Environmental Impact of the Golden Snail (*Pomacea* sp.) on Rice Farming Systems in the Philippines

Summary Report of the Workshop held at the Freshwater Aquaculture Center, Central Luzon State University
Nueva Ecija, Philippines
9-10 November 1989

Edited by

BELEN O. ACOSTA
ROGER S.V. PULLIN

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Cover: *Rice tillers infested by golden apple snail,* (Pomacea *sp.*) Photo by Oscar Granado.

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Contents

Preface

The human race has transferred plants and animals, wild types or genetically modified, from their national ranges to new environments since the beginnings of recorded agricultural history. Many of the transfers have been astoundingly successful. The world is largely fed by about 20 plant species and a few terrestrial livestock species, plus a wider assemblage of aquatic species. The consequences of transferring pests and predators of food organisms are obvious. Some transfers of the food organisms themselves have, however, been ecologically and economically disastrous. This applies particularly to species that breed prolifically and spread rapidly through early life history stages being distributed by wind or water. The International Center for Living Aquatic Resources Management (ICLARM), as an affiliate member of the International Union for the Conservation of Nature (IUCN), and having a mandate to pursue strategic research for the benefit of developing country fisherfolk and fish farmers, is among the organizations concerned to minimize the harmful ecological and environmental effects of transfers of aquatic organisms.

ICLARM's long association in collaborative research with the Freshwater Aquaculture Center of Central Luzon State University (FAC/CLSU) provided the basis for this workshop. Both ICLARM and FAC/CLSU were horrified at the worsening ecological and environmental effects of the introduction to the Philippines of the golden snail (*Pomacea* sp.) and felt that these effects should be reviewed and publicized to try to find solutions to ameliorate the damage already caused and to alert others to avoid similar occurrences with other species.

The 'golden snail story' in the Philippines is a classic example of an ill-conceived introduction, made for the private gain of a few and without any sound analysis of economic benefits or possible ecological effects. The introduction was made by the private sector in the guise of offering a means of livelihood improvement to producers countrywide, with the rationale that there was a huge export market for 'escargots' that could be supplied by farming the golden snail. This was not true. The snails escaped, became widely established and now have serious effects on over 400,000 ha of rice lands. The private sector has since introduced the Louisiana swamp crayfish (*Procambarus clarkii*) to the Philippines. It will surely escape from aquaria and tanks. The effects remain to be seen.

ICLARM and the FAC/CLSU convened this workshop to bring together participants from the public and private sectors who have been actively working on the golden snail. They discussed possible solutions to the problems of snail control and exchanged information and ideas. Thirteen papers were presented and discussed. The majority reflects the actual experiences and practices of farmers and researchers.

The organizers hope, nevertheless, that the golden snail story, documented in these proceedings, will help to deter both the public and private sectors in developing countries from further unwise introductions of new exotic species, based on uncritical acceptance of the magic phrase 'export potential' and will encourage all parties concerned with species transfers to examine the potential ecological and economic consequences and to proceed only according to established International Codes of Practice. These proceedings provide an abject lesson in how <u>not</u> to do things, for which the Philippines is now paying the price.

Roger S.V. Pullin
Director, Aquaculture Program
ICLARM

Acknowledgements

We wish to acknowledge the active participation of the various institutions and organizations represented in the workshop. We are especially grateful to the Food and Agriculture Organization (FAO) Intercountry Programme for Integrated Pest Control in Rice in South and Southeast Asia, and the Philippine Bureau of Plant Industry (BPI) Crop Protection Unit for all the help they rendered.

Opening Remarks

Dr. R.G. Arce, Director of the Freshwater Aquaculture Center, Central Luzon State University (FAC/CLSU), welcomed everyone and pointed out the significance of the workshop to Filipino farmers facing snail infestation and the growing concern on the environmental impact of the golden snail on rice farming in particular and on food production in general. He also cited the gathering as a good opportunity for Filipinos to undertake a more critical assessment of the golden snail problem.

Dr. R.S.V. Pullin, Aquaculture Program Director, International Center for Living Aquatic Resources Management (ICLARM), then emphasized that snail control is very important not only in the Philippines but also in other parts of the world because some snails can act as intermediate hosts for parasites of animals and humans. The general experience is that aquatic snails are among the most difficult organisms to control. Biological control using snail-eating fish has not been very successful and may involve introducing exotic snail-eating fish. Chemical control also has environmental drawbacks. Tin-based compounds have dangerous environmental effects, as have been experienced in cage aquaculture with tin-based antifoulants. Dr. Pullin urged the workshop participants to suggest some new ideas on how to control the snail problem.

Summary of Papers Presented and Associated Discussions

Mr. J.P. Baldia presented an overview of golden snail research in the Philippines. Most experiments have dealt with snail biology, especially the effects of different types of food, population density, sex ratio and water change on snail eggs.

The private sector at first sought to develop golden snail culture methods. However, research now concentrates on the control of golden snail as a serious pest affecting newly transplanted rice. Government and private institutions have initiated research on the biological, chemical and mechanical control of the golden snail.

When asked to comment on the export potential of golden snail, Mr. Baldia said the export potential of the species as "escargot" was well publicized when it was first introduced into the Philippines. However, the potential is now thought to be imaginary.

Mr. B. Guerrero next presented information (gathered by Mrs. L. Guerrero) on the biology of the golden snail in relation to Philippine conditions and discussed its taxonomy, life cycle, growth rate and food habits compared with those of native snail (*Pila luzonica*). He noted that in the Philippines there is some confusion on the species name. Prof. A. Yambot commented that the FAC/CLSU sent golden snail specimens to the Smithsonian Institute. Dr. George Davis, Curator and Chairman, Department of Malacology, Academy of Natural Sciences, Philadelphia, identified these as *Pomacea insularis*. FAO and the Commonwealth Agricultural Bureaux International Institute of Biological Control (CIBC) likewise identified the specimens as *Pomacea insularis*. The International Rice Research Institute (IRRI)[1], however, identified the species as *Pomacea*

[1]Saxena, R.C., A.V. de Lara and H.D. Husto. 1987. Golden apple snail: a pest of rice. Int. Rice Res. Newsl. 12(1):24-25.

canaliculata (Lamarck). In the paper of Dr. Saxena et al., the samples were identified as *P. canaliculata* by morphologically characterizing it. Mr. R. Basilio mentioned that according to Dr. Mochida,[2] *P. canaliculata* was introduced to Batangas from Taiwan in 1983 while *P. vigas* was introduced to Makati, Metro Manila from Florida, USA. In 1984, another species of *Pomacea* was introduced to Cebu from Argentina. Records suggest that there are now different species of golden snail in the Philippines.

The golden snail grows very fast and has displaced the native snail or kuhol in parts of the country. This was confirmed by Mr. C. Rodriguez. He mentioned that the kuhol became extinct in the Cagayan Valley since the proliferation of the golden snail.

There is no evidence of hybridization between the golden snail and the native kuhol. Prof. A. Yambot and Ms. A. de Lara observed no hybridization in laboratory experiments at FAC/CLSU and at the Institute of Biological Sciences, University of the Philippines at Los Baños (IBS/UPLB). Copulation between kuhol and golden snail is not possible because of the difference in age of maturity.

Mr. R.B. Edra gave a detailed account on how the exotic species, *Pomacea* sp., was introduced in the Philippines, spread and invaded ricefields. There was considerable discussion on how the golden snail got into the country as an exotic species. Mr. Sumangil lamented that while private entrepreneurs did their best to promote the golden snail as export potential when it was introduced, no attempt was made to inform or caution the public of its potential to become a pest, as was known from experience in South America. This partly reflects the failure of the government to enforce regulations on screening exotic species. Dr. Pullin emphasized the unreliability of an assumed "export potential" for a commodity unless this is well quantified. The participants agreed that the authorities concerned should question assumed "export potential" very critically, especially when it involves introduction of exotic species.

Mr. R. Basilio addressed the problem of golden snail infestation in rice farming. He discussed the extent of damage and losses due to infestation. Golden snail is considered a pest in both irrigated and rainfed environments because of its resilience. It can survive up to eight months without water.

Messrs. M. Rondon and D. Callo described the distribution and mode of infestation of golden snail in rice farming. The total area infested as of December 1988 was about 426,000 ha. The highest infestations were reported in Region VI (Western Visayas), Region XII (Central Mindanao) and Region II (Cagayan Valley). Almost all the major rice producing areas in the Philippines are now infested.

Dr. P. Kenmore commented that Surinam had a similar problem of golden snail infestation 25–30 years ago. It was a major rice pest. He pointed out that it may be useful to compare the Filipino farmers' experiences with those of Surinam. A snail control project in Surinam was started in the late 1950s by Mr. J.B.M. Van Dinther. The snail was found in the coastal swamp areas along the northern coast of South America and spread to other places as far north as Puerto Rico and down to Argentina. However, its main area of distribution remains the north coast of South America. Historically, people from India brought to that area during colonial days to work as laborers on the plantations, brought rice seedlings with them. The golden snail was not then a major pest in the small-scale rice farming systems as the farmers controlled the snails effectively by hand collection. However, when a large-scale mechanized irrigated rice production scheme began in the 1950s, snails proliferated in the area and became a major pest problem. One possible reason was the decline of natural enemies with intensive large-scale monoculture of rice in a limited environment.

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[2]Mochida, O. 1987. *Pomacea* snails in the Philippines. Int. Rice Res. Newsl. 12(4):48-49.

From the 1950s to the 1970s, Mr. Van Dinther also tried different chemicals against snails and in his review paper he found that none gave satisfactory results.[3] Many fish were killed as well as snails. Dr. Kenmore's view was that, based on this example, the golden snail problem is likely to affect the way Filipino farmers will grow rice in the long-term future. He strongly suggested that the situation in the Caribbean and South America be compared with that in the Philippines by people with first hand experience, in terms of short-term and long-term management. They should work in partnership with Philippine scientists.

Messrs. E. Guzman and F. Enriquez reviewed nonchemical strategies to reduce damage on rice by golden snails. These include altering farming practices and/or providing the snails with alternative feeds (e.g., taro leaves) and attractants to divert them from feeding on rice seedlings and to facilitate handpicking. In Cagayan Province, the farmers put sacks into one corner of a ricefield to attract snails, then they collect the sacks and place them on the roads to be crushed by passing vehicles. Mr. L. Mateo commented that papaya leaves are not very effective in attracting snails. Experiments at CLSU showed that newspaper is a better attractant.

Ms. E. Atienza discussed lowland ricefarmers' current control practices against the golden snail: biological, chemical and mechanical methods and control by modified farming practices. Regions II, V, VI, XI and XII are involved in an integrated pest management (IPM) participatory project of the Philippine Rice Research Institute (PhilRice). Farmer cooperators interviewed during the study complained of abrasions on their hands and feet acquired from working in ricefields containing many dead snails. A follow-up survey is needed to determine the extent of this problem. Handpicking of snails was the control method most commonly used by farmers with small landholdings and very limited cash resources. Ms. A.V. de Lara suggested that farmers collect bigger and sexually mature (2–3 cm shell height) snails, so that collection can be made once a week and would not be too laborious. Screens with 2-mm mesh are used to prevent newly hatched snails from entering ricefields. Moreover, some farmers use such control methods and chemicals instead of chemicals alone.

Mr. E. Imperial presented insights on practical management techniques to reduce golden snail damage to lowland rice based on field experience and communication with farmer cooperators in Cavite. These techniques include the introduction of ducks to ricefields, the use of wire mesh screens and appropriate water management. Mr. Imperial mentioned that Azolla is also grown in ricefields in which ducks forage. Profs. A. Cagauan and A. Yambot considered the presence of Azolla a disadvantage to snail consumption by the ducks: the ducks would rather eat the Azolla. In their experiments at FAC/CLSU, such high-protein plants have promoted good reproduction of snails.

Mr. Imperial mentioned further that people develop itchiness or allergies when they go into the ricefields where ducks have been used for snail control. Itchiness is probably caused by trematodes, their cercariae released by the snail intermediate host, penetrating the skin. The ducks are probably the final hosts. Dr. Pullin emphasized that when biological control for snails is investigated there should be an economic as well as a biotechnical analysis. The snails are a part of a foodchain. Thus, with biological control based on predation, there will be large biomass of something else – a duck or fish or whatever is used to eat the snails. Something profitable must be done with that biomass which has itself taken nutrients and energy from the farming system.

Mr. J. Cruz described the chemical control of golden snail: the chemical and physical properties of molluscicides and directions for use. Dr. Pullin raised

[3]Van Dinther, J.B.M. 1973. Molluscs in agriculture and their control. World Crops 25:282-286.

the concern of putting large amounts of tin-based compounds into aquatic environments. There is great concern over tin in marine foodchains as a result of the widespread use of antifoulant compounds. Dr. Pullin inquired if there is any available information on the impact of antisnail tin-based compounds on the natural environment and on other organisms. Mr. D. Lobo replied that information is available on the breakdown and pathways of organo-tin compounds under temperate conditions. They have a half life of 75–90 days. Their fate under tropical conditions is yet to be determined.

Mr. D. Callo commented that the Philippine Fertilizer Pesticide Authority (PFPA) confirmed reports that some chemical products used to control golden snail are hazardous to health and that there has been misuse in the methods of application; e.g., overdosage and application before transplanting. There is a need to follow directions in the use of these chemicals as stressed in the paper of Mr. J. Cruz. Farmers, however, find it difficult to acquire adequate protective clothing.

Dr. P. Kenmore stated that the two important aspects to consider in the use of chemicals are their legal status and human safety. He referred to the letter he received from Mr. Louie Villareal, Administrator of PFPA, regarding pesticides for golden snail. It listed pesticides not officially cleared by PFPA for the control of golden snail. Aquatin, Telestan and Bayluscide are registered for use in the Philippines as molluscicides, but not on rice, because their specific use for the control of golden snail has not been thoroughly evaluated. Moreover, PFPA Circular No. 5 Series 83, restricts the use or application of Endosulfan: it should not be used in aquatic ecosystems. Dr. Kenmore emphasized that while such pesticides are popular among farmers for the control of golden snail, there is no official PFPA endorsement of their use against snails in ricefields. He added that Brestan has been cleared for use in rice as a fungicide but not as a pesticide against snails. A World Health Organization directive states that when using compounds containing tributyl-tin, the use of protective clothing such as goggles, breathing apparatus, rubber gloves and other protective clothes is required. It is absolutely impossible for rice farmers to follow this. Mr. Cruz commented that these compounds are actually not being recommended by any chemical company for use against golden snail. Farmers take it upon themselves to try their effectivity in their farms.

Mr. C. Rodriguez presented a paper on the evaluation of molluscicides for golden snail control.

Messrs. H. Dupo and H. Sambuichi presented their work on control of golden snail with Dimotrin (cartap hydrochloride). This compound is a derivation of nereistoxin, a naturally occurring insecticidal substance isolated from the marine polychaete worms. Cartap is not an organochlorine or organophosphate compound and has no prolonged residual effects. Its residues disappear after 7–14 days.

Messrs. M. Rondon and J. Sumangil discussed the integrated pest management (IPM) of golden snail. The IPM technology for golden snail was developed through a series of surveys and interviews with farmers regarding their snail control practices and with scientific inputs from the Department of Agriculture. This technology includes physical, biological and chemical methods and modified farming practices.

Dr. M. Escalada described a strategic extension campaign for golden snail control launched by the Department of Agriculture and FAO in response to rice farmers' needs for information on control measures for golden snail. Information on this aspect will be translated in five major Philippine dialects: Tagalog, Cebuano, Ilocano, Bicol and Hiligaynon.

Working Group Reports

Chemical Control

Dr. R.S.V. Pullin
Chairperson

The group chaired by Dr. R. S.V. Pullin discussed the pros and cons on the use of pesticides based on their effectiveness, cost, environmental impact and public health aspects, including some legal issues.

1. *Effectiveness - Alone or with other methods*

   a. Tin-based compounds. These are effective and can eliminate 98-100% of snails. These are best used in combination with other methods, particularly the use of small canals to concentrate snails.

   b. Dimotrin (cartap hydrochloride). This compound is also effective, especially with appropriate water management.

   c. Others. The use of other pesticides (e.g., Endosulfan, Machete) was discussed. It was recognized that these were not designed for snail use. More work is needed to determine the efficacy of pesticide combinations with other methods.

2. *Cost*

   Brestan - an application of about 250 g/ha costs P195 (US$1 = P25.60 as of 1990) plus 1/2 man-day (about P30). There is one application per crop.

   Aquatin - an application of about 0.5 l/ha costs P150 + application time costs. One application per crop.

   Cartap hydrochloride - the costs for using the compound against golden snail have not yet been determined.

   If costs come down, use of molluscicides will almost certainly increase.

3. *Environmental Impact*

Waterbodies are the main recipients of all pesticide run-off. There is virtually no information at present on the transport and possible accumulation in sediments and foodchains, etc., of tin-based molluscicides in the tropics. The companies marketing these products are engaged in environmental impact research, but the addition of large amounts of organo-tin compounds to the national environment gives serious cause for concern: see p. 31–33 for a bibliography on environmental problems caused by tin compounds in aquatic ecosystems. Other public-funded institutions should be supported to do more research, e.g., FAC/CLSU which is accredited for this purpose.

The extreme toxicity of Endosulfan to fish was noted, as were the possible negative effects of pesticide use, as opposed to IPM, on rice-fish culture.

Cartap hydrochloride is classified as moderately toxic (FAO/WHO) ADI = 1–10 mg/kg. In field trials the a.i. disappears in three days. It is degraded by sunlight and absorbed by soil and plants. Rice plants retain measurable a.i. for only 7–14 days.

Triphenyl-tin (TPT)-based pesticides are contact pesticides. They degrade down the TPT-acetate-TPT-hydroxide-DTP-MPT-tin pathway.

4. *Public Health Aspects*

Workers

The companies marketing molluscicides are concerned about worker safety. Some safety gear (gloves, measuring cups, etc.) are given free. To increase awareness, safety inserts such as pictograms in English and Tagalog are inserted into products. The companies all follow the International Code of Conduct of FAO.

It was recognized that the non-use of protective clothing by Philippine farmers is a serious problem and the most frequent source of health problems due to molluscicides. Leaky sprayers are also a major problem. Boots are not appropriate for work in ricefields. The most important item of clothing is a long-sleeved shirt.

Consumers

TPT-based compounds are contact pesticides and the chance of their being found in milled rice is negligible. For cartap hydrochloride, its rapid degradation will prevent it from reaching rice consumers. However, no firm conclusions about accumulation of molluscicides in foodchains or sediments, etc., can be made before more environmental research is done. Research relating to public health should best be done by independent authorities, e.g., medical establishments.

Others

Livestock can be at risk when watered in treated areas. Domestic water supplies may also be contaminated when surface waters are used. These are risks associated with all pesticide usage.

5. *Legal Issues*

The group discussed the issue of the role of the PFPA and the lack of formal clearance for application of tin-based compounds as molluscicides in ricefields. Representatives of the chemical companies stated that they have always made it clear to the PFPA that their compounds are being used this way by farmers. However, formal registration for such use is still lacking and therefore it is not stated as a use on product labels.

The PFPA and its committees were discussed as was the work of a previous committee (Masagana 99 Committee of Pesticide Use/Efficacy – now discontinued). It was noted that PFPA clearance for a compound and its use is not without time limits. Clearance can be reviewed or revoked at any time. The group recommended that stronger monitoring be done. Pesticide regulation in Japan under the Ministry of Agriculture is very strict. Cartap is registered for use in 36 countries.

Brestan and other tin-based compounds are effective weapons against the golden snail but more research on the environmental impact of these and other molluscicides is needed to estimate the true 'cost' of this chemical control. In the long term, a switch to methods less dependent on chemicals may be needed, depending upon the results of this research.

Biological Control

Mr. J. Sumangil
Chairperson

A list of snail biological control agents mentioned in the papers presented during the technical session was drawn up by Mr. J.P. Sumangil's group. External agents (predators) include ants, dragonflies, spiders, fish, frogs, snakes, ducks, other birds, rats and man. Internal agents are the parasites and the possibility of genetic manipulation. Each agent was evaluated for its inherent advantage and disadvantage.

Ants feed on newly laid golden snail egg clusters and attack aestivating snails.

Webs of certain spiders, if situated beneath golden snail egg clusters, trap hatchlings and prevent them from reaching the water.

The common carp (*Cyprinus carpio*) possibly eats golden snail eggs. However, it was stressed that the eggs are nearly always laid above the water line. The only other fish species known to consume large quantities of aquatic snails is the Chinese carp (*Mylopharyngodon piceus*). It was also suggested that perhaps fish could be bred or enticed to eat snails.

Frogs are not effective biological control agents of golden snail.

There was no information regarding predation on golden snails by snakes and lizards.

Ducks are being raised for their own value and not as biological control agents for golden snail. It is just incidental that the snails are used as feed. Snails are the intermediate hosts and release cercariae which pierce human skin, causing itchiness. The use of ducks in IPM for golden snail also has a disadvantage. It was pointed out that ducks act as intermediate host of a trematode whose free-living miracidia (larvae) float in the paddy water. These larvae pierce human skin with their stylet, causing itchiness when exposed in paddies.

Birds, especially cattle egrets, herons and other waders are presumed to feed on golden snail, but this has yet to be verified.

Rats eat snails, especially the aestivating ones. Snails provide a high-protein diet which contribute to a rise in their population. Even if these rodents are their predators, rats are still rice pests. Rats may be more vicious beyond the tillering stage and are therefore only incidental in kuhol regulation.

Golden snails are eaten by pigs and humans, but the foraging or harvesting activities needed preclude the use of this for effective control.

Genetic manipulation was also discussed. One proposal was to produce transgenic snails with less destructive attributes (voracious appetite, rapid growth and breeding, food preference, etc.). Another was to produce and release individuals to interbreed with resident populations and produce sterile progeny.

The group found that there is still much work to be done on the biological control of golden snail.

Control Through Farming Methods

Dr. P. Kenmore
Chairperson

Dr. P. Kenmore pointed out that the rice plants are vulnerable to snail damage until 4-5 weeks after transplanting. The snail population should therefore be low from transplanting time up to one month hereafter, but can be high 4–6 weeks before harvest. Golden snails can serve as a protein source for poor people at times.

Interviews with farmers have revealed that they themselves have developed the following methods to control golden snail:

- handpicking of the snails at critical times;
- construction of small canals, where snails will concentrate when fields are drained to facilitate handpicking;
- transplanting older, less vulnerable seedlings;
- increasing the number of seedlings per hill;
- placing sticks in the field to attract golden snails for egg deposition, thereafter eggs can be easily collected and destroyed;
- placing screens at water inlets to prevent snail entry;
- releasing ducks into ricefields before transplanting and 35–40 days after transplanting to reduce the snail population.

These combined methods give satisfactory control of golden snail.

Pesticides are not always efficient in the farmers' fields. Their application before rice transplanting is dangerous to human health. People have suffered from damage to skin, fingernails and toenails after working in treated fields. However, application after transplanting is often too late, as snails can destroy part of the crop even in the first night after transplanting. The pesticides currently used for golden snail control are not officially registered for this purpose in ricefields in the Philippines.

The farmers' control measures do not influence the system negatively, except for the draining of a field at transplanting time. This promotes development of weeds. It could be compensated for by transplanting older seedlings and a higher number of seedlings per hill.

Fish that eat young snails could be kept in the drainage areas where snails collect and in the trenches and ponds associated with rice-fish culture.

The only molluscicides that would fit well into the cropping system would be those that are nonpersistent, have low toxicity to people and fish, would be applicable before transplanting and cheap. There are none available yet with these properties.

Research Needs and Priorities

Dr. J. Medina
Chairperson

Dr. J. Medina's group identified research gaps based on the papers presented. These were then classified into long-term and short-term needs and priorities.

I. Long-term
   - A. Reproductive physiology and genetics of golden snail. Studies for the controlled reproduction of golden snail by making them sterile; e.g., chromosome manipulation through physical pressure, temperature shock and chemical means.
   - B. Susceptibility of the different developmental stages of golden snail to adverse environmental conditions; e.g., temperature and available moisture.

II. Short-term
   - A. Economic utilization of golden snail
     1. As protein ingredient to animal feed.
     2. As human food.
     3. As a possible source of fertilizer.
   - B. Aquaculture research
     1. Golden snails as biofilters in aquatic ecosystems.
     2. Predator-prey relationships in fish-duck-snail integrated systems.
     3. Snails as feed components in finfish and crustacean culture.
   - C. Socioeconomics
     1. Marketing of golden snail.
     2. Socioeconomic impact of snail infestation farming methods to farmers.
     3. Farmers' attitudes towards control methods for golden snail.
   - D. Environmental impact
     1. Impact of pesticides – analysis of residues in crops, aquatic organisms and soils.
   - E. Control methods
     1. Research to develop more efficient collection methods of golden snail, attractants to divert snails from rice plants and mechanical equipment.

Final Discussions and Recommendations

The important aspect recognized in the workshop was that snail-control methods have been developed and tested in farmers' fields. All concerned researchers were urged to share future results and disseminate them among farmers.

Recognizing that the golden snail is an exotic pest originating from South America, it was recommended that the Philippine Department of Agriculture seek funds to support a biological control project to include acquisition of knowledge from South America or the Caribbean; training of Philippine scientists and support for travel/field work; and publications.

On the use of chemicals to control golden snail, it was noted that Philippine farmers are using chemicals that have never been evaluated for application in tropical ricefields. Tropical rice farming systems are not just the rice plants. They encompass the entire ricefield ecosystem, including the people working in it. Extreme caution is therefore necessary because of the hazards that chemicals can bring to its biota.

The participants recommended that a list be compiled of molluscicides that are affordable, effective, legally recommended and safe for use in ricefields under tropical conditions. These molluscicides should not pose toxicity risks to people and organisms such as fish. Moreover, there was a unanimous agreement on the need to determine the true costs and benefits between pesticide use and non-use. If pesticides are indeed necessary, the optimum timing of use must be determined.

Some participants strongly suggested that since the golden snail is already in the Philippines, its economic utilization should be further explored. The paucity of information on the economics of golden snail utilization clearly suggests a great need to conduct such studies. Snails are potential human food especially for the poorest people, as the farmworkers who have little or no other source of protein in their diet. Thus, a better way of solving the infestation problem is to regard the golden snail as a pest during certain periods only. When the rice plants are not vulnerable to attack, the golden snails can be allowed to grow and be harvested.

The introduction of the golden snail in the Philippines has resulted in severe adverse environmental impacts. The government must adopt or implement stricter policies and guidelines to regulate introductions of exotic species. Strict quarantine procedures should be undertaken on the arrival of all imported species. These must involve close coordination between the government and the private sector.

An Overview of Golden Snail Research in the Philippines

Jose P. Baldia, *NU-GENES Technologies, Dolmar Bldg., EDSA, Mandaluyong, Metro Manila, Philippines*

Julia B. Pantastico, *Advanced Biotechnologies, Inc., Liberty Bldg., Pasay Road, Makati, Metro Manila, Philippines (Present address: 432 Roda Subdivision, Anos, Los Baños, Laguna, Philippines)*

Abstract

Research agencies and private organizations have conducted preliminary laboratory research and field trials on the biology and growth of golden snail (*Pomacea canaliculata*). However, whereas the biology of native snail species is well known, that of the golden snail has been touched only superficially. Experiments have been conducted on the golden snail to investigate the effects of food, population density, sex ratio and water change on its eggs.

Before the golden snail was recognized as a pest, the Mindanao Baptist Rural Life Center in production-oriented research, recommended the culture of golden snail in small trenches 1–2 m wide, with the dikes planted to vegetables. Farming of golden snail along lake shore areas in Laguna de Bay was also initiated as a possible livelihood project at the Binangonan Research Station of the Southeast Asian Fisheries Development Center. The private sector also attempted to develop golden snail culture into a viable industry and studies were conducted on the effects of crowding and the nutrition of snails on leafy vegetables. Four years later, the golden snail was recognized as a serious pest having the attributes of fast growth, phenomenal reproductive capacity and a voracious appetite for vegetation. Aside from rice, it attacks ornamental plants, corn, citrus and ramie (*Boehmeria nivea*). Research on control measures was then undertaken by national and international institutions. The Food and Agriculture Organization of the United Nations and the Philippine Department of Agriculture have produced a handbook for extension workers and farmers on combating golden snail problems with minimal application of chemicals (FAO and Department of Agriculture. 1989. Integrated golden "kuhol" management).

The Biology of Golden Snail in Relation to Philippine Conditions

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Abstract

There is scarcity of information on the biology of the golden snail in the Philippines. What little is known comes from scientific and popular publications. There is confusion over identification and nomenclature of the golden snail in the Philippines. Authors refer to species such as *Ampullaria gigas, Pomacea* sp. and *Pila leopordvillensis*.

Golden snail species in the Philippines have separate sexes. Females are identified by their concave operculum; males by a convex operculum. They can spawn year-round under

favorable field and laboratory conditions. They copulate by day. The females deposit eggs at night on substrates such as sticks, macrophytes (including grass) and even rocks. The egg masses are pinkish-red and contain 50–500 eggs. They hatch within 10–15 days outdoors. Young snails start feeding on detritus and soft aquatic plants. Adults become voracious feeders on fresh plant materials. They are hardy and withstand low dissolved oxygen in water and organic pollution. They grow fast and have been reported to reach 5 cm in diameter within a year. They attain maturity at 3.0–3.5 cm diameter.

Introduction of the Golden Snail and Escalation of its Infestation of Philippine Ricelands

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Abstract

The golden snail reportedly originated in the Amazon River basin in South America. From Argentina and Brazil, it became established in Florida, USA and from there it was extensively propagated and exported to other States and to Europe and Asia. In 1980, the BioResearch Petshop Inc. brought to the Philippines from Florida two species of golden snail, crossbred these and produced a fast-growing stock. In 1984, another batch of breeders from Taiwan was introduced by the Philippine Escargot Producers and Marketing Associated Inc. (PEPMA). PEPMA planned to market snail-breeding and growout technology packages. Private entrepreneurs, public agencies and farm organizations competed in promoting and selling their production systems as well as marketing schemes. Snail production expanded very rapidly because the seed stock and tested technologies for mass production and easy harvesting of acceptable and saleable snails were all available. Snail transfers increased tremendously. Snails were purposely stocked in new waters, released from ponds or escaped from the rearing facilities of aquaculturists and aquarium hobbyists. In rivers, streams and irrigation systems, the golden snail turned into a dreadful pest. In 1986, farmers in northwestern Luzon, Philippines, were the first to express alarm over the invasion by the golden snail in ricefields with newly transplanted rice plants.

Problems of Golden Snail Infestation in Rice Farming

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Abstract

The problems of golden snail infestation in rice farming systems include damage to the rice plants, rice yield losses, additional expenses, side effects of chemicals and destructive effects on native snails.

The actual damage to rice crops by golden snails was first reported in 1986 from Region II. By 1987, eight regions were infested and about 9,500 ha were damaged. This increased to about 131,000 ha in 1988, equivalent to approximately 3.6% of the total area planted to lowland rice. The most heavily infested areas were Isabela and Kalinga-Apayao in Region II and Occidental Mindoro in Region IV. The extent of damage to rice crops depends on snail size and population density and crop growth stage. Snails with a shell height of 1.5 cm feed on young plants up to four weeks old. Those with a shell height of 6.5 cm can feed on young plants up to nine weeks old. Plants at two weeks after transplanting are the most vulnerable to damage by snails. This has been shown by laboratory and field tests. Damage increases with snail density. The missing hills were 6.5% and 93% at snail population densities of 0.5 snails/m^2 and 8 snails/m^2, respectively. At a density of one snail/m^2 with shell height of 2–3 cm, the number of tillers may be reduced by 19% at 30 days after transplanting. This loss can be up to 98% when snail density increases to 8 snails/m^2. To avoid yield losses due to snails, farmers can retransplant, but this brings additional expenses. Spot replanting of damaged hills results in non-uniform rice maturity that can also result in reduced yields and quality. Draining the ricefield is one way to control golden snail damage but this may promote the growth of weeds.

Chemicals are effective against snails but most farmers cannot afford the cost. The chemicals can also be toxic to fish, frogs and other beneficial organisms. Continuous application of chemicals decreases aquatic productivity and contaminates the environment. Some of the chemicals have adverse effects on humans working on the farms. The population of the native snail (*Pila luzonica*) has been reduced drastically with the increase in golden snail populations.

Distribution and Mode of Infestation of Golden Snail in Rice Farming

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Abstract

The golden snail has become a major pest throughout the Philippines. In 1988, infestations were reported from Visayas and Mindanao. The golden snail reproduces rapidly. An egg cluster (about 25–500 eggs) hatches in 8–15 days with 80% success. The young snails start crawling when they reach 2–5 mm in size. Young rice seedlings are very susceptible to snail damage. Rice plant damage is most severe for young plants up to eight days after transplanting. The snails attack the base of the young seedlings before devouring the upper parts. Severely damaged ricefields are characterized by missing hills and floating cut fragments of rice plants. Golden snails can survive even out of water because of their breathing organs. When fields are drained, the snails can aestivate.

The golden snail is now a problem in all rice-growing regions of the Philippines. The total area infested as of December 1988 is about 426,000 ha. The highest infestations are in Regions VI (Western Visayas), XII (Central Mindanao) and II (Cagayan Valley). The lowest infestation has been reported from Region VII (Central Visayas).

Nonchemical Strategies to Reduce Golden Snail Damage to Rice

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Abstract

Golden snail is now considered as the most serious rice pest in Cagayan Province, Philippines. Almost all wetland ricefields are now snail-infested. This has prompted farmers to resort to chemical control. However, farmers with small landholdings usually control snails by handpicking and subsistence farmers use delayed transplanting and field draining.

Several nonchemical strategies have been evaluated to minimize or reduce damage to rice seedlings during the critical period of infestation. These include altering farming practices and/or providing alternative feeds and attractants to snails to divert them. Keeping ricefields drained continuously for three weeks starting from transplanting has reduced snail damage by 75%. Transplanting older seedlings has also reduced damage by 80%. However, the draining method is not applicable in waterlogged areas or when there is heavy rain. Providing the snails with alternative feeds to rice seedlings – such as papaya leaves, cassava leaves, taro leaves and other succulent plant materials – works best during the first five days after transplanting. This can reduce damage by 75% over the five-day period.

Farmers' Current Control Practices Against the Golden Snail (*Pomacea* sp.) in the Philippines

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Abstract

Rice farmer-cooperators of the Philippine Rice Research Institute's Integrated Pest Management (IPM) Participatory Project consider the golden snail second to tungro (a viral disease) as a serious rice pest. Lowland rice farmers cope with the snail problem by chemical, biological, mechanical methods and other control methods including modified farming practices. IPM farmer-cooperators rely mainly on molluscicides (specifically those based on triphenyl-tin acetate, Aquatin and Brestan) for snail control. However, 49% use combinations of any or all the following methods: application of Brestan or Aquatin with the insecticide Endosulfan; handpicking; construction of trenches; and intermittent draining of the ricefields. The dosage of Endosulfan used is higher (80–150 ml/16 l of water) than the dosage recommended to control insect pests.

Farmers in Central Luzon, Iloilo and Sultan Kudarat have experienced difficulty in hiring transplanters in fields sprayed with molluscicides because of health problems: itching and severe skin irritation when chemicals are applied prior to transplanting; and abrasions to

hands and feet caused by snail shells. The modified farming practices employed by farmers are: intermittent draining in direct-seeded and transplanted ricefields, coupled with construction of small canals and deep strips; thorough land preparation which destroys weeds and disperses and injures snail eggs; and use of screens or nets in water inlets to prevent entry of snails from irrigation canals and nearby fields.

The most common biological control approach is herding of ducks to forage on the snails but the effectiveness of this is reduced by the availability of other food sources. Among potential natural predators of snails, only rodents seem to have significant effects. The most common mechanical control method is regular handpicking and destruction of the snails but its effectiveness varies with farm size and availability of cash to hire labor. A community-wide campaign to encourage school children to collect snails was launched at one IPM project site. Leaves of kangkong (*Ipomoea aquatica*), sweet potato (*Ipomoea batatas*) and papaya (*Carica papaya*) are used to attract the snails and facilitate collection.

Practical Management Techniques to Reduce Golden Snail Damage in Lowland Rice

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Abstract

The golden snail ravages newly transplanted rice seedlings causing numerous missing hills in the field. Missing hills, if not replanted, will considerably reduce rice yield. Farmers around the International Institute of Rural Reconstruction (IIRR) project site use an expensive chemical spray to control golden snail. Some snails are killed but many survive and multiply rapidly once irrigation water is introduced to ricefields. To solve this problem, IIRR through its low-input rice production project, developed some techniques to reduce golden snail damage to lowland rice. These include the introduction of ducks in the ricefields, the use of wire mesh screens to exclude snails and appropriate water management.

Chemical Control of Golden Snail

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Abstract

The recommendations of the Agricultural Pesticide Institute of the Philippines (APIP) for chemical control of snails are based on various studies concerning their biology and life cycles, distribution and mode of infestation, destructive and dormant phases, environmental influences on their reproduction and movement; physical, chemical properties of toxicants

for their control; dosage, timing and application methods; and toxicological effects on man and the environment. The breakthrough in chemical control of snails began in the late 1960s when Planters Products found that the compound organo-tin acetate, which was being tested as fungicide, also gave good snail control in milkfish ponds.

In 1988, the area treated with molluscicides to control the golden snail covered about 500,000 to 600,000 ha. The major molluscicides used were organo-tin compounds (Aquatin, Brestan and Telustan) and Niclosamide (Bayluscide), a compound based on 5,2'-dichloro-4'-nitro-salicylic-anilide-ethanolsamine, which is specific for water snails.

APIP encourages all concerned by bringing to their attention adverse effects from the use of molluscicides. APIP plans to establish a monitoring and early warning system by which the pest population explosions can be discovered and the corresponding authorities warned so that necessary action can be undertaken. The institute also suggests proper and timely coordination among government agencies to devise possible solutions to pest problems.

Evaluation of Molluscicides for the Control of Golden Snail (*Pomacea canaliculata*)

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Abstract

The early control measure employed by farmers against the golden snail was handpicking. A study was conducted in response to farmers' request for more effective control measures, given the alarming extent of snail infestation. In 1986, pesticide trials in a farmer's field at Aurora, Isabela, Philippines, showed that Brestan (triphenyl-tin acetate) applied at the rate of .23 kg a.i./ha was effective against golden snail (100% mortality). Endosulfan and Brodan EC [Chloropyrifos and BPMC (Fenobucarb or 2-SEC-Butylphenyl methyl carbamate)] applied at 0.5 kg a.i./ha using 200 l/ha spray solution killed 71 and 94% of snails, respectively. Water depth affected the efficiency of golden snail control. Brestan and Aquatin applied at the same rates effectively controlled the golden snail at 2–3, 5 and 10 cm water depths. Either Brestan, Bayluscide or Aquatin when mixed with the machete (butachlor or N-butoxymethyl-2-chloro-2',6'-diethyl acetanilide) gave higher mortality on golden kuhol than when applied singly. Brestan can be applied any time of the day without affecting the treatment efficiency. Safety measures should be observed when applying pesticides, particularly triphenyl-tin chloride and triphenyl-tin acetate, due to health hazards to operators. Applicators have experienced skin irritations, inflammation and impaired healing of wounds due to exposure.

Control of Snail Damage on Rice with Dimotrin (Cartap Hydrochloride)

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Abstract

Experiments were conducted to evaluate the use of Dimotrin (cartap hydrochloride) on snails (*Pomacea* sp.) infesting transplanted and direct seeded rice in a Shell Research Farm in Calauan, Laguna, Philippines. The two commercial formulations of Dimotrin used in the experiment were 50% SP (500 g/l soluble powder) and 4G (40 g/kg granule).

Initial results indicate that Dimotrin 50% SP and Dimotrin 4G applied at the rate of 125 to 500 g a.i./ha immediately after transplanting wetbed seedlings (2–3 cm water) provide protection from snail damage by suppressing their feeding for at least seven days after rice transplanting. Dimotrin 50% SP at 500 g a.i./ha resulted in 93% snail mortality at seven days after planting. Dimotrin 50% SP applied at 1,000 g a.i./ha and Dimotrin 4G applied at 500 and 1,000 a.i./ha resulted in 87–88% protection for 7–14 days after seeding. Moreover, plots treated with Dimotrin 50% SP and Dimotrin AG applied at 175, 250 and 500 g a.i./ha had acceptable levels of protection from snail damage for 8–18 days. In plots with 2–3 cm water maintained throughout and sprayed once just after transplanting, the crop protection due to suppression of snail feeding effect was only good up to two days after treatment in both 150 and 250 g a.i./ha either as spray or granules. During the first six days, there was no feeding of snails in plots without water because the snails burrowed under the soil surface. When water was introduced at seven days after transplanting, the residual effect of the treatments was insufficient to inhibit feeding or cause mortality of snails. Twelve days after planting, Dimotrin 50% SP and Dimotrin 4G provided sufficient crop protection both at 150 and 250 g a.i./ha due to the feeding suppression effect.

Integrated Pest Management for Golden Snail

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Abstract

The experience of several Philippine farmers indicates that the commercial methods of golden snail control and the application of synthetic molluscicides offer only temporary relief. Hazards to human beings, livestock, fish, and other organisms are associated with

molluscicides. To respond to farmers' demands for assistance in the control of golden snail, an integrated pest management technology has been developed based on pooled knowledge from farmers' practices and strategies. These include the following:

1. Handpicking of adult snails and egg clusters.
2. Construction of small canals or depressed strips.
   a. Direct-seeded – making small canals (25 cm wide x 5 cm deep) along the inner edges of paddies. Snails follow the flow of water or concentrate in these canals when paddies are drained 1–2 days after broadcast of pregerminated seeds.
   b. Transplanted – making similar depressed strips in the paddies at a distance of 10–15 cm by passing the harrow during the last harrowing. Snails congregate in the strips when paddies are drained for easier collection.
3. Use of older seedlings – transplanting older seedlings (25–30 days old for early maturing varieties; 30–37 days old for late maturing varieties) at a spacing of 20 x 20 cm, using 3–5 seedlings per hill. Young seedlings like those in the "dapog" method are more susceptible to snail damage.
4. Proper water management.
5. Use of stakes to attract snails for egg deposition on waterlogged breeding areas.
6. Use of traps or screens in water inlets.
7. Use of ducks to eat snails.
8. Use of botanical antisnail preparations (e.g., dried tobacco leaves).
9. Application of pesticides on heavily infested fields. The chemicals sold for golden snail control are Brestan, Aquatin, Telustan and Bayluscide. Pesticide application is done immediately after transplanting of rice seedlings or as needed. The other chemicals used are Thiodan, Endox and Endosulfan.

Strategic Extension Campaign on Golden Snail Control

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Abstract

The Philippine Department of Agriculture (DA), through the support of the Food and Agriculture Organization (FAO) Intercountry IPC Programme, has implemented a Strategic Extension Campaign (SEC) to improve rice farmers' level of knowledge and practice of control measures against the golden snail. To meet this objective, the campaign followed a 10-step conceptual framework in its planning, implementation, management and evaluation. The SEC approach has been successful in other FAO-assisted projects. Originally intended for the five provinces where the golden snail has been a major rice pest, the SEC will now be implemented in rice-growing areas across all 13 regions covered by the second phase of the Philippine Rice Production Enhancement Program (RPEPII). Farmers' experiences and technical knowledge will be used to assemble a package of control measures. Farmers' reports are consistent across regions with respect to nonchemical control measures and the toxic effects of molluscicides.

To design the SEC, regional core groups from the Department of Agriculture conducted the following:

1. Baseline data gathering and needs assessment. Problems and reasons for non-adoption by farmers of recommended golden snail control measures were identified.

2. Formulation of communication objectives and goals, based on the identified problems.
3. Development of specific problem-solving extension strategies. Regional core groups prepared a simplified snail control technology, planned the SEC and developed prototype campaign materials.
4. Audience analysis and segmentation. The target groups were categorized in terms of their location, socioeconomic status, access to information sources and communication and interaction patterns.
5. Media selection. Based on audience analysis, the media selected for the SEC were posters (instructional and motivational), comics, stickers, pamphlets and handbook.
6. Message design and development. To ensure that the target audience correctly perceives, interprets and understands the meaning of the message, regional core groups pretested prototype materials among rice farmers and agricultural technologists in their respective regions. Results of the pretest served as the basis for suggesting improvements in the campaign materials.
7. Management planning and objectives. A management plan has to specify how the materials should be developed or produced, by whom, at what cost and within what time frame. The management plan developed by regional core groups and some DA representatives covers the following key points in campaign implementation: briefing or orientation of intermediaries, logistics, schedule of activities, launching program and budgetary requirements.

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Program of Activities

09 November, Thursday

1400	Registration Tour of CLSU-FAC Facilities	
1830	Dinner	
1930	Socials	

10 November, Friday

<u>Morning Session</u>

0710	Opening Ceremonies National Anthem Welcome Address	R.G. Arce Director, CLSU-FAC
	Workshop Guidelines	R.S.V. Pullin Director, Aquaculture Program ICLARM

Technical Session
Chairpersons: Drs. R.G. Arce and R.S.V. Pullin

0800	An overview of golden snail research in the Philippines	J.P. Baldia/J.B. Pantastico
0820	The biology of golden snail in relation to Philippine conditions	L. Guerrero
0840	Introduction of the golden snail and escalation of its infestation of Philippine ricelands	R.B. Edra
0900	Problems of golden snail infestation in rice farming	R. Basilio
0920	Distribution and mode of infestation of golden snail in rice farming	M.B. Rondon/D.P. Callo Jr.
0940	Nonchemical strategies to reduce golden snail damage to rice	E.D. Guzman/F.B. Enriquez
1000	Coffee Break	
1020	Farmers' current control practices against the golden snail (*Pomacea* sp.) in the Philippines	E.C. Atienza/C.B. Adalla
1040	Practical management techniques to reduce golden snail damage in lowland rice	E. Imperial
1100	Chemical control of golden snail	J.J. Cruz

1120	Evaluation of molluscicides for the control of golden snail (*Pomacea canaliculata*)	C.D. Rodriguez/O.J. Lorenzana
1140	Control of snail damage on rice with Dimotrin (cartap hydrochloride)	H.C. Dupo/S.P. Ferido/H. Sambuichi
1150	Integrated pest management for golden snail	M.B. Rondon/J.P. Sumangil
1210	Strategic extension campaign on golden snail control	M.M. Escalada
1230	Lunch Break	
Afternoon Session		
1330	Group Workshops	
	a. Chemical Control Chairperson	R.S.V. Pullin
	b. Biological Control Chairperson	J.P. Sumangil
	c. Control through farming methods Chairperson	P. Kenmore
	d. Research needs and priorities Chairperson	J. Medina
1500	Coffee Break	
1520	Presentation of outputs, final discussion and recommendations	

Participating Institutions

Agricultural Pesticide Institute of the Philippines	(APIP)
Department of Agriculture	(DA)
Bureau of Plant Industry	(BPI)
Philippine Rice Research Institute	(PhilRice)
Regional Crop Protection Center	(RCPC
Central Luzon State University	(CLSU)
Freshwater Aquaculture Center	(FAC)
Food and Agriculture Organization/ Intercountry Programme for Integrated Pest Control in Rice in South and Southeast Asia	(FAO/IPC)
International Center for Living Aquatic Resources Management	(ICLARM)
International Institute of Rural Reconstruction	(IIRR)
International Rice Research Institute	(IRRI)
University of the Philippines at Los Baños	(UPLB)
National Crop Protection Center	(NCPC)
Visayas State College of Agriculture	(VISCA)

Appendix

BIBLIOGRAPHY ON (i) MOLLUSCS AND THEIR CONTROL, WITH SPECIAL REFERENCE TO GOLDEN SNAIL, (ii) TIN, AND TIN-BASED COMPOUNDS IN AQUATIC ECOSYSTEMS*

*Editors' Note - The available literature on golden snails and their control is not extensive. Here we have added items on other molluscs that could be of relevance for future workers on the golden snail problem and have also included useful references on the ecological effects of tin-based pesticides, since they are widely used against the golden snail.

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Tin and Tin-based Compounds in Aquatic Ecosystems

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(iii) Subject Index

Freshwater Aquaculture Center, Central Luzon State University

The Freshwater Aquaculture Center is the lead national center for freshwater aquaculture under the Philippine aquatic research and development system. Its major function is to conduct production-oriented researches geared towards the development of technologies appropriate for the efficient and economic utilization of the country's freshwater and inland fisheries resources. Established in 1973, it is a semi-autonomous unit sharing a common core of technical staff with the College of Fisheries of Central Luzon State University, Nueva Ecija, Philippines. Its operation is financed from a share of the university research budget. However, substantial support for specific research activities is provided by international research and donor agencies through direct linkages and collaboration.

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International Center for Living Aquatic Resources Management

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