Volume 8 | Issue 1 Article 14

2019

Sex-specific Personalities in the Purple Marsh Crab

Jillian Sterman
DePaul University, jillian.sterman@gmail.com

Jessica Barton
DePaul University, jessbarton89@gmail.com

Panagiota Delmedico
DePaul University, patty_delmedico@yahoo.com

Samantha Sweeney
DePaul University, sam.sweeney@aol.com

Sex-specific Personalities in the Purple Marsh Crab

Acknowledgements
Special thanks to the South Carolina Department of Natural Resources staff Nick Wallover, Beth Hudson, and Matt King for allowing us to use their facilities and resources for the experiment, and Sara Teemer who helped with numerous aspects of the project. The project was initiated in the BIO 318 course (Field Studies in Marine & Estuarine Biology) offered through the Department of Biological Sciences at DePaul University.

Sex-specific Personalities in the Purple Marsh Crab

Jillian Sterman*, Jessica Barton, Panagiota Delmedico, Samantha Sweeney

Department of Biological Sciences

Timothy Sparkes, PhD; Faculty Advisor

Department of Biological Sciencees

ABSTRACT Animals are considered to possess personalities when individuals differ in behavior, and these differences are consistent between situations. Several studies have identified personalities in diverse groups but less is known about personality variation between the sexes. In this study, we examined variation in two key personality traits (boldness, activity) in female and male purple marsh crabs (*Sesarma reticulatum*) using a semi-field approach. Specifically, we measured boldness and activity on two consecutive days using the same behavioral assays during each time point. Consistency (personality) was determined using Kendall's coefficient of concordance based on Spearman correlation coefficients for each behavior. The results showed that personalities differed between the sexes. Females exhibited activity personalities but not boldness personalities. Males did not exhibit personalities for either behavior.

INTRODUCTION

Animals are considered to express personalities when they exhibit individual differences in behavior, which are consistent over time and across situations (Réale et al., 2007). Typically, there are five categories used to assign personalities: activity, boldness, exploration, aggressiveness, and sociability (Réale et al., 2007). The study of personality traits has been increasing in recent years and personalities have been identified in a diverse array of animals (Réale et al., 2010), including several relatively simple organisms (e.g., crabs, Briffa et al., 2008; isopods, Park and Sparkes, 2017). In some cases, personalities differ between the sexes (Park and Sparkes, 2017), which likely indicates that personality evolution has been shaped by sex-specific selection pressures. Less is known about this type of relationship. We examined sex-specific variation in personalities in purple marsh crabs (*Sesarma reticulatum*) using two of the key axes of animal personality (activity, boldness). Understanding variation in individual behavior is important because this variation can influence the interactions of individuals, populations, and species within the ecosystem (Sih et al., 2004).

*jillian.sterman@gmail.com

Research Completed in Winter 2018

Members of the species *S. reticulatum* belong to the family Grapsidae. While most grapsid crabs do not construct burrows (Hartnoll, 1964), members of *S. reticulatum* form interconnected burrows in the mud of salt marshes throughout their entire range (Wright, 1966; Seiple and Salmon, 1987). In these sites, burrow density appears to be influenced by local conditions such as the amount of cover available in the area (Mulstay, 1975).

Understanding variation in behavior in *S. reticulatum* is important because their behavior can have impacts on ecosystem dynamics. For example, studies have shown that *S. reticulatum* densities have risen in some areas along the New England coastline due to the reduction of predation pressure (Holdredge et al., 2008). As a potential result of the decrease in predation pressure, herbivory of *S. reticulatum* on cordgrass has increased in intensity in the salt marshes of Cape Cod, Massachusetts, causing extensive damage to this keystone plant species responsible for the maintenance of stability in salt marsh ecosystems (Holdredge et al., 2008). Thus, understanding variation in behavior of *S. reticulatum* can also be beneficial in conservation efforts in salt marsh ecosystems (Coverdale et al., 2012).

Previous research on the behavior of *S. reticulatum* has shown that there are differences between these sexes in behavior (Mulstay, 1975). For example, both males and females participate in burrow construction but only males construct and maintain domes on burrows. This type of variation in behavior between the sexes is common in nature. Nothing is known about the potential importance of personalities in the behavioral repertoires of female and male *S. reticulatum*.

METHODS

Species and study site

The species is distinguished by its small size, with a carapace width measuring approximately 22-23 mm at maturity for males and females, a brownish-purple color, and the swollen appearance of the chelipeds (Mulstay, 1975). The species ranges from Massachusetts to the Gulf of Mexico in Texas (Zimmerman and Felder, 1991). Members of *S. reticulatum* are abundant in areas of tall *Spartina alterniflora* (cordgrass) where the marsh borders the tidal creek (Teal, 1958), and overlap in their habitat occupancy with the mud fiddler crab, *Uca pugnax* (Mulstay, 1975). Marsh crabs feed on *S. alternaflora* and *U. pugnax*and and are nocturnal with highest activity levels between 6 p.m. and 4 a.m. (Palmer, 1967; Mulstay, 1975).

Collection and animal maintenance

Female and male crabs were collected from a salt marsh located adjacent to the Michael D. McKenzie Field Station (Bennett's Point, South Carolina, USA), which is operated by the South Carolina, Department of Natural Resources (32.5533°N, 80.4753°W). The crabs were collected during two time-periods (December 2017 and 2018). During the first collection (2017), we used a preliminary study to familiarize ourselves with the behavioral repertoires of females and males and identified key behaviors to use for personality analysis. During 2018, we ran the personality trials described here.

Purple marsh crabs were collected during the morning on Dec 15, 2018. Each crab was captured by digging in the burrows and sorting through the mud. A total of 23 individuals were collected and placed together into a plastic bucket with a small amount of mud for transport. Mud, marsh water, and cordgrass were collected in separate containers for use in the laboratory. The crabs were transported to an outdoor lab located at the field station. The outdoor lab had slatted walls, which allowed natural light to enter the room, and maintained a temperature consistent with the natural habitat of the crabs. Each crab was placed in individual plastic storage cups (236 ml) containing mud, marsh water, and cordgrass to simulate the marsh environment. The storage cups were covered with mesh held in place with a rubber band. Each crab was assigned an identification code, and the storage cups were labeled accordingly. A plastic bin was placed over the storage containers to prevent disturbance by local wildlife (e.g., squirrels).

The testing arena was a glass aquarium (76 L, 64 cm × 34 cm × 44 cm). The bottom of the aquarium was lined with a sheet of waterproof paper, with a 6 × 12 cm grid comprised of 5 × 5 cm squares. A red lamp was hung overhead to allow the trials to be run at night given the nocturnal behavior of the focal organisms.

Behavioral assays

Each individual *S. reticulatum* was habituated for two hours. Trials began at 7 p.m. (Eastern Standard Time) and were finished before 12 a.m. Previous studies have shown that only two trials are necessary to establish consistent behavior (Bell et al., 2009), therefore two trials were conducted in this study. The first trial was run on the night of collection, the second trial was run 24 hours later, using the same method.

Boldness assay

The rubber band and mesh were removed from the cup. Crabs were guided with a finger onto a plastic platform (a small rectangular plastic sheet) facing the direction of the handler. A timer was started as the crab and platform were placed in the aquarium on a designated square. The timer was stopped at the moment the *S. reticulatum* individual moved in a bold manner (e.g., leg movement, shifting carapace position, running, raising of the chelipeds, clamping of the chelipeds, or any other obvious bodily movement excluding eye-stalk movement).

Activity assay

The number of squares that an individual moved was recorded within a period of 5 minutes after the boldness test was completed. The entire carapace was required to move into a new square for the movement to count as 1. After 5 minutes, the individual was guided back onto the platform and transferred to the storage cup, which was sealed by the mesh and rubber band. Tested crabs were placed on a separate table from untested individuals. After completion of trial 1, individuals were moved back to the table they were habituated on and covered with the plastic bins. After the second trial was completed, the individuals were euthanized, using 70% ethanol, and in placed in labeled vials.

Gill damage

Gill damage was observed in a small number of crabs collected in the preliminary study (2017). Gills are typically white, whereas damaged gills contain black or brown-colored regions. To determine the extent of gill damage in the current study, we dissected each crab and recorded if gill damage was present.

Statistical Analysis

Body sizes were compared between the sexes using an unpaired t-test. Consistency was determined for females and males independently using Kendall's coefficient of concordance (W) based on Spearman correlation coefficients for each behavior (Briffa et al. 2008; Park and Sparkes 2017).

RESULTS

Of the 23 crabs examined, 14 were female and 9 were male. Females were larger than males (female = 11.1 mm, SD = 1.9; male = 8.0 mm, SD = 3.1, t = 3.1, df = 21, $p < 0.01$). Table 1 summarizes the results obtained for activity and boldness in the trials.

Sex	Behavior	Trial 1	Trial 2
Female	Activity	8 (5, 11)	5 (1, 8)
n = 14	Boldness	30 (5, 62)	22 (1, 97)
Male	Activity	4 (1, 7)	2 (0, 8)
n = 9	Boldness	11 (1, 67)	69 (8, 142)

Table 1. Personality assays for female and male *S. reticulatum*. Shown are median values with lower and upper quartiles in parentheses.

Activity exhibited consistency between trials for females indicating that females possess an activity personality ($W = 0.92$, $\chi^2 = 23.8$, df = 13, $p < 0.05$). This relationship is shown in Figure 1. There was no consistency in activity for males ($W = 0.83$, $\chi^2 = 13.3$, df = 8, $p > 0.05$). There was also no consistency in boldness for females ($W = 0.71$, $\chi^2 = 18.4$, df = 13, $p > 0.1$) or males ($W = 0.75$, $\chi^2 = 12.0$, df = 8, $p > 0.1$).

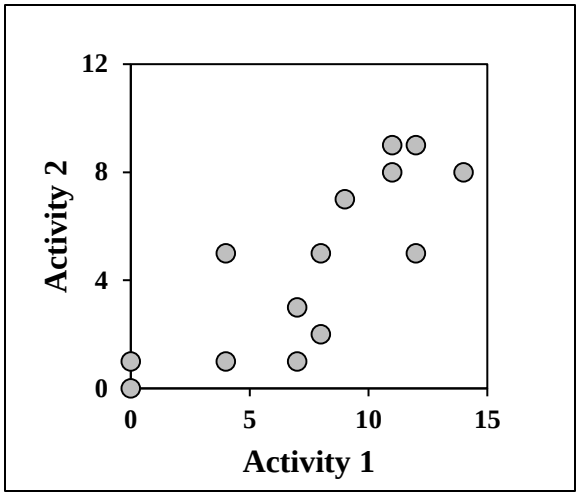

Figure 1. Relationship between the two measures of activity for female *S. reticulatum*.

DISCUSSION

In this study, we examined if personalities were present in female and male *S. reticulatum* and if these personalities differed between the sexes. Using activity and boldness as measures of personality, the results showed that personalities were present the species and that the personalities differed between the sexes. Females expressed activity personalities but not boldness personalities. Males did not express activity or boldness personalities. It should be noted that the sample size was smaller for males than for females, hence it is possible that personalities were present in males but not detected. Similarly, larger sample sizes for both females and males may have identified boldness personalities in both sexes.

In recent years, there has been a growing interest in the occurrence and diversity of personalities in animals including decapod crustaceans (Gherardi et al., 2012). For example, personalities have been identified in common hermit crabs (*Pagurus bernhardus*), banana fiddler crabs (*Uca mjoebergi*), big hand crabs (*Heterozius rotundifrons*), signal crayfish (*Pacifastacus leniusculus*) and noble crayfish (*Astacus astacus*) (reviewed in Gherardi et al., 2012). These studies have generally focused on the personality trait 'boldness'. The results presented here did not find evidence of boldness personalities but instead identified activity personalities that were sex-specific. Sex differences in personality have not been well- studied but may be common since male and female crabs often differ in behavior (e.g., purple marsh crab, Mulstay, 1975; common hermit crab Neil and Elwood, 1985). This type of variation likely indicates that sex-specific selection pressures occur for both behavior and personality in nature.

Gill damage, was identified in 7 of the 23 crabs examined (30%). In each case, the damage occurred in a female (7/14, 50%). At this time, the specific cause of the damage is not known but it is possible that the damage is due to a pathological effect of parasite infection. No parasites were observed in the current samples but the samples collected in the preliminary study revealed that damage appeared to be associated with the presence of a crustacean macroparasite. Previous studies have shown that parasites can influence animal personalities (Barber and Dingemanse, 2010). Thus, future studies are needed to determine if parasite infection plays a role in personality evolution in this system.

ACKNOWLEDGEMENTS

Special thanks to the South Carolina Department of Natural Resources staff Nick Wallover, Beth Hudson, and Matt King for allowing us to use their facilities and resources for the experiment and Sara Teemer who helped with numerous aspects of the project. The project was initiated in the BIO 318 course (Field Studies in Marine & Estuarine Biology) offered through the Department of Biological Sciences at DePaul University.

REFERENCES

Barber, I., Dingemanse, N. J. (2010). Parasitism and the evolutionary ecology of animal personality. *Philisophical Transactions: Biological Sciences*, 365, 4077-4088.

Bell, A. M., Hankison, S. J., Laskowski, K. L. (2009). The repeatability of behaviour – a meta-analysis. *Animal Behavior*, 77, 771-783.

Briffa, M., Rundle, S. D., Fryer, A. (2008). Comparing the strength of behavioral plasticity and consistency across situations: animal personalities in the hermit crab *Pagurus bernhardus*. *Proceedings of the Royal Society*, 275, 1305-1311.

Coverdale, T. C., Altieri, A. H., Bertness, M. D. (2012). Belowground herbivory increases vulnerability of New England salt marshes to die-off. *Ecology*, 93, 2085-2094.

Gherardi, F., Aquiloni, L., Tricarico, E. (2012). Behavioral plasticity, behavioral syndromes and animal personality in crustacean decapods: An imperfect map is better than no map. *Current Zoology*, 58, 567-579.

Hartnoll, R. G. (1964). The freshwater grapsid crabs of Jamaica. *Proceedings of the Linnean Society of London.*, 175, 145-169.

Holdredge, C., Bertness, M. D., Altieri, A. H. (2008). Role of crab herbivory in die-off of New England salt marshes. *Conservation Biology*, 23, 672-679.

Mulstay, R. E. (1975). Aspects of the life history and social behavior of the purple marsh crab, *Sesarma reticulatum* Say. Ph.D Thesis, State University of New York at Stony Brook, 233 pp.

Neil, S. J., Elwood, R. W. (1985). Behavioural modifications during egg-brooding in the hermit crab, *Pagurus bernhardus* L. *Journal of Experimental Marine Biology and Ecology*, 94, 99-114.

Palmer, J. D. (1967). Daily tidal components in the persistent rhythmic activity of the crab, *Sesarma*. *Nature*, 215, 64-65.

Park, T., Sparkes, T. C. (2017). Multidimensionality of modification in an isopod-acanthocephalan system. *Frontiers in Ecology and Evolution*, 5, 103.

Réale, D., Reader S. M., Sol, D., McDougall, P. T., Dingemanse, N. J. (2007). Integrating animal temperament within ecology and evolution. *Biological Reviews*, 82, 291-318.

Réale, D., Dingemanse, N. J., Kazem, A. J. N., Wright, J. (2010). Evolutionary and ecological approaches to the study of personality. *Philosophical. Transactions of the Royal Society B* 365, 3937–3946.

Seiple, W. H., Salmon, M. (1987). Reproductive, growth and life-history contrasts between two species of grapsid crabs, *Sesarma cinereum* and *S. reticulatum*. *Marine Biology*, 94, 1-6.

Sih, A., Bell, A. M., Johnson, J. C., Ziemba, R. E. (2004). Behavioral syndromes: an integrative overview. *The Quarterly Review of Biology* 79, 241-277.

Teal, J. M. (1958). Distribution of fiddler crabs in Georgia salt marshes. *Ecology*, 39, 185-193.

Wright, H.O. (1966). Comparative studies of social behavior in grapsoid crabs. Ph.D Thesis, University of California, Berkely. 226 pp.

Zimmerman, T. L., Felder, D. L. (1991). Reproductive ecology of an intertidal brachyuran crab, *Sesarma* sp. (nr. *reticulatum*), from the Gulf of Mexico. *Biological Bulletin*, 181, 387-401.