'Golden' menace in Ifugao rice terraces

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If the golden apple snail (GAS) were real "gold", farmers in the Ifugao Rice Terraces (IRT) would have been grateful to those who brought it to the world-renowned spot in the Philippines.

Now one of the major rice pests in the IRT, GAS has been significantly reducing the current yield of about 1.34 tons per ha annually, which is barely enough to feed the families for the whole year.

Scientifically known as *Pomacea canaliculata* (Lamarck 1822), GAS has been known in the Philippines to habituate only the lowland areas and its reproduction is limited by low temperature, high elevation, and salinity. Surprisingly, a group led by Dr. Ravindra Joshi, a crop protection specialist at the Department of Agriculture-Philippine Rice Research Institute (DA-PhilRice) discovered that GAS can survive in cool, elevated areas as demonstrated by a large number of GAS in the IRT, which is 4,000-5,000 ft above sea level.

Unaware of the possible threats posed by GAS, rural folks in the IRT brought it from the lowland areas for human and animal consumption and for weed control. Rice seedlings raised in the lowland areas, which could have borne eggs or hatchlings, were also transplanted in the IRT particularly in the upper terraces. GAS was spread all over the IRT through the terrace irrigation system.

The International Rice Research Institute (IRRI) library website (http://www.ricelib.irri.cgiar.org) shows some 65 references indicating that GAS research has been concentrated in the lowland areas. As a result, most of the control measures established cannot be applied in the IRT because of its unique characteristics. Current GAS research in cool, elevated areas looks at possible control measures such as the use of indigenous plants as attractants, search for natural predators, modification of water management techniques, development of crop protection practices that can be timed to increase GAS mortality, and discovery of more palatable food recipes for human and animal consumption.

A female golden apple snail can lay about 25-320 strawberry pink eggs at one time. These eggs mature in about 10-15 days

EDITOR'S NOTE

You may well ask why a rice paper in an aquaculture newsletter? "We need a new solution to the old golden apple snail problem, and an integrated approach with fishfarming may be the answer," explains Dr. Ravindra Joshi, a PhilRice research fellow, when he visited SEAFDEC/AQD on January 25. He presents this problem in the hope that researchers on aquaculture may become interested enough to work with him. Dr. Joshi can be reached at: <philrice@silang.slu.edu.ph> or <joshiravi@hotmail.com> Telefax (63-02) 843 5122

Tracing the origin

Earlier studies conducted by researchers from the University of the Philippines at Los Banos (UPLB) and DA-PhilRice claim that GAS was introduced in the Philippines between 1982 and 1984 from Taiwan, Florida, and Argentina as food and protein source of Filipino farmers. Because of this, GAS was massively cultured and distributed in different lowland areas of the country and now has become one of the major pest problems in rice production.

In Argentina, GAS is not a problem according to Dr. Nestor Cazzaniga of the Universidad Nacional del Sur Departmento de Biologia. Although rice is not a staple food in Argentina, large portions of lands are planted to rice because it is exported. Because its production is highly mechanized, fields are properly leveled and water is well-managed and controlled, making it less prone to GAS infestation.

The first report on GAS infestation in the Philippines came out in 1986 when about 300 ha of irrigated lowland rice fields in Region 2 were heavily damaged. In the same year, farmers in the IRT started to notice the same. By 1988, GAS has already damaged about 4% of the country's total rice area and in 1990, the damage reached 11%.

GAS invasion in neighboring countries

A study conducted by Drs. Yoichi Yusa and Takashi Wada of the Kyushu National Agricultural Experiment Station shows that the

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Handpicking is still one of the most practical methods in controlling the golden apple snail population

The golden apple snail can damage newly planted rice seedlings overnight

introduction and culture of GAS in Japan started as early as 1964 when a company introduced it as an aquarium pet. It became popular as food in the early 1980s but the production later declined because people did not like the taste of the snail. It was later disposed into rivers, ponds, creeks, and paddies. Damage to rice was reported in 1984 and in the same year, GAS was declared as a quarantine pest by the Ministry of Agriculture, Forestry and Fisheries. Still, aquarium shops in Japan continued to import and sell apple snails as pets. Natural predators currently used include the water birds, fish, turtles, fireworm larvae, and crabs.

In Thailand, it was introduced in 1982 from Japan and Taiwan. Mainly used as decoration in aquariums, GAS rapidly multiplied and eventually produced excess stocks, which were thrown away and reached canals and rivers. The first GAS outbreak was recorded in 1988 south of Bangkok. Several indigenous plants that have been used to control it include the golden dewdrop (*Duranta repens*), mafia nok kum (*Ammannia bacifera*), pla khum dee kwai, and soapberry tree (*Sapindus semarginatus*).

In Vietnam, it was introduced in 1988 from South America and declared as a quarantine pest in 1993. By 1997, it has already spread to 7 out of the 61 provinces. In Nghe an province, an experiment on the use of fishes such as black amur and tilapia in controlling GAS shows considerable reduction in GAS density to as high as 84% from summer to autumn and 64% from winter to spring.

It was only in 1990 that GAS was first detected in a household tank in Malaysia. Its origin was unknown. Based on the size, it was concluded that GAS had been there for some three to four years earlier. The disperson of GAS in Malaysia was relatively slow because of the coordinated efforts of relevant authorities. Upon discovery of the GAS, the Department of Agriculture formed the GAS Task Force at the national level. Small working committees were also formed at the district level to monitor the status of infestation and results of control measures employed. In selected areas, effective control measures include the use of salt water, pesticides, snail metal traps, and natural predators such as ducks. An on-going trial on the integration of fish in rice culture has reported promising results.

A year later after GAS was discovered in Malaysia, *Pomacea* sp. was found in a farmer's fishpond in Lao PDR. GAS started to invade neighboring fields when heavy rains flooded the pond causing it to overflow. It was in 1993, when it damaged about 5 ha of rice that it was brought to the attention of the government.

In 1991, it was introduced in Cambodia through refugees who returned from Thailand. Farmers in Takeo intentionally raised it in their fields as food, just as they normally did with the native snails (*Pila* sp.). Since the native snails do not damage rice, farmers assumed the same for the GAS. One of the most popular attractants used is the dragon bone plant, which is reported to contain toxins.

In Australia, the software package CLIMEX was used in matching the climates of geographical regions where *P. canaliculata* is known to occur with that of other regions in the world. The matching showed that large regions within India, China, and Australia are at risk for future GAS invasion.

Control methods

The GAS are most often found in moist soils with vegetation, commonly in rice paddies. They appear to be very still as they tightly stick to the stems of rice plants and burrow into the clayey soil when soil moisture declines. Their clustered pinkish eggs remain pasted on leaves and stems. Tiny and fragile as they appear, the GAS have high survival rates. An experiment conducted by the group of Joshi demonstrates that GAS can still survive during fallow

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The safety level of vitamin E has to be determined before administration (Waagbo 1994). According to Pulsford *et al.* (1995), the phagocytic activity of kidney macrophages in flat fishes were enhanced when the fishes were fed higher amounts of vitamin E.

Conclusion

Still no clear conclusions can be drawn with respect to vitamin nutrition and fish immunity. So, attention should be given to improve the earlier recommended levels for different vitamins.

- Testing with different immune functions must include the mechanism by which a single nutrient accelerates different biological functions
- Safety levels of different vitamins must be determined before administration
- For antioxidant vitamins, care should be taken to avoid losses due to atmospheric oxidation and water leaching by using the recommended type such as phosphate esters of ascorbic acid
- More work is needed for vitamins C and E supplementation beyond minimum dietary requirements to clarify the benefits to fish health. So, metabolism of nutritional C and E forms needs further investigative biochemistry

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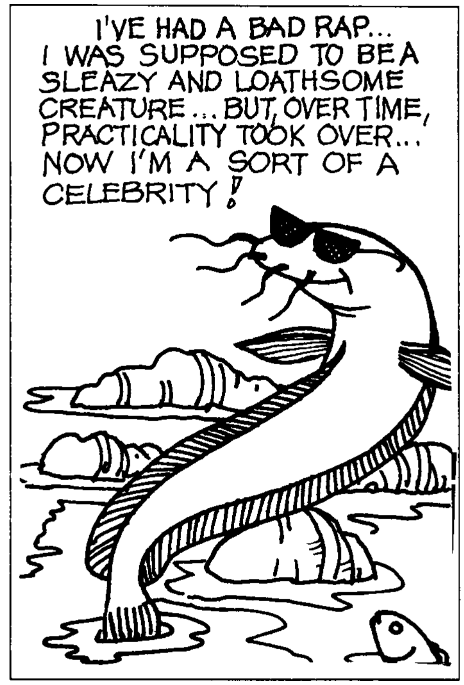

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periods and possibly even during the dry period, as these burrow deep into the soil.

A female GAS can lay 25-320 eggs at one time. Incubation ranges from 10 to 15 days, and, depending on the temperature of the microenvironment, GAS normally lives from two to three years. The GAS do not feed only on rice. They also damage many cultivated and non-cultivated plants such a lotus (*Nelumbo nucifera*), taro (*Colocasia esculenta*), duckweed (*Lenna minor* L.), swamp cabbage (*Ipomoea aquaica*), mat rush (*Juncus decipiens*), water chestnut (*Trapa bicornis*), and water fern (*Azolla* spp.). It has a wide range of possible hosts and food substrate such as commercial livestock feeds, decaying matter, animal flesh, and other important crops. Because of this, GAS is difficult to control. Compounding this problem is the occurrence of heavy rains and the application of pesticides that kill a large number of beneficial organisms, particularly in and around the rice ecosystem.

TABLE 1 Volume of molluscicides purchased, 1980-1998, Philippines

YEAR	VOLUME (kg per ha)
1998	67,340
1997	241,683
1996	130,000
1992	180
1991	159
1990	0
1989	25
1988	64
1987	9
1986	6
1985	3
1984	3
1983	0
1982	0
1981	0
1980	0

Note: Does not include 1993-1995 data
Source: Fertilizer and Pesticide Authority, 1999

Molluscicides have been widely used to control GAS but these can also kill non-pest snails and other beneficial organisms. From 1980 to 1988, the volume of molluscicides purchased increased (Table 1). The biggest volume recorded was in 1997, when about 241,683 kg per ha were purchased. The country has already spent about US$23 million from 1980 to 1998 for molluscicides (Fig. 1).

The Strategic Extension Campaign launched in 1989 by the Food and Agriculture Organization (FAO) of the United Nations, Visayas State College of Agriculture (VISCA), International Rice Research Institute (IRRI) and DA-PhilRice introduced non-chemical methods such as pasturing ducks in rice fields after harvest, handpicking, destroying egg clusters before final harrowing, transplanting older seedlings, and installation of screens in water inlets. These practices however, remain untested in the rainfed, direct-seeded, and

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hybrid rice production environments.

Joshi's team is currently conducting intensive GAS research focusing on life table analysis, off-season survival strategies, and crop compensation. According to Joshi, knowledge on the biology of the GAS can lead us to discovering more effective control measures. He also said that current control measures are not very effective if not done at the community level.

GAS study at DA-PhilRice

Studies conducted by DA-PhilRice aimed to establish the effectiveness of basal application in the reduction of GAS population and the relation of GAS shell length to rice seedling damage. Results showed that GAS with shell length of 40 mm are most destructive to rice seedlings, while GAS with shell length of 5 mm and below were not capable of destroying rice seedlings (Fig. 2). Another study documented the current status of GAS infestation in the IRT. The study was conducted in collaboration with the local government units (LGU) of the municipalities of Banaue, Mayoyao, and Hungduan and with DA, Lagawe, Ifugao. The study focused on the extent of damage and distribution; and knowledge and current control practices applied by farmers. Majority of farmers in the lowland areas uses molluscicides, while others chose to handpick the GAS and pasture ducks in the fields. In the IRT, farmers use indigenous plants and decaying weeds as attractants, the most popular of which is the trumpet flower.

Prospects for further research

A more intensive study on the biology of the GAS is needed to develop more effective control measures. One possible solution is the use of indigenous plants as attractants. In the lowland areas, farmers use kangkong (*Ipomea aquatica*), sweet potato (*Ipomea batatas*), and papaya (*Carica papaya*) as attractants.

Another promising method is integrating fish in the rice culture. Fish is integrated in rice culture because of a number of advantages such as controlling pests, increasing cash and non-cash income and the nutritional intake of farm households. A study conducted by ICLARM in 1996 at Quirino province showed that there is potential for rice-fish culture in upland areas.

The least explored area of GAS research in the Philippines is the use of aquatic predators such as fish, frogs, toads, and other water-borne organisms. Dr. Matthias Halwart of FAO, Rome says that the common carp, *Cyprinus carpio* and *Oreochromis niloticus* can be used in controlling the juvenile stage of GAS. In Taiwan, more than a million fingerlings of the *C. carpio* and *Mylopharyngodon piceus* were released to control GAS. However, it is also very important to assess the safety of plants with molluscicidal activity against fishes that feed on GAS.

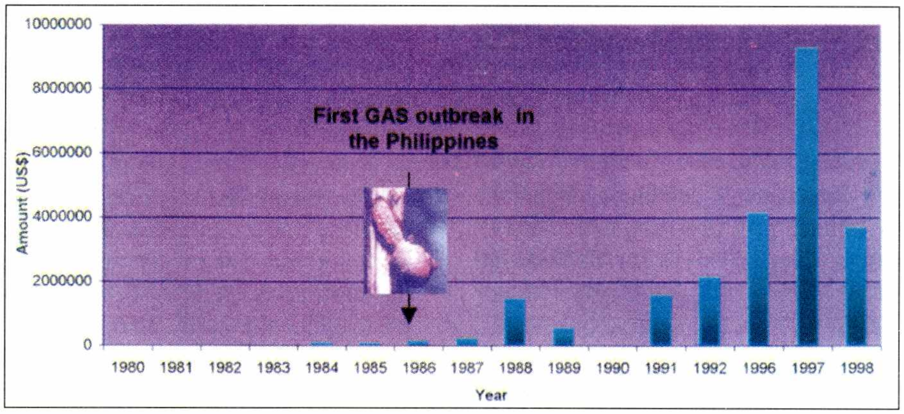

FIG 1 Total amount spent for golden apple snail control using molluscicides, 1980-1998, Philippines (from FPA 1999)

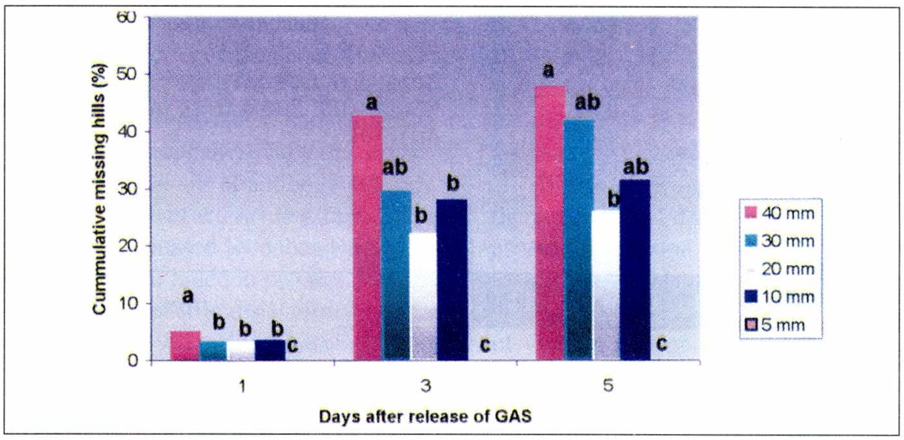

FIG 2 The effect of different golden apple snail sizes on rice seedling damage. Bars sharing the same letters are not significantly different (P<0.05) according to Duncan's Multiple Range Test (DMRT)

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Summary

The catfish industry in the Philippines is budding and projected to expand in the coming years. This is evident from conversations with active catfish farmers who all hope to be able to expand production, whether backyard or commercial because their present production can hardly supply the demands of buyers.

NIFTDC a fisheries technology and development center in Dagupan City, however, says that unless the government has a catfish program, expansion of the industry would be slow. Work on catfish research is only just starting and the culture methods remain to be on a gut feel basis. The farmers are left to survive on their own. Luckily for them, catfish is hardy, easy to grow, and has a growing market. Clearly, if catfish can provide cheap protein for more people, scientific support must be made available for the farmers.

POSTSCRIPT

The Mangabol Lake (located between the provinces of Pangasinan and Tarlac) used to be the biggest source of catfish (native or hitong tagalog, *C. macrocephalus*) in Luzon, perhaps even the Philippines (Philippine Fisheries, 1952). An annual festival used to be held in the area, according to people in Bautista, Pangasinan. Fishers from all over Luzon would gather in Mangabol Lake, and on the day of the festival, a fog horn would sound and fishers simultaneously dive into the lake with their snare. The diver who got the biggest catch would win a prize (usually prestige). But the 1991 Mt. Pinatubo eruption overran the lake and Mangabol Lake remains to be unproductive until the present time.

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running water and then placed inside the incubators. Incubators can be made of marine plywood or plastic basin with a flow-through water system and provided with aeration.

Pituitary glands can be dissected from the heads of sacrificed male catfish. Pituitary glands contain hormone(s) that can also be used to spawn the female catfish in subsequent runs.

Fertilization and hatching

Using the above procedure, fertilization rate can reach more than 90%, while hatching rate may range from 30 to 70%. When stripped, there are approximately 100 eggs per gram body weight of the female fish; about 500 eggs are contained in one gram. A female catfish has 20-25 g of stripped eggs on the average.

Hatchery and nursery rearing

Larvae can be maintained for four days in the same incubators without feeding. Catfish larvae are then transferred to bigger tanks and fed with newly hatched *Artemia* nauplii for three days and *Moina* for four days. Thereafter, larvae are given formulated feed of 150-200 microns size that contains 44% protein. Two week-old catfish fry can be sold to grow-out pond operators, who are advised to rear the fry in net cages suspended in either tanks or ponds. Or, the fry are reared further for 4-6 weeks in bigger nursery tanks or ponds to reach 3-5 cm, the appropriate size for stocking in grow-out ponds.

Packaging and transport

Catfish fry are counted and graded according to size, and then placed inside a plastic bag half-filled with water at 500 to 1000 fry per bag. The bag is thereafter oxygenated and tied. Native "bayong" bags may be used to hold the plastic bags in, when transporting a short distance only. When transporting by plane however, the plastic bags are better placed in styrofoam boxes with crushed ice filled to the brim.—NJD