

Invasive apple snails (*Pomacea* spp.) in Vietnam: Short review

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A single adult *Pomacea* spp. eating young rice seedling on a rice field in Phu Loc, Thua Thien Hue, Vietnam. (Credit: Dr. Do Van Tu).

Originating from South America the apple snail species of *Pomacea*, commonly referred to as golden apple snail, was imported into Vietnam from 1985 to 1988 with the intention of raising it for human consumption (Cuong, 2006; Huynh, 2006). Not long after that, the introduced snails quickly spread to most freshwater ecosystems of the country, becoming one of the major invasive agricultural pests, notably in wetland rice and vegetables, but also other aquatic crops in Vietnam (Do Van Tu, personal observation). A similar serious pest status was reported from southern and eastern Asia and islands of the Pacific (Cowie, 2002; Joshi & Sebastian, 2006; Joshi et al., 2017), and it is listed as one of the world's 100 worst invasive alien species (GISD, 2017).

***Pomacea* species complex**

Based on morphology, two *Pomacea* species have been identified in Vietnam, *Pomacea canaliculata* and *Pomacea maculata* (Do, 2015). Early on Cowie et al. (2006) and Hayes et al. (2008) provided molecular and morphological data identifying *P. canaliculata* and *P. maculata* (as *P. insularum*, which is now a junior synonym of *P. maculata*, according to Hayes et al. 2012).

Origin and Introduction of *Pomacea* spp.

According to the final report of the project "Integrated Pest Management of Golden Apple Snail on Rice in Vietnam" in 1998, *Pomacea* spp. was imported into Vietnam in 1988

through various ways without thorough quarantine. Before 1988, however, there were newspapers reports referring to some foreign businessmen bringing these snails into Vietnam because they had favourable characteristics such as being easy to raise, rapid growth, strong reproductive ability, high nitrogen level content and others. Some reported that many commercial companies could buy large quantities of these snails for export (MARD, 1998).

By 1990-1993, *Pomacea* spp. was being promoted by media as “a food industry that could bring prosperity to farmers” (PPD, 2000). So, in a short period, many people asked, inquired and rushed to find apple snails to raise and reproduce in ponds, lakes and in their houses with the intention to generate income.

By January 1991, based on many research documents, there were about 20 centres selling *Pomacea* spp. and thousands of families were raising them at the Mekong Delta River. In 1990, the Liksin Company, a printing and paper company in Ho Chi Minh City invested on their large-scale raising. From here, *Pomacea* spp. started to spread nationwide. At the same time, in 1990-1991, two foreign enterprises, one in Ho Chi Minh City and the other in Kien Giang Province, were involved in large-scale production of these apple snails for export (Huynh, 2006).

In 1992, from South Vietnam, *Pomacea* spp. started infesting Central and North Vietnam. However, after a long time, there was less interest to buy them for export and for the local

markets. Consumers observed that *Pomacea* spp. flesh was not as good and delicious as local snails (*Pila* spp. and *Viviparidae*). As a result, no one wanted to continue raising them for food. The end of the miraculous story was the same as that of the Philippines. From private ponds and lakes, these non-native apple snails started to invade ditches, canals and then the rice fields (Huynh, 2006).

The damage by *Pomacea* spp. on rice was first recognized in Kien Giang Province in 1994. Many rice fields had to be re-sown two or three times because of their ravages. In the same year, the Thu Duc and Hoc Mon districts under HCMC, these apple snails seriously damaged the water morning glory (*Ipomoea aquatica*) plants (Huynh, 2006).

By November 1994, *Pomacea* spp. infested 38 provinces and damaged 1,678 ha of rice and 140 ha of vegetables. Four years later, in 1998, infestation had increased to 57 of 61 provinces and cities and 304 of 534 districts in the whole country at different infestation levels. Many provinces in North and Central Vietnam recognised the presence of *Pomacea* spp. but less damage on rice was reported (Hung, 1999). However, in the Mekong Delta River, southern Vietnam, about 1.826 million hectares of rice fields, were infested because of favorable climatic conditions, rich food sources, year-round sowing, interlocking river systems and annual floods. As a result, apple snails could reproduce freely and the infested area increased greatly especially in times of flood. In the Ca Mau, Bac Lieu, Kien Giang, Soc Trang, Dong Thap and Vinh



Scattered *Pomacea* spp. infesting a rice field in field in Phu Loc, Thua Thien Hue (Do Van Tu, Vietnam. (Credit: Dr. Do Van Tu).



Pomacea spp. being sold as feeds for human and livestock in Krong Pa Market, Gia Lai, Vietnam. (Credit: Dr. Do Van Tu).

Long provinces, their density per square meter was very high. In some districts in Ho Chi Minh City, their density reached from 50-200 snails per square meter. Generally, *Pomacea* spp. invaded area increased yearly, mainly on rice and morning glory crops (Huynh, 2006).

Currently, *Pomacea* spp. is distributed throughout the country, from the mountains to the plains and estuaries, even in islands far from the mainland such as Bach Long Vy and Con Dao. It is listed as an invasive alien species in Vietnam (MONRE-MARD, 2013). However, apple snails are still sold in local markets especially in the south of Vietnam for human consumption and as livestock feed. The price for one kilogram of these apple snails is about 15,000 Vietnamese Dong (about 0.7 \$US).

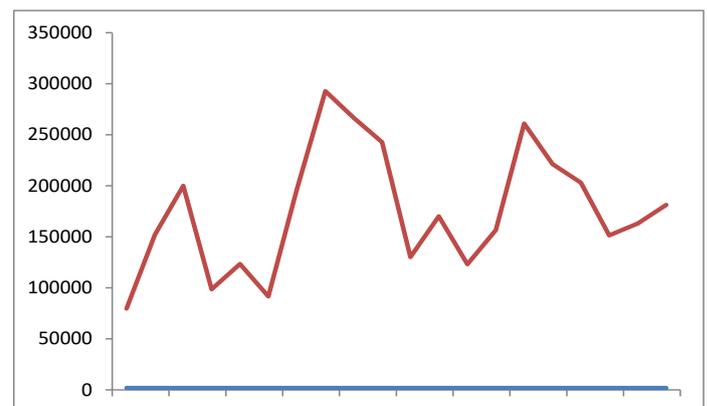
Impacts from *Pomacea* spp. invasions

In Vietnam, *Pomacea* spp. eats more than 20 kinds of crops, mainly vegetables, rice, water fern (*Azolla* spp.) and morning glory. They can consume 100% of newly sown rice plants and 20% of newly transplanted rice within 1 day (PPD, 2000).

Apple snail infestations of rice fields have fluctuated between 1997 to 2016. However, the infested area has increased.

Native apple snail (*Pila* spp.) is becoming rare, but the introduced apple snail (*Pomacea* spp.) becoming more abundant. There are many localities where *Pila* spp. has become extinct and *Pomacea* spp. are now found in abundance (Do Van Tu, personal observation). Other native fauna and flora are likely to be negatively impacted by the introduction of apple snails. However, there have not been any studies in Vietnam on their impacts to biodiversity and ecosystems.

Infestation of rice fields (ha) with *Pomacea* spp. in rice fields from 1997 to 2016 in Vietnam.





Water level is kept low for newly transplanted rice in order to prevent *Pomacea* spp. infestation in Phuoc Son, Quang Nam, Vietnam. (Credit: Dr. Do Van Tu).

Control management activities

In Vietnam a range of culture, biological and chemical control measures have been promoted as part of an integrated pest management strategy to control *Pomacea* spp. (Cuong, 2006; Huynh, 2006). These are:

Culture measures

Pick snails by hand. This is practical and economical only in small farm holdings. Before sowing rice, farmers collect apple snails and their egg masses in the field, around the lakes, rivers, streams, canals, and other places where the pest abounds.

Keep the water level below 2 cm when sowing and dig small trenches around field for deeper water. Adult and juvenile apple snails congregate on these trenches. Capturing them becomes easier and less costly.

Increase the seeding density (5-10%) to compensate for the plants that will be eaten by snails. Transplanting older rice seedlings (40-day-old) minimizes snail damage.

Keep shallow depth of water (0-3 cm) from sowing until 15 days later to restrict the snail movements and feeding.

Use trees and sticks as plugs in places with many apple snails to attract them to climb and lay eggs. Eggmasses are then collected and destroyed.

Use of filters such as nylon mesh with small holes at the water inlets to prevent re-infestation in rice field through the flow of snail-infested water.

Field sanitation such as cutting the grass around the field, removing dry rice straw and other plants which can be shelters of snails or egg laying sites.

After harvesting, dry the field for a while to prevent snail from breeding and also enhance snail mortality due to heat and desiccation.

Biological measures

Plants with snail-killing action: Several plants such as Chinaberry tree (*Melia azedarach*), Oleander (*Nerium oleander*), Poison vine (*Derris elliptica*) and Great basil (*Ocimum basilicum*) have been recommended to kill the adult and juvenile apple snails. However, high application rates (20-40 kg ha⁻¹) make their usage impractical.

Plants with attractant action: Leaves of papaya (*Carica papaya*) and cassava (*Manihot esculenta*) are potent snail attractants. Dead crabs and pig waste are sometime also

used as attractant. A small bundle of the leaves is submerged in stagnant water at the edge of the field. Significant numbers of snails are attracted to the leaves after 24 hours and are collected and destroyed the following day. This method significantly reduces the time and labour required in the normal handpicking operation.

Ducks are allowed in the fields to consume snails and their egg masses.

An Food and Agriculture Organization (FAO) project in Vietnam entitled Integrated Golden Apple Snail Management in Rice used biological controls to combat apple snails, finding that rice-fish farming - where fish (black carp, common carp and catfish) are raised in the rice fields – is one of the best ways to control the snails. Common carp is the most efficient control agent for apple snails, having a better survival rate than black carp and eating more snails. Field experiments showed that the common carp reduced populations of the snail, particularly young snails of less than 1 cm shell height, by 90% in rice fields over a period of three months (FAO, 1998).

Apple snails are utilised as feed in giant freshwater prawn (*Macrobrachium rosenbergi*) farming (Hasan & Halwart, 2009), and for striped catfish (*Pangasianodon hypophthalmus*) fingerlings (Da *et. al.* 2012).

Chemical measures

Before 2006, farmers usually used the following pesticides to kill apple snails: Bayluscide 250EC, BOLIS 6B, Clodansuper 700WP, Oxdie 700WP, Pazol 700WP, VT-Dax 700WP, Tungsai 700WP, Padan 98%WP, Deadline Bullets (metaldehyde), Thiodane / Endosol (Endosulfan). In addition, lime is applied at 200kg/1000m² (before sowing or after harvesting), at 2-5 cm water depth and kept for 2-3 days, then dried.

Many pesticides are used against apple snails, a list of permitted pesticides is available. However, some pesticides not on the list are very toxic, but can be found in the markets.

Interventions by government

Since 1994, the Vietnamese Government has introduced some policies and decisions to control and prevent further spread of *Pomacea* spp. These include:

Decision No. 190 / NN-PPD / QD dated 31.03.1994 of the Ministry of Agriculture and Food Industry.

Golden apple snail (*Pomacea* spp.) is considered an alien invasive species in the Circular 27/2013/TTLT-BTNMT-BNNPTNT issued by the Ministry of Natural Resources and Environment and Ministry of Agriculture and Rural Development on September 26, 2013.

In recent years, especially in 2013, Vietnamese traders collected *Pomacea* spp. and exported them to China. This encouraged many households to culture them, and wait for the dry season to sell for higher price. Official Letter No. 3879/BNN issued by the Ministry of Agriculture and Rural Development (MARD) strengthens the inspection and handling of the introduced apple snails to prevent its spread and culture.

According to this Official Letter, apple snail trafficking and culturing in some provinces, cause risk of transmission and spread of the pests.

Many campaigns on a national scale have been launched to eradicate *Pomacea* spp. The media also participated actively to promote and raise awareness about their harmful effects, as well as preventative actions to take. However, with changes in natural conditions (frequent flooding), low awareness of the people, especially the less drastic measures of the administration, *Pomacea* spp. is still spreading strongly and causing serious damage to agriculture and the aquatic ecosystems of the country.

Conclusions

Introduction of *Pomacea* spp. around early 1985 to 1988 to Vietnam was followed by their rapid range expansion and development as invasive agricultural pests, especially in wetland direct-seeded rice ecosystems, vegetables and other aquatic crops. The invasion of these species have caused significant economic and ecological damage.

Pomacea spp. are also host to disease-causing trematodes and nematodes, including the endoparasite rat lungworm (*Angiostrongylus cantonensis*) which cause the disease Eosinophilic meningoencephalitis in humans; and intestinal fluke (*Echinostoma ilocanum*) (CABI, 2014). Many Vietnamese farm workers can be exposed to such infections if they consume under cooked snails, and also in wetlands because of a lack of protective clothing. We are not aware if the Ministry of Health has monitored the level of snail-borne disease infections in farm workers.

The two species of *Pomacea* remain the dangerous pests in Vietnam. Currently there are no measures to effectively prevent the growth, development and spread of *Pomacea* species. Therefore more applied research is needed to develop eco-friendly, and sustainable management options that can easily be adopted especially by smallholder farmers, as well as on community-area-wide especially with increased threats of flooding of the Mekong River and other water bodies caused by climate change.

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Egg mass of Pomacea spp. at the bank of a rice field in Phu Loc, Thua Thien Hue, Vietnam. (Credit: Dr. Do Van Tu).

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