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International Council for the  
Exploration of the Sea

Shellfish Committee

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BODY FORM AND WEIGHT-LENGTH RELATIONSHIPS  
IN THE LOBSTER (Homarus vulgaris Edw.)

by

J. A. Pope.

Marine Laboratory  
Aberdeen

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1. INTRODUCTION

The facility and accuracy with which carapace length can be measured has led to an increasing use of this measurement as opposed to overall length for scientific purposes. In Canada this measurement is the basis of legislation for the American lobster and data regarding the relationship between carapace length and overall length are available for their species.

The present paper is based on observations carried out by the staff of the Marine Laboratory, Aberdeen, in order to provide a reliable method of converting carapace length to overall length for the lobster (H. vulgaris) so that previous work may be interpreted in relation to current measurements on carapace length and also to enable results to be presented to the fishing industry in terms of overall length.

The relationship between overall length and weight for the lobster (H. vulgaris) has also been investigated.

2. METHODS

During the months of July and August, 1954, the F.R.V. "Kathleen" undertook lobster fishing experiments on the commercial lobster grounds around Orkney. Lobsters caught in these experiments were measured taking the overall length from the tip of the rostrum to the end of the telson, excluding the setae, with the abdomen fully extended, and the carapace length, from the posterior of the eye socket to the posterior of the cephalothorax in a direct line with the eye socket, this method being the same as that adopted by Canadian workers and illustrated by Turner (1954). Both measurements were taken to the nearest millimetre.

The overall length-weight relationship has been determined from series of measurements made on lobsters caught in experiments carried out on the same grounds during each of the years 1949, 1951 and 1953.

3. RELATIONSHIP BETWEEN OVERALL AND CARAPACE LENGTH

The experiments undertaken in 1954 yielded a sample of 186 measurements from 83 males and 103 females. In the case of the males the ranges of overall and carapace lengths were 19.2-31.9 cm. and 6.6-11.9 cm., respectively. The corresponding ranges for the females were 19.4-39.2 cm. and 6.8-14.0 cm.

A graphical analysis of the data indicated that, over the ranges encountered in the present study, there was a linear relationship between the two measurements for both male and female lobsters. The degree of this linear association may be measured by the correlation coefficient which had the values +0.984 and +0.985 for males and females respectively.

The equation of the fitted regression line for estimating overall length from carapace length for males is

$$L = 2.507C + 25.9 \quad (1)$$

where L = overall length and C = carapace length, both being in millimetres.

The corresponding regression line for females is

$$L = 2.678C + 15.4 \quad (2)$$

Further analysis showed that the relationship between overall length and carapace length was significantly different for males and females in this sample, female lobsters having a larger average overall length than males over the range of carapace lengths represented here, the difference increasing with increasing carapace length and being of the order of 1 cm. for a carapace length of 12 cm., overall length 32.7 cm. and 33.7 cm. for males and females respectively.

The relationships (1) and (2) may be compared with four sets of relationships for the American lobster estimated by Wilder (1953). He gives the regression equations of carapace length, for males and females separately, in respect of lobsters from grounds around Prince Edward Island and Nova Scotia. It is worth pointing out here that Wilder used equations for deriving carapace length from overall length in order to estimate overall length from carapace length and consequently the estimates of growth rate given by him are not strictly accurate. It is unlikely, however, that any serious error has arisen since the correlation between overall length and carapace length will normally be very high.

Since the original data from which Wilder obtained his regressions are not given it is not possible to test whether the observed area and sex differences are real or not in his case, nor is it possible to make accurate comparisons with the present results. It is likely that Wilder assumes the area differences to be real and his reference to the work of Templeman (1935, 1944) would appear to support this supposition.

The regressions of carapace length on overall length are required for the present data for comparison with Wilder's equations. These were found to be

$$C = 0.386L - 7.0 \quad (3)$$

for males, and

$$C = 0.362L - 2.6 \quad (4)$$

for females, all lengths being in millimetres.

As the standard errors of the parameters in Wilder's equations are not given the observed differences between the slopes and intercepts have been tested using 99% confidence limits for the parameters of equations (3) and (4). The use of 99% limits in place of the more conventional 95% limits will at least partly overcome lack of knowledge of the errors in Wilder's estimates. The results are shown in Table 1.

Table 1. Comparison of Relationships Between Overall Length and Carapace Length.

	Slope		Intercept	
	Males	Females	Males	Females
Present Data (99% limits)	0.363-0.409	0.343-0.381	5.44-8.46	1.00-4.25
Wilder's Data				
(a)	0.374	0.348	4.53	1.38
(b)	0.375	0.348	4.88	1.31
(c)	0.395	0.362	8.68	3.77
(d)	0.374	0.353	5.73	2.58

The slopes of Wilder's equations all fall within the 99% intervals for the present data in respect of both males and females. In the case of the intercepts the interval for equation (4) includes all four female intercepts given by Wilder although only one for males falls in the interval for the present data. These results suggest that for female lobsters at any rate, there is no significant difference between the present data and those of Wilder.

#### 4. LENGTH-WEIGHT RELATIONSHIP

From samples taken in 1949, 1951 and 1953 the lengths in millimetres and the weights in ounces of 302 lobsters comprising 151 males and 141 females, all non-berried, were obtained. The measurements for each sex were analysed separately, differences between years being ignored. The length ranges for males and females were 19.2-40.2 cm. and 19.3-40.0 cm. respectively, and the corresponding ranges in weight 5-72 oz. and 6-62 oz.

Preliminary analysis showed that the weights varied approximately as the cubes of the lengths indicating a linear relation between log weight and log length. Accordingly regression lines were fitted to the logs of the measurements the equations of these lines being for males

$$\log W = 3.551 \log L - 7.29 \quad (5)$$

and for females

$$\log W = 3.039 \log L - 6.10 \quad (6)$$

where L is the length in millimetres and W the weight in ounces.

Further analysis showed that both the slopes and the intercepts of the two lines differed significantly, indicating a real difference in the relationship for the two sexes.

The relationships (5) and (6) may be compared with observations on the weights and lengths of lobsters caught off the west coast of Scotland in 1924 and reproduced in the Report on Lobsters (1926). The latter data give the mean weights in ounces of lobsters in different inch length intervals and are shown in Table 2 together with estimates obtained from equations (5) and (6) corresponding to lengths centred at the mid-points of these intervals.

Table 2. Comparison of Length-Weight Relationships with 1924 Data.

Weight (oz.)	Size (in.)	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16
Males	Present Data	9.6	14.4	21.7	30.2	38.6	53.5	68.2	87.3
	1924 Data	11.5	15.5	21.0	28.0	38.0	49.5	54.5	65.4
Females	Present Data	9.5	13.5	19.1	25.1	31.1	41.1	50.7	62.5
	1924 Data	11.6	15.0	19.5	25.2	34.0	45.0	52.9	58.0

The agreement between the two sets of data is clearly very good over the range 9-13 inches, but poor outside these limits. This is to be expected, however, as the sizes to which the mean weights in the 1924 data refer are not exactly at the mid-points of the size intervals due to the shape of the length frequency distribution of the lobsters on the grounds. The actual length frequency distribution is also given in the Report where it is clear that the mean size of lobsters in the 8-9 inch group, for example, is likely to be above 8.5 inches while the mean sizes for the groups above 13 inches are likely to lie nearer the lower class limits. Taking these factors into account the present data are in good agreement with the 1924 data which are of more limited application.

Comparisons have also been made with four sets of relationships connecting weight and carapace length for the American lobsters given by Wilder (1954). The estimated weights corresponding to various overall lengths obtained from equations (5) and (6) are shown in Table 3 together with weights estimated from Wilder's equations. As Wilder gives his equations in terms of carapace length it was necessary to use his overall length-carapace length relationships as an intermediate step in estimating the weights of the American lobsters.

Table 3. Comparison of Length-Weight Relationships with Canadian Data.

Weight (oz.)	Overall Length (cm.)	Present Data	Wilder's Data			
			(a)	(b)	(c)	(d)
Males	20.0	7.5	10.0	9.6	9.6	9.3
	24.0	14.4	18.1	17.0	18.7	16.3
	28.0	25.6	30.2	28.1	31.0	28.5
	32.0	41.8	47.1	43.1	47.1	43.3
	36.0	63.0	68.1	61.7	73.7	61.3
Females	20.0	7.7	8.7	8.6	9.5	9.2
	24.0	13.4	15.0	14.6	16.2	15.6
	28.0	21.9	24.1	23.2	25.7	24.7
	32.0	33.3	36.2	34.7	38.2	36.6
	36.0	47.3	50.9	48.5	53.3	54.1

The results in Table 3 show that, length for length, Orkney lobsters appear to be lighter than the American lobsters. Such differences in weight between areas so far apart are not surprising and differences of this order even around the coast of Britain may well occur.

The author wishes to express his gratitude to Dr. H. J. Thomas for advice throughout the preparation of this paper.

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