

## SCDNR MARINE RESOURCES RESEARCH INSTITUTE STATE REPORT.

*Gulf and South Atlantic Regional Panel on Invasive Species, May 11<sup>th</sup>-12<sup>th</sup> 2017, Savannah, GA.*

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### Asian tiger shrimp (*Penaeus monodon*) invasion of the South Atlantic Bight.

Researchers at the South Carolina Department of Natural Resources' (SCDNR) Marine Resources Research Institute remain interested in improving our understanding of the invasion of the South Atlantic Bight and Gulf of Mexico by the Asian tiger shrimp, *Penaeus monodon*. While levels of reporting and concern over this species among the general public have declined in recent years, since their peak in 2011, (see Table 1 below), SCDNR Wildlife Biologist I Elizabeth Gooding ([goodinge@dnr.sc.gov](mailto:goodinge@dnr.sc.gov)) remains the point of contact for reports and specimen collections of this invasive species from South Carolina. The total number of *P. monodon* reported from SC is 431 specimens, with a size range of 61 to 330 mm TL.

**Table 1.** Number of Asian tiger shrimp *P. monodon* reported to the USGS Aquatic Nuisance Species database by state and by year between 2005 and 2016.

	NC	SC	GA	FL	PR	AL	MS	LA	TX	All states
2005	0	0	0	0	0	0	0	0	0	0
2006	5	0	0	0	0	1	0	0	0	6
2007	1	1	0	1	0	0	0	1	0	4
2008	8	6	4	2	0	1	0	0	0	21
2009	14	15	3	1	0	5	3	4	0	45
2010	2	20	1	2	0	0	0	7	0	32
2011	329	144	3	25	0	28	16	128	5	678
2012	21	64	55	41	1	3	14	8	1	208
2013	4	100	193	30	0	0	6	0	0	333
2014	1	63	0	5	0	5	5	1	0	80
2015	4	16	5	7	0	41	17	9	3	102
2016	0	2	0	3	0	23	5	1	0	34
All years	389	431	264	117	1	107	66	159	9	1543

When *P. monodon* specimens are donated to the MRRI, in addition to measuring and sexing the individuals, the first three pairs of pleopods are collected. These samples are currently being held in a tissue repository in Beaufort, NC which is maintained by the NOAA National Centers for Coastal Ocean Science Laboratory.

### Update on the Island apple snail, *Pomacea maculata*.

In 2008, the Island apple snail, *Pomacea maculata* (previously *P. insularum*), was reported from a stormwater pond in Socastee, nearby Myrtle Beach, South Carolina (SC). Native to South America, *P. maculata* was likely introduced to the US via the aquarium trade. In 2010 and 2011, *P. maculata* shells were reported from a location in Mount Pleasant, South Carolina, and in 2013, *P. maculata* was also reported from a pond in West Ashley, South Carolina.

From May 2015 to April 2016, three distinct surveys for *P. maculata* were conducted, including a survey of 100 randomly selected retention ponds across coastal SC to determine the distribution of the species, surveys of ponds within a 0.5-mile radius of known *P. maculata*

populations to assess the extent of these localized populations, and a survey of one pond biweekly to observe growth and abundance patterns of an established population. Since the last GSARP meeting held in October 2016, the following manuscript on this work has been submitted to *Aquatic Invasions*:

Gooding, E., Kingsley-Smith, P.R., Brown, T., Knott, D.M., Dillon, Jr. R. & Fowler, A. (2017). Determining the spatial extent and reproductive activity of invasive *Pomacea maculata* (Perry 1810) in eastern South Carolina, USA.

An additional two manuscripts documenting two additional non-native gastropod species previously unreported in South Carolina were submitted to *BioInvasions Records* in 2016, with details as follows:

Gooding, E., Dillon, Jr. R., Brown, T., Kingsley-Smith, P.R., Knott, D.M. & Fowler, A. (2016). Northern range expansion of the freshwater snail *Pyrgophorus parvulus* (Guilting 1828) and first confirmed report from South Carolina, USA.

Gooding, E., Dillon, Jr. R., Brown, T., Kingsley-Smith, P.R., Knott, D.M. & Fowler, A. (2016). First record of the freshwater Malaysian trumpet snail, *Melanoides tuberculata* (Müller, 1774), in South Carolina, USA.

Following peer review, the recommendation was that these manuscripts be consolidated into a single paper and resubmitted to *BioInvasions Records*. This work is still ongoing.

College of Charleston Graduate Program in Marine Biology M.S. student Elizabeth Underwood continued to make progress on her thesis research on *P. maculata*, under the supervision of Dr. Peter Kingsley-Smith who is serving as her major advisor. Her research includes determining the population genetic structure of *P. maculata* in South Carolina and Georgia using a suite of microsatellite markers, calculating the frequency of the rat lungworm parasite (*Angiostrongylus cantonensis*) in *P. maculata* in South Carolina, and determining the salinity and temperature tolerances of newly hatched *P. maculata* under laboratory conditions to predict potential habitat for invasion.

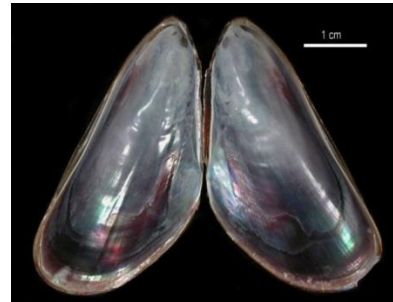
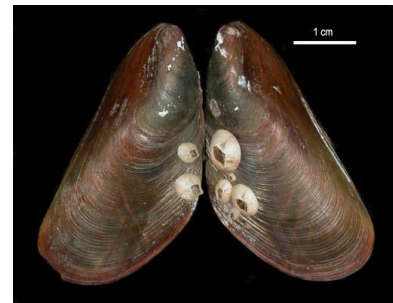
Elizabeth has isolated DNA from 100 *P. maculata* collected from each of three retention ponds in South Carolina (West Ashley, Mount Pleasant, and Myrtle Beach). PCR analysis was conducted using a suite of 14 microsatellite makers and genotypes were generated for 100 snails from each location using capillary gel electrophoresis. Several diversity indices, including number of alleles, allelic richness, expected heterozygosity, observed heterozygosity, and inbreeding coefficient were calculated using various software programs. Effective population sizes, which can be thought of as the numbers of individuals successfully contributing offspring to the next generation, were determined for each population. The genetic structure among each of the three populations was also determined by calculating genetic distances ( $F_{ST}$ ) and conducting analyses using the program STRUCTURE. Each population exhibited low genetic diversity across all indices; however, no inbreeding was detected in each of the populations. Effective population sizes were small, ranging from 13.5 to 18.7. Significant population structure was detected among all South Carolina populations investigating, indicating low gene flow and connectivity among these populations. Equivalent analyses are also being conducted on *P. maculata* collected from three locations in Georgia in August 2016 (50 *P. maculata* from Pooler, 90 *P. maculata* from St. Marys, and 48 *P. maculata* from Kingsland). Full genotypes for

these individuals are being generated and data analyses will be completed in May 2017. To date, 100 *P. maculata* from West Ashley, 100 *P. maculata* from Myrtle Beach, and 87 *P. maculata* from Mount Pleasant have been screened for the presence of the rat lungworm parasite, *Angiostrongylus cantonensis*, using quantitative PCR. None of these *P. maculata* have tested positive for *A. cantonensis*.

Logistics and methodologies for experimental trials to determine the salinity tolerance of *P. maculata* hatchlings continue to be determined. Nine adult pairs of adults are being held in biosecure facilities within the Hollings Marine Laboratory in Charleston, SC. Adults have been successful at depositing egg clutches in the tanks. Egg clutches will be allowed to hatch and the resulting hatchlings will be used in experimental trials. Hatchlings will be subjected to five different salinity treatments (0, 4, 8, 12, and 16 psu) immediately after hatching for a duration of 14 days. Mortality will be checked daily by placing hatchlings under a dissecting microscope and locating the heartbeat. Experimental trials will begin in mid-May 2017.

### **Charrua mussel, *Mytella charruana*, appears to be expanding northward in South Carolina.**

The charrua mussel, *Mytella charruana*, (shown right; images courtesy of SERTC), a mussel in the same family (Mytilidae) as the invasive Asian green mussel, *Perna viridis* as well as several species native to South Carolina (e.g., the ribbed mussel *Geukensia demissa*), has the potential to heavily foul structures that are submerged in seawater. Native to Central and South America, *M. charruana* first appeared in the United States in 1986 at a power plant in Jacksonville, FL where it clogged a seawater intake pipe. It is believed that its arrival was most likely via transport in ballast water or in the fouling community on hulls of vessels arriving from South America. Although cold winter temperatures eliminated that population in 1987, *M. charruana* has since returned to the Indian River Lagoon, FL where it has increased in number since its discovery in 2004, suggesting that a reproducing population has become established there. A large population of *M. charruana* was discovered in 2006 in Liberty County, Georgia, near Savannah.



Until very recently (September 2016), few living *M. charruana* had previously been found in South Carolina. In 2008 a single specimen was reported from Hunting Island and two specimens were found in the Ashepoo River. In 2013, several more specimens were found in the Ashepoo River, which was the most northerly record of its occurrence on the US east coast at that time. Despite the meager number of reports of living *M. charruana* in South Carolina, in 2008 large numbers of shell valves from recently dead mussels were found in the hull scrapings from the bottom of a large barge that was engaged in interstate transport between Jacksonville, FL and Norfolk, VA. Thousands of adult *M. charruana* valves, along with a similar number of the invasive *P. viridis*, were found on the ground following routine hull maintenance at a shipyard on Yonges Island, SC. Unfortunately, federal regulations that aim to reduce the risk of introductions through the international shipping trade fail to address the problem of the further dispersal of invasive species through this kind of interstate commerce, once a founding

population has become established. The arrival of recreational vessels from areas where the mussel is already established provides an additional potential vector of introduction. It seems certain that the movement of large numbers of reproductive *M. charruana* through South Carolina provides a substantial, perhaps continual, supply of larval propagules capable of settling and extending the range of the species into suitable habitats along the Intracoastal Waterway. Such propagule pressure may explain what appears to be a recent population explosion of *Mytella charruana* in Charleston Harbor.

During the first two weeks of September 2016, owners of hull cleaning services in Charleston reported that they have seen substantial aggregations of *M. charruana* on recreational boats docked at four different marinas in Charleston. A small sample from one boat (three images shown *below*; images courtesy of David Knott) included individual mussels ranging in size from 4.5 mm to 38.5 mm shell length.



These business owners expressed their concern about the significant increase in the amount of time it takes to clean hulls that are fouled by *M. charruana*. In response to their concern, a preliminary study was conducted to determine the current distribution and densities of *M. charruana* in South Carolina. The floating docks at ten marinas located along the South Carolina coast from Myrtle Beach to Port Royal were surveyed for the presence of *M. charruana*. Sites were selected in areas with high boat traffic as a likely vector for introduction. *Mytella charruana* was observed at 3 of 10 marinas, with Charleston, SC being the northernmost site at which *M. charruana* was found. The average densities of *M. charruana* at the three positive detection sites ranged from 26.7 to 1253.3 mussels per m<sup>2</sup>, and their shell lengths ranged from 1.9 mm to 42.2 mm. The broad size range of individuals collected suggests that *M. charruana* are successfully reproducing at these locations in SC. Additionally, *M. charruana* were observed in salinities from 6.1 to 23.2 ppt. It is important to understand the abiotic and biotic tolerances of *M. charruana* that can influence its potential distribution.