Lobster Tail Meat Validation Study: Maximum Size Assessment

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ABSTRACT

After completion of an assessment of the validity of Maine's minimum legal tail meat measure for American lobsters, *Homarus americanus*, (Krouse 1989), Marine Patrol of the Department of Marine Resources requested a similar study focusing on the maximum tail meat limit. Morphometric data taken from lobsters caught in offshore waters of Canada and the U.S. during 1989 revealed a wide range of tail lengths for a given carapace size and the influence of sex and shell condition on tail meat size. Of those legal-sized lobsters examined, many (32%) had oversized (illegal) tail meats (>6 1/2 in.). Due to the obvious enforcement problems with the current maximum tail meat measure, on the basis of this study I recommend adoption of a 6 3/16 in. maximum tail meat size based on measurement of the first six tail segments exclusive of the telson (middle flipper). This partial tail length was selected because of its consistency with the recently proposed minimum tail meat measure and good correspondence with the maximum carapace size, thus insuring that nearly all lobsters with legal carapaces would also be legal with respect to tail meat.

INTRODUCTION

Following completion of a recent study designed to determine a lobster tail meat measurement that corresponded with the minimum legal carapace size (Krouse 1989), the Bureau of Marine Patrol requested me to investigate the appropriateness of the current maximum tail meat length. Since 1935 when the maximum carapace length (CL) was set at 5 in. it has been "... unlawful to possess any tail section of lobster meat removed from the shell which is less...or more than 6 1/2 inches in length when laid out straight and measured from end to end, not including the small part that is on the body end of the tail section."

Upon examining the body dimensions for a small sample of lobsters acquired for this present study, the inadequacy of the currently used maximum tail meat measurement became readily apparent. Of 59 legal-sized lobsters ranging in CL from 117 to 127 mm (4.6-5 in.) with an average CL of 123.2 mm (2.46 in.), 19 (32%) had tail meat lengths in excess of the 6 1/2 in. maximum (Figure 1). In view of these findings it is apparent that many legal-sized lobsters within 13 mm (1/2 in.) of the maximum CL would have oversized tail meats. Due to the poor correlation between the maximum tail meat and CL measures there is a high likelihood for even the most law abiding seafood processors to find themselves, probably unknowingly, in possession of illegal-sized tail meats (>6 1/2 in.) which originated from otherwise legal-sized lobsters. Obviously this is a problematic situation and, as such, in need of correction.

Recognizing the problems associated with the present maximum tail meat measurement, I undertook this study for the purpose of assessing the mathematical relationship of total tail meat length with CL. The utility and validity of the total tail meat measurement as it relates to the maximum CL limit is discussed along with consideration of an alternative measurement.

PROCEDURES

Commercial sample

From May through November 1989 I purchased 101 lobsters weighing a total of 354.8 lbs (3.5 lb average) and ranging in CL from 117 to 138 mm (4.6-5.4 in.). Most of these lobsters (71%), were obtained in two trips to both Portsmouth, N.H. (May and June) and Stonington, ME (October and November) where 26 hardshell and 24 softshell lobsters, caught in the central region of the Gulf of Maine, were secured from an offshore Maine lobsterman. The remainder of the sample (24 hardshell and 5 softshell lobsters), which was allegedly caught in Canadian offshore waters, was supplied by a Spruce Head lobster dealer in June and October. Lobsters were selected on the basis of shell condition, size, and sex. Sample size was limited by budgetary constraints.

Prior to cooking, the CL, weight, sex, shell condition, and claw status were determined for each lobster (Tables 1-2). It was important to record CL's of live lobsters so these lengths could be matched with cooked tail muscle lengths because some carapaces were observed to shrink about 1 mm after cooking. Due to the large size of the lobsters used in this investigation, I arranged to have the

study animals cooked in a commercial steamer at Wotton's Lobster in Boothbay Harbor. Immediately after steaming for about 30 minutes, cold seawater was sprayed over the cooked animals to hasten cooling so processing could begin upon return to the laboratory.

In order to remove tail meats completely intact from the exoskeleton I found it necessary in most cases, particularly for females, to sever the ventral (abdominal) sternites with a cutting shears. By spreading these calcified structures the tail meats could be extracted intact with minimal distortion. In fact, all but one telson segment (middle tail flipper most apt to be damaged) were removed in their entirety. I also felt that the warm carcasses of this study further facilitated the shucking process - a condition not necessarily found in commercial picking operations.

In view of the difficulty I encountered in separating the tail meat from its shell without causing damage, the incidence of tail meat damage amongst commercially shucked lobsters is in all likelihood quite high. This is particularly true for the full-bodied hardshell lobsters.

For each extracted tail I determined both the total tail meat length (TTML) and the partial tail meat length (PTML). These measurements were accomplished according to the methodology described by Krouse (1989) in an earlier study of the minimum tail meat size.

Data treatment

Simple linear regression techniques were used to define the relation of partial and total tail meat length with carapace

length. Analysis of covariance was used to evaluate the homogeneity of the regression coefficients for the different shell condition and sex groupings.

Results and Discussion

As indicated by the scattergrams of partial and total tail meat lengths plotted against CL for all lobsters measured in this study (Figures 2-3), both morphometric relations showed a high degree of variability. Some of this variation may be related to the lobsters' sex and shell condition. For example, female and hardshell lobsters were observed to have generally longer tail meats than their respective counterparts (Figures 2-3). Other factors contributing to this wide spread of data points may be errors associated with the measurement of a soft (noncalcified) body part, the particular methodology used in determining tail meat length, and variation inherent in the morphometric parameters under consideration.

In view of the variable nature of the tail meat/CL relations and the importance of possibly reducing or, at the very least, delimiting any variability to enhance the validity of a tail meat measurement, I calculated separate regression lines for the sexes and shell condition groups. These regression lines were paired and compared using analysis of covariance techniques to test for significant effects due to sex, shell condition, and type of tail measurement. For all groupings I found statistical differences ($P<0.01$) between the regression coefficients for males and females, partial and total tail meat measurements, and hard and softshell

males (only the TTML measurements). The absence of statistical significance between the shell type groups (3 of 4 groups) may be explained, at least in part, by the nonsignificant regressions observed for softshell females (PTML) and males (TTML). In spite of these findings, on the basis of intuition and results of earlier work on smaller legal-sized lobsters, which showed significant differences between tail meat lengths of hard and softshell lobsters (Krouse, 1989), I decided to treat the shell condition groups separately.

It should also be noted that the regressions calculated for lobsters allegedly caught in Canadian waters (n=29) were not statistically significant (P>0.05). In light of this, these data are considered only in the context of the scattergrams (Figures 2-3). In comparison to the lobsters from the central region of the Gulf of Maine the Canadian lobsters appeared to have relatively shorter tail meats. Initially I had reason to believe that this size disparity might be the result of the lobsters having been stored in a pound. However, after discussing my suspicions with the dealer, who purchased the lobsters, he maintained the sample lot had been freshly caught. He further suggested that any apparent size differences may be related to the area caught, as he often noticed considerable differences in the condition of offshore lobsters depending upon catch location. Regardless of whether the tail meats of large (>120 mm CL) Canadian lobsters differ markedly from comparable size U.S. lobsters, because Canadian lobsters, if indeed different, would be smaller, the validity of a maximum tail

meat limit would not be affected. This conclusion is predicated on the Marine Patrol's primary requisite for a maximum limit: tail meats exceeding the maximum size should come from lobsters with oversized CL's (>5 in.). Indeed, as indicated by morphometric data, Canadian lobsters satisfy this requirement.

An examination of the regression lines along with the scatter of data points and respective correlation coefficients (r), which measure the intensity of association between parameters under consideration for TTML and PTML, reveals a similar fit to a linear line for both data sets of tail measurements (Figures 4-7). Accordingly, a maximum tail meat length could be based on either a total or partial length measurement. However, for the sake of conforming with the recently recommended minimum tail meat length (based on a partial measurement) and recognizing the potential error associated with the TTML determination (Krouse 1989), I feel the PTML is the measurement of choice.

To determine the PTML that best correlates with the maximum legal CL I calculated 95% prediction intervals to delimit the range of tail meat lengths for a given CL (Figures 6-7). Using the upper prediction interval, the following tail meat lengths which corresponded to the maximum CL of 5 in. (127 mm) were selected:

Softshell		Hardshell	
females	males	females	males
157 mm	144 mm	151 mm	141 mm
6.18 in.	5.67 in.	5.94 in.	5.55 in.

Assuming the lobsters of this study were representative of the coastwide population, one can then say with confidence that, on the average, only 2.5 out of 100 lobsters (5 in. CL) might have PTML's

greater than the aforementioned limits. In view of this I selected the softshell female interval of 6.18 in. (6 3/16 in.) to represent the maximum PTML limit. Because softshell females were found to have the longest tail meats, almost all lobsters with legal CL's (≥3 1/4 in. [82.6 mm] ≤5 in [127 mm] CL) regardless of sex or shell condition would be expected to have PTML's smaller than 6 3/16 in.

RECOMMENDATIONS

Similar to an earlier investigation which reported on the variable relationship between the minimum legal CL and tail meat length of lobsters (Krouse 1989), results of the present study also indicate a high degree of variability for the same morphometric relations of large lobsters (4.5-5.5 in. CL). In spite of this less than perfect association between CL and tail meat size, within certain limits, it is still possible to establish a meaningful and useful maximum tail meat measure.

Findings of this study indicate that most lobsters (97.5 of 100) with a 5 in. CL (maximum size) will have a PTML ≤6 3/16 in. Thus, if the maximum tail meat size were changed to 6 3/16 in. as I recommend, I could then be confident that nearly all lobsters satisfying the legal CL requirement (≥3 1/4≥ 5 in.) would also comply with the tail meat length limit - a very important condition according to the Marine Patrol and one not met by the current maximum tail meat measure.

I must emphasize that a 6 3/16 in. PTML does not correspond perfectly with the maximum CL so as a result, many lobsters (particularly males with relatively smaller tails) with legal-sized

tails will have oversized carapaces. Although some unscrupulous processors may attempt to exploit this loophole, Marine Patrol officials have suggested this illegal activity will be recognized and effectively addressed. Moreover, considering that less than 2% of the lobsters annually landed in Maine exceed 2 lbs, the number of lobsters >3.5 lbs (over maximum carapace limit) available to the Maine industry is minimal. Also, these larger lobsters are more valuable as live product than as processed meat.

Instructions for determining PTML in the field are detailed by Krouse (1989).

ACKNOWLEDGEMENTS

Thanks are due to Glenn Nutting for helping to obtain the morphometric data. I also acknowledge Margaret Hunter for the statistical treatment of the data. Mike Brown and Gary Robinson prepared the figures. A special note of appreciation to Steve Robbins, an offshore lobsterman, and Bill Atwood, a lobster dealer, for furnishing samples.

LITERATURE CITED

Krouse, J.S. 1989. Lobster tail meat validation study. Maine Dept. Mar. Resourc. Rept. 17 pp.

Table 1. Measurements of offshore lobsters caught in Gulf of Maine (U.S. waters) and purchased from a Maine lobsterman, May-November 1989. PA=pincer absent, CA=crusher absent, RC=regenerated crusher, RP=regenerated pincer.

Purchase date/location (shell condition)	Carapace length (mm)	Sex	Weight (g)	Claw condition
22 May '89 Portsmouth, NH (Old shells)	121	F	1445	
	127	F	1593	
	120	M	1443	
	122	F	1424	
	121	M	1663	
	127	M	1712	
	122	F	1451	
	120	M	1651	
	122	M	1858	
	125	M	1528	
	123	F	1526	
	126	F	1606	
	132	M	2196	
	131	M	1166	PA,RC
	130	M	1910	
	130	M	1403	RC
	133	M	2047	
	130	M	1626	PA
	131	F	1424	CA
	130	F	1683	
	134	F	1640	PA
	133	F	1853	
	127	F	1516	RP
	131	F	1740	
16 June '89 Portsmouth, NH (Old shells)	122	F	1516	
	123	F	1401	
	125	F	1545	
	123	M	1546	
	125	F	1463	RC
	122	F	1534	
	122	F	1393	
	125	F	1495	
	123	M	1578	
	121	F	1455	
	119	F	1323	
	127	M	1955	
	123	F	1379	
	131	M	1453	RC
	127	M	1754	
	134	F	1723	
	129	F	1735	
	132	M	1980	
	132	M	1804	
	129	F	1754	
	132	F	1712	
	123	M	1389	RC
	123	M	1611	
	120	M	1390	

Purchase date/location (shell condition)	Carapace length (mm)	Sex	Weight (g)	Cla condi
26 Oct '90 Stonington ME (New shells)	122	M	1650	
	121	M	1560	
	123	M	1790	
	121	M	1520	
	126	M	1540	
	126	M	1690	
	123	F	1400	
	123	F	1470	
	121	F	1410	
	126	F	1700	
3 Nov '89 Stonington ME (New shells)	122	F	1420	
	121	F	1290	RP
	125	F	1530	
	138	M	2180	
	128	F	1610	
	127	F	1470	
	134	F	1950	
	134	M	2040	
	129	F	1490	RP
	133	F	1840	
	129	F	1720	
	130	M	1950	
	127	M	1970	
	138	M	2010	
	135	M	2080	

Table 2. Measurements of offshore lobsters caught in Canadian water and purchased from Maine lobster dealer, June and October 1989.

Purchase date (shell condition)	Carapace length (mm)	Sex
29 June '89 (Old shells)	117	F
	130	M
	130	F
	128	F
	131	F
	137	M
	122	M
	127	M
	126	F
	119	M
	123	F
	125	M
	139	M
	129	M
	129	M
	128	F
	126	M
	130	F
	122	M
	126	F
	128	M
	124	F
	129	F
	120	F
20 Oct '89 (New shells)	127	M
	125	M
	128	M
	125	M
	133	M

FIGURE 1. Total tail meat length-carapace length relationships for soft and hardshell male and female lobsters caught by offshore fishermen in Canadian and U.S. waters, May-November 1989. ME=Maine, CAN=Canadian, H=hardshell, and S=softshell.

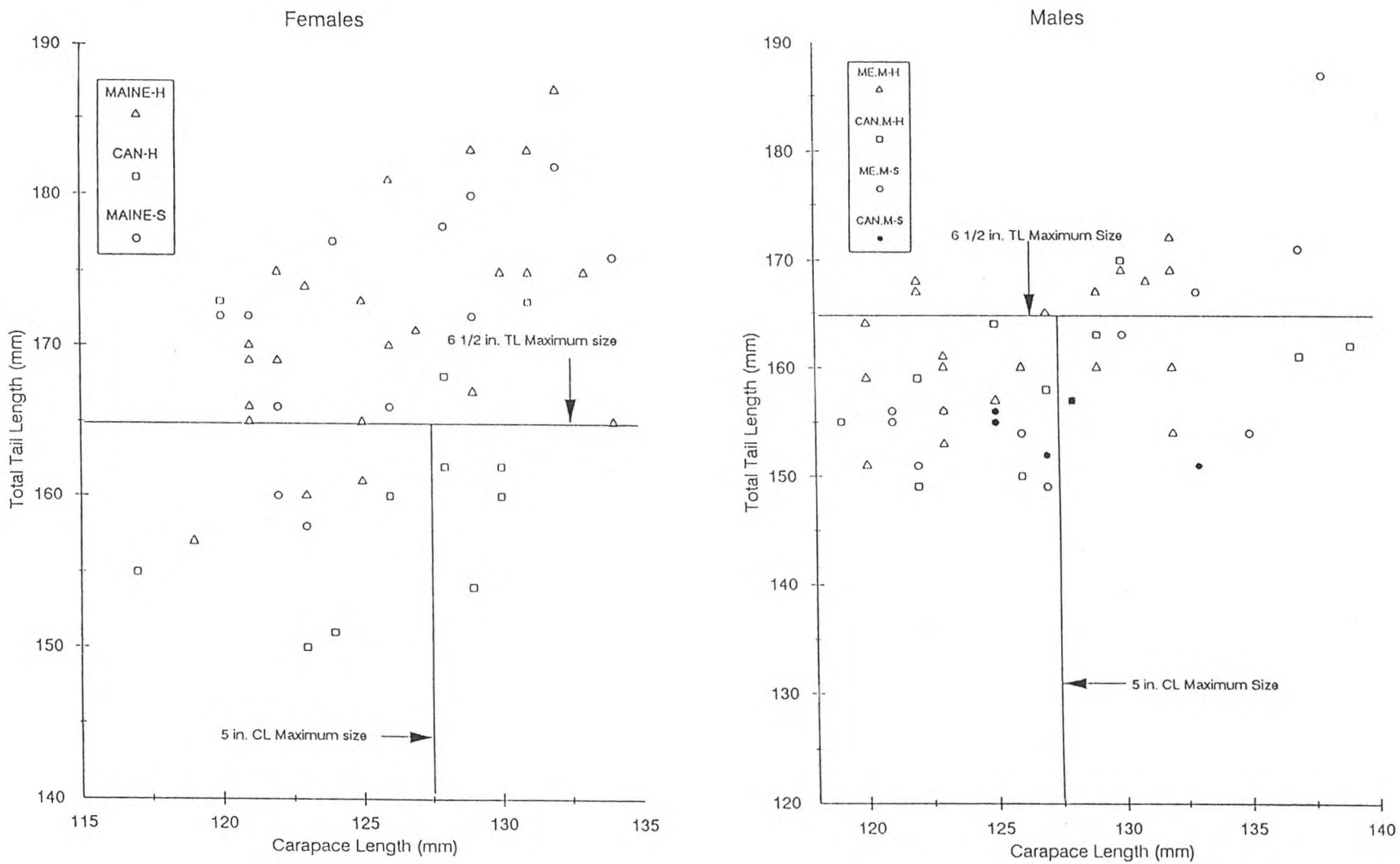

FIGURE 2. Total tail meat length-carapace length relations for lobsters caught by offshore fishermen in Canadian and U.S. waters, May-November 1989. Me=Maine, Can=Canadian, M=males, F=females, S=softshells, and H=hardshells.

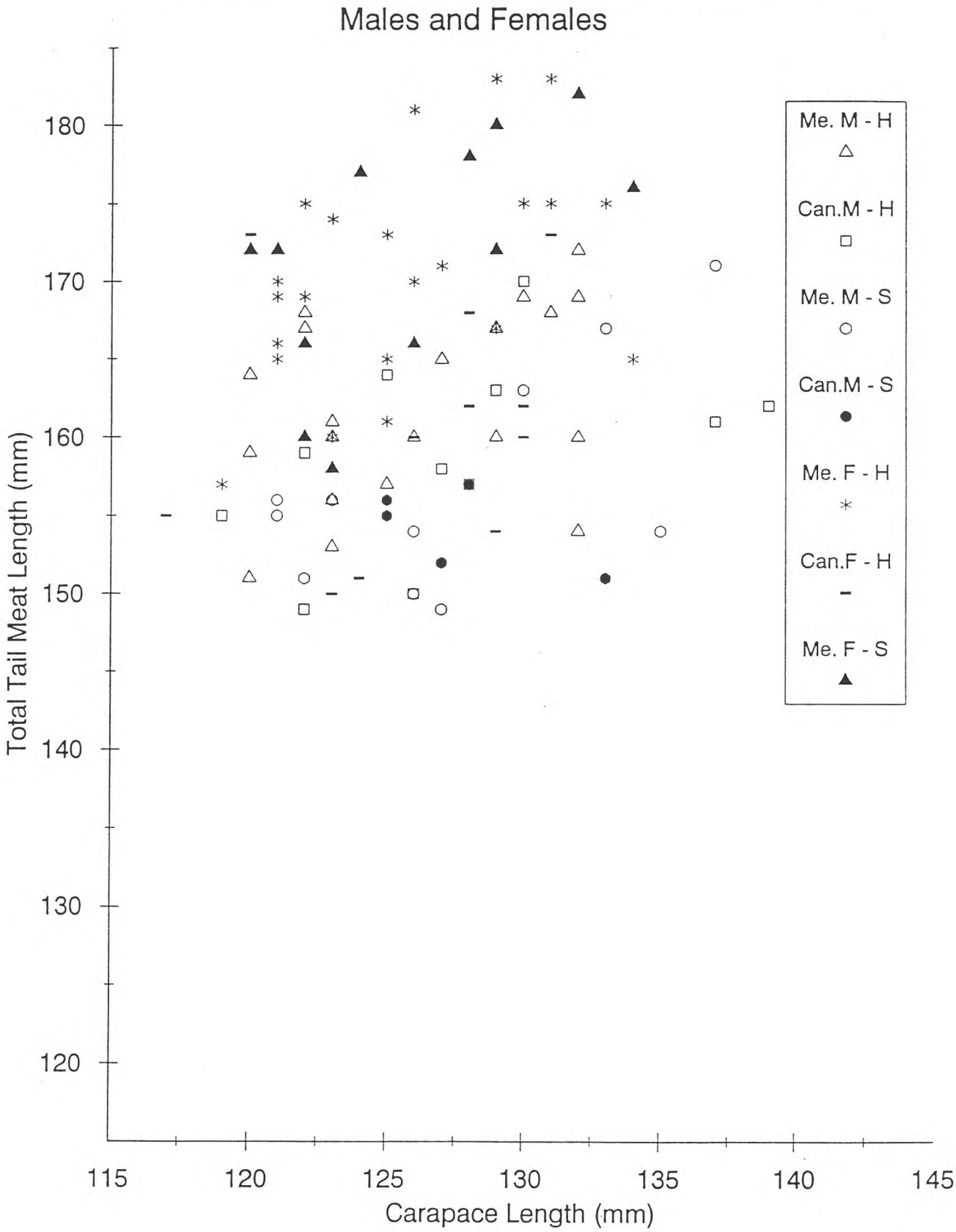

FIGURE 3. Partial tail meat lengths-carapace length relationships of lobsters caught by offshore fishermen in Canadian and U.S. waters, May-November 1989. Me=Maine, Can=Canadian, M-males, F=females, S=softshells, and H=hardshells.

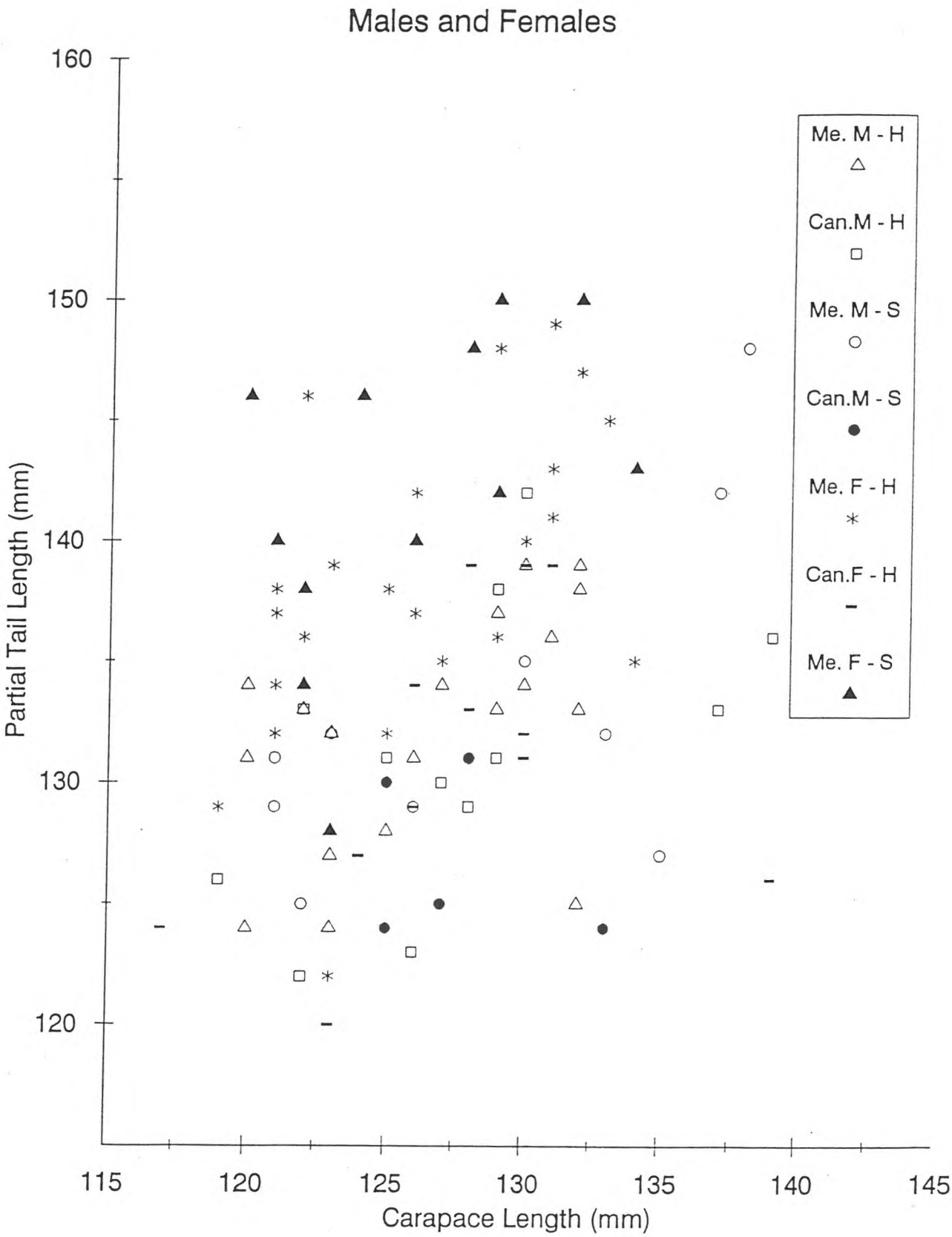

FIGURE 4. Total tail meat length-carapace length regressions for male and female hardshell lobsters caught in U.S. offshore waters, May-June 1989.

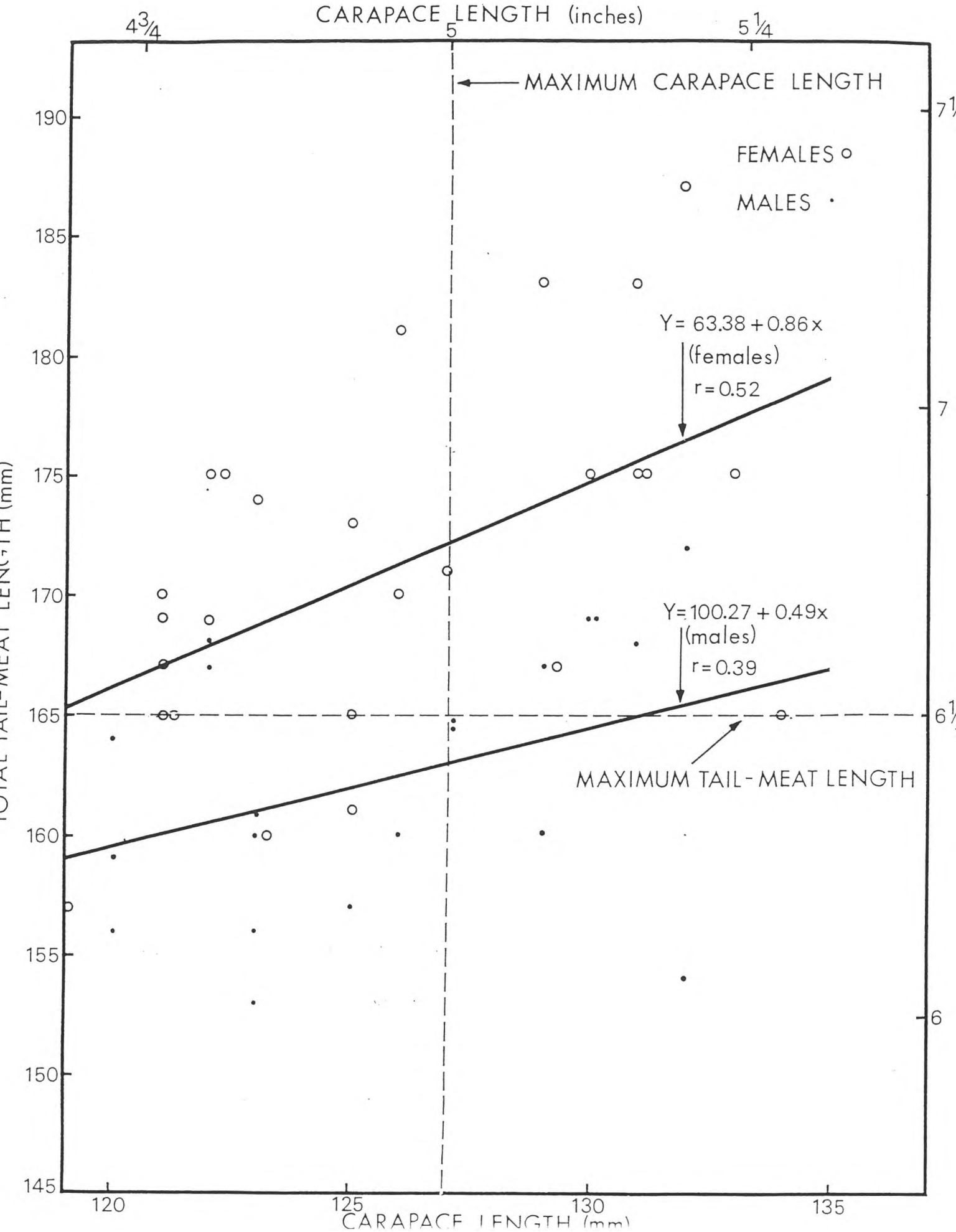

FIGURE 5. Total tail meat length-carapace length regressions for male and female softshell lobsters caught in U.S. offshore waters, October-November 1989.

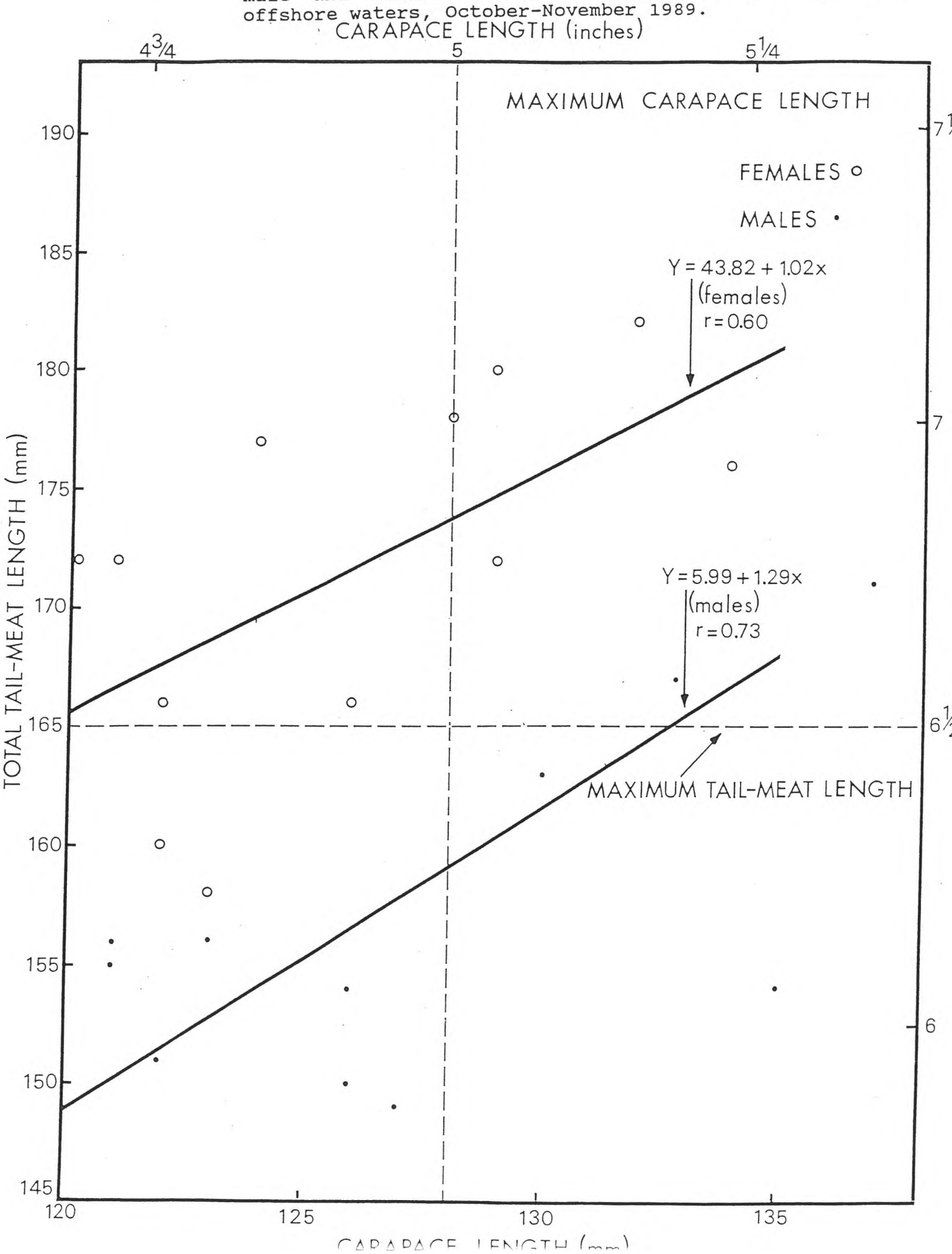

FIGURE 6. Partial tail meat length-carapace length regressions for male and female hardshell lobsters caught in U.S. offshore waters, May-June 1989.

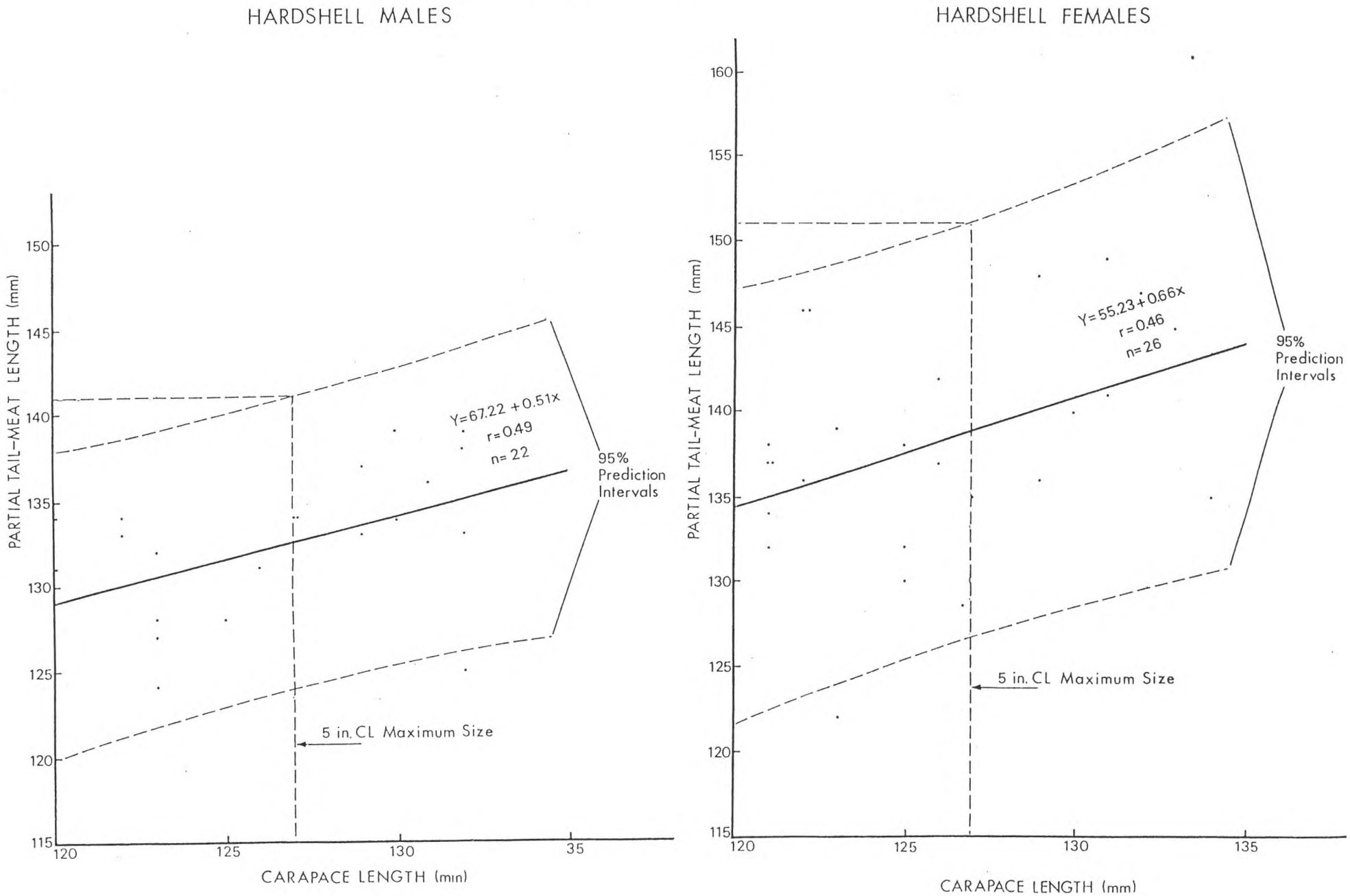

FIGURE 7. Partial tail meat length-carapace length regressions for male and female softshell lobsters caught in U.S. offshore waters, October-November 1989.