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Fecundity of the Lobster, Homarus americanus, in Newfoundland Waters

by

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Carapace length-fecundity relationships are presented for spring (April-June) caught samples of lobsters (Homarus americanus) from three areas in Placentia Bay, Newfoundland. Comparisons between these and relationships available in the literature for other areas indicate geographic variation in size-fecundity relationships for this species.

Introduction

In lobster (Genus Homarus) fisheries generally, current minimum legal size limits are below the size at 50% female maturity and fishing mortality rates are very high (Anon. 1979). Under such conditions widespread recruitment overfishing appears to be a distinct possibility. Conventional yield per recruit assessment models are not totally adequate when dealing with lobsters and this has lead to the development of models which are much more species oriented (Caddy 1977, 1979; Ennis and Akenhead 1978). A feature of these models which resulted from concern with recruitment overfishing is provision for assessing the effect on popuation fecundity of changes in size limit and fishing mortality. In addition to size-maturity information, such assessments require data on fecundity.

Unfortunately, the general applicability of size-fecundity relationships for the lobster (Homarus americanus), which are available from the literature, is suspect. Saila et al. (1969) concluded that the methodology used by Herrick (1911) resulted in quite substantial overestimates of egg numbers. The size-fecundity relationship they (Saila et al. 1969) presented was based on samples obtained from three widely separated areas, however, Squires (1970) and Squires et al. (1974) concluded that size-fecundity relatonships for lobsters in different areas could be quite different. Squires' (1970) methodology was similar to that of Herrick but he found that his estimates varied from actual counts by less than

2%; an error factor comparable to that reported by Saila et al. (1969) and Perkins (1971) using electronic counters. Aiken and Waddy (1980) suggested that standardized egg counts from different areas would clarify the question of geographic variation in lobster fecundity and concluded that Herrick's estimates should not be dismissed until the results of these or other, more explicit studies are available.

This paper presents new fecundity data for a Newfoundland area as a contribution to the literature on the subject and provides comparisons with published size-fecundity relationships.

Materials and Methods

Ovigerous females were included in samples obtained during spring (April-June) trap fishing in the area of Arnold's Cove, Placentia Bay, on the southeast coast of Newfoundland in 1969 and in the areas of Ship Harbour and Paradise in Placentia Bay in 1970. Portions of the samples were usually held in floating wooden boxes (approx. 100 lb capacity) for several days before being subjected to detailed biological examination. Carapace lengths (mm) were recorded and the abdomens of ovigerous specimens with attached egg masses were preserved individually in 10% formalin. Loss of eggs over the holding period cannot be discounted, but it is felt that such losses were minimal.

Eggs were removed from the abdominal pleopods, washed on a screen of fine-meshed plankton netting to remove the larger pieces of connective tissue and other material, then left to soak in fresh water overnight. After soaking, the eggs were spread thinly over very shallow pans to dry at room temperature until they were quite hard (usually after about 24 h) and could withstand being rubbed over a fine-meshed screen to remove the remaining connective tissue. After drying and final cleaning, the weight of the egg sample was obtained (to the nearest .0001 g). A subsample representing approximately 1/30 of the whole sample, regardless of size, was weighed and the eggs counted manually. The number of eggs in the whole sample was then calculated.

To determine the error associated with this method, total numbers for 11 samples were determined manually for comparison with the estimated total numbers for the same samples. The error ranged from a high of -3.6% to a low of 0.04% and for the 11 sets of counts totalled the error was 0.54%.

Results and Discussion

Curvilinear size-fecundity relationships derived from log-log (base 10) regression analysis for spring-caught (April-June) samples are presented (Fig. 1) for three areas in Placentia Bay, Newfoundland along with the same relationships obtained from re-analysis of the data presented by Squires (1970) and Squires et al. (1974) for two Newfoundland west coast areas. Various combinations of these log-log relationships were compared by analysis of covariance. In all comparisons between relationships for Placentia Bay and the comparison between the two relationships for the west coast, residual variances were similar. However, in all comparisons between one of the Placentia Bay and one of the west coast relationships, residual variances were significantly different (Table 1). Two of the four sets of relationships with similar residual variances had significantly different slopes, the other two had similar slopes but significantly different means. There was wide variation in fecundity at size and the samples differed in size composition (Table 2). Significant differences in these relationships may result in large part from differences in sample size and size composition.

Samples with at least 6 specimens in the same 5 mm size group were compared by analysis of variance. All comparisons between Placentia Bay samples showed no significant differences (Table 3). For the comparisons between the two west coast samples and between samples from each of the two areas, there were significant differences for some size groups but not for others. Although results of the analyses are inconclusive it would appear that lobsters in Placentia Bay are more fecund than those on the west coast (Fig. 1).

Data for the three Placentia Bay areas were combined as were data for the two west coast areas. The curvilinear relationships derived from log-log regression analysis were plotted with those available from the literature for other areas (Fig. 2). Substantial differences between areas are apparent, however, such a comparison cannot be considered conclusive.

Perkins (1971) reported substantial egg loss during incubation (36% between October and June) for lobsters from the offshore canyon areas of the northeast U.S.A. This should not be a significant factor in the above comparisons, however, since in all cases samples were obtained during late spring-early summer towards the end of the incubation period.

Fecundity values calculated from the relationships in Fig. 2 range from 4800 to 7450 at 70 mm carapace length and from 25,400 to 38,300 at 125 mm. The relationship of Saila et al. (1969) gives the lowest values over the entire range of sizes considered. This relationship is suspect, however, since it is based on samples obtained from three widely separated areas. Over most of the size range considered the relationship for Placentia Bay gives higher estimates than those from the relationship derived by Saila et al. (1969) from Herrick's (1911) data, indicating that Herrick's data should not be discounted as Saila et al. (1969) suggest.

A definitive statistical comparison of size-fecundity relationships for lobsters from different areas would require large samples which adequately cover a wide range of sizes. These would have to be taken at approximately the same stage in the incubation period by the same method of capture and be subjected to similar handling and procedures for determining egg numbers. These requirements are unlikely to be met in the foreseeable future. However, as tenuous as the comparisons presented here may be, the available data indicate substantial geographic variation in size-fecundity relationships for lobsters.

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Table 1. Results of analyses of covariance of size-fecundity relationships presented in Fig. 1.

Relationships compared	Mean squares		Slopes		Means	
	F	P	F	P	F	P
Arnold's Cove vs Ship Hr.	1.29	>.20	9.44	<.01		
Arnold's Cove vs Paradise	1.27	>.20	0.57	.542	6.29	.013
Paradise vs Ship Hr.	1.02	>.50	15.86	<.001		
Arnold's Cove vs Boswarlos	3.08	<.001				
Arnold's Cove vs NW Coast	3.48	<.001				
Boswarlos vs NW Coast	1.13	>.50	0.98	.674	15.08	<.0001
Paradise vs Boswarlos	2.42	<.001				
Paradise vs NW Coast	2.73	<.001				
Ship Hr. vs NW Coast	2.69	<.001				
Ship Hr. vs Boswarlos	2.38	<.001				

Table 2. Summary of fecundity data on which relationships shown in Fig. 1 are based.

Carapace	Arnold's Cove				Paradise				Ship Harbour				Boswarlos				North West Coast			
length	N	$\bar{X}$	Max	Min	N	$\bar{X}$	Max	Min	N	$\bar{X}$	Max	Min	N	$\bar{X}$	Max	Min	N	$\bar{X}$	Max	Min
66-70																	1	4700	4700	
71-75	3	9096	10115	8293	1	6756	6756						4	800	9300	7000	4	10075	11500	9100
76-80	4	9375	11423	7299	12	9716	12535	7727					37	8178	11800	4600	14	10236	15100	6800
81-85	12	11821	13479	9894	16	11391	15704	7112					21	8414	12800	3500	21	11214	16100	6700
86-90	11	14393	19909	9836	9	13156	16992	10245	1	13773		13773	8	10850	15300	7800	8	13887	18800	9400
91-95	8	18085	20858	15833	8	16445	10767	11248	6	17348	22555	12703	4	14667	14000	13000	7	13500	22100	6900
96-100	3	21432	29888	16414	8	19697	24421	14304	4	20291	14875	12926	1	19200	19200		5	20240	23900	16700
101-105	2	23379	24223	22535	4	26213	27530	24477	4	22544	25216	21351	1	22800	22800		2	12500	14300	10700
106-110					3	24920	30099	20477	5	26266	28878	22548					1	26000	2600	
111-115					3	29462	33660	25516	6	32559	36896	27894								
116-115					2	38536	24250	34621	12	32247	43116	24135								
121-125					2	39778	46669	32887	6	32018	38601	19915								
126-130					1	36337	36337		4	40794	45443	34078								
131-135					2	42591	43537	41645	6	43467	49681	37882								
136-140					1	42837	42837		5	46038	55937	40638								
141-145									4	44511	57457	36395								
146-150									2	47904	48092	47716								
151-155									2	56986	61573	52399								
156-160									1	56995	56995									

Table 3. Results of analyses of variance of fecundity data for different size groups from the various samples.

Samples Compared	Size Groups (mm)			
	76-80	81-85	86-90	91-95
Arnold's Cove - Paradise	-	NSD	NSD	NSD
Arnold's Cove - Ship Hr.	-	-	-	NSD
Paradise - Ship. Hr.	-	-	-	NSD
Arnold's Cove - Boswarlos	-	**	*	-
Arnold's Cove - NW Coast	-	NSD	NSD	NSD
Paradise - Boswarlos	*	**	NSD	-
Paradise - NW Coast	NSD	NSD	NSD	NSD
Ship Hr. - NW Coast	-	-	-	NSD
Boswarlos - NW Coast	**	**	NSD	-

NSD - no significant difference $P \geq .05$

* $.01 < P < .05$

** $P < .01$

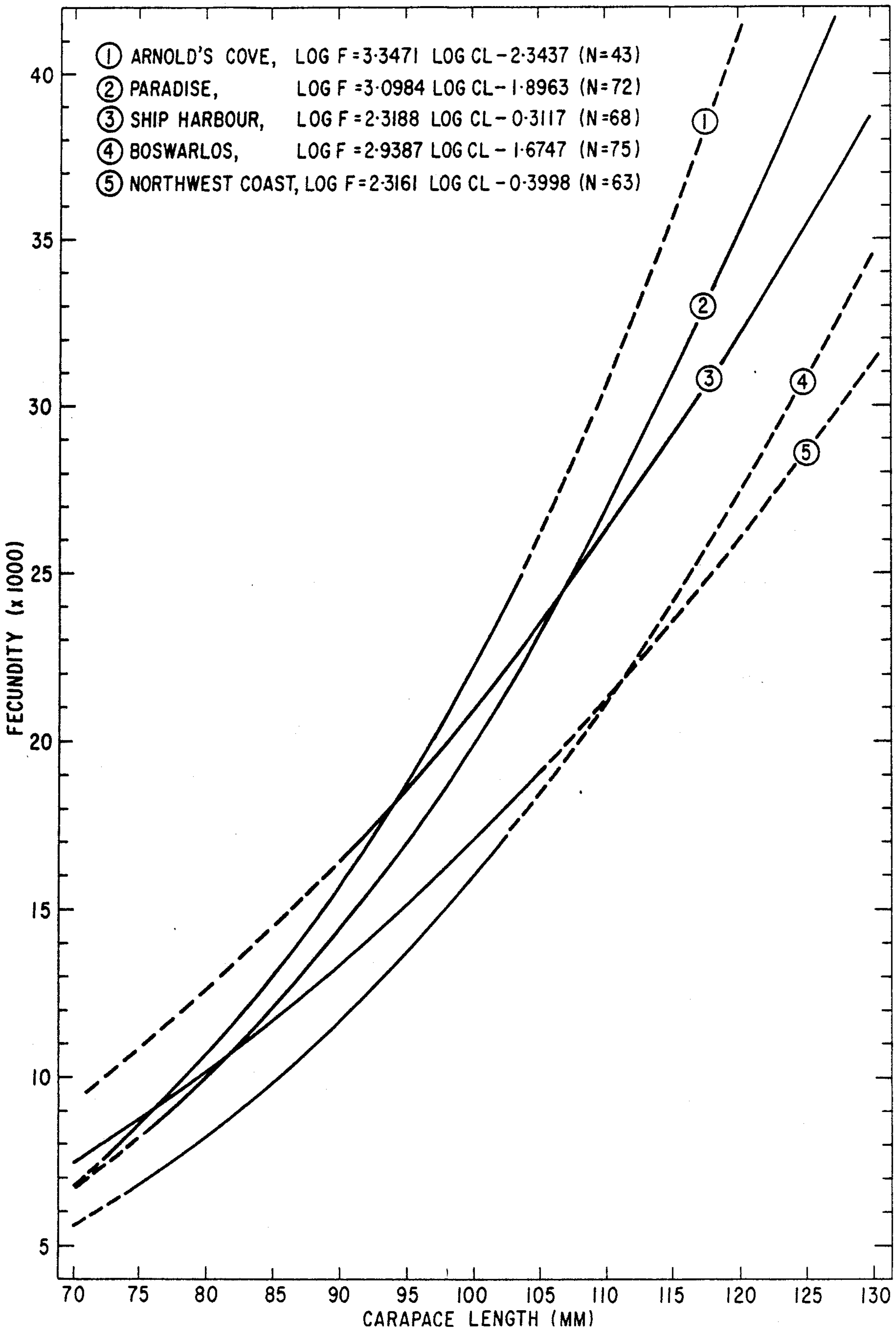

Fig. 1. Carapace length-fecundity relationships for lobsters from three areas in Placentia Bay, Newfoundland and two areas on the west coast of Newfoundland. Dashed lines indicate extrapolations beyond the data.

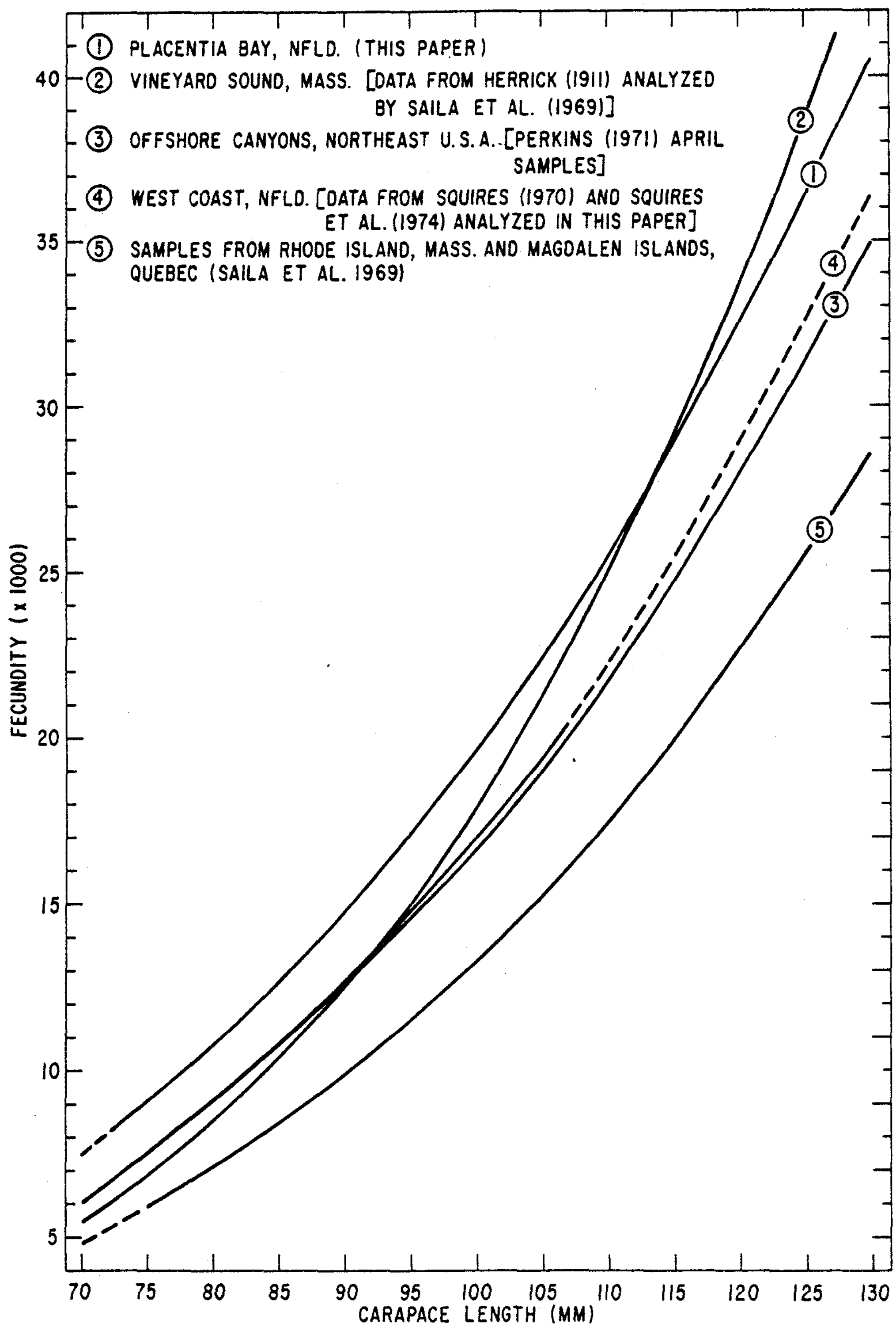

Fig. 2. Carapace length-fecundity relationships for lobsters from two Newfoundland areas and those available from the literature for other areas. Dashed lines indicate extrapolations beyond the data.