endnotes

[1] "Molluscicides." *Webster Third New International Dictionary of the English Language (Unabridged)*. 1993. Print.
[2] The information in this section came from the source: Joshi, R.C. and A.G. Cagauan. "Golden Apple Snail Pomacea spp. in the Philippines." *The Apple Snail Website*. ICMAM Special Working Group on Golden Appel Snail, 22 Oct. 2002. Web. 20 Nov. 2014. <http://applesnail.net/pestalert/conferences/icam07/philippines.htm>.
[3] Joshi, R.C. and A.G. Cagauan.
[4] The information in this section came from the source: Joshi, R.C. and A.G. Cagauan.
[5] Ibid.
[6] Ibid.
[7] Ibid.
[8] The information in this paragraph came from the source: "Bioassay." *Wikipedia*. CC-BY-SA, n.d. Web. 21 Nov.2014. <http://www.princeton.edu/~achaney/tmve/wiki100k/docs/Bioassay.html>.
[9] The information in this paragraph came from the source: "Alagaw." *Philippine Medicinal Plants*. n.p., Feb. 2014. Web. 21 Nov. 2014. <http://www.stuartxchange.org/Alagaw.html>.
[10] Matucan, Mary Rose A. Personal Interview. 3 Jan. 2013.