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WEIGHT COMPARED TO LENGTH FREQUENCY DISTRIBUTIONS FOR SHRIMP AGEING

by

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ABSTRACT

Shrimp are commonly aged by length frequencies. This preliminary study has two objectives: (1) to separate age classes using weight frequency distributions and (2) to compare relative proportions and average sizes of shrimp obtained in each age class from corresponding weight and length frequency distributions. Shrimp were sampled from Canso area and Esquiman channel during May and July 1979. Separation of age classes from length and weight distributions was made by the Hasselblad (1966) method, using NORMSEP computer program (Abramson, 1971). Contingency tests did not show any significant differences between the proportion or the mean size (length or weight) of shrimp per age class obtained from length or weight distributions. It is possible to estimate directly the biomass per age class in using weight distributions.

RESUME

Les fréquences de longueur servent habituellement à déterminer l'âge des crevettes. Cette étude préliminaire a deux objectifs: (1) séparer des classes d'âge au moyen de distributions de fréquences de poids et (2) comparer les proportions relatives et les tailles moyennes des individus obtenues dans chaque classe d'âge à partir des distributions de fréquence de longueur et de poids correspondantes. Des échantillons de crevettes ont été recueillis dans les régions de Canso et du chenal d'Esquiman en mai et en juillet 1979. La séparation des classes d'âge a été effectuée à partir des distributions de longueur et le poids selon la méthode de Hasseblad (1966) au moyen du programme NORMSEP (Abramson, 1971). Les tests de contingences effectués n'ont montré aucune différence significative entre les proportions ou les tailles moyennes (longueur ou poids) des individus par classe d'âge obtenues à partir des distributions de longueur ou de poids. L'utilisation des distributions de poids peut permettre l'estimation directe de la biomasse par classe d'âge.

INTRODUCTION

In fisheries science, length frequencies are commonly used to age exploited animals (e.g. Peterson method), particularly when there are no evident characteristics to age them, as in the shrimp Pandalus borealis. Since the hatching period of Pandalus borealis is short, synchronous and annual (Haynes and Wigley, 1969), it is possible to associate modes of a length frequency distribution to age classes. As shrimp grows in length, its weight also increases. Therefore, a weight frequency distribution should show modes similar to those found in a length frequency distribution.

This study has two objectives: (1) to separate age classes with weight frequency distributions and (2) to compare relative proportions and average sizes of shrimp obtained in each age class from corresponding weight and length frequency distributions.

MATERIAL AND METHODS

For this preliminary study, we sampled shrimp from the Canso area and the Esquiman channel during the months of May and July 1979.

Shrimp were preserved in 4% Formaldehyde buffered with sea water. Later, shrimp were sexed and females were further separated into two groups: females with sternal spines (which have never spawned and are younger) and females without sternal spines (which have spawned at least once) (McCrary, 1971). Each specimen was then weighed to the nearest 0.1 gram and the cephalothorax measured from the eye socket to the mid part of the posterior edge of the carapace to the nearest 0.1 mm.

Separation of age classes from length and weight frequency distributions was made by the Hasselblad (1966) method, using NORMSEP computer program (Abramson, 1971). Briefly, NORMSEP adjusts normal curves to each mode representing an age class, and the intersection of two adjacent normal curves defines the separation of two adjacent age classes. In addition to the mean size of shrimp in each age class, NORMSEP gives an estimate of the number of shrimp in each age class and their relative abundance.

NORMSEP needs regular intervals to operate. Therefore, length measurements were grouped in 0.3 mm intervals and weight measurements were grouped in 0.05 Lng intervals on a natural log scale, since weight of shrimp increases exponentially with length.

To optimize the fitting of normal curves on each age class, NORMSEP was applied separately on male and female frequency distributions for both length and weight. Smallest and largest animals at either end of distributions were ignored since their abundance was very low.

Growth of males being regular, age classes are usually well separated by NORMSEP; but, when sex inversion takes place growth becomes discontinuous and slower (due to an ovigerous period) and age classes are much more difficult to separate. However, the presence of sternal spines helps to differentiate the first female age class.

Relative proportion of shrimp from each age class in corresponding length and weight distributions were compared with a contingency analysis to tests for significant differences. To be able to compare the mean length of shrimp of each age class (obtained from length frequency distributions) with the corresponding mean weight (obtained from weight frequency distribution), we used length-weight relationships to convert the mean weight to length (Table 1).

RESULTS

Esquiman channel: In May and July 1979, weight and length frequency distributions had similar structures and same amount of modes, both for males and females (Fig. 1). In most cases, relative proportions of shrimp in each age class from weight and length distributions corresponded well together (Table 2). In fact, contingency tests did not show any significant differences at a level of 0.05 (Table 3). Furthermore, if we use length-weight relationships to convert the mean weight (LnWGT) to length for each age class, this calculated length from weight distributions is practically identical to the mean length obtained from length distributions (Table 2).

Canso: As for Esquiman channel, corresponding weight and length frequency distributions were similar for male and female in May and July 1979 (Fig. 2). In July, relative proportions of shrimp in each age class from weight and length distributions matched well (Table 2) and there was no significant difference ($p = 0.05$) between them. However, in May contingency tests did show a significant difference between relative proportions of shrimp in each age class (Table 3).

We were not able to separate female age classes in May and July. Therefore, females were considered as a single age class and we did not run any particular test over this portion of the population.

As for Esquiman area, the calculated lengths per age class from weight distributions fits well with corresponding mean lenghts obtained from length distributions (Table 2).

DISCUSSION

Problems encountered with the weight distributions were often the same as for the length distributions; such as not being able to distinguish modes or have NORMSEP working properly. For example, neither length nor weight frequency distributions were adequate to separate female age classes in Canso area. On the other hand, the relative proportion of animals and their mean size (weight or length) per age class are similar in most cases.

The advantage of using weight distributions is that the biomass of a specific age class can be estimated directly. Weighing consumes less time than measuring. However, specimens have to be well preserved in an isotonic solution. Gain or loss of weight or missing parts will introduce important bias.

Before using weight distributions to age shrimp, we strongly recommend tests on more frequency distributions. Inadaquate separations of age classes will have important consequences when estimating biomass per age class.

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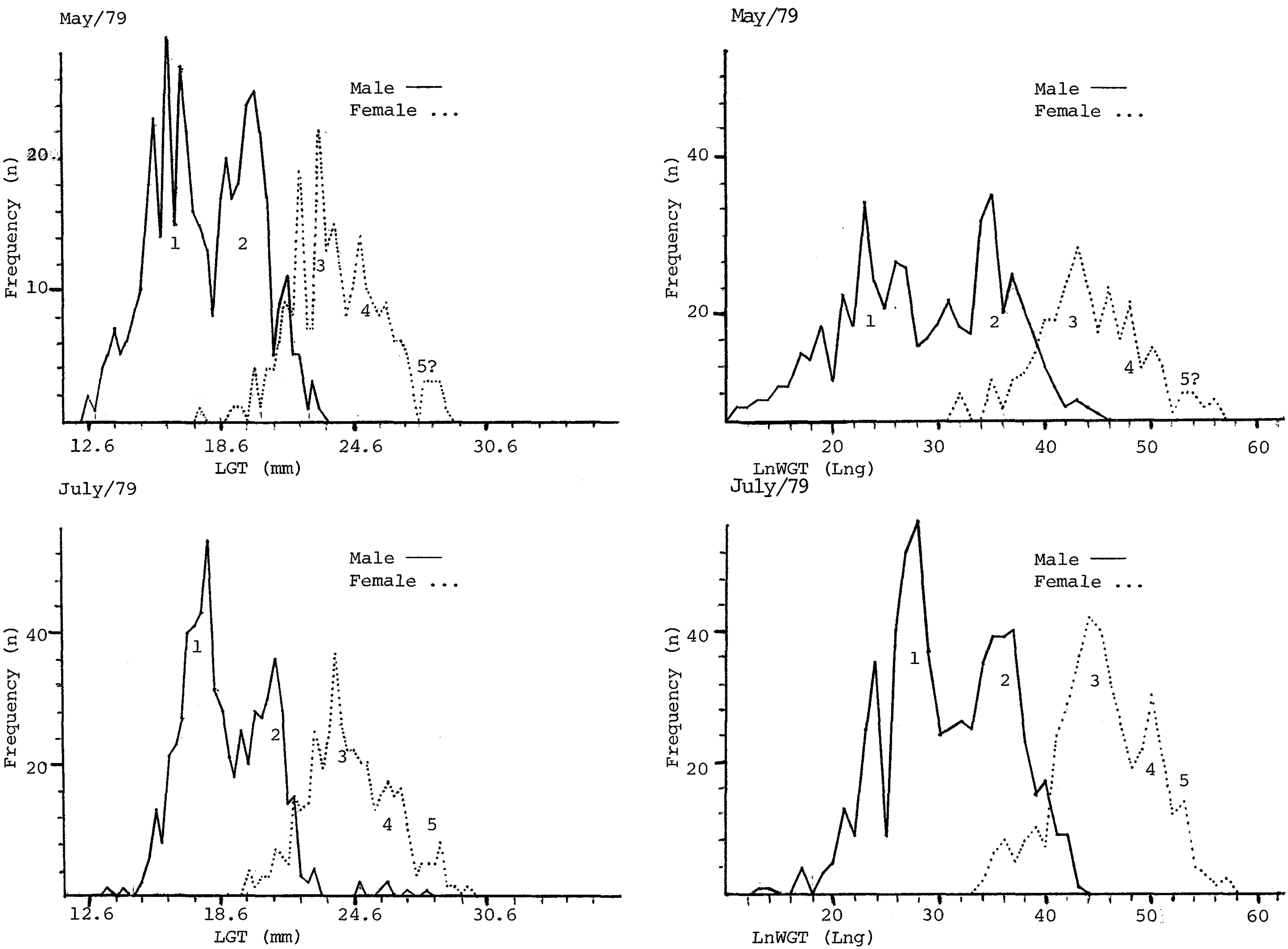

Figure 1: Esquiman Length and Weight Frequency Distrubutions

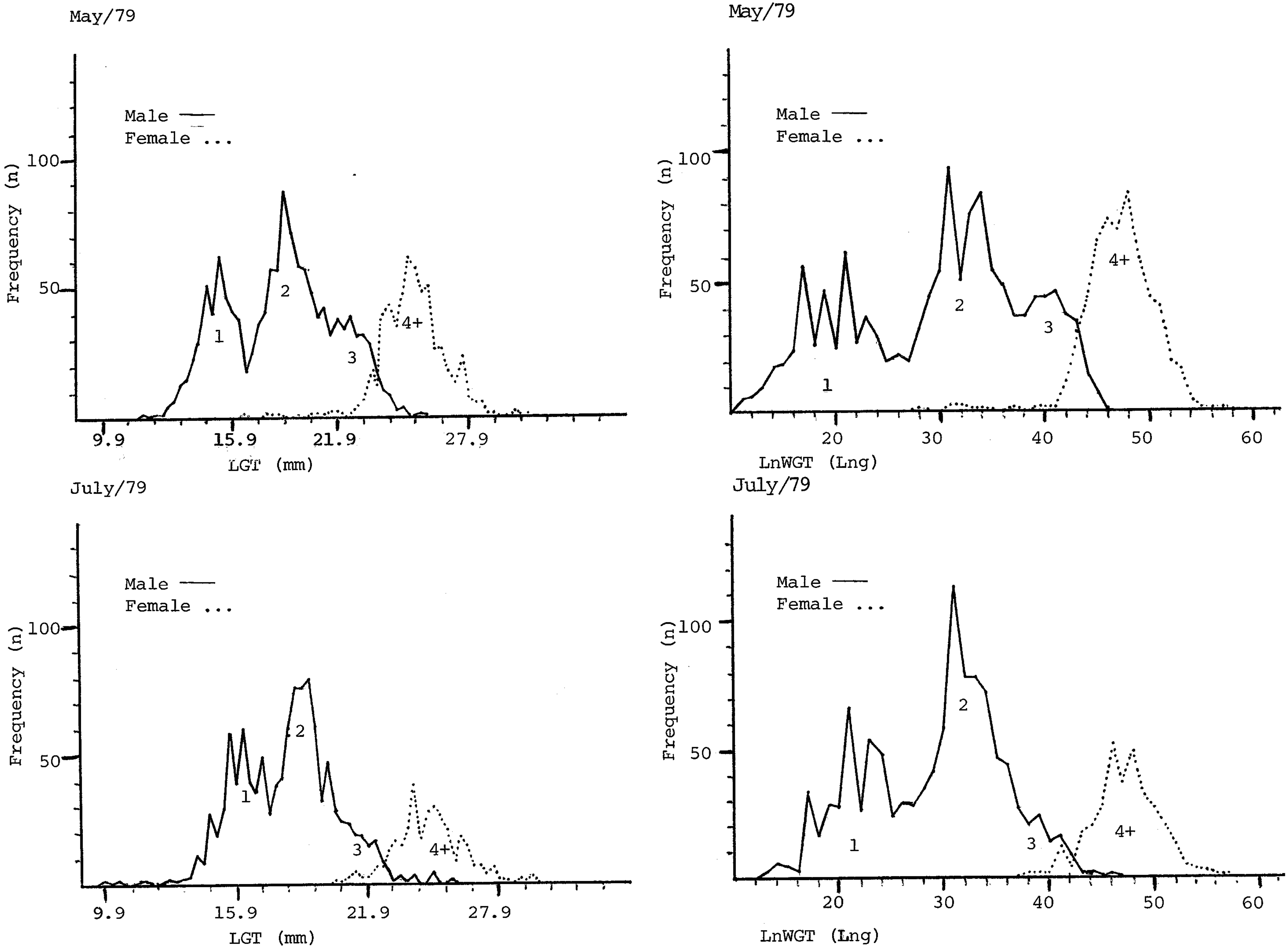

Figure 2: Canso Length and Weight Frequency Distrubutions.

Table 1. Length weight relationships

CANSO

Males:	LnWGT = 2.92964 LnLGT - 6.95763
	r = 0.9589
Females:	LnWGT = 2.65801 LnLGT - 6.10640
	r = 0.9153

ESQUIMAN

Males:	LnWGT = 2.50025 LnLGT - 5.78015
	r = 0.8508
Females:	LnWGT = 2.45424 LnLGT - 5.55504
	r = 0.8553

Table 2. Relative proportion of shrimp, mean length (LGT) with std. deviation for each age class from length frequency distribution, and corresponding proportion of shrimp, mean weight (natural log) (LnWGT) with std. deviation for each age class from weight frequency distribution.

ESQUIMAN MAY/79

AGE CLASS	Weight frequencies				Length frequencies		
	LnWGT (Lng)	Lnσ	% Ind	WGT LGT[1] (Lng) (mm)	LGT (mm)	σ	% Ind
MALE							
1	1.19	0.20	52.78	16.24	16.49	1.45	57.72
2	1.78	0.16	44.65	20.57	20.15	1.01	40.27
FEMALE							
3	2.11	0.13	47.76	22.72	22.56	1.24	42.43
4	2.39	0.50	42.26	25.46	25.00	1.46	54.06

ESQUIMAN JULY/79

AGE CLASS	Weight frequencies				Length frequencies		
	LnWGT (Lng)	Lnσ	% Ind	WGT LGT[1] (Lng) (mm)	LGT (mm)	σ	% Ind
MALE							
1	1.38	0.17	58.51	17.53	17.67	1.08	63.19
2	1.83	0.12	38.16	20.98	20.78	0.78	33.78
FEMALE							
3	2.23	0.13	65.52	23.86	23.95	1.29	75.00
4	2.53	0.08	19.45	26.96	26.58	0.51	14.70
5	2.65	0.11	7.92	28.31	28.37	0.54	6.28

Table 2. Continue

CANSO MAY/79
MALE

AGE CLASS	Weight frequencies				Length frequencies		
	LnWGT (Lng)	Lnσ	% Ind	WGT LGT[1] (Lng) (mm)	LGT (mm)	σ	% Ind
1	1.06	0.20	33.67	15.44	15.22	0.93	31.47
2	1.66	0.16	48.69	18.94	18.44	0.89	41.31
3	2.07	0.10	17.64	21.79	21.17	1.11	26.91
FEMALE							
4	2.37	0.13	88.49	24.26	24.12	1.03	81.56

CANSO JULY/79
MALE

AGE CLASS	Weight frequencies				Length frequencies		
	LnWGT (Lng)	Lnσ	% Ind	WGT LGT[1] (Lng) (mm)	LGT (mm)	σ	% Ind
1	1.13	0.17	36.41	15.81	16.28	1.02	38.58
2	1.62	0.12	48.74	18.69	19.08	0.77	44.11
3	1.93	0.14	13.66	20.77	21.29	0.98	15.57
FEMALE							
4	2.38	0.15	97.82	24.36	24.66	1.27	89.58

[1] = Mean length for each age class calculated from the natural log. of the mean weight (from the weight frequency distributions) using length-weight relationships (Table 1).

Table 3. Contingency Test Results

ESQUIMAN

May/79 Male

Age Class	1	2	
# Ind. LGT	259	180	$X^2 = 2.09$ [a]
# Ind. WGT	235	199	$X^2 = {}_{05} = 3.84$ [b]

May/79 Female

Age Class	3	4	
# Ind. LGT	98	125	$X^2 = 3.62$ [a]
# Ind. WGT	113	100	$X^2_{05} = 3.84$ [b]

July/79 Male

Age Class	1	2	
# Ind. LGT	391	208	$X^2 = 2.88$ [a]
# Ind. WGT	362	236	$X^2_{05} = 3.84$ [b]

July/79 Female

Age Class	3	4	5	
# Ind. LGT	302	59	25	$X^2 = 5.97$ [a]
# Ind. WGT	263	78	32	$X^2_{05} = 5.99$ [b]

a = Calculated value

b = Critical value (Snedecor and Cochran, 1967)

Table 3. Contingency Test Results

CANSO

May/79 Male

Age Class	1	2	3	
# Ind. LGT	408	536	349	$X^2 = 34.25$ [a]
# Ind. WGT	437	632	228	$X^2_{.05} = 5.99$ [b]

July/79 Male

Age Class	1	2	3	
# Ind. LGT	422	482	170	$X^2 = 4.53$ [a]
# Ind. WGT	398	532	149	$X^2_{.05} = 5.99$ [b]

a = Calculated value

b = Critical value (Snedecor and Cochran, 1967)