# Distribution of red deepsea crab (*Chaceon quinquedens*) by size and sex in the Gulf of Mexico

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The red deepsea crab (*Chaceon quinquedens* (Smith, 1879)) has supported a commercial fishery off the coast of New England since the 1970s (Wigley et al., 1975) and has had annual harvests from 400 metric tons (t) (1996) to 4000 t (2001) (NEFMC, 2002). In 2002, a fishery management plan for the northeast fishery on the Atlantic coast was implemented and total allowable catch was reduced to approximately 2500 t (NEFMC 2002). Although there are management plans for the golden crab (*C. fenneri*) and the red deep sea crab for Atlantic coast regions, there is no fishery management plan for red deepsea crabs in the Gulf of Mexico. Successful management for sustainable harvests should be based on a knowledge of the life history of the species, but *C. quinquedens* has been a difficult species for which to obtain life history and abundance information because of its deep distribution.

Previous studies used trap surveys to estimate the relative abundance and distribution of *C. quinquedens* and almost all had similar results (Wigley et al., 1975; Stone and Bailey, 1980; Lockhart et al., 1990; Lindberg and Lockhart, 1993; Waller et al., 1995; Trigg et al., 1997). Typically, *C. quinquedens* is found at depths from 100 to 2000 m (Haefner, 1978; Hastie, 1995) in the western Atlantic Ocean and the Gulf of Mexico (Haefner and Musick, 1974). The largest populations of *C. quinquedens* are found on soft sediments along the continental slope (Lindberg and Lockhart, 1993). Red deepsea crabs typically are found in progressively shallower depths as they increase with size (Wigley et al., 1975; Trigg et al., 1997), and this finding indicates that the megalopae, after settling in deeper water, move up the continental slope as they grow. Bathymetric sexual segregation has been reported for many of the *Chaceon* species, including *C. quinquedens* (McElman and Elner, 1982; Lockhart et al., 1990). Females typically are found in shallower waters than those that males inhabit (Wigley et al., 1975; Lockhart et al., 1990), although females have also been found at depths similar to those of males (Wenner et al., 1987).

In previous studies, *C. fenneri* and *C. quinquedens* were found to have similar distributions. However, most studies in which this comparison was made had relatively larger collections of *C. fenneri* than *C. quinquedens* (Lockhart et al., 1990; Lindberg and Lockhart, 1993). The two congeners may be expected to have similar distribution patterns because of their genetic and morphological similarities; however, assumptions made about the distribution of *C. quinquedens* based on the distribution of *C. fenneri* may lead to inappropriate management strategies. Similarly, populations of crabs in the Gulf of Mexico and Middle Atlantic Bight may use habitat differently and further investigation is warranted (Lockhart et al., 1990). Depth limitations of prior surveys have indicated that juveniles may not have been sampled, as evidenced by the depth-limited NEFSC (Northeast Fisheries Science Center) 400 m surveys from 1964 to 1999 where fewer than six crabs smaller than 7-cm carapace width were captured per tow (Steimle et al., 2001).

*Chaceon quinquedens* is closely related to *C. fenneri* (Weinberg et al., 2003). However, *C. fenneri* is tan and found at shallower depths than the red *C. quinquedens* (Lockhart et al., 1990; Lindberg and Lockhart, 1993). Commonly, when one species of *Chaceon* is studied, data are extrapolated to other congeners because of a limited sample of those congeners or because data have not yet been collected for the congeners. Most of the life history patterns that have been attributed to *C. quinquedens* have been attributed because of its close relationship with *C. fenneri*. Little or no genetic difference between *C. fenneri* and *C. quinquedens* populations was found in the eastern Straits of Florida and the Gulf of Mexico (Weinberg et al., 2003). The hypothesis was that the distribution of *C. quinquedens* would be similar to the distribution observed for *C. fenneri* in previous studies. To examine this hypothesis, we compared the size distribution and sex distribution of *C. quinquedens* near six shipwrecks at varying depths in the Gulf of Mexico. Because fish communities around these shipwrecks were being examined at the time, we took the opportunity to explore red deepsea crab distributions.

## Materials and methods

From July 29 to August 16, 2004, six World War II era shipwrecks were surveyed with the remotely operated vehicle (ROV) XL-11 deployed from the HOS *Dominator* in the Gulf of Mexico. The shipwrecks were located

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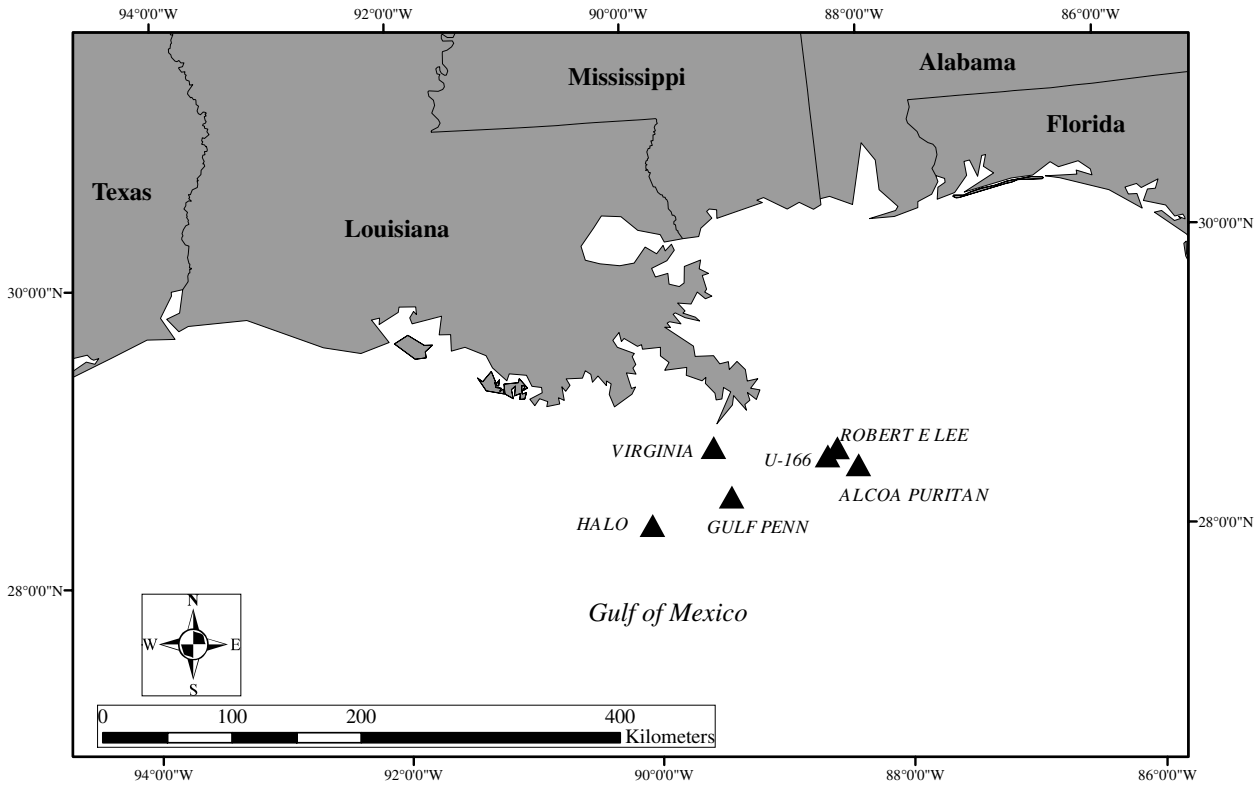


**Figure 1**

The locations of the shipwreck sites surveyed in the Gulf of Mexico with the XL-11 ROV. Red deepsea crabs (*Chaceon quinquedens*) were found at the four deeper sites (*Gulf Penn, U-166, Robert E. Lee,* and *Alcoa Puritan).*

in the Mississippi Canyon or adjacent areas (Fig. 1) and varied in water depth from 90 to 1970 m. At each wreck, ROV transects were conducted over the wreck and over the debris field. Once transects were completed, traps were set and biological sampling with the ROV began. Transects over the wreck and in parallel lines adjacent to the wreck until about 300 m were mapped before the deployment of the ROV. The ROV and trap sampling time lasted a minimum of eight hours and a maximum of sixteen hours. At each wreck, both a small baitfish trap (95 cm width × 75 cm length × 50 cm height) and a chevron fish trap (150 cm width × 180 cm length×60 cm height) baited with herring and squid were set within a few meters of the wreck and approximately 300 m away from the wreck. A baited crab trap (64 cm width × 97 cm length × 51 cm height) was placed near the wreck, and two minnow traps (23 cm diameter × 44 cm length) bound together were placed far from the wreck; both were baited with canned cat food and biolume sticks. Additional collections were made at the direction of biologists using the manipulator arm of the ROV for larger invertebrate specimens and the suction hose of the ROV (approximately 10 cm in diameter) for smaller invertebrate specimens.

Each crab specimen collected was measured from the anterolateral spine on one side of the carapace to the anterolateral spine on the opposite side for carapace width (CW) to the nearest 0.1 mm with vernier calipers. Shell condition and missing appendages were noted and sex was recorded. If the crab was female, presence and color of eggs were also recorded. Voucher specimens from each wreck were either preserved in 90% ethanol or frozen.

Statistical analyses were performed with SPSS 14.0 (SPSS, Inc., Chicago, IL) software to determine if crab size or sex was related to the distribution of the crabs. To determine if there was a correlation with size and depth, a linear regression was performed with a 95% confidence interval. To examine the relationship of sex with depth, the Kruskal-Wallis test was used because the data were non-normal. Data were also non-normal for depth distribution, but linear regression was used to determine if a linear correlation existed.

## Results

*Chaceon quinquedens* was found at the four deepest of the six shipwrecks, and there was no linear distribution of the crabs by sex. A total of 127 specimens was collected at the four sites, with CW ranging from 21.2 mm to 141.1 mm (Table 1). No significant correlation occurred between depth and crab size ($R^2$=0.051). The smallest crabs were found at the shallowest depth, and

**Table 1**

Carapace width (mm) and numbers of females and males of red deepsea crab *Chaceon quinquedens* found on four shipwrecks in the Gulf of Mexico.

| | | Carapace width (mm) | | | Sex | |
|---|---|---|---|---|---|---|
| Shipwreck | Depth (m) | Average | Minimum | Maximum | Female | Male |
| *Gulf Penn* | 533 | 24.1 | 21.2 | 31 | 0 | 4 |
| *Robert E. Lee* | 1428 | 95.0 | 56.5 | 141.1 | 27 | 21 |
| *U-166* | 1428 | 116.0 | 61.5 | 136.5 | 18 | 6 |
| *Alcoa Puritan* | 1950 | 66.5 | 43.7 | 120.3 | 22 | 26 |

the largest crabs were found at intermediate depths. The four smallest specimens were collected with the suction arm of the ROV (all at the *Gulf Penn* shipwreck) and one crab was collected with the manipulator arm of the ROV. All other samples were collected in the fish traps. No crabs were collected in the minnow traps, and crabs were rarely observed on the shipwrecks. Although slightly more than half of the crabs were collected close to the shipwrecks (74 ±7 m), insufficient data were collected to compare wreck effects on crab size or sex distribution.

Males and females did not have significantly different distributions. A total of 67 females and 57 males was collected (three of unknown sex collected at the *U-166* site) and no depth pattern could be attributed to sex (Table 1; $P=0.059$).

## Discussion

Previous reports of the distribution of *C. quinquedens* have been contradictory to our findings, which were influenced by the addition of a different sampling technique, the ROV. Without the ROV, the four smallest crabs would not have been observed or collected at the shallowest depth. Red deepsea crabs are typically found on silt substrate, and although their abundance on the shipwrecks was not analyzed in our study, we noted that crabs were rarely found on the shipwrecks (see also Kilgour, 2007).

A strong correlation of crab size with depth has been reported in some studies of *C. quinquedens* (Wigley et al., 1975; Lockhart et al., 1990; Lindberg and Lockhart, 1993; Waller et al., 1995; Trigg et al., 1997), but not in others (Wenner et al., 1987). The variation in results may have been caused either by a temporal variation in sampling, or a sampling bias from gear. In our study, the smallest crabs were found at the shallowest site and this result was contrary to that of previous reports (Lockhart et al., 1990; Lindberg and Lockhart, 1993; Waller et al., 1995; Trigg et al., 1997). A linear relationship between crab size and depth was not observed in our study, but this result may have been due to the ROV collections which were composed of the smallest crabs; crabs of a similar small size were not collected with traps at the same site.

An almost equal ratio of females to males occurred in our study and our sampling did not occur during the reported mating season (Wigley et al., 1975; Haefner, 1978; Biesiot and Perry, 1995). Female *C. quinquedens* were found only at the three deepest sites, whereas males were found at four of the six sites; this finding contradicts that of previous studies where depth segregation by sex was observed (Wigley et al., 1975; Lockhart et al., 1990). Sampling methods to date may have been inadequate because the use of traps has been the primary method for obtaining information for this species. Sampling biases often result in more males being collected, particularly when females are ovigerous, because females tend to avoid traps while brooding eggs (Howard, 1982; McDonald et al., 2004; Taggart et al., 2004). Additionally, sampling bias exists for larger males and for smaller males and females; smaller crabs are less likely to enter traps when large males are present (Taggart et al., 2004). *Chaceon quinquedens* is difficult to study because of its deep distribution; techniques other than trap and trawl sampling may be necessary to accurately understand the movements, spatial distribution, and life history of this species.

The bathymetric distribution of many deepwater crab species is suspect because the methods by which these patterns were determined may be biased. We used two different techniques, an ROV and traps; the bathymetric distribution of *C. quinquedens* was different from that of previous studies where a single sampling technique was used. The best data available are used for fishery management, but many times these data represent sampling techniques that may not provide a complete distribution of the species in question. Our study, in spite of a small sample size, demonstrates the importance of using more than one technique for observing the life history and distribution of a deepwater species to reduce the biases of sampling techniques. Both the ROV and the trap surveys have sampling biases, but in combination, may reveal a more accurate picture of the bathymetric distribution of red deepsea crab. The use of multiple sampling gears to gain knowledge of the life history of deepwater crabs is necessary.

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