THE GOLDEN APPLE SNAIL (*Pomacea canaliculata* Lamarck) SITUATIONS AND INTEGRATED MANAGEMENT ACTIVITIES IN THE MEKONG DELTA OF VIET NAM

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1. INTRODUCTION

The Golden apple snail (*Pomacea canaliculata* (Lamarck)), is an important pest of irrigated rice in Viet Nam. Particularly, for the direct-seeded rice in the Mekong delta of South Viet Nam. Since 1988 when some Vietnamese farmers introduced *Pomacea canaliculata*, it is easy rearing methods, fast growth, high protein content and good taste of travelers would be back from Taiwan and Philippines.
Two years later, there were 2 private entrepreneurs to make large rearing at snail farming where farm organizations completed in promoting and selling the snail to other countries (one of them in Ho Chi Minh City and the other one in Kien Giang province). Until 1993, through FAO office in Vietnam, we were aware of the damage of Golden apple snails. The alarming state of Golden apple snail infestation became more vivid through out a workshop on the Golden apple snail management was organized in Tien Giang province in South Vietnam. The Prime Minister of Vietnamese Government released Decree No. 528/TTg, date September 29, 1994 on Golden apple snail prevention, control programs and it was banned raising and transportation. From September, 1994 to June, 1995 we assessed the distribution of Golden apple snail between rice and non-rice habitats and carried out control in whole country , we found out that it appears the most of provinces and total funds for snail control were 2,079 million VND with snails and egg masses were destroyed about 689 tons and 102 tons, respectively.
Today, the average of infected rice area by Golden apple snail around 80,000 ha in the south Vietnam annually. This pest is difficult to control and it spreads everywhere even in the canals of communities therefore is known about the association between population densities of this snail, damage to tillers and yield loss. This report will give the information on status of the snails and the effectiveness of its control measures in the south of Vietnam in order to combine between scientists help farmers to stop the Golden apple snail from spreading and being a threat to the rice crops.

2. THE GOLDEN APPLE SNAIL OUTBREAKS IN RECENT YEARS

Based on the survey results made by Plant Protection Department (PPD) in 1995, the Golden apple snail had been spread to all provinces in the whole country (61/61 provinces), infected 22,717 ha of rice cultivation, 460 ha of Water morning glory *(Impomoea aquatica)* ponds and pools and 1,147 km of community canals.

The Golden apple snail is causing serious damage on rice, every rice cropping season there are many ha of rice cultivations where the Golden apple snails attack and farmers must re-seeded 2-3 times.

According to Matthias Halwart (1994) showed that approximate distribution of the Golden apple snail in rice in the south of Vietnam with year of first appearance was 1988. In the past 16 years, there were 5 years (1999, 2003, 2004, 2005 and 2006) of outstanding outbreaks of snail in the south of Vietnam. The snail population and the infected area (including rice and non-rice habitats) are usually much higher and larger than before 1999 (Table 1 & 2). In order to explain this problem it maybe depend on the flooding situations in yearly higher and higher continuously in the Mekong Delta in the south of Vietnam. Although, the geographical distribution of the Golden apple snail is over provinces in the south of Vietnam, the provinces which are growing rice with available irrigation, many water ways in the southwestern part of Ho Chi Minh city is the Golden apple snail occurs much more abundantly and frequently than in other northeastern part. On the other hand, the translocation movement of the Golden apple snail during flooding time (July to October) from province to another province is very clearly in the Mekong Delta.

Table 1. Infected rice area by Golden apple snail in past 16 years in the south of Vietnam

Year	**Infected rice area (ha)**	**Year**	**Infected rice area (ha)**
1997	64,087	2005	291,805
1998	36,079	2006	139,727
1999	136,575	2007	96,630
2000	99,356	2008	90,625
2001	99,414	2009	82,399
2002	95,106	2010	92,776
2003	129,398	2011	94,067
2004	297,484	2012	75,742
Total	**1,921,270.00 ha/16 years** ~ Average **120,079.38 ha/year**		

Table 2. Volume of snails and egg masses were caught in the campaigns in yearly

Year	Volume of snail (kg)	Volume of egg masses (kg)
1997	125,853.3	4,139.5
1998	575,491.0	813.0
1999	24,940,436.2	263,893.3
2000	8,607,117.0	145,868.5
2001	6,955,614.9	19,414.2
Total	**41,204,539.4**	**434,128.5**

3. CURRENT ACTIVITIES OF GOLDEN APPLE SNAIL MANAGEMENT

Today, the infestation of the Golden apple snail in the south of Vietnam has become popular in the both public and private sectors. Thus, the use of an integrated snail management system can not be done by individuals acting alone, must be carrying out with a group of farmers to act together to help establish such as system. The social benefits of learning/awareness about snail control and ecology, environmental benefits. . . how the snail control program may lead to a stable yield or a reduction in cost of snail control.

Generally, with funds coming from Government or local Government for basic research or extension on Golden apple snail management is done by the technicians of Sub-Department of Plant Protection or Extension Agency in provincial levels. They have been efforts include research, farmer training by many methods such as "talk and chalk", panels, leaflets, T.V., radio. . . On the other hand, Leaders of local Government have organized the campaigns of "community snail control" by soldiers, students and a large of farmers to make low population of snail in community water-ways by hand-picking method in yearly.

4. RESULTS OF RESEARCHES

4.1 Physiology and Ecology

According to Kim Cuc (1991), the Golden apple snail has gills and a lung-like breathing organ. Thus, it can life in wetland or upland habitats and even low oxygen condition at 0.3 mg O_2 per liter. Golden apple snail is a botanical polyphagous animal; when female snails grow up at 3 gram weight (around 30 day-old) or more they can mate and lay eggs. The female snails as crawlers on the base of trees out of the water level lay egg masses with bright pink color (each egg

mass from 10-500 eggs). There is a wonderful when the female snail is finished mating, separate out of male and female and then 8-10 days after mating the female lays eggs-the eggs are still hatching. This reason prove that sperms of male can still alive in female body until 8-10 days after mating. On the increase of weight of Golden apple snail depend on the stages, water temperature, population rearing, food for feeding, fecundity . . . but in the pond conditions the juvenile snails (< 1gr/snail) and adults (5-10 gr/snail) can increase weight at 0.035-0.065 gr/day/snail and 0.330-0.700 gr/day/snail, respectively

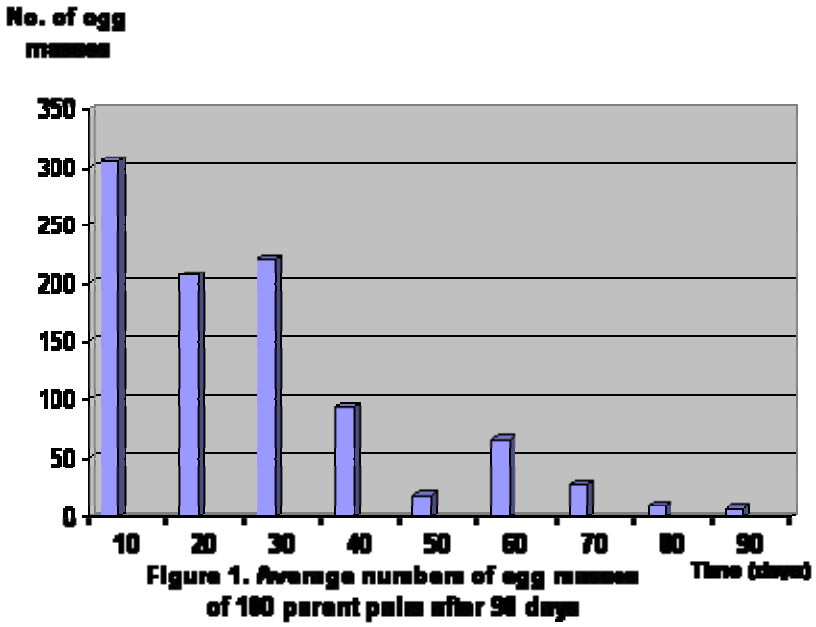


Figure 1. Average numbers of egg masses of 100 parent palm after 90 days

Figure 1 showed that females reach maturity and took them into the productivity where at first 10 days an average number of egg masses around 3 per female with 3-4 day intervals/egg mass; most of egg masses were laid at the first month. There were decrease of number of egg masses after 30-90 days.

4.2 The attractiveness of some botanical leaves on Golden apple snail

Table 3. Attractiveness capacity of some botanical leaves to Golden apple snail

Raw materials	Number of snails caught in bait traps			
	1 DAT	2 DAT	3 DAT	4 DAT
Euphorbia leaves *(Ricinus communis)*	5.67a	6.33a	3.33a	2.67a
Papaya leaves (*Carica papaya)*	4.67b	5.00a	3.67a	2.00abc
Cassava leaves	4.33ab	5.00a	3.33a	2.33ab

(Manihot utilissima)				
Jack fruit filament *(Artocarpus heterophyllus)*	3.33b	2.33b	1.33b	1.33abc
Taro leaves *(Alocasia macrorrhiza)*	1.67c	3.00b	0.67b	0.67bc
Water convolvulus *(Ipomoea aquatica)*	1.67c	1.67b	0.33b	0.33c

Note: *Means followed by a common letter are not significantly different at the 5% level by DMRT*
DAT: *Day after treated.*
*Source: Le Duc Dong, 1998.

For the experiment on attractiveness of botanical leaves to Golden apple snail with five treatments, three replications and in the pond conditions with 350m^2 large size area. Results of table 3 showed that Euphorbia, Papaya and Cassava leaves were most attractive to Golden apple snail at 2, 3 and 4 days after treated. Therefore, trend of future can make the bait trap in order to collect golden apple snail in community water-ways to avoid environmental toxicity.

Table 4. Effect of some pesticides on mortality of Golden apple snail

No.	**Pesticide**	**Dosage (gr.or ml/m^2)**	**Mortality (%)**				
			3 DAT	**5 DAT**	**7 DAT**	**10DAT**	**14DAT**
1	Bayluscide 250 EC	0.12ml	44.344a	99.994a	99.994a	99.994a	99.999a
2	Padan 95% WP	0.12g	21.676b	55.566b	91.699b	99.124a	99.999a
3	$CaCO_3$	65.00g	36.093ab	53.330b	58.013d	60.059c	62.426c
4	Meta 6%	0.80g	0.008c	23.608c	66.776c	88.694b	89.108b
5	Meta 5%	0.20g	0.001c	14.886c	24.367e	36.800d	48.866d
6	$CuSO_4$	0.65g	0.006c	0.004d	2.998f	35.977d	46.376d
7	Control	untreated	0.001c	0.111d	0.001f	0.001e	0.001e

Note: *Means followed by a common letter are not significantly different at the 5% level by DMRT*
DAT: *Day after treated*

Effect of some pesticides on mortality of Golden apple snail carried out with 7 treatments, 3 replications, randomized complete block designs, plot size 1m^2 with 50 rice hills and 15 snails (3.5 cm shell hight). For the Bayluscide 250EC at rate 0.12ml/m^2 resulted over 99% mortality at 5, 7, 10 and 14 days after treatment application. Plots treated with Padan 95% WP at rate 0.12g/m^2 were also high snail mortality (>99%) at 10 and 14 days after treatment application. The rest of treatments with lower than mortalities and the lowest in untreated plots.

Table 5. Effect of some botanical pesticides on mortality of Golden apple snail

No.	Raw materials	Dosage (kg/ha)	Mortality (%)			
			1DAT	3DAT	5DAT	7DAT
1	Rotex 5%WP (Rotenone)	30	22.187a	31.040a	73.240a	86.667a
2	Derris roots *(Derris elliptica)*	250	6.663b	19.997b	22.220b	24.397b
3	Dry leaves of Neem *(Azadirachta indica)*	150	2.193bc	4.463c	4.463c	4.463c
4	Seed powder of Pachyrrhizus *(Pachyrrhizus erosus)*	30	0.010c	2.217c	2.217c	2.220c
5	Dry neem seeds *(Azadirachta indica)*	20	0.003c	2.220c	2.217c	2.220c
6	Fresh neem seeds *(Azadirachta indica)*	150	0.003c	0.003c	0.003c	0.007c
7	Untreated	0	0.003c	0.003c	0.007c	0.007c

Note: *Means followed by a common letter are not significantly different at the 5% level by DMRT*
DAT: *Day after treated*

A similar experiment was observed on 6 botanical pesticides and control (Table 5). The Rotex 5%WP (Rotenone from Derris) (30kg/ha) resulted in 73% and 86% snail mortalities at 5 and 7 days after treatment application, respectively. While the rest of treatments gave the low snail mortalities.

5. FARMER TRAINING & IPM

Plant protection network in Vietnam have been snail control programs for each different region yearly. IPM program on Golden apple snail was combined with "community IPM" in different locations. Current activities on the management of the Golden apple snail such as:

- Dissemination of information on snail damage to farmers; this is done through T.V., local radio, extension bulletins, leaflets, farmer field schools.
- Hand picking and destroy egg masses and adults with social community.
- Recommend to farmers change direct-seeded into transplanting method where high population of Golden apple snail and serious damage in rice cropping season.

- Where the small Golden apple snail could be fed by ducks. On the other hand, the big ones could be fed to fish or shrimp after chopping.
- Could be construction of shallow canals around the rice fields in order to collect snails is easier.
- Pasturing of ducks in rice fields before transplanting to reduce population.
- Make stand up the bamboo sticks in the canals around the field and even in everywhere the field to collect egg masses.
- Install the screen wires (or plastic nets) for irrigation water crossing to prevent snail infestation.
- Molluscicide application when necessary (such as Bayluscide).

6. DISADVANTAGE STATEMENTS

- Golden apple snail become popular in the both public and private sectors. Thus, most of farmers were waiting for the Government's control programs.
- It must be difficult to prevent Golden apple snail while the flooding condition in the Mekong Delta is yearly. It was built up excessive population after flooding time.
- Biocontrol is not high effectiveness such as duck can not feed the egg masses or so large snail adults. Botanical pesticides were not available products.
- Snail control can not be done by individuals acting alone but farmer do not want collaborative together because timing loss.
- Change rice direct-seeded into transplanting must be loss more labors for input costs.

So far, regard to the snail and its impact on the rice ecosystem, IPM still lacks the collaboration of national and international scientist researchers. This can best be done in future with an interdisciplinary approach including national & international researchers./.

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