POPULATION DYNAMICS OF AN ESTABLISHED REPRODUCING POPULATION OF THE INVASIVE APPLE SNAIL (*POMACEA INSULARUM*) IN SUBURBAN SOUTHEAST HOUSTON, TEXAS

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Over the past 15 years in the United States, a rise in introductions of non-native gastropod species has prompted major concern from both the U.S. Department of Agriculture and aquatic ecologists (Robinson 1999; Levine & Antonio 2003). Due to their large size (i.e., mass and operculum width up to approximately 150 g and 55 mm, respectively; Youens & Burks 2008) and high rate of reproduction (i.e., up to 4000 eggs per clutch; Barnes et al. 2008), the freshwater gastropod family Ampullariidae contains a number of destructive invasive species (Rawlings et al. 2007) that alter ecosystem function and threaten native biodiversity (Carlsson et al. 2004; Carlsson & Brönmark 2006; Boland et al. 2008; Connors et al. 2008). Invading habitats worldwide, apple snails of the genus *Pomacea* now represent an increasing environmental problem in the U.S. Multiple introductions (Rawlings et al. 2007) of numerous species from multiple origins (Hayes et al. 2008) complicate this problem.

Native to temperate South America, the apple snail species now found in Texas (Karatayev et al. 2009), *Pomacea insularum*, possesses a round shell with a characteristic deep groove on the whorl (i.e., channeled) (Howells et al. 2006). Unlike most snails, *P. insularum*, and closely related *P. canaliculata* (another channeled species), consume macroscopic plants rather than algae (Carlsson & Lacoursiere 2005; Burlakova et al. 2008). Because molecular geneticists only recently identified *P. insularum* as a distinct species from its close relative, the mode of introduction, spread, and current distribution of this newly introduced species requires more attention from ecologists (Rawlings et al. 2007; Karatayev et al. 2009).

To address whether or not newly established populations of *P. insularum* now persist, this report analyzed size structure of *P. insularum* populations from 2006-2008. This study examined changes in proportions of juveniles and adults within sample populations. An increase in the proportion of juveniles between samples taken from 2006 to 2008 indicates changes in the size distributions of introduced populations of *P. insularum*.

Live snails were collected during five trips: May 2006 (n=100), May 2007 (n=21), September 2007 (n=77), May 2008 (n=82) and August 2008 (n=176). Each trip involved two sample sites in the Houston area: Horsepen Bay located within Armand Bayou and a drainage ditch in nearby Clear Lake. All snails taken from both sampling sites were pooled into one sampling event based on date. The same water system connects both sample sites, thus creating five population samples. To obtain a comprehensive population sample, teams explored the banks of sampling areas and pulled any observable snails using nets. This frequently involved traveling via canoe to areas inaccessible by foot. Bank sampling included careful exploration of emergent macrophyte stands and within dense patches of freely floating plants. For the Armand Bayou site, sampling days varied between 8-10 hours on the water, with a consistent traveling distance of approximately 2 km upstream. Researchers separated snails into two broad groups based upon their operculum widths: juveniles (< 40 mm) and adults (> 40 mm). Operculum width serves as a good indicator of snail size (Youens & Burks 2008) and suggestions for size at maturity for *P. insularum* currently do not exist in the literature. Cazzaniga (1990) noted that an operculum size of 40 mm for larger *P. insularum* may be similar to the 25 mm threshold in operculum width that delineates smaller adult *P. canaliculata*. To test differences in proportions of juveniles over different sample populations, all five sample populations were compared against each other using a z-test of significance for two proportions (Baldi & Moore 1996).

Data analysis revealed significant differences between proportions of juveniles across sample populations, with all samples occurring in a non-random distribution (all p-values <0.05). According to pair-wise z-tests, the sample from August of 2008 exhibited a significantly higher proportion of juveniles than three of the other four samples, with the September 2007 sample not statistically different than any of the samples (Table 1). The largest difference between proportions existed between the earliest sample, May 2006, and the most recent, August 2008. The August 2008 sample showed a change in the size structure distribution, which indicates a larger proportion of juveniles.

The increase in the overall proportion of juveniles collected from 2006 to 2008 (Table 1) suggests that the total number of juvenile *P. insularum* present in the study sites increased over this period. Juvenile snails (<40 mm) were not observed in samples taken from the earliest sampling events. The use of consistent and comprehensive sampling methods suggests that research teams did not simply miss juveniles in earlier sampling events. The continued presence of egg clutches observed during field studies coupled with the change in proportion of juveniles indicates that invasive populations of *P. insularum* in the study sites are increasing in overall size distribution. An increasing number of juveniles may imply that exotic *P. insularum* populations are growing in the aquatic ecosystems of southeast Houston. For *P. canaliculata*, Carlsson & Brönmark (2006) demonstrated that smaller snails exhibited higher feeding rates. Therefore, an increase in the population size of non-native *P. insularum* could produce more damage to aquatic vegetation due to their higher rate of consumption (Boland et al. 2008; Burlakova et al. 2008). However, invasive ecologists need future research on population size per unit area and snail consumption rates of macroscopic plants to support these predictions.

For the first time, this study documents the presence of the growing size distributions of populations of invasive *P. insularum* in southeast Texas. However, scientists still know little about the ability of this species to damage local ecosystems. Due to their recent presence, only limited estimates on the reproductive ability of *P. insularum* exist

Table 1: Individual percentages for each size class present with the total number of snails collected from each sampling event. Samples occur across six operculum width size classes with a threshold at 40 mm for adults. Different small letters denote statistical significance between sampling events in the total proportion of juveniles (10-40 mm) according to a z-test of significance for proportions.

		Juveniles				Adults		
Sampling Event	*N*	10-20 mm	20-30 mm	30-40 mm	Significance	40-50 mm	50-60 mm	>60 mm
May-06	100	0%	0%	5%	ab	73%	22%	0%
May-07	21	0%	0%	4.8%	ab	66.6%	28.6%	0%
Sep-07	77	0%	1.3%	1.3%	abc	14.8%	72.7%	10.4%
May-08	82	1.2%	6.1%	8.5%	a	43.9%	40.3%	0%
Aug-08	176	16.5%	18.8%	2.8%	c	11.9%	40.9%	9.1%

(Barnes et al. 2008). However, the potential population growth made possible by females routinely laying large egg clutches (each containing approximately 2000 eggs; Barnes et al. 2008) warrants serious concern. Without further investigation of the population size structure, invasive ecologists cannot accurately predict effects of *P. insularum* on aquatic Texas ecosystems. Ecologists must conduct future research, specifically density estimations and consumption rates, to understand fully the overall effect *P. insularum* will have in southeast Texas and possibly along the entire Gulf coast.

ACKNOWLEDGEMENTS

We thank the Texas Academy of Sciences, Southwestern University and H-E-B for providing the funds necessary for this study. Our gratitude also goes to Mark Kramer, George Regmond, Ann Brinly and the entire staff at Armand Bayou Nature Center for helping us with our data collection. We would also like to thank Rebecca Marfurt, Sarah Hensley, Matt Barnes, Abby Youens and Brandon Boland for providing initial life history data for *P. insularum*.

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