Issue Summary: Apple Snails in Hawaii

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An international invasive species

Originating in South America, the apple snail (sometimes called the golden snail) was introduced to Florida and then Taiwan in the early 1980s but there is indication that some species of *Pomacea* where introduced in 1979 to Taiwan. *Pomacea canaliculata* was first documented in Hawai`i in Maui in 1989.

There is currently an international alert for apple snails. This includes a warning by the United Nations Food and Agriculture Organization and inclusion on the Global 100 Most Invasive Species List.

Pomacea canaliculata represents a serious threat to "food security" for any region with a water-based food producing economy, such as Hawai`i and taro cultivation.

United States Bans

A U.S. Department of State Alert was released in 2002 and there is an emergency quarantine measure currently in effect in Mississippi for products from the states of California, Texas, N. Carolina, Florida and Hawai`i.

Hawaii Bans

It is illegal to transport live snails between islands in the State of Hawai`i or to release this invasive species into freshwater sources (streams, springs, ponds, wetlands, or estuaries). Apple snails can still be traded, sold, and raised for market and home consumption. Apple snails are eaten in Hawai`i by some cultural groups. The UH Sea Grant program conducts a “pest for profits” program in which they support “responsible promotion of channelized apple snail collection and culture” (State of Hawai`i Aquatic Invasive Species (AIS) Management Plan 2002). The combination of cultural food traditions and opportunity for income or trade in goods has challenged the ability of the State to control or eradicate this snail.

Apple snails are available in some local pet shops and recommended for algae management in fish tanks, however, the pet industry is working to educate its members and remove this pest from its inventory.

Transport of live snails between islands should be reported to the Department of Agriculture Pest Quarantine Branch. Deliberate release of apple snails into freshwater sources should be reported to the DLNR Division of Conservation and Resource Enforcement and Division of Aquatic Resources Aquatic Biologist on each island.

Threats and Impact

The most visible impacts of *Pomacea canaliculata* are in traditional taro producing areas where crop loss can be as high as 18-20% in some of the heaviest infested areas such as Hanalei, Kauai (State of Hawaii Agricultural Statistics 2004; taro farmer observation). Taro is the snails preferred food source. In a heavily infested wetland taro patch,

without constant vigilance, snails can consume an entire crop, including corms, stems and leaves, in one day. This represents a loss of investment of time, labor and money of 9-12 months. Surveys in 1995 in Keanae, Maui registered from 8-20 snails per foot (body weights greater than .5 grams) in an average taro patch (approximately ¼ acre). Similar surveys in 2002 in Hanalei, Kauai showed densities for the larger snails as high as 6.79 million per 30 acres planted (Tamauru, Ako and Tamaru 2004). Smaller sized snails were estimated at densities as high as 127.8×10^6 present in the same area. Their ability to move swiftly through moving water increases the risk of rapid dispersal once introduced into a watershed.

An economic study on the impact of apple snails to taro culture in Hawai`i is currently being conducted by the University of Hawai`i, College of Tropical Agriculture (Ferguson, Levin, Cowie, Hayes and Taylor, 2004 in progress). Preliminary responses indicate that the loss of taro due to apple snails will impact almost every sector of life in Hawai`i from crop losses, aesthetics, and family subsistence and health, to losses at the very root of Hawaiian culture.

Apple snails eat a range of plant material and organic debris. *P. canaliculata* is known to attack other snails and their eggs. Watercress, ong choy, lotus, rice, water hyacinth, duck weed, algae, azolla, honuhonu grass and other weeds, are documented. The young shoots of many plants, including native wetland flora are highly susceptible. Snails heavily out-compete native fauna for available plant food sources. Little is known about the snail's impact on Hawaii's native freshwater species or communities.

There are several parasites that have snails as an intermediate host. Apple snails are relatively resistant to many of these, which are often host specific. However, at least one parasite (*Angiostrongylus cantonensis*, a nematode, also know as the rat lungworm) uses the apple snail as an intermediate host. The rat is this parasite's main host, but humans can be infected when raw or undercooked snails are consumed. In rare cases this infection can cause *eosinophilic meningonencephalitis* resulting in severe neurological disorders and even death. Occurrences of this parasite and cases of infection have been documented in Hawai`i but not yet directly linked to *Pomacea canaliculata*.

There has been no study to date of possible connections between leptospirosis and apple snails. For taro farmers, or any one entering freshwater areas where snails are present, an open cut is a potential means of transmission for this disease.

The snails also show some indication of biochemical absorption such as mercury from contaminated sites (Eisemann, J.D et al 1997 - Florida). This may be cause for concern for those who consume apple snails as a food source. Areas such as Kawainui Marsh, where the snail is present, have known concentrations of nickel, cadmium and other heavy metals.

Current Distribution

Three species of *Pomacea* (*P. canaliculata, P. bridgesi,* and *P. paludosa*) and *Pila conica* from the family Ampullariidae are all classified as apple snails and can be found in Hawai`i. *Pomacea canaliculata* represents the most damaging and fastest spreading of the species.

Pomacea canaliculata was reported and collected in 1989 (Maui), 1992 (Maui, Kaua`i, O`ahu, Hawai`i), 1995 (Lana`i), and 1998 (O`ahu).

Apple snails are currently found on every major island (except Kaho`olawe) in the State. The three most important taro growing communities – Hanalei, Kaua`i, Ke`anae, Maui, and Waipi`o Valley, Hawai`i – are all heavily infested, along with the lower reaches of most windward streams, numerous taro growing areas, wetlands and estuary sites (see L.Lach and R. Cowie, 1998). Primarily documented in windward locations in the 1990s, apple snails have spread even to dry side streams and wetlands in 2005. A field survey is currently being conducted which will map the spread of this invasive species state-wide (Cowie, Hayes and Levin, 2004 in progress; maps expected to be available August 2005).

On Moloka`i, only *Pila conica*, the least aggressive species in Hawai`i has been found.

Preferred Habitat

Low- and slow-flowing freshwater sources with warmer temperatures are prime habitat for *Pomacea canaliculata*. Traditional taro growing areas, agricultural and golf course ponds, ditches, springs, slow water areas in the lower reaches of streams, wetlands, estuaries and even consistently wet areas in backyards and cement-lined channels provide habitat and food sources for apple snails. In several observations, snails have been found less than 50ft from the ocean at the mouth of streams, likely flushed downstream during heavy rain events.

Biology and Behavior

Robert Cowie (2002) provides an excellent survey of the literature and describes snail biology, species differentiation, reproduction, growth, impacts and management. Apple snails are dioecious (male and female), internally fertilizing and oviparous (hatch from eggs). Newly hatched snails are as small as the head of a pin; adults can reach the size of a baseball. They have the ability to breathe oxygen both through water and air, allowing them to survive for significant periods out of water.

Apple snails are prolific. They mate at any time of day or night, several times per week and deposit a clutch of about 200 eggs soon after (5-16 days). Eggs hatch within 2 weeks. The snails breed year round, producing between 5,000 and 10,000 offspring in one year. *Pomacea canaliculata* lays bright, bubblegum pink clusters of eggs above the water on exposed surfaces including taro stems, grass and rocks primarily at night or early morning or evening.

Maturation may be affected by temperature. In tropical climates, *P. canaliculata* can grow to maturity in just a couple of months. Taro farmers report a decline in observable

snail populations during colder, winter seasons and booms in egg production and young snails as soon as weather and water conditions warm up. *P. canaliculata* has an estimated lifespan of 4-5 years.

Control Efforts and Constraints

Snails have been observed to survive immersion in salt water for more than 24 hours, "long enough to be carried by currents from one stream mouth to another" (Cowie 2002:161). They have been known to survive electric shock (limited nervous system), chemicals, and extended droughts. Some species of *Pomacea* exhibit an alarm response to chemical stimuli in the water or vegetation disturbance (e.g., pulling weeds or taro) and react by burrowing quickly in the mud. The operculum ("trap door") of the shell can be sealed so tightly that no chemicals can penetrate.

Adults of *P. canaliculata* survive buried in the mud during drying off periods, for up to one year, although it is thought that young snails may not be able to survive for extended periods of time.

Tahitian prawns, an alien species already present in Hawai`i streams and springs, have been observed to eat quarter-sized snails of *Pila conica* and *Pomacea canaliculata* in Hawai`i. No known predators of the snails outside Hawai`i are appropriate for introduction to the state and given the density of snail populations in some areas, would likely be limited in effectiveness.

A number of chemical controls have been attempted throughout Southeast Asia and in Hawai`i. None have proven effective to date. There are no chemicals currently approved for apple snail control or use in freshwater in the State at this time. Experiments with neem and papaya sap are still in early stages.

Taro huli (shoots) and muddy tools, boots or vehicles can transfer young snails from one site to another unintentionally.

Currently, taro farmers use a combination of cleaning protocols, hand picking, screens at taro patch intakes, dry down periods and ducks to control apple snails. Trenching around the edges of taro patches and baiting the area with organic debris draws snails to the outside edges of the patch where they can be more easily removed, when water levels are lowered.

Outreach education to a broad sector of Hawaii's population, using multiple languages, formats and innovative approaches, is critical to limiting further spread of this invasive species.

Where can you get more information?

On the web:

http://www.applesnail.net/
This website is out of the Philippines and has extensive information on all aspects of the snails including references, discussion of the disease vector the snails represent for the nematode rat lungworm to humans, and under Pest Alert, an interactive map which documents the spread of the snail throughout Asia by year.

http://www.doacs.state.fl.us/pi/plantinsp/AppleSnailMainx.html
State of Missippi emergency ban on produce from California, Texas, N. Carolina, Florida and Hawaii. Links back to the above address, however, it is useful in counting the costs of the snail. It suggests that beyond costs to taro growers, that other growers and distributors of agricultural produce are assuming expenses in the name of this species in the form of costly quarantines.

http://www.columbia.edu/itc/cerc/danoff-burg/invasion_bio/inv_spp_summ/Pomacea_canaliculata.html
A comprehensive site on the snails including a ref website list for:
Socio-Economic Aspects of Biological Invasion, A Case Study: the Golden Apple Snail www.gcrio.org/ASPEN/science/eoc94/EOC3/EOC3-18.html

http://www.cphst.org/npag/Molamppc598.pdf
An NGPA report on apple snails - includes a section on incurred damage (costs) for rice paddy including increased farmer costs for control efforts.

http://cswgcin.nbii.gov/(442ao2iaw5pta355n0qa5j45)/issues/invasives/speciesprofile.aspx?tsn=568121
An extensive bibliography that covers much of the major research that has been conducted on the snails biology, ecology, invasiveness, and control efforts.

http://www.ento.csiro.au/research/rr97-99/pestm_risk.html
CSIRO website lists research on a model to predict spread of the snail (GH Baker, WA Whitby) in 1997-99.

www.agrss.sherman.hawaii.edu/onfarm/pest/pest0008.html

www.nass.usda.gov/hi/vegetble/taro.htm
Hawaii ag stats for taro – feb 2004 reports apple snails as the most significant factor in taro production declines in the last year.