Pomacea Canaliculata (Golden Kuhol) Abundance in Rice Duck Pig Farming System

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Received:- 10 June 2025/ Revised:- 17 June 2025/ Accepted:- 29 June 2025/ Published: 05-07-2025

Abstract— *The major purpose of this study is to determine the abundance golden apple snail in rice duck pig farming system. Weekly mean abundance of golden apple snail on the rice field fluctuates during the first four weeks of the experiment, gradually decreased during the succeeding weeks until the final week of the experiment. The graphical representation of each weekly mean per treatment shows the obvious decreasing significance of the golden apple snail in the rice field. Stocking densities of ducks decreased every week starting from week 4 of the experiment. The cause is not clear, but the weather can be considered as one of its causal factors since the experiment was done during rainy season. However, even if the stocking densities of ducks decreased, the abundance of golden apple snail decreased during the final weeks. The presence of duck in the rice field is effective in minimizing the abundance of golden apple snail. Distributed ducks in the rice field fed on the golden apple snails that are present in the soil which resulted to the decrease and elimination of the snails. Through this event, the field doesn't need the application of any type of insecticides because the pests were reduced*.

Keywords— Golden Apple Snail, Rice-Duck-Pig Farming System, Stocking Density.

I. INTRODUCTION

In most of the tropical countries including the Philippines, farming is one of the most common types of work. As a matter of fact, agriculture in general, plays big part in our country's economy. Agriculture involves 40% of Filipino workers, and it contributes an average of 20% to the gross domestic products. The Philippine archipelago consists of mostly sea, but the land area suitable for farming is quite impressive having 47% of the total land area. Farming is also popular especially in rural areas within the country and one of the major sources of income of a simple Filipino family.

There are different kinds of farming depending upon what type of resources the place is capable of cultivating. As technology grasps its big leap towards improving and innovating, the people must also cope-up with its pace. That is why farming methods also come up with innovative ideas. One example of innovative farming is rice duck farming.

Rice duck farming is an integrated type of farming technology. It is suitable for small scale farmers to produce organic rice in low-cost. It is very suitable for the Philippines because most of the farmers belong to the lower sector of the society. Ducks eat harmful insects and weeds averting the use of chemical pesticides and manual weeding in the rice field. They also acquire nutritious diet from eating insects and weeds in rice fields. The manure of the duck act as a natural fertilizer to the rice crop preventing the use of chemical fertilizers, the continuous movement of ducks in the rice field provides natural stimulation and aeration which increases the availability of nutrients like nitrogen, phosphorous, and potassium to the rice crop. Rice-duck technology causes the reduction of emission of methane gas from rice field contributing to reduce the global warming.

Golden apple snail (*Pomacea canaliculata*) is a common freshwater snail and a notorious agricultural pest in the Philippines and other countries in Asia. It was introduced from Florida and Latin American to Taiwan in the early 1980s to start an escargot industry (Mochida 1988, 1991; Naylor 1996). Concerted efforts have been undertaken to annihilate them but they still persist and even spread naturally and intensively. Since this snail is ecologically important, persistent and possesses attributes of a bio monitor, they are big enough to provide sufficient material (soft tissue) for analyses. They are easy to handle, collect, and culture; they are abundant, and sedentary; they can survive for a long time without food, and live long; they can be found in almost any freshwater ecosystem in many countries. The need for an extensive study for ecological management is necessary because of these things. They damage direct wet-seeded rice and transplanted rice up to 30 days old. Once the rice plant reaches 30−40 days, it will become thick enough to resist the snail. If no control measure is taken, they can completely destroy 1 m^2 of field overnight. This damage could lead to more than 50% yield loss.

Generally speaking, the use of duck in farming is widely acceptable method to use in rice farming. The use of ducks as an approach in eliminating pests such as a golden apple snail could benefit the rice field itself and it could also be beneficial in nature in many ways.

II. MATERIALS AND METHODS

The study was conducted at Future Rice Farm, Philippine Rice Institute (PhilRice), Barangay Maligaya, Science City of Muñoz, Nueva Ecija Philippines. Fence was installed using mesh net and bamboo post, fence is a requisite to ward-off astray animals that may hurt the ducks and prevent them from escaping. The total measurement of area is 486.98 m^2 and divided in to 3 treatments with 3 replications. The paddy rice field was rotovated, plowed and harrowed once. RC298 variety was used and classified as good seed. Using cloth bag, seeds were wrapped and soaked for 24 hours, after soaking, seed were planted in the seedling plots with seedling density of 50gm/sq.m. After 2 weeks, seedlings were transplanted to the paddy rice field in a straight row with planting distance of 30cm x 15cm, 2 seedlings per hill. Continuous irrigation was used with a depth of 10-15cm, organic fertilizer was applied using animal manure (ducks and pig), sugarcane, bagasse and hay. Pig slurry was applied to paddy rice field twice a week from week 1 to week 8 in 12 plots.

A total of 54 ducklings was used in the experiment and distributed into respective treatments: (T1 – Four (4) ducks, T2 – Six (6) ducks, and T3 – Eight (8) ducks). 14-day old ducks were released into the paddy rice field after two weeks from transplanting of rice plant. Ducks stayed in the field for 56 days. 1 litter of water with 5 tbsp. of sugar was used as medication and biologics of ducks.

The number of golden apple snail in each plot was counted and recorded and was done weekly. A definite of 4:00 pm for two hours was spent during the manual counting. As the counting took place in the rice field, ducks still stayed within the plots. The number of golden apple snail counted was tabulated immediately after the said activity.

III. RESULTS AND DISCUSSION

In every treatment, it was observed an obvious decrease in the abundance of golden apple snail, however, there is also a dramatic increase in its abundance that is most visible during the second and the fourth week. The increase during the second week of the experimental treatment was due to the fact that the installation of the ducks in each plot was done on August 23, 2019 after the second counting of golden apple snails. That is the reason why they were not able to consume much golden apple snails during the second week of the experiment. Aside from that, it is also considerable to indicate that some of the golden apple snails are of large sizes which cannot ingest by the ducks. During that time, the ducks are just 14-day old. The sudden increase in the number of golden apple snails during the fourth week was because of the inability of the young ducks to eat much golden apple snails on the rice fields especially the matured ones during the second week. Due to this setup, the female matured snails laid its eggs in bright pink ranging from 25 to 500 eggs per batches with the hatching time of 10 to 15 days (Halwart, 1994). The eggs hatched the most during the fourth week of the experiment that caused the snail population to increase. After the fourth week of the experiment, the abundance of the golden apple snail gradually decreased until the final week where there is a visible count of eight (8) down to zero (0) in most plots that received Treatment 3.

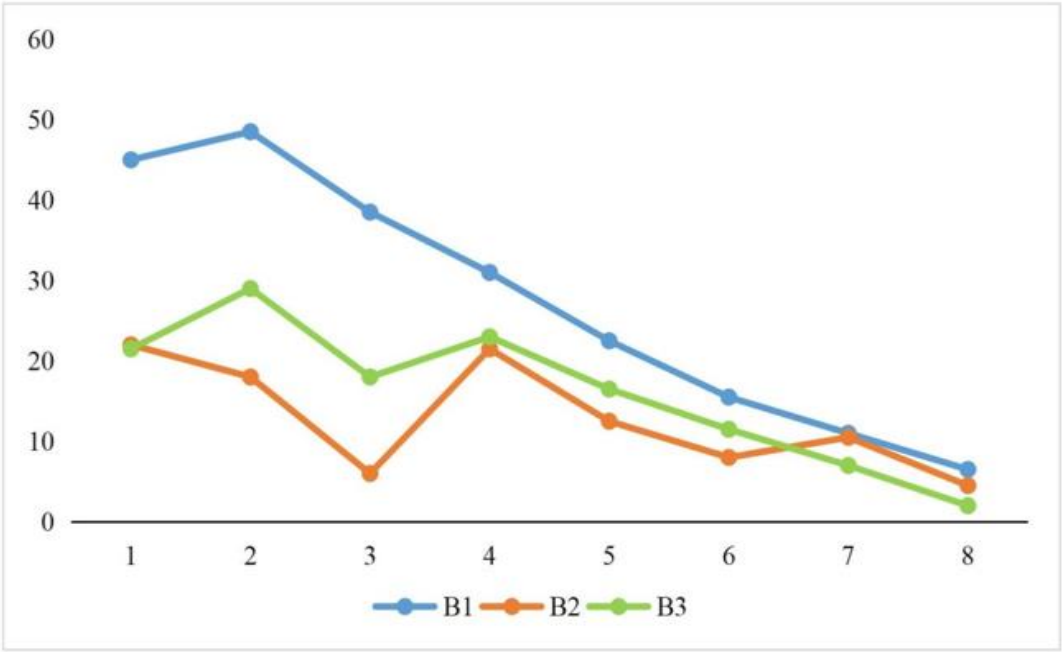

FIGURE 1: Weekly Mean Abundance of Golden Apple Snail for Treatment 1 (4 Ducks)

The graph on Figure 1 shows the average weekly abundance of golden apple snail for Treatment 1 having four (4) ducks inside the rice field. It can be seen in Block 1 (B1) and Block 2 (B2) that the number of snails from week 1 to week 2 has increased while it has decreased in Block 3 (B3). Those gaps in numbers are due to the event where the ducks were setup in week 1 just after the golden apple snail count on the field. As weeks go along, the number of snails in B1 begins to decrease. The graph shows that in B2 and B3 on the other hand, there is an indefinite time when the golden apple snails increased in numbers. Even so, during the final weeks of the setup, all blocks have experienced the decreasing number of snails.

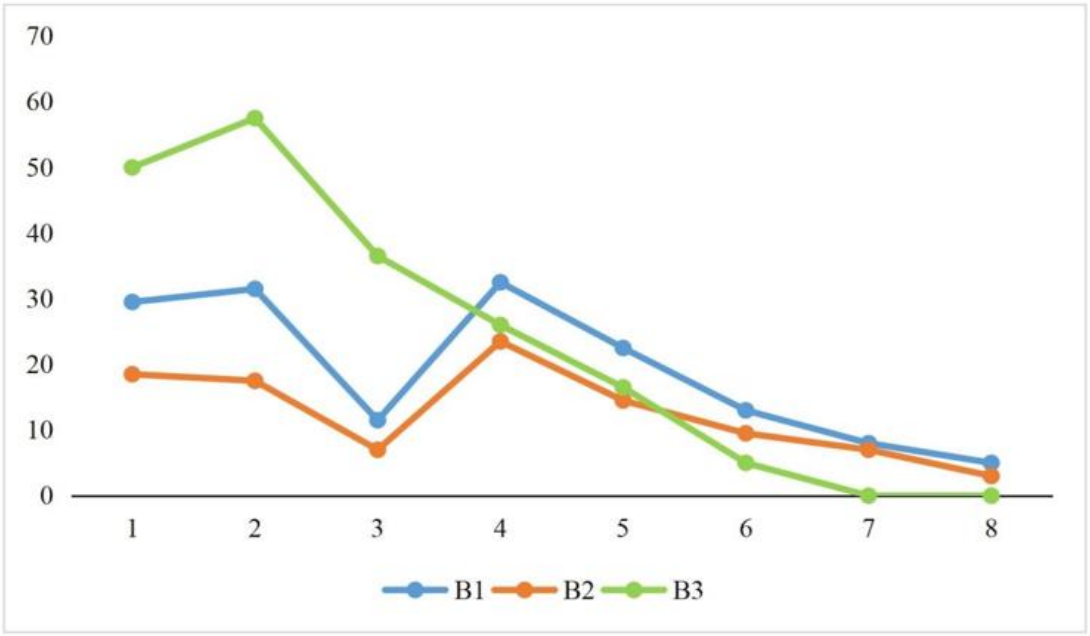

FIGURE 2: Weekly Mean Abundance of Golden Apple Snail for Treatment 2 (6 Ducks)

The average weekly abundance of golden apple snail for Treatment 2 having six (6) ducks inside the rice field is illustrated in Figure 2. It can be seen that the number of snails from the first week to the second week increases in all the blocks with this treatment. It is because during the first week, the ducks are not yet intervened in the field. However, when the ducks were installed, the snail abundance begins to decrease from second week to the third week with B3 having a constant decrease that reached zero (0) during the last two weeks. B1 and B3 had its constant decreasing moment after the fourth week.

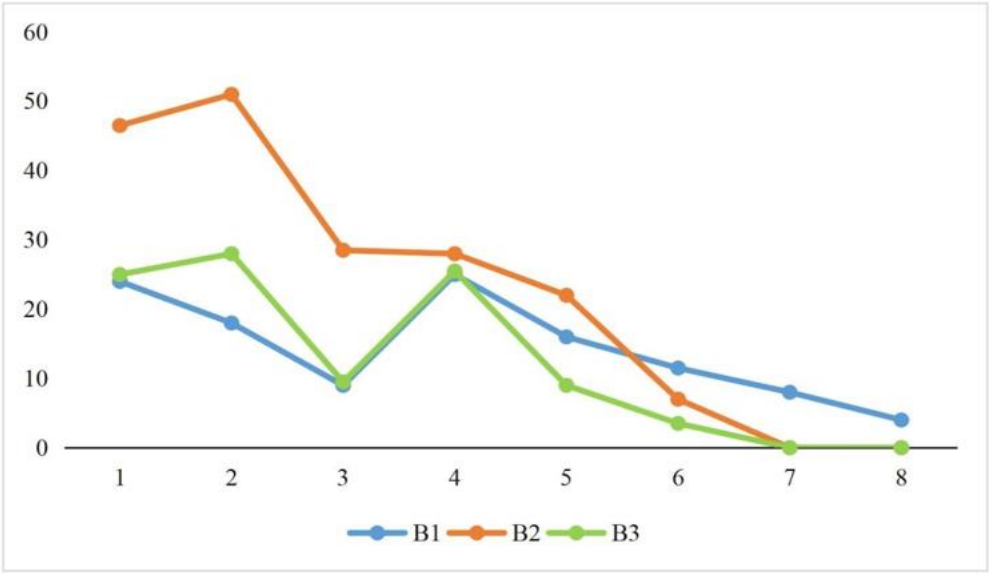

FIGURE 3: Weekly Mean Abundance of Golden Apple Snail for Treatment 3 (8 Ducks)

The graph on Figure 3 reveals the average weekly abundance of golden apple snail for Treatment 3 having 8 ducks inside the rice field. It can be seen that in B1, the number of snails from week 1 to week 3 continuously decreases. In B2 and B3 however, there is an increase in the abundance of snails from the first week to the second week. During week 1, there were no ducks yet in the field resulting to the snails to reproduce. There is also a sudden increase of snails from week 3 to week 4 because of the continuous hatching of its eggs. Even so, as weeks go by, the number of snails in all blocks begins to decrease, with B2 and B3 reached zero (0) snail visibility on the field during the final two weeks of the experiment.

The stocking density of ducks is one of the most important components of the experimental treatment. Echoed by the general objective of the study, the abundance of golden apple snail in the paddy rice field will be determined with the presence of ducks on the field. Table 4 presents the data for the effect of varying duck stocking densities on the mean weekly decrease of abundance of golden apple snail in three (3) different treatments.

TABLE 1
THE EFFECT OF VARYING DUCK STOCKING DENSITIES ON THE MEAN WEEKLY DECREASE OF ABUNDANCE OF GOLDEN APPLE SNAIL

Treatment	Block	Mean[a]
4 Ducks	1	5.5
	2	2.5
	3	2.786 ***3.595***
6 Ducks	1	3.5
	2	2.214
	3	7.143 ***4.286***
8 Ducks	1	2.857
	2	6.643
	3	3.571 ***4.357***

[a] Grand means are italicized and marked in bold.

The grand means marked in italic and bold represent the average decrease of the abundance of golden apple snail in three (3) treatments which corresponds to different number of ducks. The estimated average decreased is dependent to the number of ducks present in the field. Only a slight change can be observed in the difference of the grand means of each treatment, it is because only a little number of ducks was added in the second and third treatment respectively. Also, there is a significant change on the stocking density of ducks particularly during week 4 to 8 whereas during these weeks, the location of the

experiment experienced rainy season. During these times, ducks have the difficulty to adapt with this kind of weather. As a result, there is a risk in the survival of the ducks on the rice field that causes inevitable deaths among them. Due to the weekly mortality rate of the ducks on the paddy rice field, the abundance of golden apple snail decrease just a little amount from one treatment to another. That is why the grand means or the total average of the weekly decrease of the abundance of golden apple snail is almost the same.

The duck population started to decrease during the fourth week of the experimental setup and it gradually decreases until the final week. It reveals that the duck stocking densities decrease every week. However, the golden apple snail abundance in the paddy rice fields decreases as well from the fifth week until the eighth and final week of the experiment. Thus, even there are deaths among the stock densities of ducks, the abundance of golden apple snail in each block still decreases, as seen on Figure 1, Figure 2, and Figure 3. It is because the ducks also grow as the time goes by, allowing them to consume much snails compared to the first time they were distributed on the field. Furthermore, the ducks that were on the field are the strongest because they were able to adapt on the changing environment where they were released.

The presence of duck in the paddy rice field is effective in minimizing the abundance of golden apple snail. The distributed ducks in the rice field feed on the golden apple snails that are present in the soil which resulted to the decrease and eventually to the elimination of the snails. Through this event, the field did not need the application of any type of insecticides anymore because the pests were reduced. Moreover, the waste products of the ducks act as a natural fertilizer for the rice crop. It is recommended to consider and look closely to the external factors that may affect the experiment, especially those that occurred in nature like weather, temperature, humidity, etc. Also, they must conduct a study about the economic factors which affect the utilization of the rice duck pig farming system.

ACKNOWLEDGEMENT

The authors would like to acknowledge the Future Rice Farm of the Philippine Rice Research Institute (PhilRice) and Central Luzon State University for the vital support and logistics towards the setting up of the rice-duck-pig farming system.

REFERENCES

[1] Basillo, R., (1991). Problems of golden snail infestation in rice farming. In B. O. Acosta and R. S. V. Pullin (Eds.), *Environmental Impact of the Golden Snail (Pomacea sp.) on Rice Farming Systems in the Philippines.* Manila: International Center for Living Aquatic Resources Management. ISSN: 0115-4435

[2] Caguan G., & Joshi, C. (2003). Golden Apple snail *Pomecea spp*. In the Philippines Review on levels of infestation, control methods, utilization and future research directions. *Journal of Agriculture and Life Sciences, 37*, 7-32.

[3] Cazzaniga, N. (2006). *Pomecea canaliculata*: Harmless and useless in its natural realm. *Global advances in ecology and management of golden apple snail,* 37-60. Los Banos Philippines: Philippine Rice Research Institute. ISBN: 9789719081319

[4] Cerutti, R. (1998). An infestation of *Pomacea canaliculata* in Lake Miramar, San Diego, California. *The Festivus, 30*(25)-27, 29.

[5] Cheng E., & Chinghua, K. (2006). Control of golden apple snail, *Pomacea canaliculata* (Lamarck), in Taiwan. *Global advances in ecology and management of golden apple snails, 155-167*. Los Baños, Philippines: Philippine rice research institute (Philrice). ISBN: 9789719081319

[6] Cowie, R. (1995). Report on a visit to Cambodia to advise on apple snails as potential rice pests. *Report to Cambodia-IRRI-Australia Project, Phnom Penh, 72*, 70-74. Honolulu, Hawaii, USA: Bishop Museum.

[7] Cowie, R. (2002). Apple snails (Ampullariidae) as agricultural pests: Their biology, impacts and management. *Molluscs as crop pests*, 145-192.

[8] Cowie, R. (2013). Pathways for transmission of angiostrongyliasis and the risk of disease associated with them. *Hawaii. Journal of Medicine and Public Health, 72*, 70-74.

[9] Cowie R., Hayes A., Tran T., & Levin P. (2007). Distribution of the invasive apple snail *Pomacea canaliculata* (Lamarck) in the Hawaiian Islands (Gastropoda: Ampullariidae). *Bishop Museum Occasional Papers, 96*, 48-51.

[10] Douangboupha B., & Khamphoukeo K., (2006). Golden apple snail damage and management practices in rice farmers' fields in the Lao PDR. *Global advances in ecology and management of golden apple snails*, 275-280. Los Baños, Philippines: Philippine Rice Research Institute.

[11] Halwart, M. (1994). Fish as biocontrol agents in rice: The potential of common carp Cyprinus carpio (L.) and Nile tilapia *Oreochromis niloticus* (L.). Fish as biocontrol agents in rice: the potential of common carp Cyprinus carpio (L.) and Nile tilapia *Oreochromis niloticus*. http//doi: 10.1080/09670879409371882

[12] Hayes, K., Cowie, R., Thiengo, S., & Strong, E. (2012). Comparing apples with apples: Clarifying the identities of two highly invasive *Neotropical Ampullariidae (Caenogastropoda). Zoological Journal of the Linnean Society, 166*, 723-753.
https://doi.org/10.1111/j.1096-3642.2012.00867

[13] Hayes, K., Joshi, R., Thiengo, S., & Cowie, R. (2008). Out of South America: Multiple origins of non-native apple snails in Asia. *Diversity and Distributions, 14*(4). https://doi.org/10.1111/j.1472-4642.2008.00483

[14] Hendarsih-Suharto, R., Marwoto, R., Heryanto, M., Mulyadi, S., & Siwi, S. (2006). The golden apple snail, Pomacea spp., in Indonesia. *Global advances in ecology and management of golden apple snails*, 231-242. Los Baños, Philippines: Philippine Rice Research Institute.

[15] Hollingsworth, G., & Cowie H. (2006). Apple snails as disease vectors. *Global advances in ecology and management of golden apple snails*, 121-132. Los Baños, Philippines: Philippine Rice Research Institute (PhilRice). ISBN : 9789719081319

[16] Howells, R., Burlakova, L., Karatayev, A., Marfurt, R., & Burks, R. (2006). Native and introduced ampullariidae in North America: history, status, and ecology. *Global advances in ecology and management of golden apple snails*, 73-112. Los Baños, Philippines: Philippine Rice Research Institute.

[17] Hung Chin, T., Yao Shen, C., & ChuanMin, Y. (2013). Human parasitic meningitis caused by Angiostrongylus cantonensis infection in Taiwan. *Hawaii Journal of Medicine and Public Health, 72*(6), 26-27.

[18] Ichinose, K., & Tochihara, M. (2001). Control of apple snail by common carp under a semi-natural condition. *Kyushu Plant Protection Research, 47*, 73-76. ISSN : 0385-6410

[19] Ichinose, K., & Tochihara, M., Wada, T., Suguiura, N., & Yusa, Y. (2002). Influence of common carp on apple snail in a rice field evaluated by a predator-prey logistic model. *International Journal of Pest Management, 48*(2),133-138.

[20] Levin, P., Cowie, H., Taylor, M., Hayes, A., Burnett, M., & Ferguson, A. (2006). Apple snail invasions and the slow road to control: Ecological, economic, agricultural, and cultural perspectives in Hawaii. *Global advances in ecology and management of golden apple snails*, 325-335. Los Baños, Philippines: Philippine Rice Research Institute. ISBN: 9789719081319

[21] Lopez, A., Altaba, R., Andree, & KB., Lopez, V. (2010). First invasion of the apple snail Pomacea insularum in Europe. *Tentacle-The Newsletter of the IUCN/SSC mollusc Specialist Group, 18*, 26-28.

[22] Mochida, O. (1988). Nonseedborne rice pests of quarantine importance. *Rice Seed Health*, 117-129. Los Baños, Philippines: International Rice Research Institute.

[23] Mochida, O. (1991). Spread of freshwater Pomacea snails (Pilidae, Mollusca). ISSN: 0026-279

[24] Naylor, R. (1996). Invasions in agriculture: Assessing the cost of the golden apple snail in Asia. *Ambio, 25*(7), 443-448.

[25] Pantua, C., Mercado, V., Lanting, O., & Nuevo, B. (1992). Use of ducks to control golden apple snail Ampullarius canaliculata in irrigated rice. *International Rice Research Newsletter, 17*, 27.

[26] Rawlings, A., Hayes, A., Cowie, R., & Collins, T. (2007). The identity, distribution, and impacts of non-native apple snails in the continental United States. *BMC*

[27] *Evolutionary Biology, 7*(97). https://doi.org/10.1186/1471-2148-7-97

[28] Serra,A.B.(1997). The use of goldensnail(Pomacea sp.) as animalfeed in the Philippines. *Tropicultura 15*(1), 40-43.

[29] Smith, D. (1992). Introduction and dispersal of apple snails (Ampullariidae) on Guam. *Pacific Science Association Information Bulletin, 44*, 12-14.

[30] Suh, S., Sato, Y., & Morishima, H. (1997). Genetic characterization of weedy rice (Oryza sativa L.) based on morpho-physiology, isozymes and RAPD markers. *Theory of Applied Genetics, 94*, 316– 321.

[31] Tamburi, E., & Martín, R. (2011). Effects of food availability on reproductive output, offspring quality and reproductive efficiency in the apple snail Pomacea canaliculata. *Biological Invasions, 13*(10), 2351-2360. https://doi.org/10.1007/s10530-011-0047-2

[32] Thiengo, C., Simões, R., Fernandez, A., & Maldonado, A. (2013). Angiostrongylus cantonensis and rat lungworm disease in Brazil. *Hawaii Journal of Medicine and Public Health, 72*(6), 18-22.

[33] Tran, T., Hayes, A., & Cowie, H. (2008). Lack of mitochondrial DNA diversity in invasive apple snails (Ampullariidae) in Hawaii. *Malacologia, 50*(1-2), 351-357.

[34] Vega, A. (1991). *Agro-economic evaluation of non-chemical methods against golden snail (Pomacea canaliculata Lam.) in irrigated lowland rice*. MSc Thesis. *University of the Philippines, Los Baños*, 65.

[35] Wada T. (2004). Strategies for controlling the apple snail Pomacea canaliculata (Lamarck) (Gastropoda: Ampullariidae) in Japanese direct-sown paddy fields. *JARQ, Japan Agricultural Research Quarterly, 38*(2), 75-80.

[36] Wallace, G. D., & Rosen L. (1969). Studies on eosinophilic meningitis. V. Molluscan hosts of Angiostrongylus cantonensis on Pacific islands. *American Journal of Tropical Medicine and Hygiene, 18*(2), 206-216.

[37] https://doi.org/10.4269/ajtmh.1969.18.206

[38] Yang, T., Wu, Z., & Lun, Z. (2013). The apple snail Pomacea canaliculata, a novel vector of the rat lungworm, Angiostrongylus cantonensis: Its introduction, spread, and control in China. *Hawaii Journal of Medicine and Public Health, 72*(6), 23-25.

[39] Yusa, Y. (2001). Predation on eggs of the apple snail Pomacea canaliculata (Gastropoda: Ampullariidae) by the fire ant Solenopsis geminata. *Journal of Molluscan Studies, 67*(3), 275-279.