Cancer irroratus, Atlantic rock crab

Background

The brachyuran crab *Cancer irroratus* Say, 1817 is officially known by the common name Atlantic rock crab (McLaughlin *et al*. 2005), but seems more often listed as the shortened vernacular, rock crab (Williamson 1984, Squires 1990). It is a member of the family Cancridae that also includes the closely related and commercially important Jonah crab, *Cancer borealis*.

Rock crabs grow to about 15 cm carapace width in males, and 11 cm in females (Robichaud and Lawton 1997, Bigford 1979) compared to 18 and 15 cm, respectively, for Jonah crabs (Elner 1985). Both species are native to the northwest Atlantic, rock crabs ranging from northern Newfoundland and Labrador to South Carolina and eastern Florida (Bigford 1979) within a bathymetric range of 0 to 751 m (Haefner 1976) and a preference for shallow waters in more northern habitats and vice versa. This range overlaps to a large extend with *C. borealis*, as well as the lobster *Homarus americanus* which also occupy similar habitats ranging from sand, gravel to rock (Williams and Wigley 1977). When interacting, both Jonah crabs and lobster apparently displace rock crab from coarse to finer substrate habitat (Jeffries 1966), peculiarly contradicting its common name. In the southern range rock crabs tend to migrate from shallow to deeper waters in late spring and summer but populations in New England and Canada apparently largely remain inshore (Bigford 1973). Larger crabs also tend to occur in deeper water.

As with most organisms not controlling body temperature, the life-cycle of the rock crab is strongly temperature dependent. Ovigerous females, carry an estimated number of eggs ranging from circa 4,000 to over 330,000, depending on size, and are most abundant in spring and fall. Spawning peaks range from February to May in New England waters (Bigford 1979). After hatching, a planktonic larval dispersal phase ensues that includes five zoeal stages and a megalopa (Sastry 1977), becoming a benthic organism when molting to the first crab instar. At 15^{o}C and normal salinity this process takes between 37-58 days. Commercial size is reached in about six years (Robichaud and Lawton 1997). Rock crabs are estimated to live up to 8 years (Reilly and Saila 1978).

A fishery of this edible species dates back to around 1900 in Massachusetts (Haefner *et al*. 1973, Wilder 1966) that gradually spread throughout New England and into Canada. In addition to the economic potential in the hard crab or crabmeat market, rock crab represents a potentially important and more lucrative soft crab resource in Chesapeake Bay (Haefner and Van Engel 1975). However, commercial exploitation remains small compared to that of the Jonah crab, the latter reported at about 5000 tons in 2005 (http://www.st.nmfs.gov/pls/webpls/mf_8850_landings.results). It is uncertain if the figures include some rock crabs, as these two species are quite similar and no separate data are reported for rock crab. In Canada, where rock crabs are most abundant in the Gulf of St. Lawrence (http://www.mi.mun.ca/mi-net/fishdeve/atlantic.htm), a fishery was initiated in the 1960's, with crabs primarily caught as by-catch in the lobster trap fishery. Commercial exploitation has since expanded and includes both by-catch and directed

fisheries. The rock crab fishery is a growing industry. Landings have grown from a few 100 tons in the 1970's to over 5,500 tons in 2000 for the southern Gulf of St. Lawrence alone (Savoie 2002).

Temperature limits, critical thresholds, vulnerability, and barriers to adaptation

Sea surface temperatures in the current distribution of the rock crab range from a February minimum of -2.1^{o}C to an August maximum of 29.6^{o}C. This falls within observations by MacKay (1943) that all 19 known species of *Cancer* are essentially found between the 4.4 ^{o}C and 23.6 ^{o}C mean surface temperature isotherm within the temperate zone. One of the reasons for the wide distribution of rock crab within the temperate zone is its tolerance to a wide range of salinities and temperatures, as exemplified by its occurrence in lower estuaries to the deep sea (Williams 1984). Williams and Wigley (1977) list a temperature range of 1.3-25 °C for the species based on general knowledge of thermal requirements. Larvae and juveniles can survive salinities ranging from 20-35 ppt (Sastry and McCarthy 1973). Zoeal larvae have been collected in Chesapeake Bay at temperatures ranging from 13 to 27.9 °C, but with very few larvae collected above 25 °C (Sandifer 1973). Results of Sastry and McCarthy (1973) indicate that rock crab larvae cannot complete larval development at 25 °C over a wide range of salinities, demonstrating sensitivity to higher temperatures during that developmental phase. In contrast, adults have been collected from waters as high as 32 °C (Bigford 1979). In terms of lower thresholds, larval development at 10 °C, the lowest temperature investigated by Sastry and McCarthy (1973) was successfully completed at salinities ranging from 25-25 ppt. Larval survival at lower temperatures, such as in the northern range of the rock crab, are therefore presently not clear. Juvenile and adult crabs have been reported in waters of as low as 5.1 °C in June in the mid-Atlantic Bight (Haefner 1976), where temperatures will clearly still be lower in winter.

The overall assessment of thermal sensitivity of the rock crab showed it to be a relatively insensitive species, ranking at the top amongst invertebrates with above average mobility and a top score for eurythermal capacity.

Impact

A 4^{o}C rise in global temperature will impact the future distribution of the Jonah crab in the western Atlantic. The most apparent impact, predicted by all models, is a loss in the southern range (red areas). In all cases this includes US waters up to Cape Hatteras to as far north as off Delaware. While rock crab is not extensively fished in these areas, the warming could create suboptimal conditions in areas further north, where crabs would likely move from present concentrations in waters less than 20 m deep (Robicheau and Lawton 1997) to those further offshore.

All models agree in indicating no gain in thermal range but rock crabs do presently not occupy the area in Labrador north of Newfoundland, available based on known thermal

minima in areas where this species occurs (blue areas without hatching). Habitats and salinity conditions are not likely to differ between the two regions. As a dominant ecological factor in controlling survival, rate of development and growth in marine organisms (Kinne 1970), temperature over space and time is likely a major contributing factor in the present absence of rock crab in northern Labrador, as it apparently is the case for the American lobster (see elsewhere in this report). With a warming of 4^{o}C it is therefore more likely that rock crab would occupy the coast of northern Labrador.

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