Male Tanner Crab Carapace Widths at Previous Intermolt Estimated from Laboratory Growth, Kachemak Bay, Alaska

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ABSTRACT: Laboratory growth observations of Tanner crab *Chionoecetes bairdi* from lower Cook Inlet suggest that only males ≥119 mm in carapace width (CW) could recruit to the legal size of 140 mm CW in a single molt. Back-calculated estimates of previous CWs indicated 84% of a sample of males captured in the fishery had CWs of 119–139 mm during their previous intermolt and 16% had CWs ≥140 mm. This suggests that some crabs ≥140 mm CW molt, but most of the harvested crabs were of sublegal size prior to their last molt.

INTRODUCTION

The size at which male crabs of the genus *Chionoecetes* cease to molt was discussed by Conan and Comeau (1986) and Donaldson and Johnson (1988). Conan and Comeau (1986) suggested that at the onset of maturity males underwent a terminal molt, whereas Donaldson and Johnson (1988) contended that terminal molt at maturity was not likely. Recent experiments showed that functionally mature Tanner crab *C. bairdi* males can molt (Paul and Paul 1995) and that terminal molts in male Tanner crabs can occur beyond the onset of maturity. Tanner crab males in Alaska mature at about 50 to 120 mm carapace width (CW; Paul and Paul 1996), but they cannot be legally harvested until they are larger: >140 mm CW in most of the Gulf of Alaska and >135 mm in Prince William Sound. All of the experimental work on molting in males has been done with specimens <140 mm CW (Donaldson et al. 1981; Paul and Paul 1995).

The objective of this investigation was to measure the CWs in a subsample of males harvested from the Cook Inlet fishery and to determine the percentage that might have recruited from sublegal sizes or molted from legal sizes. We were interested in identifying the size at which males would grow to legal size in a single molt so we could focus future studies on the length of that intermolt period. Growth-per-molt data from captive males <140 mm CW were used to back-calculate the CW measurements of a sample of male crabs harvested in Cook Inlet to estimate their size during the previous intermolt.

MATERIALS AND METHODS

Growth per molt was measured for male Tanner crabs from lower Cook Inlet and Resurrection Bay, near Seward, Alaska. Male crabs 54–139 mm CW were captured with a small otter trawl fished at 30- to 60-m depths in Kachemak Bay. Captures took place between 1980 and 1994, and each crab was transferred directly from the field to the Seward Marine Center Laboratory. We determined growth increments for 46 male crabs with CWs of 54–118 mm that fertilized primiparous mates and then molted; an additional 15 males with CWs of 110–139 mm copulated with multiparous females and then molted. The growth information and holding conditions for these 61 functionally mature males was previously published by Paul and Paul (1995). That study provides growth-per-molt measurements but no estimates of intermolt durations.

In 1995 we also observed 36 males (CWs 10–39 mm) from Resurrection Bay that were taken at a 20-m depth with a trawl. They were held in 5°C seawater in 20-L tanks and fed Pacific herring *Clupea pallasi* and mussel *Mytilus trossulus* tissue daily until they molted. One week after molting they were killed and their vas deferens were examined. None of them had spermato-

Authors: A. J. PAUL and J. M. PAUL are marine biologists with the University of Alaska Institute of Marine Science, Seward Marine Center Laboratory, P.O. Box 730, Seward, AK 99664.
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phores, so they were considered to be immature. These data are included so growth patterns of immature and mature individuals can be compared. The growth-per-molt data included in this report was extracted from observations that occurred between 1980 and 1996; we did not attempt to examine interannual variations because of paucity of growth measurements in any given year.

Premolt and postmolt CWs were measured to the nearest millimeter at the point of maximum width, not including the spines. Postmolt measurements were taken 1 week after the molt when the carapace had hardened. Linear regression using the least squares fit was used to examine the relationships between initial and postmolt CWs.

During 22–23 January 1991, CW was measured for 365 males harvested in the Kachemak Bay/Cook Inlet commercial fishery. They were taken from the processor's live tanks, which had come from several boats. Because they were harvested in just 1 bay, this sample is not representative of the size distribution of the whole fishery. Using the laboratory growth-per-molt predictions from the linear growth model ($y = ax + b$), we back-calculated to get the CWs for these individuals during their previous intermolt period ($a = (y - b)/x$). The shell condition (new or old) of these males was not assigned because we could not concur on how to grade many of the individuals.

RESULTS AND DISCUSSION

Figure 1 shows a linear relationship ($df = 84$; $P < 0.0001$) between premolt and postmolt CW for the male Tanner crabs studied. Based on Figure 1, most males would need to achieve a CW ≥119 mm in order to molt to legal size (≥140 mm CW) in a single molt. The CW growth patterns of immature and mature males fit closely along the same regression line showing they do not change markedly with maturity (Figure 1). There was also no indication in the data presented by Donaldson et al. (1981) for Kodiak Island Tanner crabs that, at the onset of maturity, CW growth patterns in males change markedly.

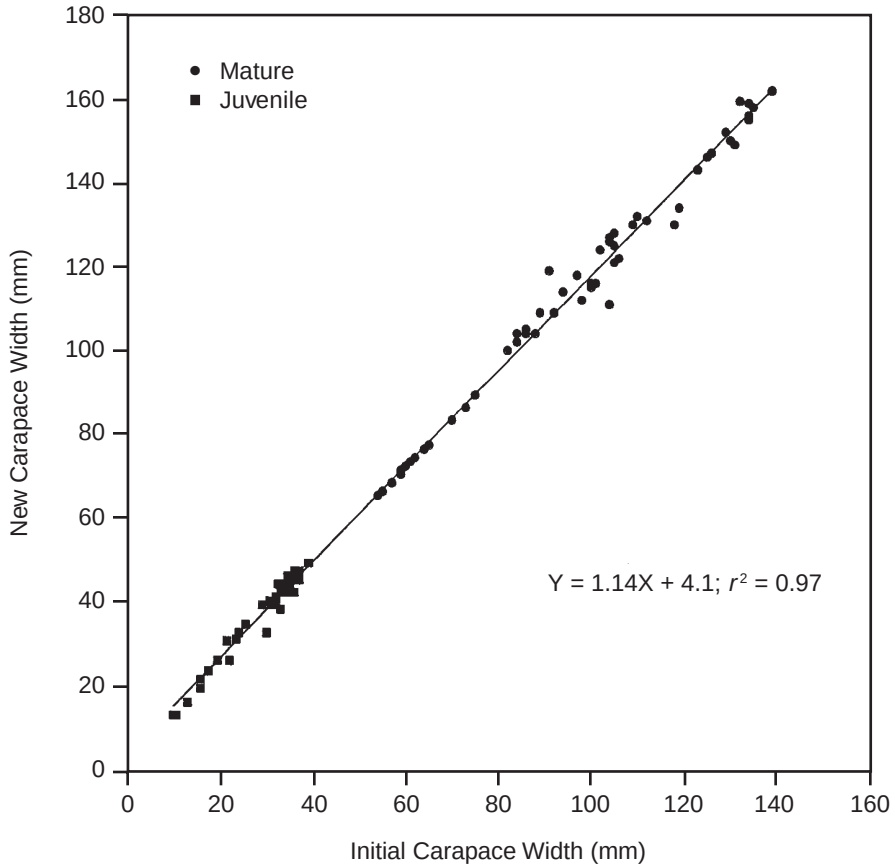

Figure 1. Measurements of premolt and postmolt carapace widths in male Tanner crabs that molted in the laboratory.

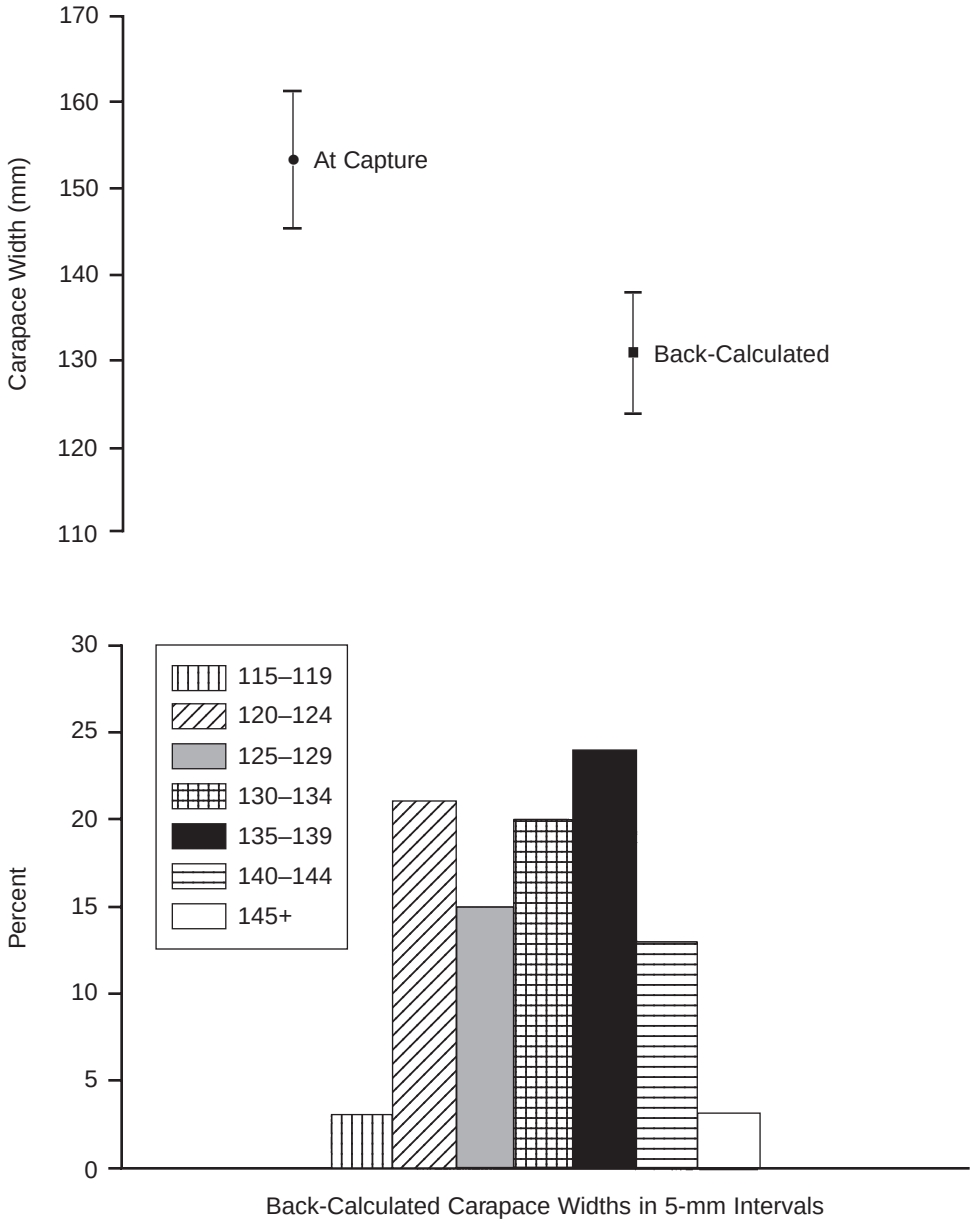

Figure 2. Measurements (mean, SD) of initial carapace width and back-calculated carapace width for previous intermolt period for 365 male Tanner crabs that were captured in Kachemak Bay, Alaska, in the commercial fishery (upper), and the size-frequency profile of back-calculated carapace widths (lower).

The 365 harvested males had an average CW of 153 mm and a back-calculated mean CW of 130 mm during their previous intermolt (Figure 2). Based on the growth-per-molt estimates (Figure 1), 84% of the 365 crabs measured were sublegal size and 16% were >140 mm CW in their previous intermolt period (Figure 2).

The lack of many males >165 mm CW may reflect removal from the population by fishing rather than an inability of males to grow beyond that size. Fishing probably decreases the average size of males left in the population, but whether the harvest modifies the growth rate of the survivors is not known. If males with a genetic potential to reach a large size are consistently removed from the population by the fishery, then there would be a tendency for the population to produce smaller males in the future. Growth rates of captive crabs could differ from those in the wild, so this pos-

sibility must be considered when applying the results of this study.

Previous observations for Kodiak Island Tanner crabs showed growth rates similar to Cook Inlet crabs (Donaldson et al. 1981); e.g., a 130-mm CW male from Kodiak would molt to 155 mm versus 152 mm for Cook Inlet crabs (Figure 1). Male Tanner crabs are functionally mature (i.e., able to copulate with and fertilize both primiparous and multiparous females) when they are ≥120 mm CW (Paul and Paul 1996). Paul and Paul (1995) reported that 74% of male Tanner crabs 110–139 mm CW molted while being held in the laboratory to determine molting frequency. The CW growth observations from that study and this study, as well as those of Donaldson et al. (1981), all support the premise of Donaldson and Johnson (1988) that molting is common for functionally mature males <140 mm CW. It is also likely that some Tanner crabs >140 mm CW molt, which accounts for the existence of males >165 mm CW in the population.

The agreement between growth measurements from this study and those from the Kodiak area (Donaldson et al. 1981) suggest that growth per molt is similar in much of the northern Gulf of Alaska. Although we did not estimate intermolt durations, mature Tanner crabs may have intermolt periods of 2–3 or more years (Donaldson et al. 1981; Paul and Paul 1995), making molting studies problematic. Many of the specimens examined from the fishery were probably skip molts, but we had no reliable method to judge this, except for crabs with very old shells. To be able to predict recruitment to the fishery, a reliable method of identifying intermolt duration needs to be developed to accompany growth predictions.

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