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A MORPHOMETRIC COMPARISON OF TWO CANCRID CRAB SPECIES

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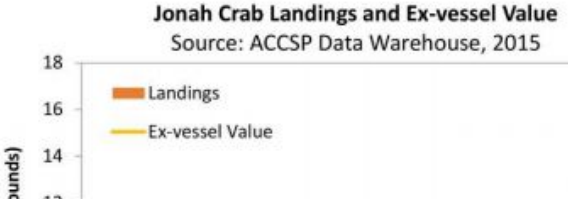
Abstract

Jonah crabs, Cancer borealis, and Atlantic rock crabs, Cancer irroratus, were collected from Maryland and Delaware coastal waters to create a species-identification card for local fishermen. Recently, Jonah crabs became federally and state regulated while Atlantic rock crabs remain unmanaged. For males of both species, the morphometric attributes studied were the length of the right third pereiopod merus (R3 merus), right chela height (RChH), right cheliped weight, right chela width (RChW), right chela length (RChL), total body weight, and carapace width (CW). There were distinct markings and color patterns on the manus that proved useful for identification purposes. The variables that differed the most between the two species are the length of the R3 merus, the RChH, and the difference between the long carapace width (LCW) (maximum width perpendicular to the medial axis) and the short carapace width (SCW) (distance between indentations anterior to the outermost anterolateral spines). The R3 merus length of the Atlantic rock crab was significantly greater than that of the Jonah crab ($P = 0.0002$) for a given CW. Additionally, the merus length showed a significantly ($P = 0.038$) steeper slope in rock crabs than in Jonah crabs. Both RChH and RChW are positively correlated with CW for both species (Jonah: $R2 = 0.6647$,$R2 = 0.7673$, respectively; Rock: $R2 = 0.8714$, $R2 = 0.8632$, respectively). We found that chela height of Jonah crab was greater than rock crab for the measured range (60-140mm). The chela width did not differ significantly between the two species ($P > 0.05$). The difference between the carapace widths are significantly different (Student's t-test, $P < 2.2e-16$). The ratio of cheliped weight to total body weight did not differ with carapace width, nor did it differ significantly between the species (ANCOVA, $P = 0.127$). RChL increased with CW, but there was no significant difference among RChL between the species for a given size ($P = 0.528$).

Introduction

The Jonah crab, *Cancer borealis* Stimpson, 1859 has an emerging fishery. Originally, Jonah crabs were caught as bycatch from the Southern New England lobster fishery (ASMFC 2015). Once



considered bait-stealing pests, fishermen realized they could profit off Jonah crabs as the lobster stock decreased. Consequently, the amount of Jonah landings have more than quadrupled from the early 2000s to 2014, as has the ex-vessel value of the fishery (Figure 1).

The majority of Jonah crab landings come from Massachusetts (~70%) and Rhode Island (~25%), with small claw-only fisheries found within the DelMarVa region and New Jersey that accounts for an insignificant portion of the fishery (<1%) (ASMFC 2016). Because landings have rapidly increased, coupled with Rhode Island fishermen targeting Jonah crabs using untagged lobster traps, the Atlantic States Marine Fishery Commission (ASMFC) have chosen to enact a fishery management plan (FMP) for the Jonah crab, starting in June 2016. The 2016 ASMFC Jonah Crab FMP Addendum I established a 1000 crab-per-trip incidental bycatch limit for nontrap and non-lobster trap gear that applies to trips of any length (ASMFC 2016). Additionally, they defined a minimum legal size of 4.75 inches carapace width. A major management concern for the fishery is that Atlantic rock crabs, which are unregulated by an FMP, closely resemble Jonah crabs. Complications with species identification may lead to inaccurate landings data, as well as legal repercussions for fishermen who violate the rulings of the FMP. Jonah crabs are distributed throughout the waters along the east coast, as far north as Newfoundland and Labrador, Canada, to as far south as the Bahamas, from the intertidal to depths of 800m (Haefner 1977, Stehlik et al. 1991, Wenner et al. 1992). Jonah crabs tend to inhabit areas of rocky substrate, along with American lobster, *H. americanus* (Musick and McEachran 1972). According to Musick and McEachran (1972), Jonah crabs have a high abundance along the continental shelf edge, likely due to their relative stenothermality (McEachran 1972). In deeper water, the temperature remains relatively constant, whereas the coastal waters of the continental shelf are subject to a wide range of temperatures (5-30°C) (NEFSC 2016). Jonah crabs are morphologically similar to the Atlantic rock crab, *Cancer irroratus* Say, 1817. The distribution of the Atlantic rock crab ranges from northern Newfoundland and Labrador to South Carolina and eastern Florida (Bigford 1979) within a bathymetric range of intertidal to 751 meters depth (Haefner 1976). Rock crabs prefer sandy substrates (Musick and McEachran 1972) and rarely are found in the same habitat as the Jonah

Figure 1. Jonah crab landings and ex-vessel value since 1990. Taken from the Atlantic States Marine Fisheries Commission, http://www.asmfc.org/species/jonah-crab.

crab. Large Atlantic rock crabs (≥ 101mm CW) are most abundant in the 40-60 meter range on the shelf (Haefner 1976). Musick and McEachran (1972) found that Atlantic rock crabs were highly abundant inshore, and that the population was widespread over the continental shelf, likely due to the shelf sediments being mostly sandy with rocky patches. The bathymetric distribution study conducted by Musick and McEachran (1972) suggests a continuous population from southern New England to the Chesapeake Bight. According to Haefner (1976), Atlantic rock crabs are eurythermal and most abundant in the 4-14°C temperature range. When collected in the fall and winter, however, Musick and McEachran (1972) showed that rock crabs were evenly distributed throughout the 2-13°C range, with a slight spike in abundance within the 4-8°C range. The focus of this research project is to identify measurements and morphometric characteristics that are easy and useful to

discern between the two aforementioned crab species. Information collected by this still will help aide fishermen in distinguishing between Jonah and Atlantic rock crabs.

Methods

Atlantic rock and Jonah crabs were collected as bycatch from lobster and black sea bass traps from Wes and Chet Townshend, fishermen of the DelMarVa region in June and July 2016. For this study, a sample size of n = 98 male Jonah crabs and n = 146 male Atlantic rock crabs were used. For each crab collected, we noted: weight, sex, shell condition, carapace length (CL, right eye socket to middle of the rear of the carapace), the spine width (SW, the distance between the longest anterolateral spines on opposite sides of the carapace), carapace width (CW, the distance between the bases of the longest spines), right and left chela length (ChL, defined as the length of the claw from the beginning of the palm to the end of the propodus), right and left chela height (ChH, males only), thickness of the right chela (ChW, males) or width of the abdomen (AW, females), weight of the claw starting from the basi-ischium plane (ChWt). and the length of the merus of the right third pereiopod (R3 merus). If the right limb was missing, we measured the left equivalent. Lengths were measured to the nearest 0.01mm using Mitutoyo brand digital calipers, and weights were measured to the nearest gram. Claws were collected from each 10 mm CW size class, starting at 50 mm CW and kept frozen until photographs were taken. Male crabs were dissected to observe if there was seminal fluid present in the proximal region of the vas deferens (Moriyasu *et al.* 2002) to gauge gonadal sexual maturity. All crabs were sexually mature. Data was analyzed using both Minitab 17 and the R program.

Results

Carapace Width

The carapace widths of Jonah and rock crab were both normally distributed (Figure 4). A t-test of the distribution revealed that the mean SCW of Jonah crab (108.08 mm) was significantly higher ($P < 2.2e-16$) than the mean SCW of the rock crab (88.41 mm) (Figure 5). The difference between the LCW and SCW is significantly greater in Atlantic rock crabs than in Jonah crabs ($P <2.2e-16$).

R3 Merus Length

A regression analysis was run to determine if there was a correlation between carapace width and the length of the right merus of the third pereiopod. There was a positive correlation between the two variables (Jonah $R2 = 0.9176$; Rock $R2 = 0.898$). Through an analysis of covariance (ANCOVA) we found that there was a significant difference in the length of the R3 merus between the male Atlantic rock crab and the male Jonah crab ($P = 0.002$) for a given carapace width. In addition, there was a significant difference ($P = 0.038$) in the slopes of the two lines.

Right Chela Height

There was a positive correlation between the two variables for both species, but the correlation was stronger in the Atlantic rock crab (Jonah $R2 = 0.665$; Rock $R2 = 0. 0.871$). ANCOVA revealed that at small carapace widths, the heights of Jonah and Atlantic rock crabs are not significantly different ($P = 0.50291$). However, at larger carapace widths, Jonah crab chela heights become significantly greater than those of the Atlantic rock crab.

Right Chela Length

Using the length of the right chela is not a reliable way to distinguish Jonah and Atlantic rock crabs. The chela length was positively correlated for both species (C. *borealis*: R2 = 0.6847; C. *irroratus:* R2 = 0.8757). There was no significant difference between the two crabs (P = 0.528).

Conclusion

Based on the results of this study, we believe appropriate criteria to differentiate between the two species are the merus length, the chela height, and the difference between short and long carapace widths. For a given carapace width, the merus length of the Atlantic rock crab becomes increasingly larger than that of Jonah crab (Figure 7). Thus, the walking legs of rock crabs are generally longer than that of Jonah crabs for the same size class. Longer walking legs can be seen as advantageous, because the Atlantic rock crabs use their longer pereiopods to burrow quickly into the sand to avoid predation (Fogarty, 1976). Fogarty (1976) found that the Atlantic rock crab can completely bury itself in an average of 16.3 seconds, while the Jonah crab requires about 48.9 seconds. Both rock and Jonah crabs prefer rocky-bottomed substrates, as they provide more places to hide from predators. Because Jonah crabs have larger claws and are more aggressive, they are able to outcompete the rock crabs for the space, thus forcing the rock crabs onto the less-preferred sandy-bottomed substrate (Bigford, 1979).

In addition to these quantitative characteristics, there are other ways to tell these two species apart, which may be more useful in a fisherman-oriented species identification card. The carapace of the Atlantic rock crab is smooth to the touch, while on a Jonah crab the carapace is rough and bumpy. Furthermore, the spines and grooves of the carapace are similarly smooth on rock crabs and rough on Jonah crabs. The patterns on the back of the legs of Jonah and Atlantic rock crabs are another way to tell them apart—rock crabs have small purple spots whereas Jonah crabs have a red and white camouflage-like appearance (Figure 10). Lastly, and perhaps most importantly, if one were to look at the pair of pereiopods directly behind the chelipeds, they would find that these walking legs are longer than the cheliped in the Atlantic rock crab—a characteristic not present in the Jonah crab.

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