Condition Indices, Energy Density and Water and Lipid Content of Atlantic Herring *(Clupea harengus harengus)* of southeastern Newfoundland

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CONDITION INDICES, ENERGY DENSITY AND WATER AND LIPID CONTENT OF ATLANTIC HERRING (*CLUPEA HARENGUS HARENGUS*) OF SOUTHEASTERN NEWFOUNDLAND

by

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ABSTRACT

McGurk, M. D., J. M. Green, W. D. McKone, and K. Spencer. 1980. Condition indices, energy density and water and lipid content of Atlantic herring (<u>Clupea harengus harengus</u>) of southeastern Newfoundland. <u>Can. Tech. Rep. Fish. Aquat. Sci.</u> 958: iv + 41 p.

Condition indices, energy densities and water and lipid contents of the soma and the gonads of Atlantic herring were measured for the period March 1977-March 1978. Body condition index, somatic energy density and somatic lipid content reached a maximum in October and a minimum in early June, immediately after spawning, confirming earlier reports for this species. The testes growth rate was greatest over the summer and zero during the winter whereas the ovaries grew at a slower rate throughout the summer and winter. The ovaries had a consistently lower lipid content (1-2%) than the testes (2-4%) but the range of energy densities of the ovaries (7-8 kj·g^{-1}) was higher than that of the testes (4-6 kj·g^{-1}). The slope of the linear regression of energy density on percent water for the soma was higher than the slopes of the gonads and higher than the slope of a similar regression reported in the literature.

Key words: Atlantic herring, <u>Clupea harengus</u>, condition, energy, lipid, gonads, soma, seasonal

RÉSUMÉ

McGurk, M. D., J. M. Green, W. D. McKone, and K. Spencer. 1980. Condition indices, energy density and water and lipid content of Atlantic herring (<u>Clupea harengus harengus</u>) of southeastern Newfoundland. <u>Can. Tech. Rep. Fish. Aquat. Sci.</u> 958: iv + 41 p.

De mars 1977 à mars 1978, on a mesuré la condition physique, la densité énergétique et la teneur en eau et en lipides des parties somatiques et germinales du hareng de l'Atlantique. L'indice de condition physique ainsi que la densité énergétique et la teneur en lipides du soma ont atteint un maximum en octobre et un minimum au début de juin, immédiatement après la fraie, ce qui a confirmé ce qu'on savait déjà de cette espèce. La croissance des testicules a été maximale l'été et nulle l'hiver tandis que celle des ovaires était lente l'été et l'hiver. La teneur en lipides des ovaires (1 à 2%) était inférieure à celle des testicules (2 à 4%), mais la densité énergétique y était supérieure (7 à 8 contre 4 à 6 kj·g^{-1}). Pour le soma, la pente de la droite de régression du rapport de la densité énergétique sur la teneur en eau était supérieure aux pentes calculées pour les gonades et supérieure à la pente d'une régression similaire trouvée dans une publication.

INTRODUCTION

The seasonal cycles of the condition indices, the energy densities and the water and lipid content of the body tissues of the Atlantic herring are important for two reasons. First, they are important to those engaged in the herring fishery, for the body condition index and the lipid content influences the commercial value of the fish. Second, the phenomenon of the transfer of material from the musculature to the gonads is important to those studying the reproductive biology of the herring. It is quite possible that environmental factors regulate the allocation of energy between the soma and the gonads and this has important implications for those attempting to understand the reasons behind the success or failure of year-classes.

There have been several studies of the chemical composition of herring from the Canadian Atlantic, however none of these have examined the soma and the gonads as separate compartments. Most of these studies were concerned with whole-body analysis (Leim 1957, 1958; Stoddard 1967, 1968; Hodder et al. 1973; Varga et al. 1977) and one with the analysis of the fillets (Ackman and Eaton 1976).

Direct calorimetric measurements of the seasonal cycle of the energy content of herring from the Canadian Atlantic have not been reported. An indirect estimate of the whole-body energy content of overwintering herring of southwest Newfoundland was made by Winters (1977) who used lipid and water data from Hodder et al. (1973) and standard factors for the energy density of lipid and solids.

This report presents the results of a study of the seasonal cycle of the condition indices of the body and the gonads and the seasonal cycle of the lipid and water content and the energy density of the body and gonads. The samples were taken from the southeast Newfoundland herring stock complex.

MATERIALS AND METHODS

SAMPLING

Ten samples of herring were obtained from commercial catches between March, 1977 and February 6, 1978. Samples were taken every six to eight weeks except during the pre-spawning and spawning period when they were taken every two to three weeks.

The seasonal nature of the inshore herring fishery made it impossible to obtain all samples from one population. Eight of the samples were taken from the Placentia Bay-St. Mary's Bay management unit, one was taken from the adjacent Conception Bay-Southern Shore management unit and one from the Bonavista Bay management unit (Fig. 1). It is assumed that the energy cycles of these three units are synchronous. This is reasonable since the mean date of spawning for the spring-spawners in each unit are within a week of each other (G. Winters, personal communication). Also recent tagging studies (G. Winters, personal communication) have shown that migration occurs between the first two units but because the extent of intermixing is unknown they are separated for management purposes.

A sample consisted of 50-60 specimens taken from the catch of a commercial vessel. The catch was sampled either on board the ship or in the fish processing plant several hours after off-loading. The fish were packed in ice and transported to the laboratory. There 10-15 fish of each sex were chosen and length, defined as the distance from the tip of the snout to the end of the longest caudal ray, was measured to 0.1 cm. Wet body

Fig. 1. Map showing the east coast of Newfoundland and the locations of the samples. Each dot represents one sample.

weight was measured to 0.1 g. The otoliths were removed for age determination. The weight of the stomach contents, if any, was taken to 0.1 g and was later used to correct the wet body weight. The gonads were weighed to 0.1 g, sexed and assigned a maturation stage (Anonymous 1964).

The body was separated into three compartments: the head, the gonads and the soma. The head was treated as a separate entity because it is assumed to play a negligible role in the internal energy flows of the body due to its lack of energy storage organs. A subsample of gonad tissue was placed in a plastic bag which was immediately sealed and frozen at -20°C for later lipid and water analysis. The remainder of the gonad was reserved for calorimetry. The head and the vertebral column, including the caudal fin, were removed and weighed to 0.1 g. The fillets and the viscera, hereafter referred to as the soma, were combined and minced in a meat grinder and then homogenized in a heavy duty Waring blender. A subsample of the homogenate was placed in a plastic bag which was immediately sealed and frozen at -20°C for later lipid and water analysis. Another subsample was reserved for calorimetry.

Twice during the year a number of heads were ground, homogenized and subsampled for lipid and water analysis and for calorimetry.

WATER

The frozen subsamples were thawed, then transferred to tared aluminum pans, weighed and dried in an oven at 100°C for two days. The pans were cooled in a desiccator and then weighed again. Mean percent water was computed from duplicate samples and never differed by more than 1%.

LIPID

Percent lipid was determined by the Soxhlet method (Association of Official Analytical Chemists 1975) using ether as a solvent. Mean percent lipid was computed from duplicate samples of dried tissue. A third replicate was performed if the difference between the duplicates was greater than 1% and the mean percent lipid was then computed using the two values which differed by less than 1%.

CALORIMETRY

The fresh subsamples of gonad and soma were dried in an oven at 100°C for two days and then ground to a fine powder using either a mortar and pestle or a ball mill grinder. All subsamples were stored in a desiccator until bombed. Ten subsamples of soma and ten subsamples of gonad of each sex were bombed in duplicate with a Parr adiabatic calorimeter. All energy values were corrected for the heat of fuse wire combustion and for the heat of acid formation. An additional test was performed if the first two tests differed by more than 126 joules$\cdot g^{-1}$. All tests were done within 30 days of procuring a sample in order to avoid possible inaccuracies due to tissue oxidation.

RESULTS

CONDITION INDICES

The sample number, date, location and the number of specimens processed of each sample are listed in Table 1. The measurements of length and weight of each specimen are listed in Appendix 1.

The mean body condition index, C, is defined as

(1) $$C = W \times 10^6/L^3,$$

where W is body weight in grams and L is the length in millimeters. The mean C of each sex of each sample is shown in Table 2. T-tests revealed that, except for the sample taken on October 25, there are no significant differences between the mean C's of the two sexes. The means of the sexes were combined and are shown in Fig. 2A. There is a decrease in mean C over the winter and spring followed by an increase over the summer months to a peak in December. The sudden drop in mean C at the time of spawning was calculated by subtracting the mean gonad weight at spawning from the mean body weight at spawning. The post-spawning mean C was calculated as 6.60 for a wide range of body weights. The dotted line was drawn by eye.

The monthly gonad condition index I, defined as

(2) $$I = W_{gonad}/W,$$

is shown in Fig. 2B and 2C. The ovaries appear to increase in condition throughout the winter and spring whereas the testes appear to remain constant or even to decrease in condition over the same period. The testes grow rapidly over the summer and reach their maximum condition in October. The ovaries grow at a slower rate, reaching their maximum condition immediately before spawning.

Table 1. List of dates and locations of the herring samples analyzed.

Sample number	Date	Area	Number of fish measured	Number for lipid and water	Number for calorimetry
1	Mar. 1	Placentia Bay	36	22	0
2	Mar. 31	Placentia Bay	26	24	12
3	Apr. 29	St. Mary's Bay	36	0	14
4	May 18	St. Mary's Bay	28	23	19
5	June 3	St. Mary's Bay	26	23	22
6	Aug. 12	Southern Shore	23	17	17
7	Oct. 25	Bonavista Bay	45	20	20
8	Dec. 20	St. Mary's Bay	24	21	18
9	Jan. 17	Placentia Bay	24	0	0
10	Feb. 6	St. Mary's Bay	24	20	0
		Total	292	170	122

Table 2. The mean body condition index (± 1 s.d.) of each sex of each sample. The bracketed number is the sample size. NS means there is no significant difference between the means and S means there is a significant difference.

Sample Date	Male	Female	
Mar. 1, 1977	8.88 ± 0.94 (14)	8.69 ± 0.55 (22)	NS
Mar. 31, 1977	8.27 ± 0.62 (12)	8.57 ± 0.46 (13)	NS
Apr. 29, 1977	7.80 ± 0.31 (17)	8.25 ± 0.44 (18)	NS
May 18, 1977	7.67 ± 0.68 (12)	7.92 ± 0.66 (16)	NS
June 3, 1977	7.96 ± 0.39 (12)	7.78 ± 0.74 (13)	NS
Aug. 12, 1977	7.66 ± 0.49 (14)	7.46 ± 0.41 (9)	NS
Oct. 25, 1977	8.23 ± 0.39 (21)	7.69 ± 0.41 (24)	S ($P < 0.01$)
Dec. 20, 1977	8.56 ± 0.68 (12)	8.20 ± 0.37 (12)	NS
Jan. 17, 1978	8.47 ± 0.53 (12)	8.19 ± 0.41 (12)	NS
Feb. 6, 1978	7.80 ± 0.54 (12)	7.73 ± 0.55 (12)	NS

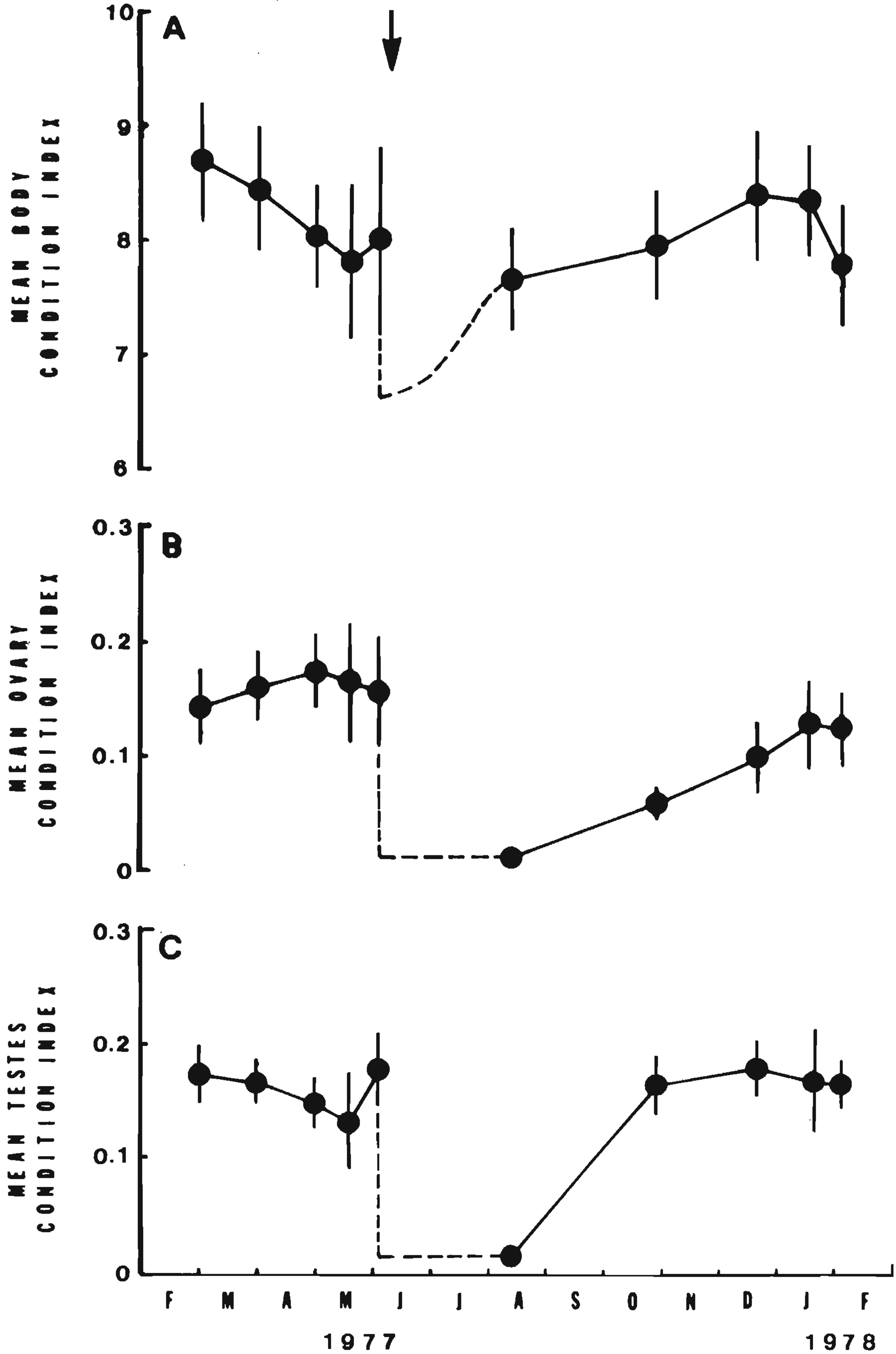

Fig. 2. Annual cycle of: A. mean (± 1 s.d.) body condition of the combined data of both sexes; B. mean (± 1 s.d.) ovary condition index and C. mean (± 1 s.d.) testes condition index. The arrow indicates mean time of spawning.

In order to determine if there is any variation of condition index with age the mean condition indices of each sample were separated into age classes as is shown in Tables 3, 4 and 5. Immatures were not included in these tables. Examination of the tables shows that there is a possible positive correlation between the condition indices and age. In order to test this an index, D, of the deviation of the monthly means at age from the monthly mean for the entire sample, $\bar{C}$, was first calculated. It is defined as

(3) $$D_i = \left(\sum^{j}(C_{ij} - \bar{C}_j)n_{ij}\right)/\sum^{j} n_{ij}$$

where n is the sample size of the monthly mean at age, i is age and j is the sample number. The D of the body condition index is significantly correlated with age ($r = 0.83$; $0.01 < P < 0.05$) as is that of the ovaries ($r = 0.97$; $P > 0.01$). The D of the testes is not correlated with age ($r = 0.011$; $P < 0.05$). The scatter of the points is shown in Fig. 3A, 3B and 3C. A regression of D on age was calculated for the body and the ovary respectively.

body:

(4a) $$D = 0.0660\ (\text{Age}) - 0.5105;\quad R^2 = 0.70$$

ovary:

(4b) $$D = 0.0094\ (\text{Age}) - 0.0835;\quad R^2 = 0.95$$

LIPID AND WATER

The percent lipid and percent water of each compartment, based on the net weight of the compartment, of each specimen analyzed are listed in Appendix 2. T-tests revealed that there were no significant differences ($P > 0.05$) between the percentages of lipid and water of the soma of the males and that of the females at any time of the year. The two sets of data were therefore pooled. The annual cycles of mean (± 1 s.d.) percent water and mean (± 1 s.d.) percent lipid of the soma, the ovaries and the testes are shown in Fig. 4 and 5. The gonads of the specimens of the August 12 sample were sexed incorrectly and were therefore omitted. The percent water of all these compartments increased over the winter and spring to a maximum immediately before spawning. The percent water of the soma was at a minimum in mid-summer and gradually increased over the fall and early winter, whereas the percent water of both the ovary and the testes steadily decreased from a peak in October. The percent lipid of the soma, ovary and testes followed a pattern that is essentially the opposite of that of the percent water.

Table 3. Mean monthly body condition index for each age. The sample size is enclosed in brackets. Only sexually mature fish are included in the calculation of the mean. See text for explanation of D.

Month	3	4	5	6	7	8	9	10	11+	Mean ± 1 s.d.
Feb.	-	-	8.65 (7)	-	8.85 (1)	8.45 (4)	8.48 (10)	-	8.92 (13)	8.68 ± 0.53 (35)
March	-	-	8.13 (7)	8.86 (1)	-	8.27 (4)	8.71 (8)	8.25 (3)	8.64 (3)	8.43 ± 0.54 (26)
April	-	-	-	-	-	7.96 (11)	8.02 (18)	-	8.22 (6)	8.03 ± 0.44 (35)
May	-	-	7.51 (3)	6.73 (1)	7.45 (3)	7.99 (5)	7.83 (9)	8.18 (1)	8.08 (6)	7.81 ± 0.67 (28)
June	-	8.30 (1)	-	-	8.09 (1)	7.90 (11)	7.66 (9)	-	8.14 (3)	7.98 ± 0.83 (25)
July	-	-	-	-	-	-	-	-	-	-
Aug.	-	-	-	-	-	7.59 (4)	7.72 (11)	7.42 (1)	7.38 (7)	7.64 ± 0.45 (23)
Sept.	-	-	-	-	-	-	-	-	-	-
Oct.	-	-	-	-	-	8.57 (3)	7.92 (29)	7.78 (2)	7.86 (11)	7.94 ± 0.48 (45)
Nov.	-	-	-	-	-	-	-	-	-	-
Dec.	-	-	8.32 (2)	-	-	-	8.35 (6)	-	8.40 (16)	8.38 ± 0.57 (24)
Jan.	-	8.06 (8)	7.85 (1)	8.45 (6)	-	-	-	-	8.54 (9)	8.33 ± 0.49 (24)
Feb.	-	7.56 (3)	7.32 (4)	7.65 (2)	8.27 (1)	-	-	7.87 (10)	8.05 (4)	7.77 ± 0.53 (24)
D	-	-0.206	-0.234	-0.017	-0.050	-0.015	-0.025	0.017	0.405	

Table 4. Mean monthly ovary index for each age. The sample size is enclosed in brackets. Only sexually mature fish are included in calculating the mean. See text for explanation of D.

Month	3	4	5	6	7	8	9	10	11+	Mean ± 1s.d.
Feb.	-	-	0.1003 (5)	-	0.1546 (1)	0.0976 (1)	0.1524 (6)	-	0.1640 (9)	0.1429 ± 0.0331 (22)
March	-	-	0.1252 (3)	0.1664 (1)	-	0.1728 (1)	0.1697 (6)	0.1592 (1)	0.2040 (1)	0.1612 ± 0.0303 (13)
April	-	-	-	-	-	0.1491 (5)	0.1790 (10)	-	0.2007 (3)	0.1743 ± 0.0315 (18)
May	-	-	0.1108 (2)	0.0464 (1)	0.1434 (2)	0.1988 (1)	0.2066 (4)	0.2088 (1)	0.1722 (5)	0.1656 ± 0.0504 (16)
June	-	0.0745 (1)	-	-	-	0.1722 (4)	0.1513 (5)	-	0.1755 (2)	0.1559 ± 0.0484 (12)
July	-	-	-	-	-	-	-	-	-	-
Aug.[a]	-	-	-	-	-	0.0136 (3)	0.0123 (4)	0.0145 (1)	0.0150 (1)	0.0133 ± 0.0021 (9)
Sept.	-	-	-	-	-	-	-	-	-	-
Oct.	-	-	-	-	-	-	0.0607 (15)	0.0592 (2)	0.0605 (7)	0.0605 ± 0.0128 (24)
Nov.	-	-	-	-	-	-	-	-	-	-
Dec.	-	-	-	-	-	-	0.1046 (2)	-	0.0979 (10)	0.0990 ± 0.0296 (12)
Jan.	-	0.0901 (2)	0.0886 (1)	0.1291 (4)	-	-	-	-	0.1498 (5)	0.1279 ± 0.0391 (12)
Feb.	-	0.0623 (1)	0.1113 (3)	-	0.1072 (1)	-	-	0.1378 (4)	0.1453 (3)	0.1238 ± 0.0310 (12)
D		-0.0546	-0.0362	-0.0208	-0.0136	-0.0073	0.0059	0.0106	0.0119	

a. Probably sexed incorrectly and so represents mean value for both sexes

Table 5. Mean monthly testes index for each age. The sample size is enclosed in brackets. Only sexually mature fish are included in the calculation of the mean. See text for explanation of D.

Month	3	4	5	6	7	8	9	10	11+	Mean ± 1s.d.
Feb.	-	-	0.1381 (3)	-	-	0.1711 (2)	0.1778 (4)	-	0.1929 (4)	0.1723 ± 0.0252 (13)
March	-	-	0.1615 (4)	-	-	0.1571 (3)	0.1736 (2)	0.1809 (2)	0.1683 (2)	0.1664 ± 0.0181 (13)
April	-	-	-	-	-	0.1542 (6)	0.1394 (8)	-	0.1553 (3)	0.1474 ± 0.0225 (17)
May	-	-	0.1187 (1)	-	0.0541 (1)	0.1421 (4)	0.1453 (5)	-	0.1092 (1)	0.1314 ± 0.0422 (12)
June	-	-	-	-	0.1486 (1)	0.1806 (6)	0.1927 (4)	-	0.1181 (1)	0.1768 ± 0.0313 (12)
July	-	-	-	-	-	-	-	-	-	-
Aug.[a]	-	-	-	-	-	0.0405 (1)	0.0148 (7)	-	0.0143 (6)	0.0164 ± 0.0079 (14)
Sept.	-	-	-	-	-	-	-	-	-	-
Oct.	-	-	-	-	-	0.1830 (3)	0.1602 (14)	-	0.1694 (4)	0.1640 ± 0.0270 (21)
Nov.	-	-	-	-	-	-	-	-	-	-
Dec.	-	-	0.1501 (2)	-	-	-	0.1796 (4)	-	0.1881 (6)	0.1789 ± 0.0245 (12)
Jan.	-	0.1333 (6)	-	0.2067 (2)	-	-	-	-	0.1987 (4)	0.1673 ± 0.0459 (12)
Feb.	-	0.1521 (2)	0.1609 (1)	0.1663 (2)	-	-	-	0.1674 (6)	0.1785 (1)	0.1651 ± 0.0206 (12)
D	-	-0.0288	-0.0179	0.0203	-0.0528	0.0063	0.0031	0.0054	0.0109	

a. Probably sexed incorrectly and so represents a mean value for both sexes.

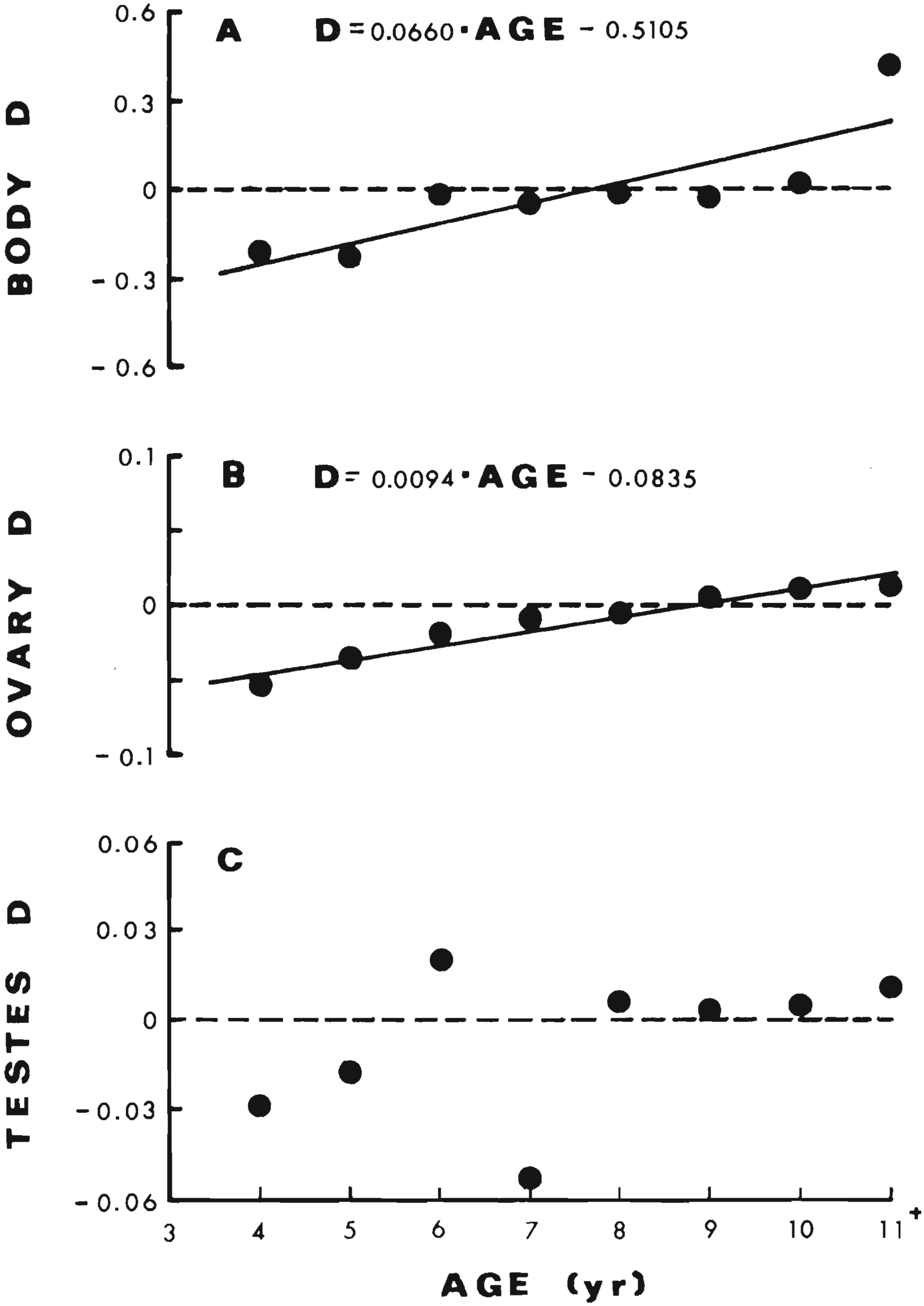

Fig. 3. The relationship between D and age for: A, the body; B, the ovary and C, the testes.

In order to determine if the percent lipid of the soma varies with body length the data on percent lipid of each sample was grouped into length classes and a mean value for each length class calculated as is shown in Table 6. Examination of Table 6 shows that there is no apparent trend of percent lipid of the soma with length.

Examination of the percent lipid and percent water of the compartments of individual specimens suggest that lipid and water make up a constant percent of the wet weight of a compartment. The mean (± 1 s.d.) combined percent is 80.21 ± 0.99% for the soma, 75.89 ± 2.84% for the testes and 68.10 ± 3.29% for the ovaries. Correlation analysis revealed that the percent lipid of the soma is highly negatively correlated with the percent water ($r = -0.98$; $P < 0.01$), as are the percent lipid and percent water of the testes ($r = -0.70$; $P < 0.01$). The percent lipid of the ovaries, however, is not significantly correlated with the percent water ($r = 0.24$; $P > 0.05$). This means that it is possible to use percent water as a prediction of percent lipid for the soma and the testes. The ovaries have a mean (± 1 s.d.) percent lipid of 1.23 ± 0.33% at all times of the year. Percent lipid was linearly regressed on percent water for the soma and the testes and the following equations were obtained
(Fig. 6)

soma:

(5a) $$\% \text{ lipid} = 86.71 - 1.095\ (\% \text{ water}),$$

Testes:

(5b) $$\% \text{ lipid} = 13.81 - 0.150\ (\% \text{ water}).$$

ENERGY DENSITY

The energy densities ($kj \cdot g^{-1}$ wet weight) of each compartment of each specimen are listed in Appendix 3. T-tests revealed that there is no difference between the mean energy densities of the soma of males and those of the soma of females for any sample and so the two sets of data were pooled. The annual cycle of mean energy densities of the three compartments are shown in Fig. 7.

In order to determine the energy conversion factors for lipid and solid the percentages were converted to weights and the energy densities to total energies by multiplying the percentages by the wet weight of the tissue. Solid is defined as the tissue residue left after extraction of lipid and water. Then total energy was regressed on the weight of lipid and the weight of solid to obtain the following equations for the soma, the testes and the ovaries respectively:

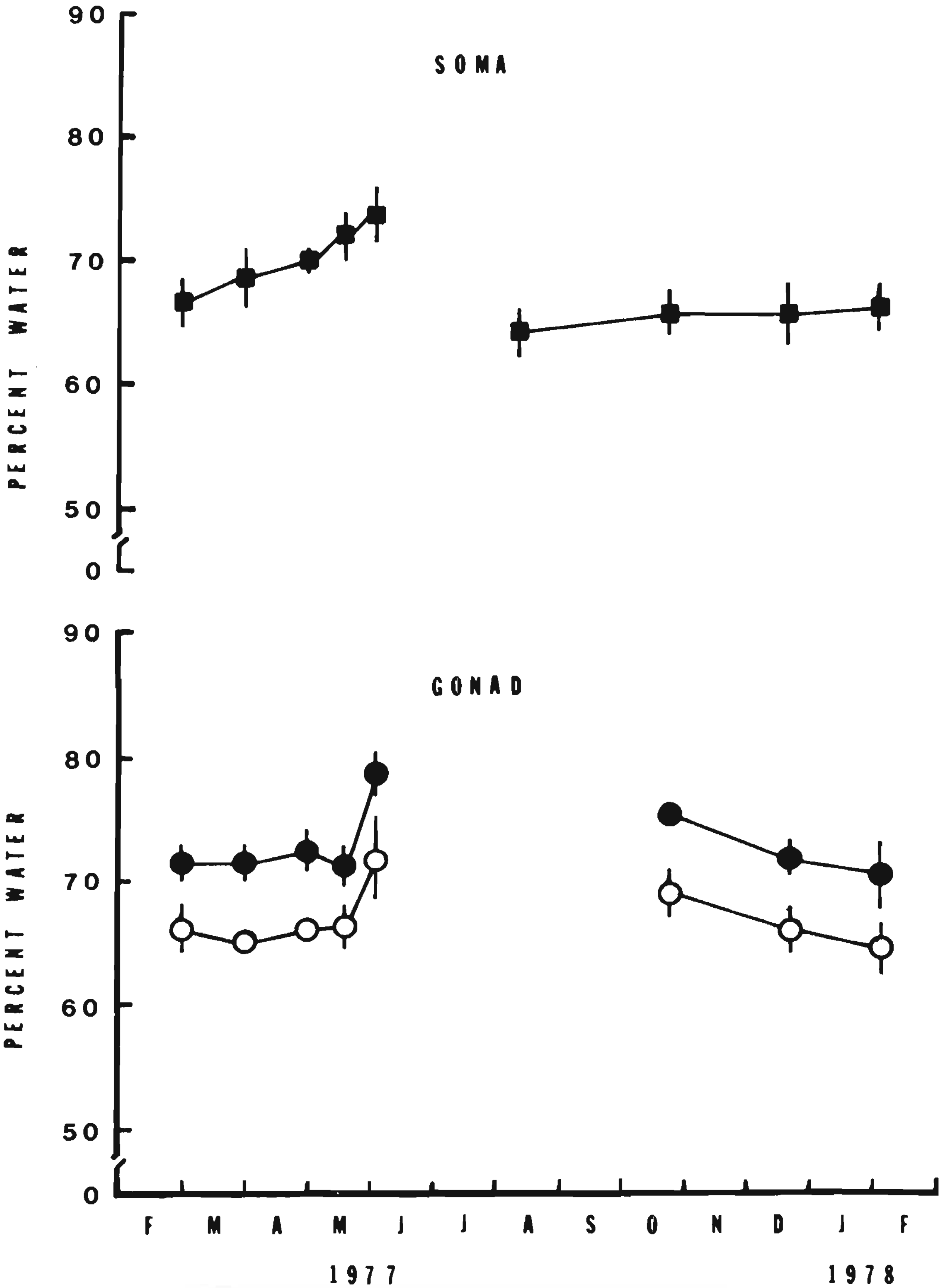

Fig. 4. The mean (± 1 s.d.) percent water of the soma of the combined sexes and of the gonads. The gonads of the specimens of the August 12 sample were sexed incorrectly and were therefore omitted. The open circles are females, the closed circles are males and the squares are pooled males and females.

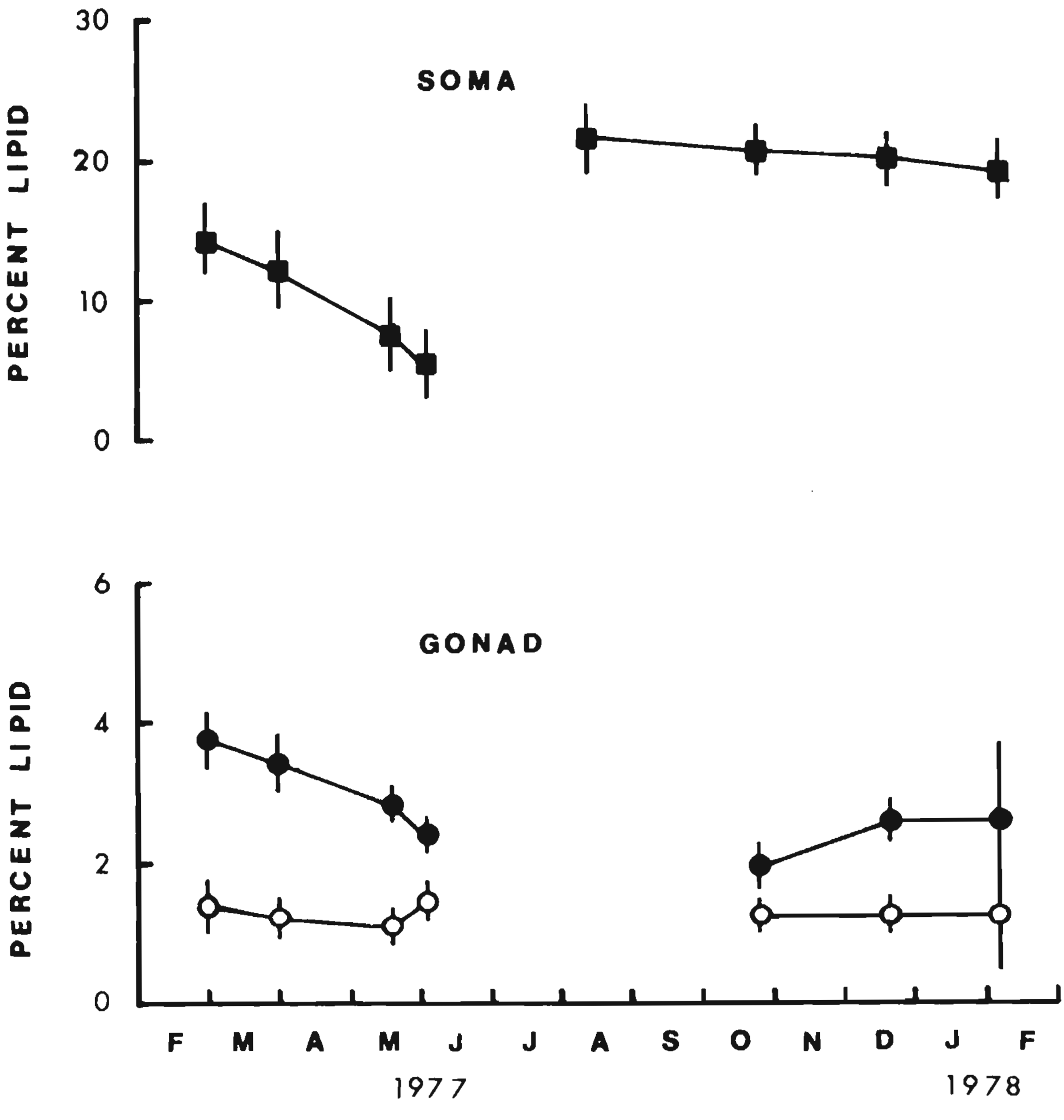

Fig. 5. The mean (± 1 s.d.) percent lipid of the soma of the combined sexes and of the gonads. The gonads of the specimens of the August 12 sample were sexed incorrectly and were therefore omitted. The open circles are females, the closed circles are males and the squares are pooled males and females.

Table 6. The mean percent lipid of the soma of the combined sexes separated into length classes for each sample. The number of specimens is in parentheses.

Sample Number	29.1-30.0	30.1-31.0	31.1-32.0	32.1-33.0	33.1-34.0	34.1-35.0	35.1-36.0	36.1-37.0	47.1-38.0
1	-	-	-	-	-	-	-	-	-
2	-	-	-	16.94 (2)	13.88 (6)	15.14 (8)	12.50 (5)	16.41 (1)	-
3	-	-	-	13.00 (4)	12.36 (9)	10.96 (7)	13.57 (2)	14.18 (1)	-
4	-	-	-	-	-	-	-	-	-
5	-	-	8.26 (3)	5.66 (5)	5.61 (4)	8.05 (6)	9.41 (3)	7.43 (2)	-
6	7.48 (1)	-	3.70 (1)	6.22 (5)	5.20 (8)	5.39 (5)	6.17 (3)	-	-
7	-	-	-	-	16.66 (8)	16.03 (3)	16.67 (5)	16.58 (1)	-
8	-	-	-	15.27 (2)	14.88 (11)	16.02 (3)	16.13 (3)	17.00 (1)	-
9	-	-	-	15.88 (1)	15.94 (2)	14.32 (6)	14.65 (8)	15.36 (4)	-
10	-	-	-	-	-	-	-	-	-
11	-	16.34 (1)	13.45 (1)	14.65 (2)	15.00 (5)	13.98 (4)	12.89 (3)	10.76 (3)	17.22 (1)

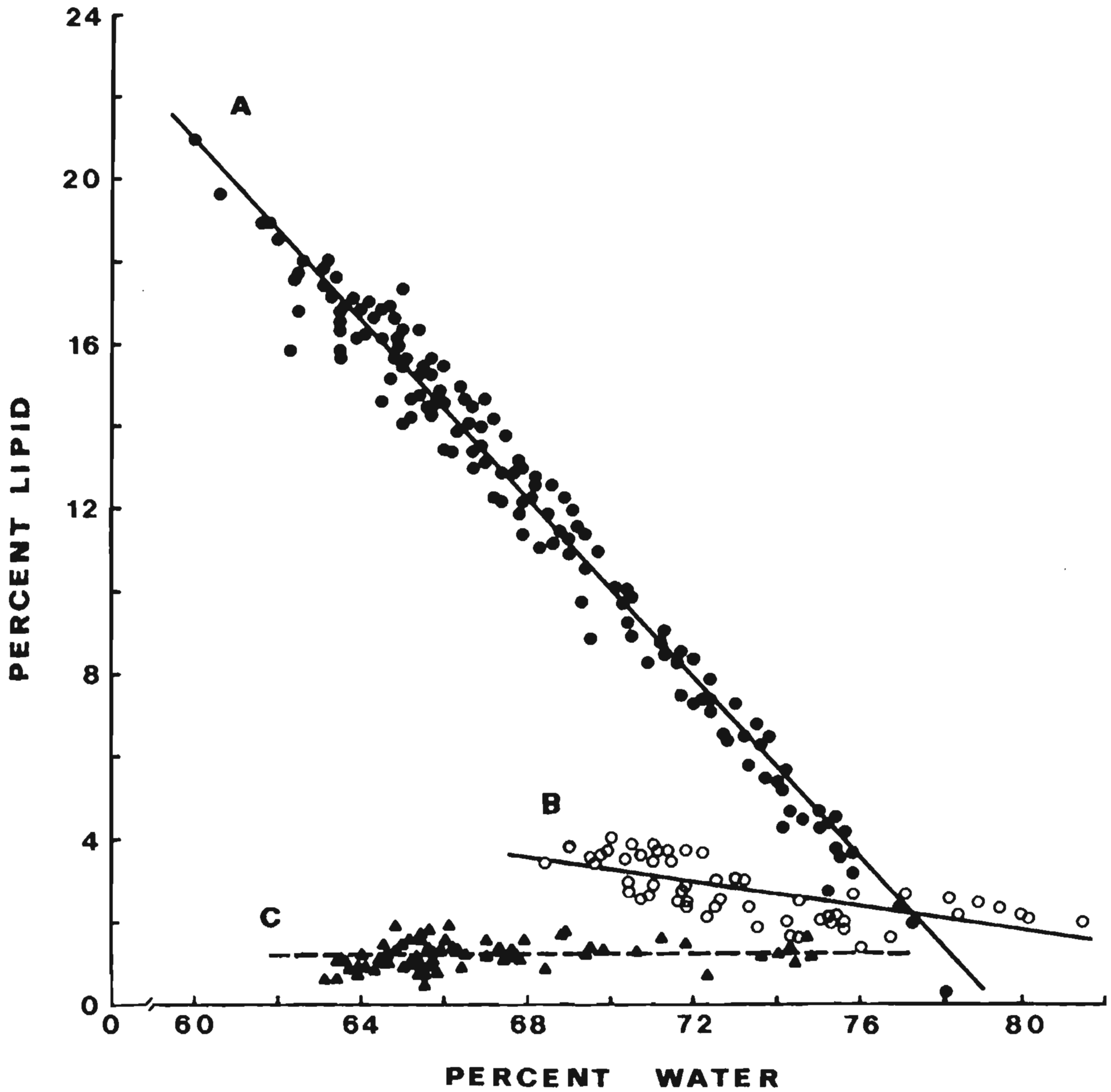

Fig. 6. The relationship between the percent lipid and the percent water of: A, the soma of the combined sexes; B, the testes and C, the ovaries. The regression equation for A is: % lipid = 86.710 − 1.095 (% water); r = −0.98; R^2 = 0.97; n = 140. The regression equation for B is: % lipid = 13.81 − 0.150 (% water); r = −0.70; R^2 = 0.49; n = 59. The dashed line, C, is the mean percent lipid of the ovaries. The sample size of C is 69.

soma:

(6a) Energy = 50.48 + 38.80 (lipid) + 20.30 (solid)

testes:

(6b) Energy = -1.45 + 20.59 (lipid) + 22.07 (solid)

ovaries:

(6c) Energy = -5.80 + 18.13 (lipid) + 25.19 (solid)

The equations are significantly different from each other (t-test, $P < 0.001$). The equation for somatic energy, (6a), was found to be not significantly different (t-test, $P > 0.1$) from the equation,

(7) Energy = 39.75 (lipid) + 20.92 (solid).

The coefficients in equation (7) are those commonly used in the ecological literature (1 g lipid = 9500 cal = 39.75 kj; 1 g solid = 5000 cal = 20.92 kj) (Beamish et al. 1975). However, both equations (6b) and (6c) are significantly different from equation (7) ($P < 0.001$). The use of equations (6b) and (6c) introduces a 4.42% and an 11.79% error, respectively, in the estimation of total energy.

The energy density of a tissue can be estimated by determining the percent water content and then by substituting that value into equations (5) and (6). The calculations can be simplified by deriving one expression for the dependence of energy density on percent water. Energy density was regressed on percent water to obtain the following equations for the soma, the testes and the ovaries respectively:

soma:

(8a) Energy density = 36.17 - 0.400 (% water)

testes:

(8b) Energy density = 24.08 - 0.248 (% water)

ovary:

(8c) Energy density = 25.52 - 0.260 (% water)

The slopes and the elevations of all three lines are significantly different from each other (t-test, $P < 0.001$). The lines are shown in Fig. 8. Kitchell et al. (1977) derived a linear regression between energy density and percent water using data from the literature and their line is presented for comparison.

DISCUSSION

There is a continuous decrease in the body condition index and the somatic energy density of the Atlantic herring throughout the winter and spring. If one assumes, as did Winters (1977), that overwintering herring of the Newfoundland area feed negligibly or not at

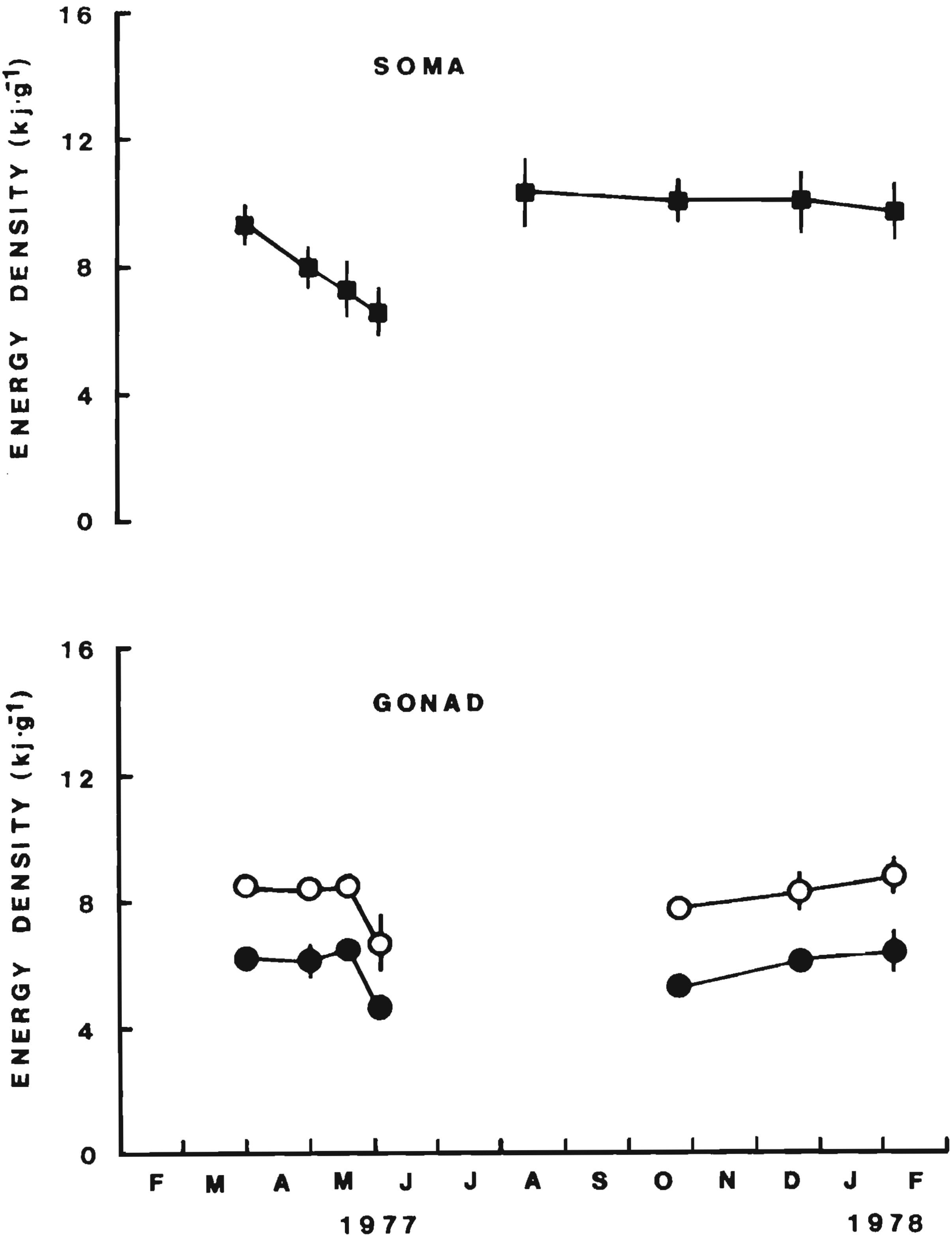

Fig. 7. The annual cycle of the mean (± 1 s.d.) energy density of the soma, the testes and the ovaries. The gonads of the specimens of the August 12 sample were sexed incorrectly and were therefore omitted. The open circles are females, the closed circles are males and the squares are pooled males and females.

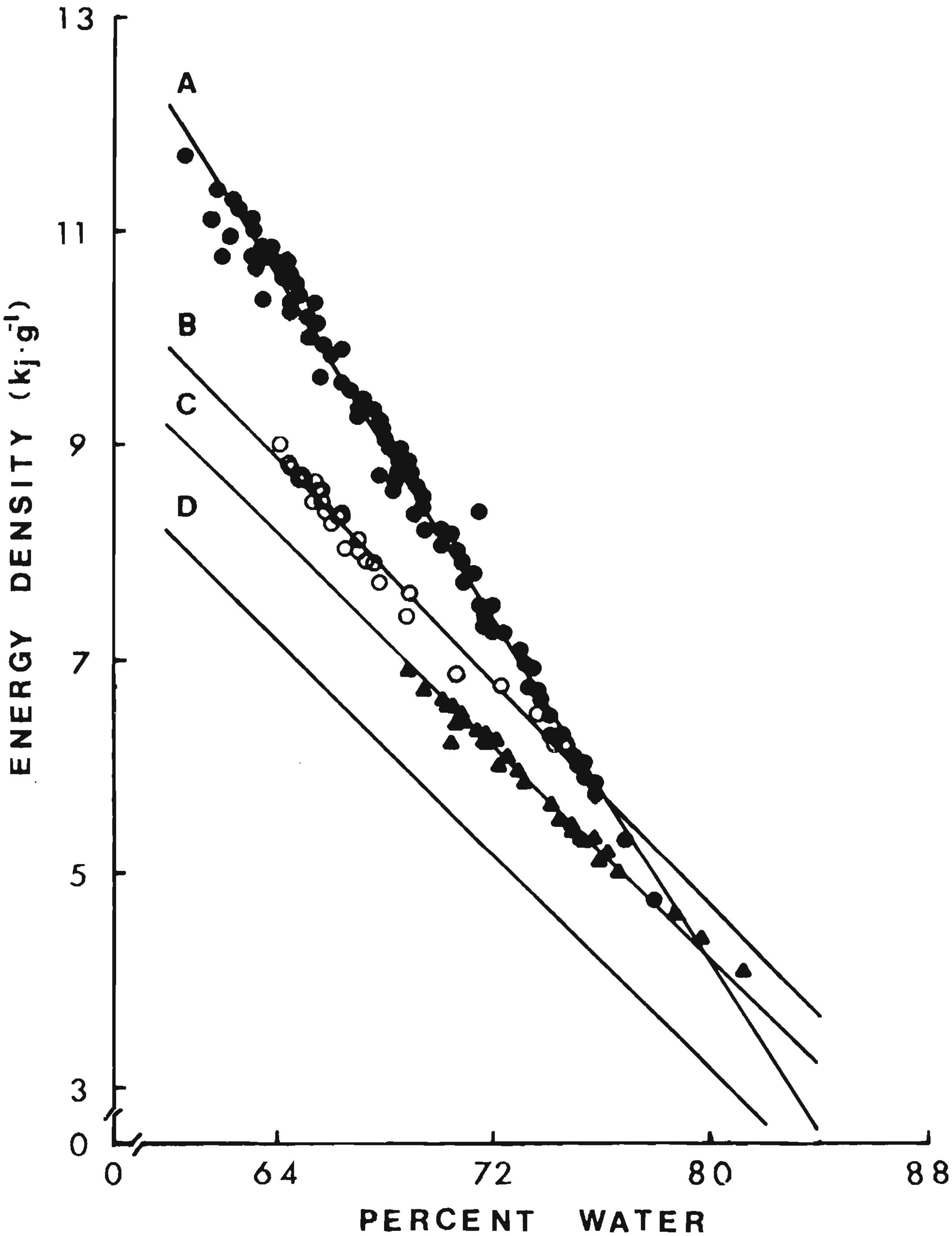

Fig. 8. The relationship between the energy density and the percent water of: A, the soma of the combined sexes; B, the ovaries and C, the testes. The line from Kitchell et al. (1977), D, is presented for comparison. The regression equation of A, B and C are, respectively:

Energy Density = 36.172 - 0.400 (% water); r = -0.99; R^2 = 0.99, n = 121.
Energy Density = 25.522 - 0.260 (% water); r = -0.99; R^2 = 0.99, n = 43.
Energy Density = 24.082 - 0.248 (% water); r = -0.99; R^2 = 0.98; n = 48.

all then this loss of body weight and somatic energy density represents energy expended in metabolism. Making this assumption Winters (1977) calculated a mean overwintering metabolic rate of Atlantic herring.

The significantly higher mean body condition index of the males compared to that of the females of the October 25 sample is most probably the result of the fact that the testes grow faster than the ovaries (Table 2 and Fig. 2B and 2C). This sexual difference in the scheduling of gonad growth is a phenomenon that has also been observed in North Sea herring (Iles 1964). It can be speculated that the testes begin growth sooner than the ovary because the male has a higher total body energy content than the female after spawning. The testes, being approximately half as energy rich as the ovaries would represent less of an energy drain to the pre-spawning male than the ovaries do to a pre-spawning female. This implies that a threshold of body energy exists above which gonad growth is possible but below which gonad growth is suppressed. One piece of supporting evidence for this hypothesis is the observation by Wilkins (1967) that juvenile Atlantic herring that had been starved for four months in captivity did not undergo sexual maturation, whereas their wild counterparts had begun to mature sexually during that period.

There is a large body of data on the seasonal cycle of the percent lipid and the percent water of the flesh and the gonads of many species of fish. Herring have been particularly well studied in this respect (reviewed by McBride et al. 1959; Leim 1957; Stoddard 1967, 1968; Hodder et al. 1973; Ackman and Eaton 1976; Varga et al. 1977). There is general agreement among the aforementioned that the percent lipid of the herring tissue varies seasonally depending upon the amount of food available and upon the state of maturation of the gonads. There is also agreement that the percent lipid and the percent water of the flesh vary inversely with each other and that the percent solid varies little with season.

Hodder et al. (1973) found no correlation between the percent lipid and the length of the fish, which is in agreement with this study (Table 6). They did, however, find that, on the average, females have a 5% higher absolute lipid content than males over the entire range of the lipid content values. It was not tested to determine if there is a statistically significant difference. No significant differences in percent lipid and percent water between sexes were found in this study. Perhaps the 5% difference is related to the sampling method, Hodder et al. (1973) performed whole body analysis while this study considers the body as three separate compartments.

The reported seasonal cycle of percent lipid of Hodder et al. (1973) is virtually identical to that reported here (Fig. 5); a maximum of approximately 15% in January and a minimum of approximately 6% in June, immediately after spawning. They also reported that the lipid/water relationship did not appear to be strictly linear and so fitted the data with a second degree polynomial regression. Since equation (5a) has a very high correlation coefficient ($r = -0.98$) (Fig. 6) and it explains 98% of the variance of the data it is not considered necessary to attempt to improve the fit by using polynomial regression.

The energy density of a tissue can be determined directly by bomb calorimetry or indirectly by conversion of the weights of lipid and solid to energy units with standard energy density factors. The energy density of lipid is commonly reported as 38.91 - 39.75 kj $\cdot$ g^{-1} (Beamish et al. 1975). However, Niimi (1972, referenced in Beamish et al. 1975) reports a value of 35.56 kj $\cdot$ g^{-1} which suggests that the value should be revised or at least reexamined. Also, since solids can consist of differing proportions of protein (23.64 kj $\cdot$ g^{-1}), carbohydrate (16.74 kj $\cdot$ g^{-1}) and ash the energy density coefficient of solid of 20.92 kj $\cdot$ g^{-1} can serve only as a mean value. These standard factors are appropriate for determining the energy content of herring soma but introduce error if used to determine that of the gonads. This is likely due to the difference in the proportions of protein and other solids in the soma and the gonads.

The significant differences between equations (8a), (8b) and (8c) can be explained as due to the differing proportions of lipid, water and solid found in the soma and the gonads. The close fit of these equations (R^2 = 0.99) indicates that they can be used to calculate the energy density of a body compartment with high accuracy. Their use would greatly simplify the task of monitoring the energy content of a herring population should such a program be initiated. The greatest source of inaccuracy in the estimates of energy content would lie in the estimation of the compartment weights.

Kitchell et al. (1977) proposed the following relationship between the energy density and the percent water of fish flesh:

$$\text{Energy density} = 23.17 - 0.25\ (\%\ \text{water}).$$

The slope of the regression is almost indistinguishable from that of equations (8b) and (8c) but is quite different from equation (8a), (Fig. 8). Both (8b) and (8c) have a higher elevation than Kitchell's regression and this is almost certainly due to the fact that many of Kitchell's samples were whole-body samples which include bone. This would tend to lower the energy density of a sample and therefore lower the elevation of Kitchell's regression. The reason for the higher slope of equation (8a), 0.400 as compared to 0.25, lies in the life-history of the herring. It must store large amounts of energy in the form of lipid in its musculature in order to survive long periods of nonfeeding. Therefore the seasonal change in the energy density of the herring soma is greater than most fish, especially if one considers tropical fish such as tuna as did Kitchell et al. (1977).

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APPENDIX 1: Lengths and Weights of Samples

Sample number	Length (cm)	Weight (g)	Sex[1]	Age	Mat. stage	Gonad wt.(g)	Liver wt.(g)	Head wt.(g)	Back wt.(g)
1-002	33.4	327.0	1	-	4	60.8	-	-	-
1-003	31.5	273.0	2	-	4	32.3	-	-	-
1-004	33.6	388.0	1	-	4	79.6	-	-	-
1-006	35.5	367.8	2	-	4	25.6	-	-	-
1-007	35.5	390.0	2	-	4	50.0	-	-	-
1-008	34.4	345.5	1	-	4	74.7	-	-	-
1-010	38.0	399.9	2	-	4	43.8	-	-	-
1-011	33.8	311.5	2	-	4	28.0	-	-	-
1-012	33.5	330.0	1	-	4	54.0	-	-	-
1-013	32.0	288.0	1	-	4	44.6	-	-	-
1-014	35.3	402.0	1	-	4	79.4	-	-	-
1-015	34.0	322.5	1	-	4	59.1	-	-	-
1-016	34.5	352.0	2	-	4	45.8	-	-	-
1-017	35.0	375.0	2	-	4	36.1	-	-	-
1-018	35.0	384.7	2	-	4	49.5	-	-	-
1-019	36.2	437.7	2	-	4	82.2	-	-	-
1-020	33.7	333.2	2	-	4	42.4	-	-	-
1-021	33.7	308.4	2	-	4	29.0	-	-	-
1-022	35.3	356.0	2	-	4	62.1	-	-	-
1-023	33.9	354.5	1	-	4	58.9	-	-	-
1-026	32.4	287.4	1	-	4	45.2	-	-	-
1-027	36.5	385.7	2	-	4	45.0	-	-	-
1-028	31.4	274.0	1	-	4	41.1	-	-	-
1-029	32.7	285.0	1	-	4	46.1	-	-	-
1-030	34.5	361.0	2	-	4	59.7	-	-	-
1-031	32.2	264.2	1	-	4	40.7	-	-	-
1-032	32.0	258.6	2	-	4	29.4	-	-	-
1-033	33.5	330.7	2	-	4	50.6	-	-	-
1-034	29.3	219.2	1	-	4	27.9	-	-	-
1-035	31.5	250.0	2	-	4	21.5	-	-	-
1-036	32.6	300.0	2	-	3	17.5	-	-	-
1-037	34.0	369.1	1	-	4	77.5	-	-	-
1-038	33.5	358.0	1	-	4	71.3	-	-	-
1-039	33.2	317.8	2	-	4	31.5	-	-	-
1-041	34.5	339.2	2	-	4	32.4	-	-	-
1-042	33.5	320.0	2	-	4	40.2	-	-	-
1-043	33.0	343.3	1	-	4	56.5	-	-	-
1-044	35.5	406.0	1	-	4	82.5	-	-	-
1-045	33.6	348.5	2	-	4	46.6	-	-	-
2-001	35.5	436.3	2	11	4	83.7	-	-	-
2-004	35.7	374.5	2	11	4	49.3	-	-	-
2-005	33.7	356.0	1	9	4	69.0	-	-	-
2-006	32.2	307.2	1	8	4	-	-	-	-
2-007	33.8	330.0	2	9	4	57.9	-	-	-
2-008	35.4	393.4	2	11	4	62.0	-	-	-
2-009	34.2	353.8	2	7	4	54.7	-	-	-

[1] 1 = male; 2 = female

Sample number	Length (cm)	Weight (g)	Sex	Age	Mat. stage	Gonad wt.(g)	Liver wt.(g)	Head wt.(g)	Back wt.(g)
2-010	33.3	305.5	1	9	4	51.3	-	-	-
2-011	34.8	362.2	2	5	4	40.0	-	-	-
2-012	34.5	329.9	2	9	4	39.5	-	-	-
2-013	34.9	392.7	1	11	4	76.1	-	-	-
2-014	34.0	350.8	1	8	4	65.3	-	-	-
2-015	35.2	334.9	1	9	4	59.2	-	-	-
2-016	34.8	375.7	1	11	4	78.3	-	-	-
2-017	33.4	316.9	2	5	4	26.2	-	-	-
2-018	34.8	327.2	2	9	4	52.5	-	-	-
2-019	34.5	353.2	1	5	4	52.5	-	-	-
2-020	36.9	421.3	2	11	4	64.1	-	-	-
2-021	35.5	412.6	2	11	4	67.4	-	-	-
2-022	32.5	290.0	2	5	4	31.6	-	-	-
2-023	34.6	354.3	2	9	4	42.9	-	-	-
2-024	33.8	343.9	1	9	4	59.4	-	-	-
2-026	34.8	382.5	2	9	4	71.7	-	-	-
2-027	35.8	430.2	2	11	4	78.0	-	-	-
2-028	34.9	368.1	1	11	4	65.4	-	-	-
2-029	34.5	354.5	2	9	4	53.1	-	-	-
2-030	31.8	266.3	2	5	4	23.3	-	-	-
2-031	37.4	443.5	1	11	4	85.0	-	-	-
2-032	35.1	413.4	2	11	4	73.5	-	-	-
2-033	33.4	283.4	1	8	4	44.2	-	-	-
2-034	32.3	300.0	1	5	4	46.0	-	-	-
2-035	32.5	316.2	2	5	4	35.4	-	-	-
2-037	36.0	431.1	2	11	4	68.6	-	-	-
2-038	35.6	360.3	2	11	4	58.1	-	-	-
2-039	34.7	336.0	2	8	4	32.8	-	-	-
2-040	31.7	368.9	1	5	4	41.5	-	-	-
3-001	34.2	332.3	1	9	4	64.3	-	-	-
3-002	32.7	298.7	1	5	4	47.4	-	-	-
3-003	36.1	408.8	2	11	4	83.4	-	-	-
3-004	34.0	375.0	2	9	4	72.7	-	-	-
3-005	33.2	298.7	1	8	4	46.1	-	-	-
3-006	33.2	360.8	1	11	4	67.7	-	-	-
3-007	33.3	308.4	1	5	4	49.2	-	-	-
3-008	35.3	371.6	2	8	4	64.2	-	-	-
3-009	34.2	359.1	2	9	4	65.7	-	-	-
3-010	32.3	278.9	2	5	4	43.1	-	-	-
3-012	32.8	304.2	1	8	4	55.5	-	-	-
3-020	33.2	299.3	2	5	4	34.2	-	-	-
3-021	33.0	304.1	1	10	4	52.6	-	-	-
3-026	36.0	383.1	2	10	4	61.0	-	-	-
3-027	35.0	385.7	2	9	4	70.5	-	-	-
3-028	34.9	312.9	1	11	4	46.6	-	-	-
3-029	34.4	329.0	1	10	4	62.1	-	-	-
3-030	33.6	297.1	1	8	4	40.0	-	-	-

Sample number	Length (cm)	Weight (g)	Sex	Age	Mat. stage	Gonad wt.(g)	Liver wt.(g)	Head wt.(g)	Back wt.(g)
3-031	34.8	350.0	1	9	4	53.8	-	-	-
3-032	34.0	330.2	2	9	4	39.8	-	-	-
3-033	33.4	285.5	1	5	4	49.6	-	-	-
3-034	34.0	334.2	2	9	4	55.7	-	-	-
3-036	34.6	357.8	2	9	4	61.2	-	-	-
3-038	34.8	373.2	2	6	4	62.1	-	-	-
3-039	34.3	311.9	2	5	4	33.3	-	-	-
3-040	32.7	285.4	1	5	4	44.0	-	-	-
4-001	33.9	310.0	1	8	4	56.0	-	-	-
4-002	34.1	340.3	2	9	4	73.6	-	-	-
4-004	33.5	331.5	2	11	4	62.2	-	-	-
4-005	35.0	328.2	2	9	4	51.1	-	-	-
4-006	33.1	290.9	1	9	4	40.0	-	-	-
4-008	33.1	280.4	1	8	4	36.7	-	26.0	10.1
4-009	33.5	310.7	2	9	4	59.7	-	24.2	14.1
4-010	34.1	352.1	2	9	4	65.0	-	25.8	17.2
4-011	33.4	310.4	1	8	4	53.4	-	23.9	12.6
4-012	33.6	310.0	2	8	4	47.2	-	26.8	13.8
4-013	35.4	385.0	2	11	4	85.7	-	29.0	16.3
4-015	35.5	375.5	2	9	4	65.0	10.6	28.9	13.6
4-016	33.4	305.2	2	8	4	51.7	6.7	24.5	11.0
4-017	33.8	329.2	2	9	4	60.7	6.1	26.2	10.5
4-018	36.2	372.9	1	11	4	56.8	-	31.9	13.8
4-019	34.0	321.8	2	9	4	48.2	6.7	26.3	11.9
4-020	33.6	310.9	2	8	4	60.5	6.5	26.2	10.8
4-021	32.7	255.8	2	8	4	21.8	5.3	23.0	10.0
4-022	34.5	355.1	2	8	4	51.1	9.1	27.4	12.8
4-023	34.3	336.5	2	9	4	60.8	6.7	25.6	11.8
4-024	34.2	301.6	1	9	4	29.2	-	24.9	11.4
4-025	35.8	361.8	1	11	4	48.4	-	31.1	13.7
4-027	36.6	403.3	2	11	4	77.4	9.1	30.8	14.6
4-028	36.4	377.4	1	11	4	67.9	4.4	30.0	13.1
4-029	34.9	338.0	2	9	4	52.3	7.8	27.0	11.5
4-030	34.0	321.4	1	9	4	53.3	3.6	23.8	11.7
4-031	35.3	328.7	2	9	4	65.3	7.0	24.5	12.8
4-032	36.3	397.9	1	9	4	60.5	5.5	28.3	12.8
4-033	33.7	290.0	1	9	4	37.0	3.8	23.7	12.0
4-034	33.3	275.6	1	8	4	38.6	3.0	22.4	9.7
4-035	33.4	288.1	1	8	4	49.9	3.1	23.5	10.6
4-036	33.1	282.9	1	8	4	36.3	3.5	25.1	11.1
4-037	33.6	269.6	1	9	4	36.4	3.7	22.9	11.1
4-038	34.7	-	1	8	4	45.2	4.9	27.1	-
4-039	33.7	297.2	1	9	4	47.2	4.2	25.0	11.1
4-040	33.7	288.1	1	9	4	40.8	3.8	24.2	10.9
5-001	34.9	306.4	1	9	4	40.3	3.32	25.2	19.8

Sample number	Length (cm)	Weight (g)	Sex	Age	Mat. stage	Gonad wt.(g)	Liver wt.(g)	Head wt.(g)	Back wt.(g)
5-002	35.3	369.4	2	11	4	65.1	6.48	26.4	22.9
5-004	34.3	361.0	2	8	4	71.8	4.65	27.4	18.9
5-006	34.9	382.4	2	11	4	74.4	5.23	29.7	18.2
5-007	34.2	294.5	1	9	4	30.1	3.40	26.4	14.0
5-008	33.7	283.4	1	8	4	36.7	3.03	23.8	15.0
5-009	34.6	312.6	1	9	4	62.1	2.65	27.3	16.5
5-010	33.9	301.6	2	11	4	53.1	6.49	25.7	17.3
5-012	32.4	242.3	1	7	4	13.1	3.40	22.9	13.1
5-013	32.0	240.9	2	5	4	21.5	6.37	21.0	13.5
5-014	34.0	273.3	2	9	4	47.7	4.49	23.4	12.1
5-015	32.9	269.6	2	7	4	37.2	6.85	21.8	12.5
5-016	35.1	330.3	2	11	4	55.1	8.36	25.2	15.9
5-018	32.0	218.6	1	8	4	22.5	3.47	22.7	11.0
5-019	32.8	275.0	1	9	4	30.9	2.84	23.5	14.9
5-020	31.4	250.8	2	5	4	33.2	5.63	18.9	10.0
5-021	34.9	347.5	2	10	4	72.5	6.64	27.4	17.1
5-022	32.9	283.1	1	8	4	40.8	3.06	23.2	13.6
5-024	32.5	262.6	2	7	4	39.0	6.16	22.4	13.3
5-025	32.4	228.8	2	6	4	10.6	4.99	21.0	12.5
5-026	33.9	331.1	2	9	4	56.5	6.12	23.8	13.4
5-027	36.5	400.2	2	9	4	99.5	3.29	28.6	15.1
5-030	34.3	335.7	2	9	4	78.1	3.67	24.9	13.6
5-034	35.4	381.4	1	9	4	69.3	5.60	28.6	12.1
5-037	34.8	351.5	1	11	4	38.4	6.75	28.5	14.6
5-038	33.5	266.2	1	5	4	31.6	3.10	20.8	12.7
5-039	33.0	322.7	1	8	4	61.9	2.78	24.8	14.0
5-040	37.0	373.1	2	11	4	55.0	4.23	31.2	17.9
6-001	33.0	265.0	2	8	5	45.4	3.91	22.0	12.0
6-002	33.5	316.0	1	8	5	70.3	2.26	26.0	12.0
6-003	34.6	331.0	1	9	5	59.8	3.06	25.0	14.5
6-004	33.5	268.0	2	9	6	24.5	4.62	24.0	12.5
6-005	33.4	325.0	1	9	5	70.8	3.08	27.0	13.0
6-006	33.6	275.0	2	8	5	48.2	4.51	23.0	10.0
6-007	32.8	277	1	8	5	38.0	2.91	24	9
6-008	33.6	276	1	9	5	53.6	2.91	24	13
6-009	34.4	322	2	9	5	53.4	3.92	27	11
6-010	33.6	279	1	9	5	49.7	2.70	23	9
6-011	29.1	268	1	3	5	9.9	2.15	16	7
6-012	35.5	401	2	11	6	94.5	5.65	31	12
6-013	34.5	316	2	11	6	36.4	3.81	28	10
6-014	34.9	330	1	11	5	39.0	5.30	24	9
6-015	35.3	363	2	9	6	75.7	3.11	28	12
6-016	34.4	302	2	9	6	45.4	2.59	26	13
6-017	31.8	260	1	7	5	38.6	3.67	19	8
6-018	33.9	311	1	8	5	62.8	3.09	24	10
6-019	35.5	309	2	9	6	43.5	3.63	26	12

Sample number	Length (cm)	Weight (g)	Sex	Age	Mat. stage	Gonad wt.(g)	Liver wt.(g)	Head wt.(g)	Back wt.(g)
6-020	32.9	249	2	8	6	33.5	2.87	23	11
6-022	32.1	263	1	8	5	42.8	2.86	22	8
6-023	32.7	325	2	8	5	67.5	3.10	25	9
6-024	33.8	311	1	8	5	55.2	2.58	24	10
6-025	32.0	264	1	8	5	48.1	3.38	23	11
6-026	30.9	245	2	4	5	18.3	5.72	18	9
7-002	36.4	335.2	1	11	2	4.5	5.59	30.5	14.7
7-003	36.0	326.5	1	11	2	5.2	6.66	26.2	13.5
7-005	33.4	262.6	2	8	2	3.5	4.43	23.5	11.7
7-006	33.3	320.0	1	8	2	13.0	7.48	25.0	11.2
7-007	35.7	329.3	1	11	2	4.8	5.85	28.4	14.6
7-009	34.8	329.4	2	9	2	3.0	5.99	24.9	11.5
7-010	33.9	313.3	1	9	2	6.5	6.30	23.9	10.0
7-011	33.6	292.6	2	8	2	4.6	6.92	23.0	9.7
7-012	33.7	311.3	1	9	2	6.1	5.82	25.1	9.3
7-013	35.1	300.0	2	8	2	3.5	6.34	26.6	11.1
7-014	34.0	321.0	1	9	2	4.6	5.81	24.9	9.6
7-016	33.8	271.4	2	9	2	3.2	3.41	25.7	11.4
7-017	36.0	340.4	2	11	2	5.1	5.32	26.5	11.8
7-018	35.0	318.3	2	10	2	4.6	5.96	24.7	11.2
7-019	34.0	279.6	1	9	2	4.5	3.52	23.7	10.3
7-020	34.4	315.1	1	9	2	3.6	5.62	24.0	10.7
7-021	35.1	335.6	1	11	2	3.1	4.74	32.9	13.1
7-023	34.1	309.7	1	11	2	5.7	4.14	25.2	-
7-024	34.1	300.0	1	9	2	2.2	6.59	25.4	-
7-025	33.6	295.8	2	9	2	4.0	6.10	23.8	-
7-026	34.2	296.2	1	9	2	4.2	5.01	25.3	-
7-027	35.3	334.1	1	11	2	4.8	5.32	27.2	-
7-028	33.4	301.3	2	9	2	4.5	4.69	24.3	-
8-002	34.9	376.6	1	11	4	68.8	2.97	29.3	12.5
8-003	35.1	349.4	2	11	4	28.9	6.38	28.8	11.9
8-004	33.8	310.0	1	9	4	40.7	3.69	24.9	10.1
8-005	33.5	317.3	1	9	4	65.7	1.80	24.8	9.1
8-006	34.9	336.2	2	11	4	24.9	7.46	25.9	12.1
8-007	35.4	338.9	1	11	4	47.1	4.77	28.5	12.1
8-008	32.4	270.3	2	9	4	17.2	5.38	23.2	9.1
8-009	35.7	391.1	2	11	4	21.3	7.88	31.7	11.7
8-010	34.5	306.1	2	11	3	13.1	5.57	27.5	11.7
8-011	34.9	330.2	1	11	4	61.8	2.50	27.5	12.6
8-012	33.3	293.3	2	9	4	23.5	5.70	24.6	11.4
8-013	36.6	364.3	2	11	3	12.2	5.75	31.3	13.6
8-014	33.6	299.2	2	9	4	19.3	6.42	25.0	10.6
8-016	33.7	299.7	1	9	4	39.1	2.42	25.9	10.8
8-017	33.5	293.2	1	9	4	48.3	2.83	25.0	11.3
8-018	35.0	344.4	1	9	4	38.2	3.18	27.1	11.9
8-019	32.8	263.6	2	9	4	17.8	5.48	24.7	11.2
8-020	33.2	296.3	1	9	4	53.9	1.93	25.0	9.9

Sample number	Length (cm)	Weight (g)	Sex	Age	Mat. stage	Gonad wt.(g)	Liver wt.(g)	Head wt.(g)	Back wt.(g)
8-021	33.4	317.1	1	9	4	53.7	1.89	24.4	9.4
8-022	33.9	326.1	1	9	4	57.9	3.06	22.9	10.4
8-023	33.3	309.6	2	9	3	17.5	6.71	26.3	10.1
8-024	33.9	313.5	1	9	4	56.3	1.96	24.6	9.8
8-025	33.6	284.8	2	9	3	15.0	5.41	25.2	11.9
8-026	34.0	305.0	1	9	4	49.6	2.29	26.2	11.4
8-027	33.4	328.8	1	9	4	57.8	2.52	23.3	10.7
8-028	34.3	305.1	2	9	4	20.4	6.83	26.0	11.5
8-029	34.5	317.9	2	9	3	19.4	6.71	27.5	10.7
8-030	34.5	288.6	2	11	3	15.8	4.49	27.5	11.0
8-031	33.9	278.5	2	9	3	13.9	4.86	24.5	9.9
8-032	33.2	312.5	1	9	4	47.5	3.01	23.9	10.6
8-033	35.7	379.1	1	11	4	64.0	2.29	30.6	-
8-034	34.0	325.3	1	9	4	40.6	2.40	24.4	-
8-035	34.2	298.1	2	9	3	17.2	6.60	26.4	-
8-036	33.9	280.8	2	9	3	15.6	6.37	24.9	-
8-037	33.8	324.5	2	9	4	25.5	5.77	28.4	-
8-038	32.0	284.6	1	8	4	56.2	1.57	23.9	-
8-039	32.7	283.6	1	8	4	46.9	2.14	25.1	-
8-040	33.4	299.8	2	10	3	18.1	6.17	25.4	-
8-041	32.7	311.4	1	8	4	58.0	2.18	23.6	-
8-042	34.7	313.6	2	10	3	18.2	4.45	29.1	-
8-043	34.5	323.2	1	9	4	56.5	2.25	27.3	-
8-044	35.9	342.1	2	11	4	27.6	6.27	30.7	-
8-045	33.8	285.0	2	9	3	18.8	4.48	25.8	-
8-046	33.9	292.8	2	9	3	13.0	5.78	26.3	-
8-047	34.5	312.2	2	9	3	14.2	6.04	26.6	-
9-001	33.9	315.5	2	9	4	29.3	7.26	25.3	15.9
9-002	35.7	383.7	2	9	4	44.6	13.50	31.4	21.1
9-003	35.0	308.5	1	9	4	50.6	2.98	28.5	16.3
9-004	36.2	392.2	1	11	4	82.0	3.48	31.8	19.5
9-005	36.3	350.2	2	11	4	21.7	7.57	30.5	16.3
9-006	33.9	341.3	1	11	4	57.5	3.19	29.3	15.2
9-007	36.1	416.3	1	11	4	78.2	3.27	30.2	19.0
9-008	34.4	368.4	1	9	4	66.1	3.03	28.0	16.4
9-009	35.1	359.6	2	11	4	29.3	9.26	29.2	15.3
9-010	32.3	260.9	1	5	4	30.0	2.34	22.5	12.0
9-011	35.1	345.4	2	11	4	44.8	7.32	30.3	12.1
9-012	35.0	360.5	1	9	4	67.2	3.69	26.4	12.2
9-013	35.5	351.5	1	11	4	63.0	2.76	28.2	12.2
9-014	35.0	335.2	2	11	4	33.4	7.08	26.7	12.4
9-015	35.6	401.9	1	9	4	75.7	3.31	31.3	15.5
9-016	34.8	374.9	1	5	4	69.4	2.55	25.6	15.1
9-017	36.5	393.4	2	11	4	18.3	8.12	32.2	17.0
9-018	35.7	381.2	2	11	4	36.3	10.53	29.4	16.0
9-019	35.6	420.9	1	11	4	88.5	3.32	30.4	13.3
9-020	37.7	506.5	1	11	4	87.9	5.74	37.0	15.0
9-021	35.3	385.9	2	11	4	33.0	10.29	30.0	15.0

Sample number	Length (cm)	Weight (g)	Sex	Age	Mat. stage	Gonad wt.(g)	Liver wt.(g)	Head wt.(g)	Back wt.(g)
9-022	34.8	355.5	2	11	4	35.5	8.39	27.0	11.8
9-023	35.4	372.6	2	11	4	57.5	6.48	29.7	13.9
9-024	35.5	372.0	2	11	4	46.5	8.49	26.8	14.7
10-001	36.0	390.1	2	11	4	62.0	7.68	31.4	11.6
10-002	33.6	314.6	2	6	4	54.7	4.72	22.9	9.9
10-003	35.7	378.2	1	6	4	77.4	2.77	25.4	12.2
10-004	34.2	313.9	2	5	4	27.8	6.34	24.2	11.0
10-005	37.6	466.9	2	11	4	78.8	7.33	31.9	12.8
10-006	35.4	381.1	2	6	4	63.2	4.16	26.1	10.4
10-007	31.2	242.9	1	4	4	29.3	2.29	18.2	7.9
10-008	32.1	258.5	1	4	4	26.7	2.38	19.7	8.0
10-009	35.1	360.9	2	6	4	29.7	9.49	28.5	10.9
10-010	30.7	241.8	1	4	4	35.5	1.87	18.6	7.3
10-011	36.3	400.6	1	11	4	81.7	3.25	31.2	11.0
10-012	32.6	246.9	2	4	4	13.4	5.43	20.7	7.9
10-013	36.3	463.2	1	11	4	108.4	3.27	31.3	11.6
10-014	35.6	397.5	1	11	4	70.0	3.71	30.4	10.9
10-015	30.5	224.5	1	4	4	19.0	2.05	17.0	7.8
10-016	36.8	411.2	2	11	4	58.6	7.46	29.2	11.1
10-017	36.8	399.1	2	11	4	56.7	8.01	29.3	11.6
10-018	32.6	288.3	2	4	4	36.3	5.05	20.6	7.8
10-019	34.4	345.3	1	11	4	62.4	2.69	27.5	9.8
10-020	36.0	378.0	2	11	4	51.7	10.18	30.0	11.6
10-021	35.1	356.9	2	6	4	33.7	6.06	25.7	10.6
10-022	32.9	317.8	1	6	4	66.3	2.91	23.1	8.7
10-023	31.3	247.6	1	4	4	38.9	1.89	18.8	6.7
10-024	30.9	261.7	1	4	4	49.0	1.71	19.2	7.7
11-001	33.0	277.2	2	5	4	21.1	5.69	22.2	10.0
11-002	36.1	393.8	2	11	4	59.4	8.95	28.1	14.1
11-003	35.3	322.5	2	10	4	43.8	8.12	25.6	12.0
11-004	32.1	259.4	1	4	4	29.3	2.35	19.8	10.0
11-005	35.5	340.0	1	10	4	55.4	3.47	29.0	13.0
11-006	35.1	394.0	1	10	4	65.0	3.84	29.0	12.2
11-007	34.5	322.7	1	10	4	60.6	2.37	23.6	12.0
11-008	34.7	290.0	2	5	4	37.5	4.70	25.0	12.0
11-009	33.9	328.6	2	10	4	48.3	6.50	26.0	9.9
11-010	37.5	423.8	2	11	4	72.2	8.97	31.9	14.3
11-011	33.6	309.2	1	6	4	52.9	2.41	22.6	10.6
11-012	33.2	267.5	2	5	4	34.3	3.49	20.3	9.7
11-013	34.1	307.2	1	10	4	51.8	3.71	24.3	11.0
11-014	30.6	228.2	1	4	4	43.7	1.93	16.4	7.2
11-015	34.8	348.5	2	10	4	44.6	6.88	27.6	11.3
11-016	36.1	358.9	2	11	4	41.2	7.83	28.2	11.6
11-017	33.3	264.1	1	6	4	42.6	-	22.3	10.3
11-018	31.6	216.9	2	4	4	13.5	3.58	18.4	9.1
11-019	33.9	322.1	2	7	4	33.2	8.44	27.3	10.0
11-020	36.2	360.9	1	10	4	63.2	2.44	28.3	14.2

Sample number	Length (cm)	Weight (g)	Sex	Age	Mat. stage	Gonad wt.(g)	Liver wt.(g)	Head wt.(g)	Back wt.(g)
11-021	34.6	313.6	2	10	4	44.0	6.68	24.9	10.2
11-022	36.1	382.7	1	11	4	68.3	3.11	34.7	14.0
11-023	33.6	271.7	1	10	4	39.3	2.50	24.4	10.8
11-024	33.7	279.5	1	5	4	45.0	1.89	22.1	9.9

APPENDIX 2: Percent Lipid and Percent Water

Sample number	% Lipid soma	% Lipid testes	% Lipid ovary	% Water soma	% Water testes	% Water ovary
2-001	12.57	-	1.03	68.22	-	65.16
2-004	11.53	-	0.89	68.79	-	66.37
2-005	13.55	4.07	-	66.94	70.02	-
2-006	17.13	2.83	-	63.30	75.22	-
2-008	15.34	-	0.86	65.70	-	65.02
2-009	14.07	-	1.24	66.60	-	64.73
2-010	13.27	3.57	-	67.47	71.32	-
2-011	16.85	-	1.01	-	-	65.36
2-012	15.72	-	1.20	65.67	-	66.56
2-013	17.42	3.75	-	65.04	71.07	-
2-014	14.71	3.89	-	67.01	71.01	-
2-015	9.08	3.68	-	71.33	72.19	-
2-016	12.82	3.74	-	68.06	71.23	-
2-017	16.24	-	1.16	64.79	-	67.73
2-018	14.96	-	1.44	66.34	-	63.96
2-019	16.96	3.74	-	63.73	71.68	-
2-020	16.41	-	1.62	65.40	-	65.15
2-021	13.97	-	0.99	66.91	-	64.74
2-022	16.75	-	1.75	64.54	-	65.37
2-023	12.29	-	1.61	68.07	-	65.37
3-001	11.02	3.51	-	69.68	70.37	-
3-002	16.29	2.55	-	64.90	74.54	-
3-003	14.18	-	1.12	67.18	-	64.44
3-004	12.91	-	0.86	67.98	-	64.32
3-005	11.42	3.52	-	69.36	71.00	-
3-006	10.11	3.65	-	70.39	70.72	-
3-007	14.71	3.06	-	66.49	72.52	-
3-008	12.59	-	0.95	68.61	-	64.99
3-009	-	-	1.19	-	-	64.58
3-010	15.28	-	1.10	65.16	-	64.68
3-012	-	3.91	-	-	70.52	-
3-020	15.45	-	1.95	65.99	-	66.06
3-021	8.80	3.55	-	71.18	70.35	-
3-026	14.54	-	1.05	66.72	-	64.60
3-027	13.80	-	0.99	67.52	-	65.57
3-028	8.47	3.60	-	71.29	69.47	-
3-029	5.70	3.48	-	74.18	71.38	-
3-030	6.46	3.63	-	73.15	69.75	-
3-031	12.77	3.03	-	68.20	73.20	-
3-032	15.03	-	1.60	66.42	-	67.00
3-033	11.30	3.77	-	69.42	71.79	-
3-034	13.88	-	1.21	66.43	-	64.73
3-036	11.99	-	1.12	69.10	-	64.48
3-038	12.94	-	1.95	67.44	-	64.81
3-039	13.15	-	1.29	66.95	-	65.70

Sample number	% Lipid			% Water		
	soma	testes	ovary	soma	testes	ovary
3-040	11.61	2.92	-	69.18	71.78	-
4-001	-	-	-	71.71	71.47	-
4-002	-	-	-	68.54	-	65.47
4-004	-	-	-	71.69	-	66.25
4-005	-	-	-	69.19	-	66.37
4-006	-	-	-	68.41	71.66	-
4-008	-	-	-	71.45	72.23	-
4-009	-	-	-	70.67	-	65.47
4-010	-	-	-	70.14	-	65.56
4-011	-	-	-	68.90	72.60	-
4-012	-	-	-	71.01	-	66.36
4-013	-	-	-	71.12	-	65.64
4-018	-	-	-	69.07	71.92	-
4-024	-	-	-	69.53	76.28	-
4-025	-	-	-	70.85	71.65	-
5-001	8.95	2.55	-	70.48	71.79	-
5-002	8.37	-	1.42	72.02	-	65.59
5-004	9.75	-	1.11	70.34	-	65.67
5-006	11.26	-	0.97	68.96	-	64.11
5-007	5.21	2.70	-	73.87	70.86	-
5-008	3.84	3.02	-	75.41	70.50	-
5-009	6.37	2.97	-	72.84	71.01	-
5-010	4.16	-	0.81	75.60	-	65.78
5-012	5.20	2.82	-	74.06	71.67	-
5-013	9.76	-	1.07	69.25	-	65.62
5-014	7.09	-	1.52	72.38	-	64.94
5-015	5.39	-	1.08	74.03	-	67.42
5-016	9.86	-	0.77	70.46	-	65.35
5-018	4.41	2.92	-	75.16	70.87	-
5-019	8.60	2.53	-	71.74	71.64	-
5-020	10.60	-	0.52	69.42	-	65.51
5-021	6.75	-	0.73	73.52	-	65.52
5-022	3.61	-	-	75.46	75.85	-
5-024	5.51	-	1.01	73.65	-	65.26
5-025	-	-	-	70.91	-	-
5-026	7.33	-	-	72.40	-	65.01
5-027	6.56	-	1.53	72.69	-	71.76
5-030	-	-	1.41	75.51	-	69.48
5-034	9.99	-	-	70.06	69.91	-
5-037	-	-	-	70.64	70.55	-
5-038	-	-	-	70.91	70.17	-
5-039	-	-	-	71.74	68.92	-
5-040	8.30	-	-	71.58	-	67.97
6-001	6.28	-	1.59	73.55	-	65.99
6-002	3.24	2.22	-	75.83	79.83	-

Sample number	% Lipid			% Water		
	soma	testes	ovary	soma	testes	ovary
6-003	6.58	2.10	-	73.17	79.98	-
6-004	8.34	-	1.35	70.91	-	76.02
6-005	4.52	2.28	-	74.56	79.38	-
6-006	4.70	-	1.36	75.00	-	67.57
6-007	5.84	2.51	-	73.34	78.82	-
6-008	2.36	2.36	-	76.85	79.26	-
6-009	4.33	-	2.05	75.03	-	72.28
6-010	0.31	2.02	-	78.00	81.29	-
6-011	7.48	-	-	71.65	-	-
6-012	4.72	-	1.17	74.28	-	73.56
6-013	4.29	-	1.43	74.10	-	74.30
6-014	7.19	2.22	-	72.00	78.33	-
6-015	7.33	-	1.69	72.05	-	74.67
6-016	4.55	-	1.14	75.41	-	74.92
6-017	3.70	2.71	-	75.78	75.78	-
6-018	7.19	2.59	-	73.02	78.10	-
6-019	6.46	-	1.07	73.77	-	74.37
6-020	7.85	-	1.28	72.43	-	74.02
6-021	10.94	-	-	69.00	-	-
6-022	2.03	2.68	-	77.16	77.09	-
6-023	9.08	-	1.81	71.18	-	68.92
6-024	-	-	-	71.30	78.20	-
6-025	-	-	-	77.00	81.20	-
6-026	-	-	-	71.30	-	66.60
7-002	16.58	-	-	63.47	-	-
7-003	18.08	-	-	62.56	-	-
7-005	19.66	-	-	60.62	-	-
7-006	18.95	-	-	61.80	-	-
7-007	18.97	-	-	61.56	-	-
7-009	16.15	-	-	64.47	-	-
7-010	17.84	-	-	62.50	-	-
7-011	16.36	-	-	63.50	-	-
7-012	17.80	-	-	63.11	-	-
7-013	11.07	-	-	68.25	-	-
7-014	18.59	-	-	62.02	-	-
7-016	11.89	-	-	67.84	-	-
7-017	17.30	-	-	63.16	-	-
7-018	17.46	-	-	63.13	-	-
7-019	12.19	-	-	67.88	-	-
7-020	14.49	-	-	65.59	-	-
7-021	17.92	-	-	63.11	-	-
8-003	18.04	-	1.18	63.14	-	66.45
8-006	18.14	-	1.09	63.15	-	67.84
8-007	13.20	1.66	-	67.84	76.72	-
8-008	16.68	-	1.72	64.76	-	68.78
8-009	17.16	-	1.43	63.82	-	67.25

Sample number	% Lipid soma	% Lipid testes	% Lipid ovary	% Water soma	% Water testes	% Water ovary
8-010	13.04	-	-	67.89	-	-
8-011	-	2.18	-	-	75.42	-
8-012	14.62	-	-	65.92	-	-
8-013	17.00	-	-	63.64	-	-
8-014	14.59	-	-	66.02	-	-
8-016	13.74	1.42	-	67.60	76.01	-
8-017	14.93	2.12	-	65.87	75.03	-
8-018	16.89	1.86	-	64.04	75.59	-
8-019	14.85	-	-	65.93	-	-
8-020	12.34	-	-	68.89	-	-
8-021	15.70	2.15	-	65.10	75.36	-
8-022	17.04	1.91	-	64.73	75.74	-
8-024	16.90	2.21	-	64.51	75.19	-
8-025	16.38	-	-	64.23	-	-
8-026	11.93	2.07	-	68.52	75.63	-
8-027	15.53	2.02	-	65.48	75.30	-
8-029	-	-	1.58	-	-	67.89
8-030	-	-	1.65	-	-	71.22
8-031	-	-	1.35	-	-	69.77
8-036	-	-	1.22	-	-	69.38
8-044	-	-	0.90	-	-	68.38
8-047	-	-	0.74	-	-	72.26
9-001	15.90	-	1.30	63.47	-	65.68
9-002	15.19	-	1.35	64.65	-	65.87
9-003	14.10	2.42	-	65.03	71.80	-
9-004	14.25	2.41	-	65.20	73.25	-
9-005	14.65	-	1.41	64.49	-	66.27
9-006	15.97	2.65	-	65.38	72.59	-
9-007	16.15	2.79	-	63.91	70.41	-
9-008	16.43	2.95	-	63.52	70.46	-
9-009	12.88	-	1.41	67.69	-	65.65
9-010	15.88	2.05	-	62.33	74.20	-
9-011	12.37	-	0.93	71.52	-	64.17
9-012	10.15	3.10	-	70.11	73.01	-
9-013	14.23	2.41	-	65.68	72.49	-
9-014	17.65	-	1.17	62.38	-	65.28
9-015	15.73	2.15	-	64.78	72.27	-
9-016	14.34	2.65	-	65.68	70.74	-
9-017	16.37	-	1.28	64.99	-	70.55
9-018	12.98	-	1.36	66.68	-	64.80
9-019	16.74	-	-	64.33	-	-
9-021	17.05	-	1.50	64.17	-	64.48
9-022	13.25	-	1.13	67.17	-	66.98
11-001	13.43	-	1.85	66.66	-	65.61
11-002	-	-	1.09	-	-	63.43

Sample number	% Lipid soma	% Lipid testes	% Lipid ovary	% Water soma	% Water testes	% Water ovary
11-003	14.77	-	0.65	65.35	-	63.42
11-004	15.86	1.71	-	-	74.33	-
11-005	11.14	1.88	-	68.74	73.53	-
11-006	12.76	3.76	-	68.21	69.88	-
11-007	11,40	3.45	-	67.94	69.62	-
11-008	13.36	-	0.63	65.69	-	63.13
11-009	14.63	-	0.94	65.73	-	63.91
11-010	17.22	-	1.11	63.34	-	63.64
11-011	12.26	3.00	-	67.23	70.36	-
11-012	15.66	-	0.88	63.49	-	63.66
11-013	14.31	3.45	-	65.73	68.36	-
11-014	16.34	1.63	-	64.06	74.51	-
11-015	16.85	-	0.76	62.48	-	63.85
11-016	8.87	-	-	69.53	-	-
11-017	14.74	-	-	65.16	-	-
11-018	13.45	-	-	65.47	-	-
11-019	17.71	-	1.39	63.37	-	66.15
11-020	11.18	-	-	68.61	-	-
11-022	12.22	3.84	-	67.42	68.96	-

Sample number	Head % lipid	Head % water
7-027	9.07	69.23
7-028	9.07	69.23
11-008	11.37	67.99
11-009	11.31	68.98
11-010	11.53	68.80

APPENDIX 3: Energy Density

Sample number	Energy Density (kilojoules/g wet wt.) soma	testes	ovary	head
3-002	10.474	5.499	-	-
3-003	9.444	-	8.802	-
3-004	9.063	-	-	-
3-005	8.491	6.415	-	-
3-008	8.968	-	8.667	-
3-010	10.016	-	-	-
3-012	-	6.217	-	-
3-028	-	6.718	-	-
3-031	8.966	5.835	-	-
3-032	9.787	-	8.091	-
3-034	9.584	-	8.685	-
3-039	9.270	-	8.414	-
3-040	8.608	6.215	-	-
4-001	7.258	6.329	-	-
4-002	8.754	-	8.553	-
4-004	7.423	-	8.317	-
4-005	8.459	-	8.321	-
4-006	8.653	-	-	-
4-008	7.495	6.253	-	-
4-009	7.984	-	-	-
4-010	8.035	-	8.559	-
4-011	8.647	6.084	-	-
4-012	7.735	-	8.340	-
4-013	7.688	-	8.512	-
4-018	8.340	6.232	-	-
4-024	8.194	5.207	-	-
4-025	7.924	6.306	-	-
5-001	7.973	6.312	-	-
5-002	7.497	-	8.511	-
5-004	8.125	-	8.502	-
5-006	8.725	-	8.981	-
5-007	6.574	6.498	-	-
5-008	5.934	6.578	-	-
5-009	7.038	6.445	-	-
5-010	5.918	-	8.350	-
5-012	6.477	6.243	-	-
5-013	8.483	-	-	-
5-014	7.253	-	8.702	-
5-015	-	-	7.903	-
5-016	8.164	-	8.638	-
5-018	6.034	6.484	-	-
5-020	8.415	-	8.506	-
5-021	6.920	-	8.481	-
5-024	6.720	-	-	-

Sample number	Energy Density (kilojoules/g wet wt.) soma	testes	ovary	head
5-037	7.884	6.592	-	-
5-038	7.735	6.625	-	-
5-039	7.500	6.891	-	-
6-001	-	-	8.240	-
6-002	5.751	4.383	-	-
6-003	6.956	4.358	-	-
6-004	7.712	-	5.777	-
6-005	6.310	4.472	-	-
6-006	6.097	-	7.868	-
6-007	6.743	4.622	-	-
6-008	5.328	4.457	-	-
6-009	6.065	-	6.753	-
6-010	4.745	4.078	-	-
6-011	7.323	-	-	-
6-012	6.357	-	6.484	-
6-013	6.290	-	6.193	-
6-014	7.269	4.745	-	-
6-015	7.262	-	6.201	-
6-016	6.040	-	6.092	-
6-017	5.842	5.326	-	-
6-018	7.079	4.742	-	-
6-019	6.631	-	6.201	-
6-020	7.198	-	6.289	-
6-021	7.066	-	-	-
6-023	7.761	-	7.591	-
6-026	7.783	-	-	-
7-002	10.707	-	-	-
7-003	11.214	-	-	-
7-005	11.685	-	-	-
7-006	11.376	-	-	-
7-007	11.112	-	-	-
7-009	10.253	-	-	-
7-010	10.942	-	-	-
7-011	10.373	-	-	-
7-012	10.772	-	-	-
7-013	8.564	-	-	-
7-014	10.772	-	-	-
7-016	8.709	-	-	-
7-017	10.662	-	-	-
7-018	10.710	-	-	-
7-019	8.680	-	-	-
7-020	9.635	-	-	-
7-021	10.757	-	-	-
7-024	-	-	-	6.735
7-025	-	-	-	6.802
7-026	-	-	-	6.735

Sample number	Energy Density (kilojoules/g wet wt.) soma	testes	ovary	head
8-003	11.013	-	8.016	-
8-006	11.119	-	7.687	-
8-007	9.234	5.012	-	-
8-008	10.399	-	7.398	-
8-009	10.839	-	7.889	-
8-010	9.155	-	-	-
8-011	-	5.314	-	-
8-012	9.892	-	-	-
8-013	10.763	-	-	-
8-014	9.843	-	-	-
8-016	9.325	5.109	-	-
8-017	9.930	5.377	-	-
8-018	10.705	5.276	-	-
8-019	9.949	-	-	-
8-020	8.840	-	-	-
8-021	10.197	5.340	-	-
8-022	10.521	5.285	-	-
8-024	10.593	5.371	-	-
8-025	10.565	-	-	-
8-026	8.835	5.281	-	-
8-027	10.130	5.329	-	-
9-001	-	-	8.443	-
9-002	10.430	-	-	-
9-004	10.122	-	-	-
9-005	10.325	-	8.286	-
9-006	10.328	6.090	-	-
9-007	10.663	6.557	-	-
9-008	10.854	-	-	-
9-009	9.224	-	8.466	-
9-010	10.961	5.642	-	-
9-011	8.355	8.901	-	-
9-012	8.196	5.966	-	-
9-013	9.953	6.039	-	-
9-014	11.288	-	8.439	-
9-015	10.179	6.016	-	-
9-016	9.935	6.410	-	-
9-017	10.478	-	6.874	-
9-018	9.508	-	8.673	-
9-021	10.717	-	8.765	-
9-022	9.307	-	7.984	-