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INTERNAL DOCUMENT 242

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BIOMASS ANALYSIS OF ZOOPLANKTON COLLECTED AT 39°30'N 15°W to 46°N 14°W.

Richard M. Hull

1985

c/o Institute of Oceanographic Sciences
Wormley, Godalming, Surrey, GU8 5UB.

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NATURAL ENVIRONMENT RESEARCH COUNCIL
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CONTENTS

1. SAMPLING TECHNIQUES

The data contained within this report was collected on a scientific cruise made in March 27th - April 24th 1984 by RRS Discovery. The cruise (no. 146) was a joint physical/biological investigation carried out between 39°30'N and 46°14'N. The area is of interest as it is a transitional zone between deep water mixing coupled with seasonal thermal stratification in the North, with a region characterised by permanent thermal stratification in the South. The biological work of Cruise 146 was concerned with the effect of the physical changes of thermal stratification on the pelagic communities within this area. Consequently, a total of 32 trawls were made at the two sites, the positions of which can be found in Table 1. The samples were collected using an acoustically controlled multiple open and closing net system known as the RMT 1+8M. This consists of 3 pairs of nets which open and close sequentially. Each pair of nets (RMT 1+8) consists of a 0.32mm mesh plankton net (RMT 1) and 4.5mm mesh micronekton net (RMT 8). A monitor, attached, acoustically transmits depth, flow, temp., status of net (open or closed) and if a photometer is fitted the amount and quality of light present. In addition, the monitor receives acoustic commands from the surface and relays these to the release gear.

For this study, only material from the RMT 1 nets was used. Each RMT 1 net has a $1m^2$ mouth and was fitted with a cod-end sieve, in order to split the catches into 3 size fractions, namely >4.5mm, 1.0 - 4.5mm and 0.32 - 1.0mm. The > 4.5mm size material was preserved for reference, whilst the 0.32 - 1.0mm and 1.0 - 4.5mm fractions were halved using a Folsom splitter. One half was preserved in 5% seawater formalin, whilst the other half was deep frozen subsequent to the analysis of biomass back in the laboratory at IOS.

2. BIOMASS MEASUREMENTS FOR CRUISE 146

METHODS

In order to carry out the series of experiments on biomass measurements the samples were removed from the freezer and allowed to thaw for 10 - 30 minutes depending upon the sample size.

(a) Displacement Volume

Once thawed, the sample was washed from its tin/petri-dish into a 100cm^3 measuring cylinder and made up to the 100cm^3 mark with further additions of distilled water. The volume of distilled water added was found by pouring the contents of the measuring cylinder through a small funnel containing a filter of 320μm gauze and the filtrate collected in a 250cm^3 conical flask. The sample caught on the gauze was allowed to drain for approximately 30 seconds, before the funnel with the gauze and sample was transferred to a second 250cm^3 conical flask. Any sample material left in the measuring cylinder was removed by further washings with distilled water and these filtered through the gauze, so that the filtrate was then collected by the second conical flask. The procedure enabled the sample to be washed thoroughly to remove heavy sea salts which might introduce inconsistent results, and allowed the volume of the sample to be determined by subtracting the volume of the filtrate collected in the first conical flask from 100cm^3.

(b) Wet Weights

The measurement of the wet weight of each sample was carried out immediately after the sample had been washed and volumed. The gauze, containing the sample, was removed from the funnel and placed on a sheet of absorbent paper of double thickness in a large glass dish for a period of 10 minutes. After this time, the sample was removed from the gauze by means of a scalpel blade and placed in a preweighed and labelled foil boat. The wet weight of the sample + foil boat was then determined to 4 decimal places, and the foil boat placed on a clean petri dish prior to drying as described in the next stage. In practical terms, the time taken to carry out both the determinations of volume and wet weight for each sample, and the time restriction imposed by the period required for the removal of excess water from the wet sample, meant the samples could only be analysed in batches of fours.

(c) Dry Weights

Each batch of 4 samples was placed into an oven at 100°C, and allowed to dry for a period of approximately 24 hours ($\pm$3 hours). Once dried the samples were transferred into a dessicator containing approximately 500g silica gel granules

and left for another period of 24 hours ($\pm$2 hrs.) Finally, the samples were reweighed to 4 decimal places and stored in an airtight container with an "S" jar of dessicant. The results were noted and expressed in g $1000m^{-3}$ of seawater.

(d) Microdetermination of Carbon and Nitrogen Content

The samples were dried at 100°C for 24 hours and left in an evacuated dessicator containing approximately 500g silica gel for 6 weeks. Once thoroughly dry, the samples were well homogenised by means of a pestle and mortar prior to the determination of carbon and nitrogen content by gas chromatography. A few mg of each sample was placed into a scrupulously clean preweighed tin foil boat and weighed to an accuracy of $\pm$0.1µg on an electronic ultramicro balance ("Electrobalance"). The foil boat was then crimped before being submitted for gas chromatography by a Carlo Erba elemental analyser (mod. 1106). The samples were placed into an automatic sampler (AS50) designed to allow the continuous loading of the samples. In addition to the samples, a series of 10 tin boats containing a known amount of the standard cyclohexanone-2, 4-dinitrophenylhydrazone (containing 51.79%C : 20.14%H) and 5 blanks (empty foil boats) were analysed. The series provided a means of calibrating the instrument and ensured the tin boats were free of contaminants.

For further information on the principle of operation and technical details on the Carlo Erba elemental analyser refer to Appendix I.

DISCUSSION

The main objective of the report was to consider the interconversion of various biomass measures, previously proposed by Wiebe et al. (1975), as a way of providing such data for past and future samples without the need to carry out destructive experimental techniques.

Once the data had been collected various biomass relationships were subjected to reduced major axis regression (Yorke, 1966). The slopes of the regression lines using $\log_{10}$ transformed values of the pairs of biomass measures were calculated. The relationships were namely, displacement volume against wet weight, wet weight against dry weight, displacement volume against carbon, dry weight against carbon and carbon against nitrogen (figures 1-15). Significance testing of the slopes using Students t-distribution was made using the formula:

$$t = \frac{X_1 - X_2}{\sqrt{\frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}}}$$

where X_1, X_2 are the slope estimates and S_1^2, S_2^2 are the sample variances of the independent samples of size n_1 n_2 respectively.

Reference to table 11 shows that the slopes calculated for the 0.32 - 4.5mm (fig. 11-15) material agree closely with those derived by Wiebe. The only exception was the slopes of wet weight against dry weight, which were calculated to be significantly different at the 5% level.

The greatest dispersion around the regression line is shown in the relationships including displacement volume and to a lesser extent wet weight, particularly around the lower regions of the slopes. This is because of the errors inherent in measuring displacement volume and wet weight, which are particularly significant with the smaller values of these biomass measurements. A surprising result apparent in figure 11 showing displacement volume against wet weight for material sized 0.32 - 4.5mm, is that a density of approximately 0.7g/cm^3 is suggested. It is now realised that the volumes of zooplankton were overestimated because the significant amount of interstitial water was not taken into account. This error also appears to have been made by Wiebe et al. (1975) as their density values are also unusually low.

Having established the relationships of the various biomass measures for material sized 0.32 - 4.5mm, it was decided to consider whether any differences existed between the 0.32 - 1.0mm and 1.0 - 4.5mm material. The results of the significance testing shown in table 7, show that the slopes are different at the 5% level for every relationship considered. In particular, the slopes of wet weight against dry weight and displacement volume against carbon are lower for the 1.0 - 4.5mm material (fig. 7 & 8 respectively).

In addition, comparisons of the slopes and intercepts for each station were also made. Overall, there are greater and more numerous difference apparent when comparing the slopes of the biomass measurements for material sized 0.32 - 1.0mm between the 1st/2nd southern stations and the northern/1st southern station, than between the 2nd southern/northern stations (fig. 1-5).

Unfortunately, this trend cannot be confirmed with the 1.0 - 4.5mm sized material, because the samples of the 1st southern station were preserved in formalin and so not available for biomass analysis. Comparisons can, however, be made between data for material sized 0.32 - 1.0mm and 1.0 - 4.5mm, collected at the northern and 2nd southern stations. It would appear from the t-values shown in table 9 that there are more marked northern/2nd southern station differences for the 1.0 - 4.5mm sized material than for the 0.32 - 1.0mm sized material. In particular, there are significant differences in the relationships between displacement volume against wet weight, displacement volume against carbon and dry weight against carbon for the 1.0 - 4.5mm material found at the northern and 2nd southern stations.

TABLE 1A. STATION LIST FOR NORTHERN STATION

	Station Number	Depth (m)	Date ('84)	Latitude °N	Longitude °W	Fishing Time (Start)	(End)	Duration (Mins)	Volume Filtered ($x10^3 m^3$)
DAY	11056#1	0-50	10-IV	45°45.4'	13°54.9'	1548	1628	40	2.58
	#2	50-100	10-IV	45°46.7'	13°54.9'	1628	1708	40	2.51
	#3	100-200(0)	10-IV	45°48'	13°54.1'	1708	1826	34	5.34
	11055#1	200-305	10-IV	45°37.6'	13°59.9'	1200	1300	60	4.11
	#2	305-400	10-IV	45°39.7'	13°58.8'	1300	1400	60	3.73
	#3	400-495	10-IV	45°41.8'	13°56.9'	1400	1500	60	3.73
NIGHT	11058#1	0-50	11-IV	45°36.0'	13°41.0'	0134	0234	60	3.62
	#2	50-100	11-IV	45°35.4'	13°38.7'	0234	0334	60	3.57
	#3	95-200	11-IV	45°34.9'	13°36.4'	0334	0434	60	3.51
	11057#1	200-300	10-IV	45°38.9'	13°52.0'	2134	2234	60	3.78
	#2	300-400	10-IV	45°38.0'	13°48.7'	2234	2334	60	3.87
	#3	395-500	10-IV	45°37.2'	13°45.4'	2334	0034	60	3.67
	11050#1	500-600	7-IV	45°41.4'	14°10.9'	2120	2221	61	3.26
	#2	600-700	7-IV	45°39.8'	14° 8.8'	2221	2320	59	3.55
	#3	700-800	7/8-IV	45°38.3'	14° 6.8'	2320	0020	60	3.93

TABLE 1B. STATION LIST FOR 1st SOUTHERN STATION

	Station Number	Depth (m)	Date ('84)	Latitude °N	Longitude °W	Fishing Time (Start)	(End)	Duration (Mins)	Volume Filtered ($X10^3 m^3$)
DAY	11047#2	45-100	3-IV	39°35.7'	14°53.1	1117	1207	52	3.11
	#3	100-175	3-IV	39°35.1'	14°55.2'	1315	1416	61	4.00
	11042#1	200-300	2-IV	39°38.6'	14°49.8'	1508	1608	60	3.78
	#2	300-400	2-IV	39°38.4'	14°52.7'	1608	1708	60	3.87
	#3	400-510	2-IV	39°38.2'	14°58.8'	1708	1812	64	4.31
	11040#1	500-600	2-IV	39°39.0'	14°39.7'	1034	1134	60	3.64
	#2	600-700	2-IV	39°39.2'	14°42.5'	1134	1234	60	3.64
	#3	700-810	2-IV	39°39.1'	14°45.0'	1234	1334	60	3.60
	11036#1	800-900	1-IV	39°23.3'	14°56.4'	1000	1100	60	3.87
	#2	900-1005	1-IV	39°24.7'	14°59.0'	1100	1200	60	3.73
	#3	1000-1105	1-IV	39°26.1'	15°1.0'	1200	1308	68	4.17
NIGHT	11045#1	0-50	3-IV	39°32.0'	14°56.5'	0149	0249	60	3.78
	#2	45-95	3-IV	39°30.6'	14°58.5'	0249	0349	60	3.87
	#3	95-175	3-IV	39°29.2'	15°0.3'	0349	0449	60	3.82
	11038#1	200-300	1-IV	39°34.5'	14°51.7'	2213	2313	60	3.60
	#2	300-405	1/2-IV	39°33.9'	14°54.6'	2313	0015	62	3.86
	#3	405-500	2-IV	39°33.0'	14°57.2'	0015	0115	60	3.82
	11039#1	500-610	2-IV	39°31.5'	15°4.7'	0248	0347	59	4.05
	#2	600-710	2-IV	39°30.8'	15°7.8'	0347	0446	59	4.05
	#3	700-785	2-IV	39°30.3'	15°10.6'	0445	0544	58	3.87

TABLE 1C. STATION LIST FOR 2nd SOUTHERN STATION

Station Number	Depth (m)	Date ('84)	Latitude °N	Longitude °W	Fishing Time Start	Fishing Time End	Duration (mins)	Volume Filtered ($x10^3 m^3$)
11094#1	0-50	20-IV	39°43.8'	15°2.4'	0915	0945	30	1.91
#2	50-100	20-IV	39°44.9'	15°2.4'	0945	1015	30	1.98
#3	100-200	20-IV	39°46.1'	15°2.5'	1015	1115	60	3.93
11088#1	200-300	19-IV	39°39.0'	14°59.0'	0740	0840	60	3.66
#2	300-400	19-IV	39°40.9'	14°57.5	0840	0940	60	3.66
#3	400-498	19-IV	39°42.6'	14°56.4'	0940	1040	60	3.24
11083#1	500-600	18-IV	39°44.3'	14°59.8	1500	1602	62	3.80
#2	600-700	18-IV	39°42.2'	15°0.4'	1602	1702	60	3.35
#3	700-800	18-IV	39°40.3'	15°0.8'	1702	1802	60	3.66
11081#1	800-905	18-IV	39°37.7'	14°59.0'	0930	1030	60	3.62
#2	900-1000	18-IV	39°39.8'	14°59.1'	1030	1130	60	3.46
#3	100-1100	18-IV	39°42.0'	14°59.0'	1130	1230	60	3.48
11086#1	0-50	19-IV	39°46.3'	15°10.0'	0129	0229	60	3.35
#2	50-100	19-IV	39°45.0'	15°8.4'	0229	0329	60	3.87
#3	100-200	19-IV	30°43.5'	15°6.6'	0329	0429	60	3.86
11079#1	200-300	18-IV	39°31.6'	14°57.0'	0133	0233	60	3.42
#2	300-400	18-IV	39°31.9'	14°54.2'	0233	0333	60	3.57
#3	400-495	18-IV	39°32.1'	14°51.4'	0333	0433	60	3.89
11078#1	500-605	17-IV	39°31.8'	15°8.4'	2124	2224	60	3.78
#2	605-695	17-IV	39°31.4'	15°5.4'	2224	2324	60	3.48
#3	695-795	17/18-IV	39°31.3'	15°2.2'	2324	0024	60	3.78
11085#1	800-900	18-IV	39°39.1'	15°3.0'	2118	2218	60	3.70
#2	900-1000	18-IV	39°40.9'	15°4.9'	2218	2318	60	3.60
#3	1000-1100	18/19-IV	39°42.6'	15°6.7'	2318	0018	60	3.50

TABLE 2A. SHOWING DERIVED DATA FOR 0.32mm - 1.0mm SIZED MATERIAL FOUND AT THE NORTHERN STATION

Station Number	Depth (m)	Volume (cm^3)	Net Wet Weight (g)	Net Dry Weight (g)	Ash Free Dry Wt. (mg)	%N %	%C %	C:N Ratio -	Total Mass of Carbon (g)	Total Mass of Nitrogen (g)
11056#1	0-50	54.1	36.4870	2.3696	0.2369	9.44	47.00	4.98	1.1137	0.2237
#2	50-100	51.6	39.489	3.8651	0.4561	10.25	44.96	4.39	1.7377	0.3962
#3	100-200(-0)	17.2	13.4313	1.5107	0.2069	8.38	45.95	5.48	0.6949	0.0827
11055#1	200-305	5.1	3.4521	0.2315	0.0396	8.90	46.68	5.24	0.1081	0.0121
#2	305-400	11.8	7.5187	0.5854	0.0837	9.50	45.46	4.79	0.2661	0.0556
#3	400-495	15.4	10.1229	1.0379	0.1681	9.18	43.97	4.79	0.4563	0.0952
11058#1	0-50	29.9	35.3822	2.8571	0.2543	9.55	43.77	4.58	1.2505	0.2728
#2	50-100	33.5	26.3833	2.6355	0.4612	8.21	42.57	5.19	1.1219	0.2164
#3	95-200	21.7	14.8803	1.4502	0.2436	9.05	42.79	4.73	0.6205	0.1312
11057#1	200-300	6.7	4.7419	0.4834	0.0711	8.36	47.80	5.72	0.2311	0.0404
#2	300-400	8.5	4.9823	0.4346	0,0678	8.85	44.40	4.51	0.1930	0.0385
#3	395-500	6.6	4.3217	0.3066	0,0487	8.66	42.65	4.92	0.1308	0.02655
11050#1	500-600	6.1	4.3795	0.3475	0,0820	8.83	44.57	5.05	0.1548	0.0307
#2	600-700	8.1	4.3139	0.2567	0.0493	8.90	44.73	5.03	0.1148	0.0228
#3	700-800	4.5	3.2359	0.2415	0.0307	7.69	46.84	6.09	0.1131	0.0186

TABLE 2B. SHOWING DERIVED DATA FOR 0.32mm - 1.0mm SIZED MATERIAL FOUND AT THE 1st SOUTHERN STATION

Station Number	Depth (m)	Volume (cm^3)	Net Wet Weight (g)	Net Dry Weight (g)	Ash Free Dry Wt. (mg)	%N (%)	%C (%)	C:N Ratio	Total Mass of Carbon (g)	Total Mass of Nitrogen (mg)
11047#1	0-50	-	-	-	-	-	-	-	-	-
#2	45-100	68.0	52.2154	6.4907	4.1281	3.86	24.49	6.34	1.5896	250.54
#3	100-175	33.9	37.7439	5.0405	3.4326	4.70	24.34	5.18	1.2268	236.90
11042#1	200-300	7.40	5.1	0.7465	0.5367	4.79	28.22	5.90	0.2107	35.76
#2	300-400	6.97	4.6922	0.9253	0.6190	4.34	25.76	5.93	0.2383	40.16
#3	400-510	2.03	1.8598	0.2447	0.1269	4.93	34.25	6.94	0.0838	12.06
11040#1	500-600	6.73	4.6738	0.4217	0.1413	7.63	39.31	5.15	0.1657	32.17
#2	600-700	4.04	3.2624	0.4117	0.1511	5.16	10.27	7.81	0.1658	21.24
#3	700-810	2.22	2.1051	0.2886	0.1018	5.56	39.46	7.10	0.1139	16.05
11036#1	800-900	1.47	0.8280	0.1135	0.0435	5.75	33.78	5.87	0.0384	6.66
#2	900-1005	0.78	0.8416	0.1080	0.0556	3.56	26.56	7.46	0.0287	3.84
#3	1000-1105	0.65	0.7755	0.1373	0.0664	4.81	35.25	7.32	0.0484	6.60
11045#1	0-50	239.9	243.59	39.80	28.6958	2.77	19.82	7.15	7.8884	1102.46
#2	45-95	34.1	29.3509	2.3070	0.9366	5.85	33.09	5.66	0.7634	134.96
#3	95-175	15.36	6.8701	1.1433	0.5831	5.17	30.83	5.97	0.3524	59.11
11038#1	200-300	6.00	3.2026	0.3203	0.1576	6.78	36.79	5.43	0.1178	21.72
#2	300-405	2.27	2.1124	0.2875	0.1875	3.62	26.33	7.28	0.0757	10.41
#3	405-500	2.92	1.3769	0.2529	0.1348	4.99	31.04	6.22	0.0785	12.62
11039#1	500-610	2.96	2.1651	0.2791	0.1697	5.54	35.45	6.40	0.0989	15.46
#2	600-710	4.64	2.8478	0.3786	0.1533	4.48	41.08	9.18	0.1555	16.96
#3	700-785	1.50	1.3846	0.1531	0.0530	5.43	35.60	6.56	0.0545	8.31

TABLE 2C. SHOWING DERIVED DATA FOR 0.32mm-1.0mm SIZED MATERIAL FOUND AT THE 2nd SOUTHERN STATION.

Station Number	Depth (m)	Volume (cm^3)	Net Wet Weight (g)	Net Dry Weight (g)	Ash Free Dry Wt. (mg)	%N (%)	%C (%)	C:N Ratio	Total Mass of carbon (g)	Total Mass of Nitrogen (mg)
11086#1	0-50	3.8	28.67	3.411	1.0028	7.64	45.49	4.82	1.5517	261.62
#2	50-100	34.9	26.183	1.987	0.7431	9.66	39.56	5.17	0.7861	191.94
#3	100-200	5.1	3.221	0.511	0.2126	7.00	48.52	5.02	0.2479	35.77
11079#1	200-300	4.6	3.888	0.338	0.1501	6.10	34.11	5.59	0.1153	20.68
#2	300-400	4.0	2.590	0.334	0.1142	5.12	33.19	6.48	0.1108	17.10
#3	400-495	1.5	0.902	0.149	0.1006	5.07	34.54	6.82	0.0515	7.55
11078#1	500-605	2.2	2.240	0.236	0.0687	5.89	41.06	6.97	0.0969	13.90
#2	605-695	3.2	2.067	0.251	0.0786	5.83	42.44	7.28	0.1065	14.63
#3	695-795	0.7	0.765	0.122	-	8.97	41.52	4.63	0.0506	10.94
11085#1	800-900	0.7	0.736	0.081	0.0344	5.24	36.08	6.88	0.0292	4.24
#2	900-1000	1.6	0.706	0.083	0.0033	6.58	37.72	5.73	0.0313	5.46
#3	1000-1100	1.5	0.552	0.058	0.0358	6.30	37.90	6.02	0.0220	3.65

TABLE 2D. SHOWING DERIVED DATA FOR 0.32mm - 1.0mm SIZED MATERIAL FOUND AT THE 2nd SOUTHERN STATION

Station Number	Depth (m)	Volume (cm^3)	Net Wet Weight (g)	Net Dry Weight (g)	Ash Free Dry Wt. (mg)	%N (%)	%C (%)	C:N Ratio	Total Mass of Carbon (g)	Total Mass of Nitrogen (mg)
11094#1	0-50	38.4	29.3381	2.3288	-	9.54	49.11	5.15	1.1437	222.17
#2	50-100	35.4	21.5822	1.3841	-	9.59	49.44	5.15	0.6843	132.73
#3	100-200	4.4	3.1485	0.2149	-	7.49	42.64	5.70	0.0916	16.10
11088#1	200-300	14.2	7.2723	1.0852	-	10.38	26.42	2.55	0.2867	112.64
#2	300-400	16.6	12.7736	2.1333	-	3.52	24.63	6.99	0.5254	75.09
#3	400-498	1.53	1.3106	0.2093	-	3.90	27.29	7.01	0.0571	8.16
11083#1	500-600	3.6	2.3075	0.2379	0.0735	5.94	38.80	6.53	0.0923	14.13
#2	600-700	4.9	2.0729	0.2899	0.0783	6.40	43.10	6.73	0.1249	18.55
#3	700-800	2.2	1.3844	0.1750	0.0532	5.95	40.05	6.73	0.0701	10.41
11081#1	800-905	1.5	1.3073	0.1790	0,0539	5.88	45.92	7.80	0.0822	10.52
#2	900-1000	2.4	1.3417	0.1665	0,04779	6.67	44.68	6.69	0.0744	11.10
#3	1000-1100	1.5	0.9489	0.1105	-	5.14	43.31	8.42	0.0478	5.68
11095#1	1100-1215	-	-	-	-	-	-	-	-	-
#2	1203-1298	-	-	-	-	-	-	-	-	-
#3	1298-1403	-	-	-	-	-	-	-	-	-
11096#1	1400-1500	-	-	-	-	-	-	-	-	-
#2	1500-1600	-	-	-	-	-	-	-	-	-
#3	1600-1800	-	-	-	-	-	-	-	-	-

Derived data expressed per $1000m^3$ seawater.

TABLE 3A. SHOWING DERIVED DATA FOR 1.0mm-4.5mm SIZED MATERIAL FOUND AT THE NORTHERN STATION.

Station Number	Depth (m)	Volume (cm^3)	Net Wet Weight (g)	Net Dry Weight (g)	Ash Free Dry Wt. (mg)	%N (%)	%C (%)	C:N Ratio -	Total Mass of Carbon (g)	Total Mass of Nitrogen (mg)
11056#1	0-50	-	-	-	-	-	-	-	-	-
#2	50-100	2.3460	1.2567	0.1345	0.0402	7.35	35.87	4.88	0.0482	9.8857
#3	100-200(-0)	2.7818	1.9303	0.3074	0.1380	8.25	36.24	4.40	0.1114	25.3605
11055#1	200-305	2.1850	1.1262	0.0918	0.03461	5.80	28.88	4.98	0.0265	5.3244
#2	305-400	3.1387	2.3564	0.2524	0.0638	9.27	38.82	4.19	0.0979	23.3975
#3	400-495	5.1471	3.3126	0.4110	0.1208	8.05	35.83	4.45	0.1473	33.0855
11058#1	0-50	8.2388	4.9850	0.6843	0.1218	10.01	41.68	4.16	0.2852	68.4984
#2	50-100	11.9737	9.006	1.2993	0.2183	8.68	42.65	4.92	0.5541	112.7792
#3	95-200	3.7358	2.5542	0.2889	0.0517	9.61	44.12	4.59	0.1275	27.7633
11057#1	200-300	1.4807	0.9084	0.1280	0.0125	10.19	46.35	4.55	0.0593	13.0432
#2	300-400	2.3238	1.6548	-	-	7.24	31.36	4.33	-	-
#3	395-500	2.9528	1.4523	0.1633	0.0323	10.16	40.18	3.95	0.0656	16.5913
11050#1	500-600	5.3848	3.5179	0.4335	0.1097	8.24	42.07	5.11	0.1824	35.7204
#2	600-700	7.2727	4.5269	0.5139	0.1342	8.46	40.28	4.76	0.2070	43.4759
#3	700-800	2.2377	1.1830	0.1568	0.0299	8.90	46.68	5.24	0.0732	13.9552

TABLE 3B. SHOWING DERIVED DATA FOR 1.0mm-4.5mm SIZED MATERIAL FOUND AT THE 1st SOUTHERN STATION

Station Number	Depth (m)	Volume (cm^3)	Net Wet Weight (g)	Net Dry Weight (g)	Ash Free Dry Wt. (mg)	%N (%)	%C (%)	C:N Ratio -	Total Mass of Carbon (g)	Total Mass of Nitrogen (mg)
11047#1	0-50	26.2	14.2972	2.9651	2.2268	3.52	21.93	6.23	0.6502	104.37
#2	45-100	104.8	53.1398	11.1423	8.8247	4.50	26.22	5.82	2.9215	501.40
#3	100-175	-	-	-	-	-	-	-	-	-
11042#1	200-300	-	-	-	-	-	-	-	-	-
#2	300-400	-	-	-	-	-	-	-	-	-
#3	400-510	-	-	-	-	-	-	-	-	-
11040#1	500-600	-	-	-	-	-	-	-	-	-
#2	600-700	-	-	-	-	-	-	-	-	-
#3	700-810	-	-	-	-	-	-	-	-	-
11036#1	800-900	-	-	-	-	-	-	-	-	-
#2	900-1005	-	-	-	-	-	-	-	-	-
#3	1000-1105	-	-	-	-	-	-	-	-	-
11045#1	0-50	222.1	150.3292	37.9902	24.9597	5.59	26.80	4.80	10.1814	2123.66
#2	45-95	-	-	-	-	-	-	-	-	-
#3	95-175	-	-	-	-	-	-	-	-	-
11038#1	200-300	-	-	-	-	-	-	-	-	-
#2	300-405	-	-	-	-	-	-	-	-	-
#3	405-500	-	-	-	-	-	-	-	-	-
11039#1	500-610	-	-	-	-	-	-	-	-	-
#2	600-710	-	-	-	-	-	-	-	-	-
#3	700-785	-	-	-	-	-	-	-	-	-

TABLE 3C. SHOWING DERIVED DATA FOR 1.0mm-4.5mm SIZED MATERIAL FOUND AT THE 2nd SOUTHERN STATION

Station Number	Depth (m)	Volume (cm^3)	Net Wet Weight (g)	Net Dry Weight (g)	Ash Free Dry Wt. (mg)	%N (%)	%C (%)	C:N Ratio -	Total Mass of Carbon (g)	Total Mass of Nitrogen (mg)
11086#1	0-50	22.3	11.89	1.95	0.8112	5.18	28.18	5.44	0.5495	101.01
#2	50-100	15.5	8.23	1.20	0.3216	7.47	38.11	5.10	0.4573	89.64
#3	100-200	4.4	2.56	0.39	0.3381	7.79	36.78	4.72	0.1434	30.38
11079#1	200-300	2.0	1.08	0.19	0.1054	4.95	26.72	5.40	0.0508	9.41
#2	300-400	6.4	2.40	0.55	0.4059	2.97	20.39	6.87	0.1121	16.33
#3	400-495	2.9	0.81	0.15	0.0879	5.32	27.05	5.09	0.0406	7.98
11078#1	500-605	2.9	1.42	0.18	0.0403	8.97	41.52	4.63	0.0747	16.14
#2	605-695	3.2	1.56	0.18	0.0473	7.94	40.78	5.14	0.0734	14.29
#3	695-795	0.7	0.79	0.10	0.0256	7.72	39.37	5.10	0.0394	7.72
11085#1	800-900	0.7	0.76	0.08	0.0333	9.11	44.45	4.88	0.0356	7.29
#2	900-1000	1.6	0.91	0.12	0.0073	8.41	46.80	5.56	0.056	10.09
#3	1000-1100	1.5	0.74	0.10	0.0211	9.44	45.49	4.82	0.0455	9.44

TABLE 3D. SHOWING DERIVED DATA FOR 1.0mm-4.5mm SIZED MATERIAL FOUND AT THE 2nd SOUTHERN STATION.

Station Number	Depth (m)	Volume (cm^3)	Net Wet Weight (g)	Net Dry Weight (g)	Ash Free Dry Wt. (mg)	%N (%)	%C (%)	C:N Ratio -	Total Mass of Carbon (g)	Total Mass of Nitrogen (mg)
11094#1	0-50	2.9	2.430	0.087	-	7.29	33.34	4.57	0.0290	6.34
#2	50-100	3.1	2.038	0.303	-	8.09	38.88	4.81	0.1178	24.51
#3	100-200	0.7	0.394	0.030	-	5.79	31.36	5.42	0.0094	1.73
11088#1	200-300	6.0	2.795	0.424	0.0882	5.56	29.87	5.37	0.1266	23.57
#2	300-400	21.3	12.614	2.227	0.5429	4.51	25.32	5.62	0.5639	100.4
#3	400-498	6.9	2.796	0.476	0.0695	5.56	28.66	5.15	0.1364	26.46
11083#1	500-600	1.4	1.399	0.199	0.0474	8.28	39.35	4.76	0.0783	16.47
#2	600-700	11.5	6.543	0.902	0.1515	8.64	45.34	5.25	0.4090	77.93
#3	700-800	1.5	1.045	0.122	0.0284	7.77	41.36	5.32	0.0504	9.48
11081#1	800-905	1.5	0.692	0.100	0.015	8.83	45.90	5.20	0.0459	8.83
#2	900-1000	2.4	1.740	0.221	0.0745	8.91	48.75	5.47	0.1077	21.68
#3	1000-1100	2.2	0.961	0.120	0.0286	7.88	42.70	5.42	0.0512	9.46
11095#1	1100-1215	-	-	-	-	-	-	-	-	-
#2	1203-1298	-	-	-	-	-	-	-	-	-
#3	1298-1403	-	-	-	-	-	-	-	-	-
11096#1	1400-1500	-	-	-	-	-	-	-	-	-
#2	1500-1600	-	-	-	-	-	-	-	-	-
#3	1600-1800	-	-	-	-	-	-	-	-	-

TABLE 4A. SHOWING DERIVED DATA FOR 0.32mm-4.5mm SIZED MATERIAL FOUND AT THE NORTHERN STATION.

	Station Number	Depth (m)	Volume (cm^3)	Net Wet Weight (g)	Net Dry Weight (g)	Total Mass of Carbon (g)	Total Mass of Nitrogen (g)
DAY	11056#1	0-50	-	-	-	-	-
	#2	50-100	53.9	40.7457	3.9996	1.7859	0.4060
	#3	100-200(-0)	20.0	15.3616	1.8181	0.8055	0.1080
	11055#1	200-305	7.3	4.5783	0.3233	0.1346	0.0174
	#2	305-400	14.9	9.8751	0.8378	0.3640	0.0790
	#3	400-495	20.5	13.4355	1.4489	0.6036	0.1283
NIGHT	11058#1	0-50	38.1	40.3672	3.5414	1.5357	0.3413
	#2	50-100	45.5	35.3893	3.9348	1.6760	0.3292
	#3	95-200	25.4	17.4345	1.7391	0.7480	0.1590
	11057#1	200-300	8.2	5.6503	0.6114	0.2904	0.0534
	#2	300-400	10.8	6.6371	2.0894	-	-
	#3	395-500	9.6	5.7740	0.4699	0.1964	0.0432
	11050#1	500-600	11.5	7.8974	0.7810	0.3372	0.0664
	#2	600-700	15.4	8.8408	0.7706	0.3218	0.0663
	#3	700-800	6.7	4.4189	0.3983	0.1863	0.0325

TABLE 4B. SHOWING DERIVED DATA FOR = 0.32-4.5mm SIZED MATERIAL FOUND AT THE 1st SOUTHERN STATION.

	Station Number	Depth (m)	Volume (cm^3)	Net Wet Weight (g)	Net Dry Weight (g)	Total Mass of Carbon (g)	Total Mass of Nitrogen (g)
DAY	11047#1	0-50	_	-	-	-	-
	#2	45-100	172.8	105.3552	17.6330	4.5111	0.7383
	#3	100-175	-	-	-	-	-
	11042#1	200-300	-	-	-	-	-
	#2	300-400	-	-	-	-	-
	#3	400-510	-	-	-	-	-
	11040#1	500-600	-	-	-	-	-
	#2	600-700	-	-	-	-	-
	#3	700-810	-	-	-	-	-
	11036#1	800-900	-	-	-	-	-
	#2	900-1005	-	-	-	-	-
	#3	1000-1105	-	-	-	-	-
NIGHT	11045#1	0-50	462.0	393.9192	77.7904	18.0684	3.2262
	#2	45-95	-	-	-	-	-
	#3	95-175	-	-	-	-	-
	11038#1	200-300	-	-	-	-	-
	#2	300-405	-	-	-	-	-
	#3	405-500	-	-	-	-	-
	11039#1	500-610	-	-	-	-	-
	#2	600-710	-	-	-	-	-
	#3	700-785	-	-	-	-	-

NB. Insufficient data since 1.0mm-4.5mm sized material from Stations 11047#3 to 11039#3 all preserved i.e. no frozen samples.
Derived data expressed per $1000m^3$ seawater.

TABLE 4C. SHOWING DERIVED DATA FOR 0.32mm-4.5mm SIZED MATERIAL FOUND AT THE 2nd SOUTHERN STATION

Station Number	Depth (m)	Volume (cm^3)	Net Wet Weight (g)	Net Dry Weight (g)	Total Mass of Carbon (g)	Total Mass of Nitrogen (g)
11094#1	0-50	41.3	31.7681	2.4158	1.1727	0.2283
#2	50-100	38.5	23.6202	1.6811	0.8021	0.1572
#3	100-200	5.1	3.5425	0.2449	0.1010	0.0177
11088#1	200-300	20.2	10.0673	1.5092	0.4133	0.1362
#2	300-400	37.9	25.3876	4.3603	1.0893	0.1751
#3	400-498	8.4	4.1066	0.6853	0.1935	0.0347
11083#1	500-600	5.0	3.7065	0.4369	0.1706	0.0301
#2	600-700	16.4	8.6159	1.1919	0.5339	0.0964
#3	700-800	3.7	2.4294	0.2970	0.1205	0.0199
11081#1	800-905	3.0	1.9993	0.2790	0.1281	0.0193
#2	900-1000	4.8	3.0817	0.3875	0.1821	0.0328
#3	1000-1100	3.7	1.9099	0.2305	0.099	0.0152
11086#1	0-50	26.1	40.56	5.361	2.1012	0.3626
#2	50-100	50.4	34.413	3.187	1.2434	0.2815
#3	100-200	9.5	5.781	0.901	0.3913	0.06615
11079#1	200-300	6.6	4.968	0.528	0.1661	0.0301
#2	300-400	10.4	4.99	0.884	0.2229	0.0334
#3	400-495	4.4	1.712	0.299	0.0921	0.0155
11078#1	500-605	5.1	3.66	0.416	0.1716	0.0300
#2	605-695	6.4	3.627	0.431	0.1799	0.0289
#3	695-795	1.4	1.555	0.222	0.0900	0.0187
11085#1	800-900	1.4	1.496	0.161	0.0648	0.0115
#2	900-1000	3.2	1.616	0.203	0.0873	0.0156
#3	1000-1100	3.0	1.292	0.158	0.0675	0.0131

DERIVED DATA EXPRESSED PER $1000m^3$ SEAWATER

Table 5. SHOWING VALUES OF CORRELATION COEFFICIENTS, SLOPES AND INTERCEPTS (Including standard errors) USING REDUCED MAJOR AND REGRESSION FOR PAIRS OF BIOMASS MEASURES

		Displacement Volume/Wet Wt.	Wet Wt./ Dry Wt.	Displacement Volume/Carbon	Dry Wt./ Carbon	Carbon/ Nitrogen
WIEBE	SLOPE	0.950 $\pm 1.373 \times 10^{-3}$	0.946 $\pm 1.017 \times 10^{-3}$	0.808 $\pm 3.187 \times 10^{-4}$	0.977 $\pm 1.438 \times 10^{-4}$	- -
	INTERCEPT	0.670 -	0.975 -	-1.429 -	0.508 -	- -
0.32-1.0mm MATERIAL	SLOPE	0.9646 $\pm 3.722 \times 10^{-2}$	1.047 $\pm 2.998 \times 10^{-2}$	1.035 $\pm 4.292 \times 10^{-2}$	1.026 $\pm 2.284 \times 10^{-2}$	0.9338 $\pm 1.831 \times 10^{-2}$
	INTERCEPT	0.1516 $\pm 3.277 \times 10^{-2}$	0.9658 $\pm 1.927 \times 10^{-2}$	1.531 $\pm 4.495 \times 10^{-2}$	0.4439 $\pm 2.042 \times 10^{-2}$	0.6791 $\pm 2.965 \times 10^{-2}$
	CORRELATION COEFFICIENT	0.9551	0.9755	0.9318	0.9859	0.9886
1.0-4.5mm MATERIAL	SLOPE	1.019 $\pm 3.512 \times 10^{-2}$	0.8695 $\pm 2.85 \times 10^{-2}$	0.9464 $\pm 4.57 \times 10^{-2}$	1.069 $\pm 2.62 \times 10^{-2}$	1.006 $\pm 1.301 \times 10^{-2}$
	INTERCEPT	0.2243 $\pm 2.323 \times 10^{-2}$	0.8106 $\pm 2.204 \times 10^{-2}$	1.497 $\pm 4.95 \times 10^{-2}$	0.5049 $\pm 2.83 \times 10^{-2}$	0.7110 $\pm 2.232 \times 10^{-2}$
	CORRELATION COEFFICIENT	0.9759	0.9783	0.9522	0.9879	0.9966
0.32-4.5mm MATERIAL	SLOPE	0.9455 $\pm 3.093 \times 10^{-2}$	0.9747 $\pm 3.214 \times 10^{-2}$	0.9763 $\pm 3.977 \times 10^{-2}$	1.058 $\pm 2.462 \times 10^{-2}$	0.9678 $\pm 1.932 \times 10^{-2}$
	INTERCEPT	0.2247 ± 0.2130	0.9388 $\pm 1.877 \times 10^{-2}$	1.513 $\pm 2.831 \times 10^{-2}$	0.434 $\pm 1.735 \times 10^{-2}$	0.6968 $\pm 2.525 \times 10^{-2}$
	CORRELATION COEFFICIENT	0.9798	0.9786	0.9671	0.9894	0.9922

TABLE 6A. SHOWING CORRELATION COEFFICIENTS, SLOPES AND INTERCEPTS (including standard errors) USING REDUCED MAJOR AXIS REGRESSION FOR 0.32-1.0mm MATERIAL WITH RESPECT TO EACH STATION.

Biomass Measures	Northern Station			1st Southern Station			2nd Southern Station		
	Slope	Intercept	Correlation Coefficient	Slope	Intercept	Correlation Coefficient	Slope	Intercept	Correlation Coefficient
Displacement Volume/Wet Weight	0.99051 $\pm 4.064 \times 10^{-2}$	0.2435 $\pm 4.291 \times 10^{-2}$	0.9848	0.9867 $\pm 4.116 \times 10^{-2}$	0.1213 $\pm 3.815 \times 10^{-2}$	0.9825	0.9226 $\pm 8.438 \times 10^{-2}$	0.1626 $\pm 6.065 \times 10^{-2}$	0.8940
Wet Weight Dry Weight	0.9185 $\pm 4.318 \times 10^{-2}$	1.070 $\pm 1.943 \times 10^{-2}$	0.9833	1.010 $\pm 3.339 \times 10^{-2}$	0.8786 $\pm 2.351 \times 10^{-2}$	0.9890	1.078 $\pm 4.757 \times 10^{-2}$	0.9727 $\pm 3.35 \times 10^{-2}$	0.9764
Displacement Volume/ Carbon	1.087 $\pm 4.783 \times 10^{-2}$	1.555 $\pm 4.580 \times 10^{-2}$	0.9627	0.9837 ± 1.064	1.459 ± 0.1109	0.9804	0.8386 $\pm 5.856 \times 10^{-2}$	1.504 $\pm 3.670 \times 10^{-2}$	0.8482
Dry Weight/ Carbon	1.009 $\pm 9.344 \times 10^{-3}$	0.3516 $\pm 5.830 \times 10^{-3}$	0.9994	1.090 $\pm 2.616 \times 10^{-2}$	0.6684 $\pm 2.501 \times 10^{-2}$	0.9942	0.9891 $\pm 3.244 \times 10^{-2}$	0.4010 $\pm 3.352 \times 10^{-2}$	0.9870
Carbon/ Nitrogen	0.9736 $\pm 2.21 \times 10^{-2}$	0.7703 $\pm 3.697 \times 10^{-2}$	0.9831	0.9121 $\pm 3.291 \times 10^{-2}$	0.6344 $\pm 5.827 \times 10^{-2}$	0.9948	0.9209 $\pm 4.357 \times 10^{-2}$	0.6375 $\pm 5.539 \times 10^{-2}$	0.9843

TABLE 6B. SHOWING CORRELATION COEFFICIENTS, SLOPES, AND INTERCEPTS (including standard errors) USING REDUCED MAJOR AXIS REGRESSION FOR 1.0mm-4.5mm MATERIAL WITH RESPECT TO EACH STATION.

Biomass	Northern Station			2nd Southern Station		
Measures	Slope	Intercept	Correlation Coefficient	Slope	Intercept	Correlation Coefficient
Displacement Volume/Wet Weight	0.8870 $\pm 4.413 \times 10^{-2}$	0.2517 $\pm 2.094 \times 10^{-2}$	0.9833	1.089 $\pm 7.259 \times 10^{-2}$	0.2199 $\pm 3.468 \times 10^{-2}$	0.9452
Wet Weight/ Dry Weight	0.9060 $\pm 5.414 \times 10^{-2}$	0.8650 $\pm 3.470 \times 10^{-2}$	0.9765	0.8658 $\pm 5.672 \times 10^{-2}$	0.7925 $\pm 4.443 \times 10^{-2}$	0.9471
Displacement Volume/Carbon	0.7552 $\pm 8.467 \times 10^{-2}$	0.1296×10^{1} $\pm 8.598 \times 10^{-2}$	0.9145	1.008 $\pm 8.776 \times 10^{-2}$	1.571 ± 0.1017	0.9045
Dry Weight/ Carbon	0.9397 $\pm 4.017 \times 10^{-2}$	0.3443 $\pm 4.069 \times 10^{-2}$	0.9881	1.069 $\pm 4.719 \times 10^{-2}$	0.5174 $\pm 5.463 \times 10^{-2}$	0.9763
Carbon/ Nitrogen	0.9868 $\pm 2.914 \times 10^{-2}$	0.6435 $\pm 4.818 \times 10^{-2}$	0.9943	1.007 $\pm 1.751 \times 10^{-2}$	0.7283 $\pm 3.216 \times 10^{-2}$	0.9964

TABLE 7. SHOWING RESULTS OF SIGNIFICANCE TESTING FOR THE SLOPES AND INTERCEPTS OF THE 0.32mm-1.0mm AND 1.0mm-4.5mm SIZED MATERIAL USING THE STUDENTS t- DISTRIBUTION.

BIOMASS MEASURES	SLOPE t- VALUE	INTERCEPT t- VALUE
Displacement Volume/Wet Weight	41.08*	0.10
Wet Weight/Dry Weight	6.04*	5.74*
Displacement Volume/Carbon	2.01*	0.72
Dry Weight/Carbon	76.60*	2.56*
Carbon/Nitrogen	4.41*	1.18

* Indicates estimates significantly different at the 5% level. Degrees of freedom are 97.

TABLE 8. SHOWING RESULTS OF SIGNIFICANCE TESTING USING STUDENT'S t DISTRIBUTION FOR SLOPES AND INTERCEPTS OF 0.32-1.0mm SIZED MATERIAL FROM NORTHERN, 1st SOUTHERN AND 2nd SOUTHERN STATIONS.

Biomass Measures	Northern/1st Southern		1st Southern/2nd Southern		2nd Southern/Northern	
	Slope t-value	Intercept t-value	Slope t-value	Intercept t-value	Slope t-value	Intercept t-value
Displacement Volume/Wet Weight	1.99	3.03*	13.78*	0.79	0.9414	2.56*
Wet Weight/ Dry Weight	2.41*	8.76*	1.63	3.20*	3.47*	3.35*
Displacement Volume/Carbon	0.250	1.21	3.11*	1.09	1.59	0.49
Dry Weight/ Carbon	3.90*	0.22	3.39*	5.58*	0.76	0.34
Carbon/Nitrogen	1.59	2.91*	2.15*	2.73*	0.24	0.05
° Freedom	33		42		37	

* Indicates estimates significantly different at the 5% level.

TABLE 9. SHOWING RESULTS OF SIGNIFICANCE TESTING USING STUDENT'S T DISTRIBUTION FOR SLOPES AND INTERCEPTS OF 1.0-4.5mm SIZED MATERIAL FROM NORTHERN AND 2nd SOUTHERN STATIONS.

	Slope t- Value	Intercept t- Value
Displacement Volume/Wet Weight	3.14*	1.03
Wet Weight/Dry Weight	0.72	1.75
Displacement Volume/Carbon	2.91*	2.85*
Dry Weight/Carbon	2.88*	3.45*
Carbon/Nitrogen	0.91	2.22*

* Indicates estimates significantly different at the 5% level. Degrees of freedom are 35.

TABLE 10. SHOWING SLOPES AND INTERCEPTS (INCLUDING STANDARD ERRORS) OF 0.32-4.5mm MATERIAL COMPARED TO THOSE DERIVED BY WIEBE.

	Cruise 146 0.32-4.5mm material			Wiebe Material			Degrees of
Biomass Measures	Slope	Intercept	N	Slope	Intercept	N	Freedom
Displacement Volume/ Wet Weight	0.9455 $\pm 3.093 \times 10^{-2}$	0.2247 ± 0.213	39	0.950 $\pm 3.187 \times 10^{-4}$	in error	77	114
Wet Weight/Dry Weight	0.9747 $\pm 3.214 \times 10^{-2}$	0.9388 $\pm 1.877 \times 10^{-2}$	39	0.922 $\pm 5.8 \times 10^{-4}$	-1.749 -	94	131
Displacement Volume/ Carbon	0.9763 $\pm 3.977 \times 10^{-2}$	0.1513 $\pm 2.813 \times 10^{-2}$	39	0.808 $\pm 3.187 \times 10^{-4}$	-0.853 -	87	124
Dry Weight/ Carbon	1.058 $\pm 2.462 \times 10^{-2}$	0.434 $\pm 1.735 \times 10^{-2}$	39	0.977 $\pm 1.438 \times 10^{-4}$	0.577 -	193	230
Carbon/ Nitrogen	0.9678 $\pm 1.932 \times 10^{-2}$	0.6968 $\pm 2.525 \times 10^{-2}$	39	-	-	-	-

TABLE 11. SHOWING RESULTS FOR SIGNIFICANCE TESTING USING STUDENT'S t DISTRIBUTION OF SLOPES CALCULATED FROM DATA OF CRUISE 146 0.32-4.5mm MATERIAL

Biomass Measures	Slope t Value	Freedom
Displacement Volume/ Wet Weight	0.252	114
Wet Weight/Dry Weight	3.04*	131
Displacement Volume/Carbon	1.48	124
Dry Weight/Carbon	0.969	230

*Indicates estimates significantly different at the 5% level.

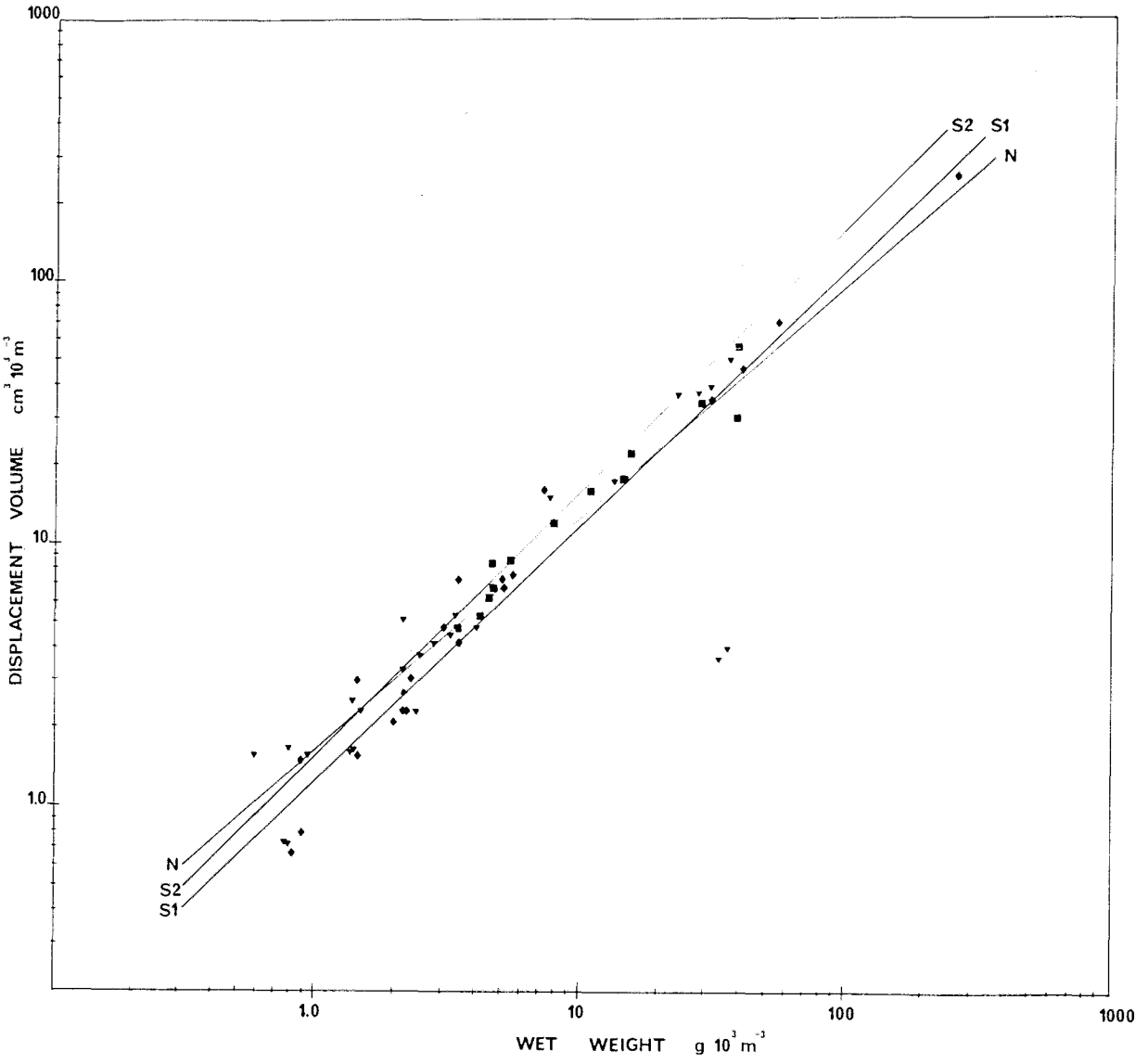


FIGURE 1. Allometric plot showing displacement volume with respect to wet weight for 0.32-1.0mm sized samples.

KEY: = Northern station (N)
= 1st Southern station (S1)
= 2nd Southern station (S2)

THIS KEY ALSO APPLIES TO FIGURES 2-15.

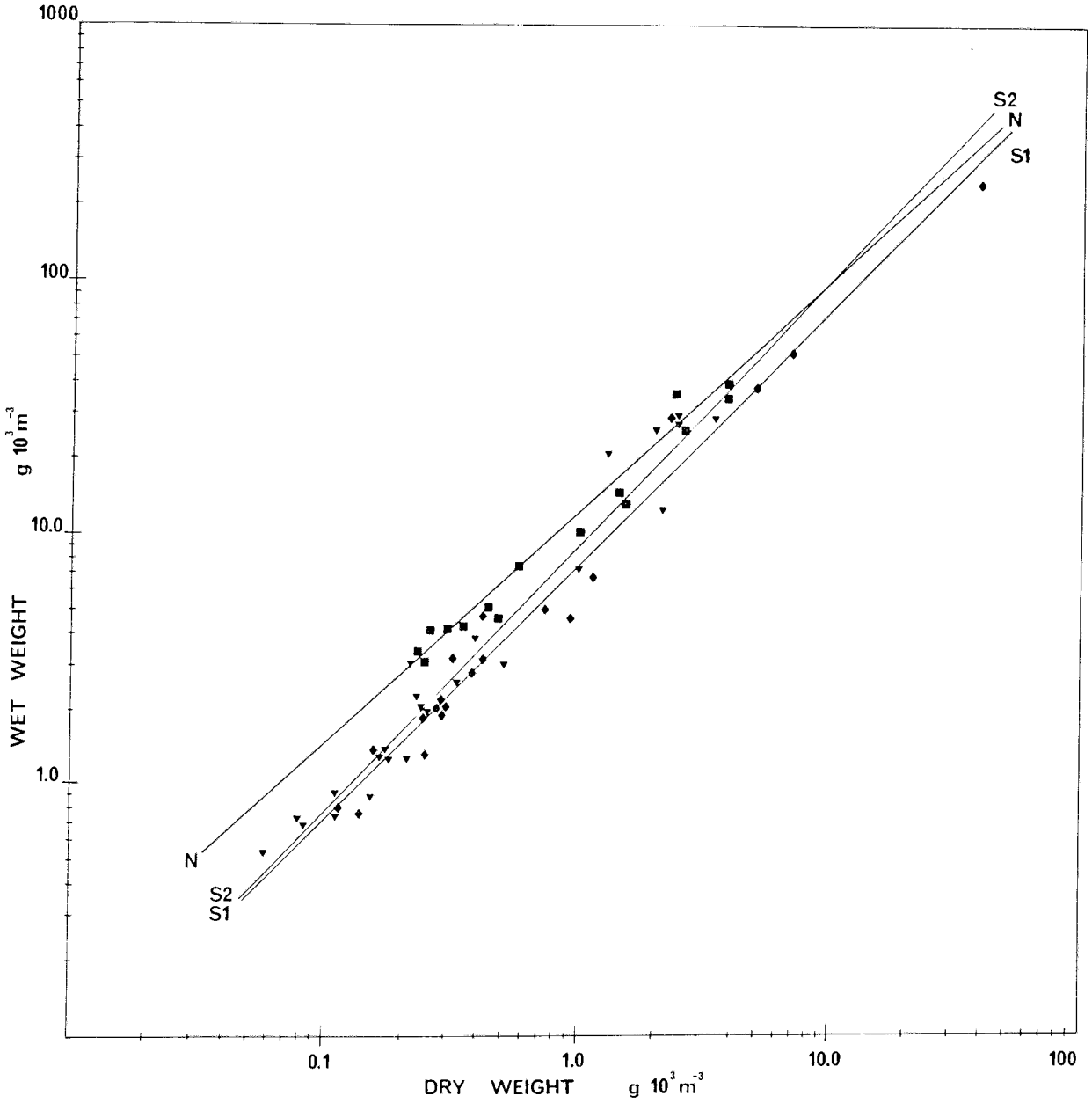


FIGURE 2. Allometric plot showing wet weight with respect to dry weight for 0.32-1.0mm sized samples.

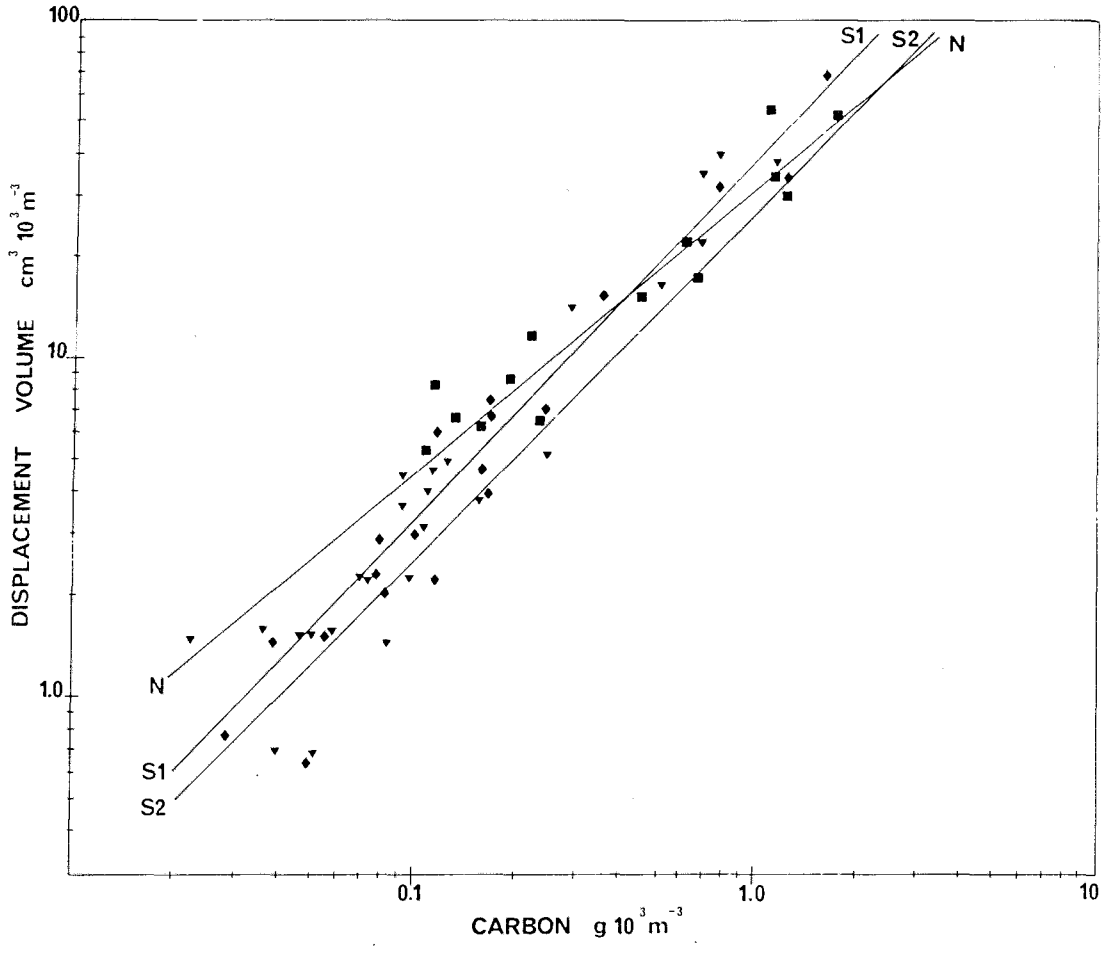


FIGURE 3. Allometric plot showing displacement volume with respect to carbon content for 0.32-1.0mm sized samples.

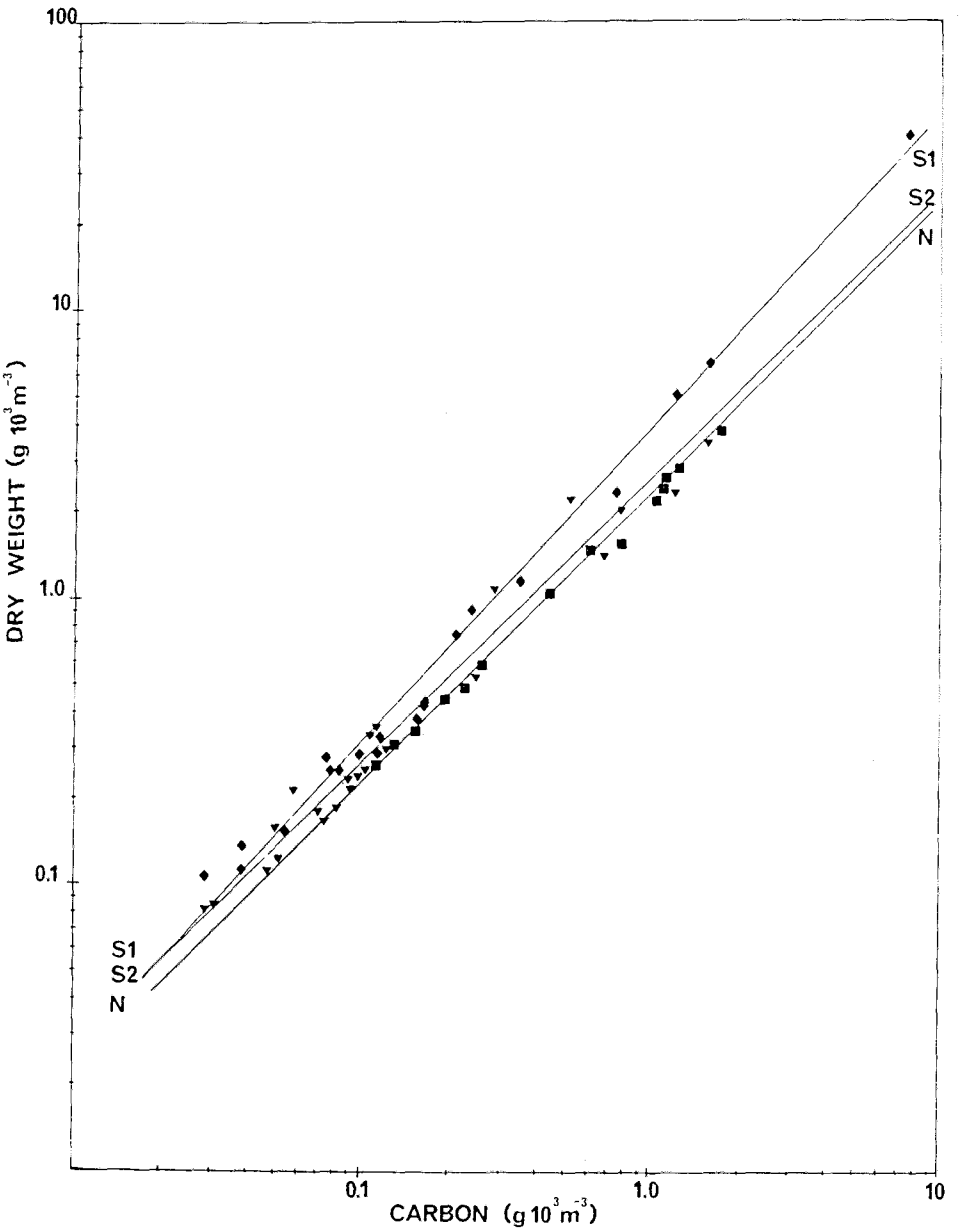


FIGURE 4. Allometric plot showing dry weight with respect to carbon content for 0.32-1.0mm sized samples.

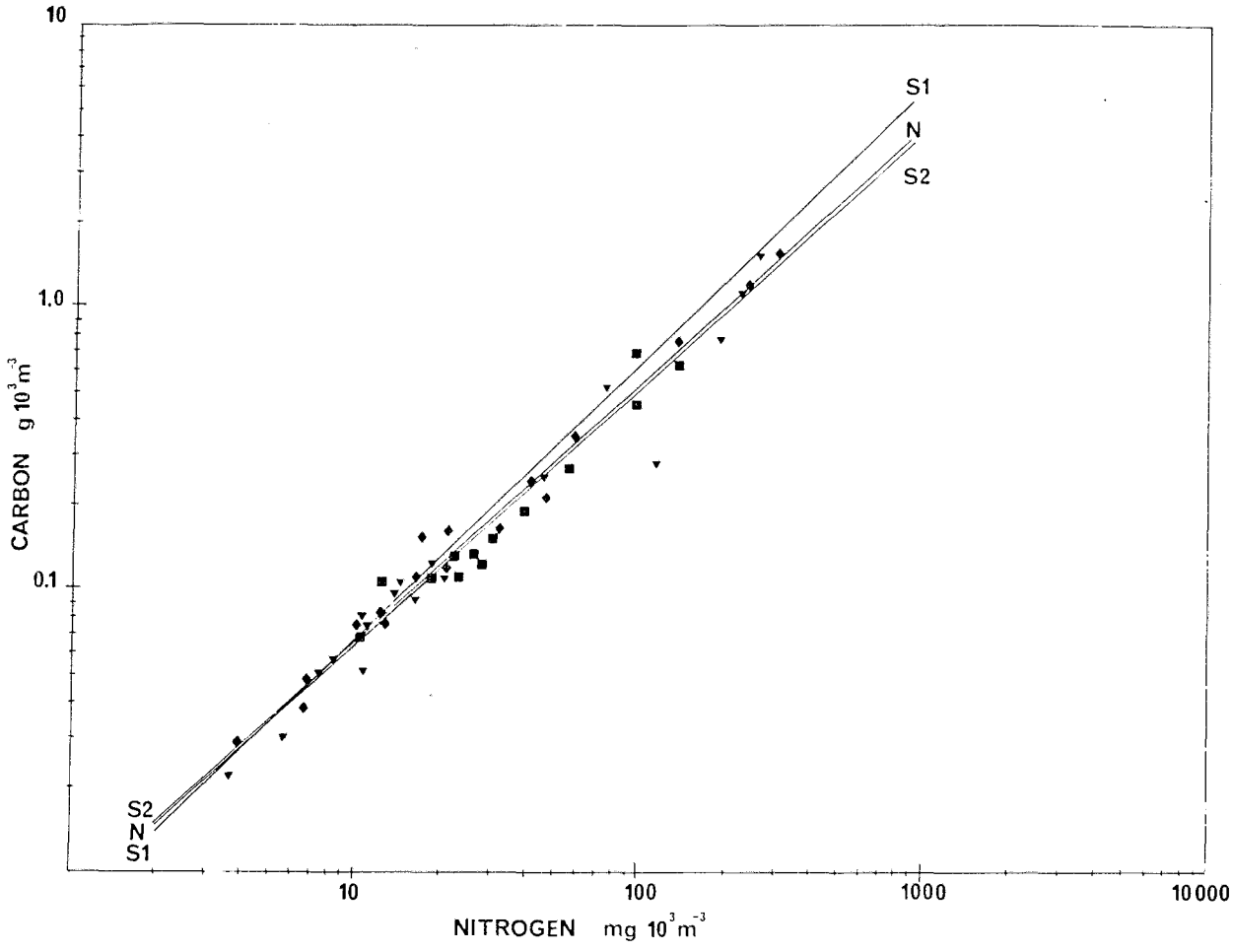


FIGURE 5. Allometric plot showing carbon content with respect to nitrogen content for 0.32-1.0mm sized samples.

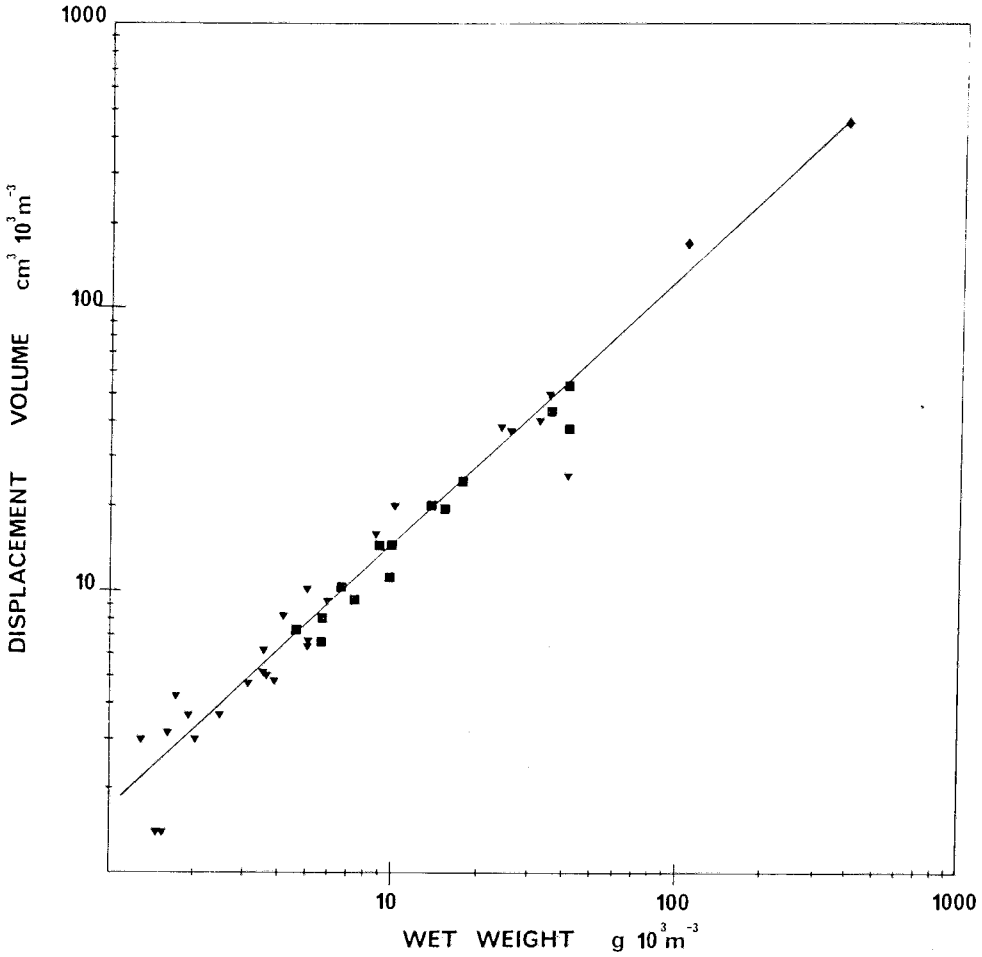


FIGURE 6. Allometric plot showing displacement volume with respect to wet weight for 1.0-4.5mm sized samples.

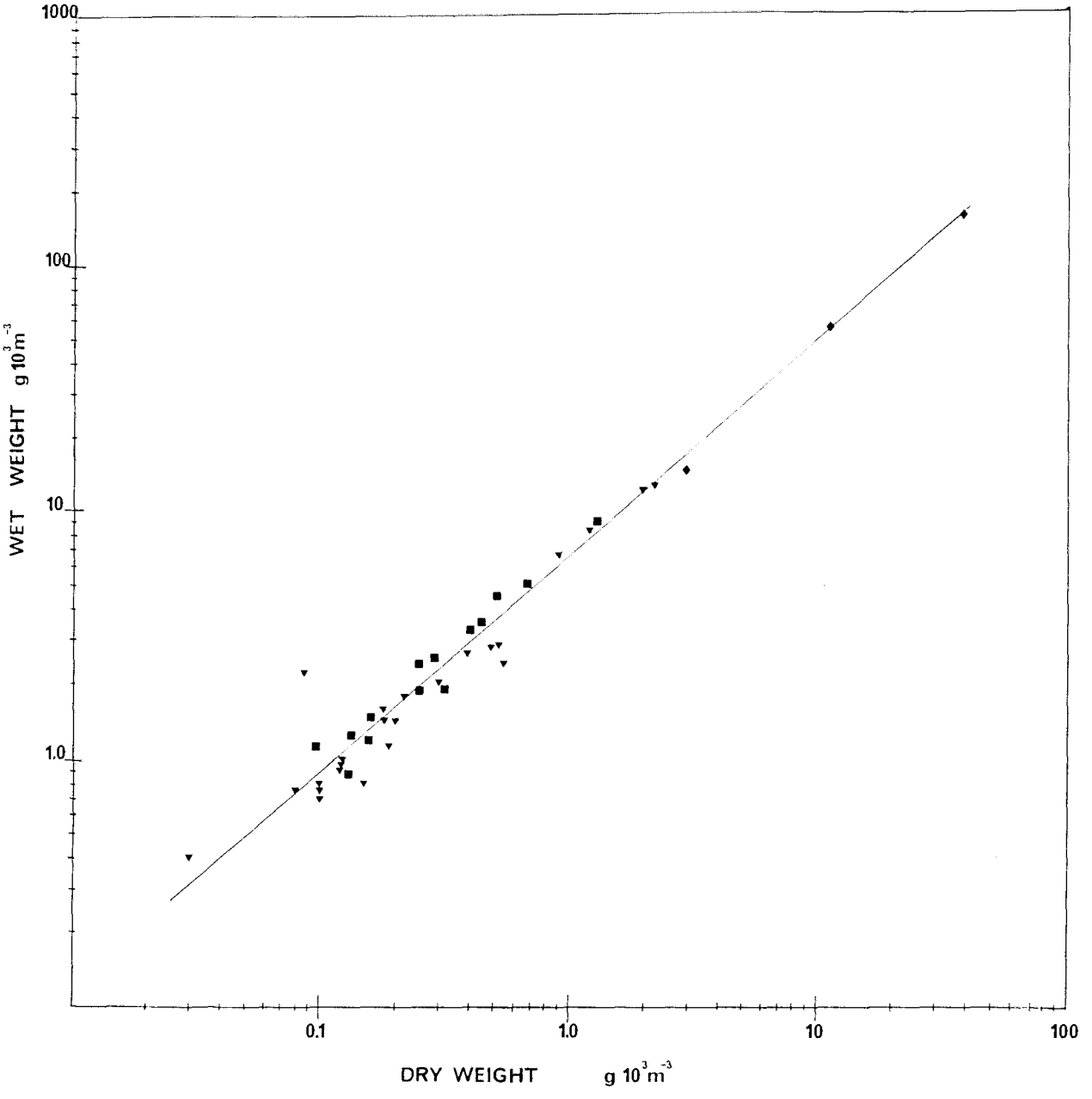


FIGURE 7. Allometric plot showing wet weight with respect to dry weight for 1.0-4.5mm sized samples.

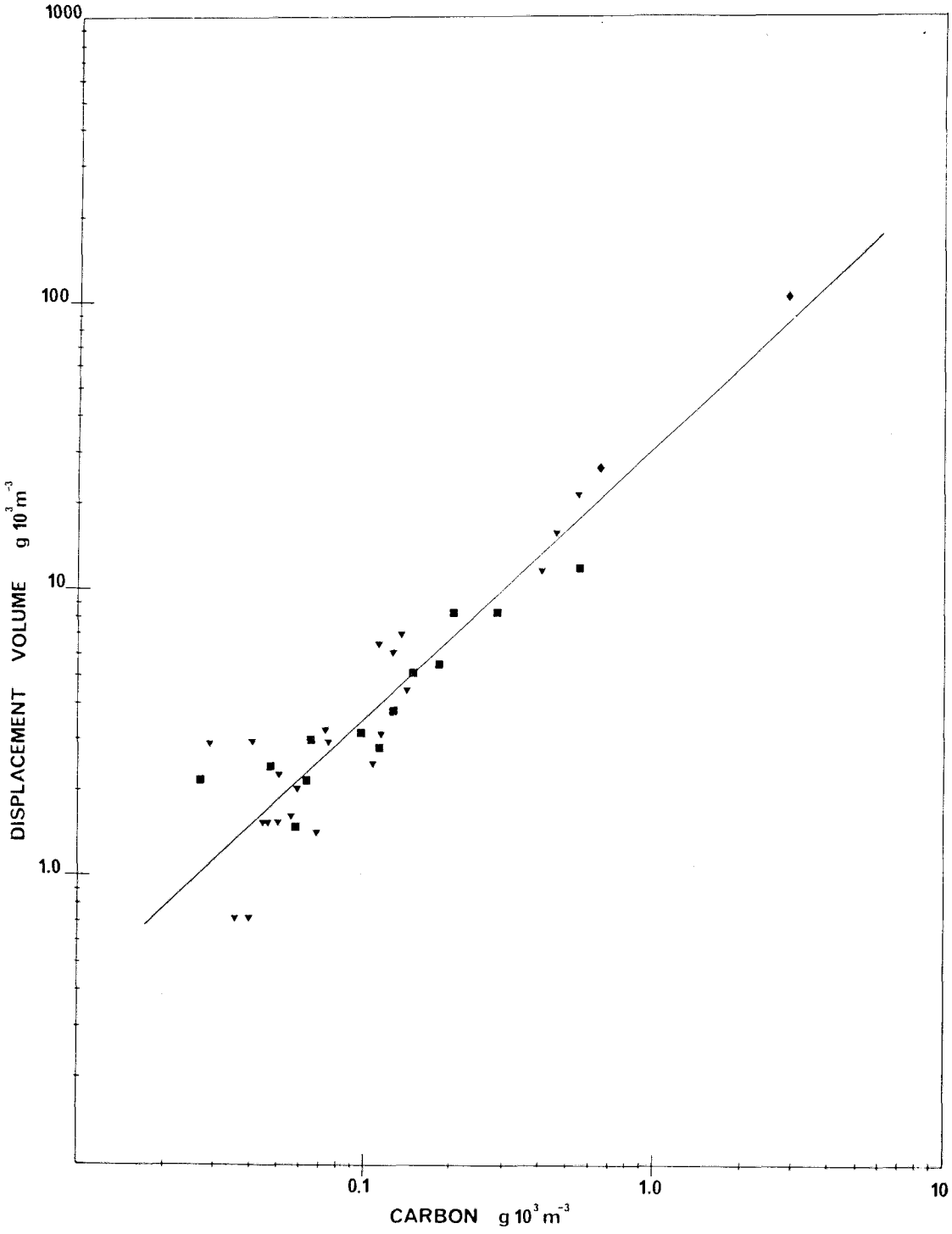


FIGURE 8. Allometric plot showing displacement volume with respect to carbon content for 1.0-4.5mm sized samples.

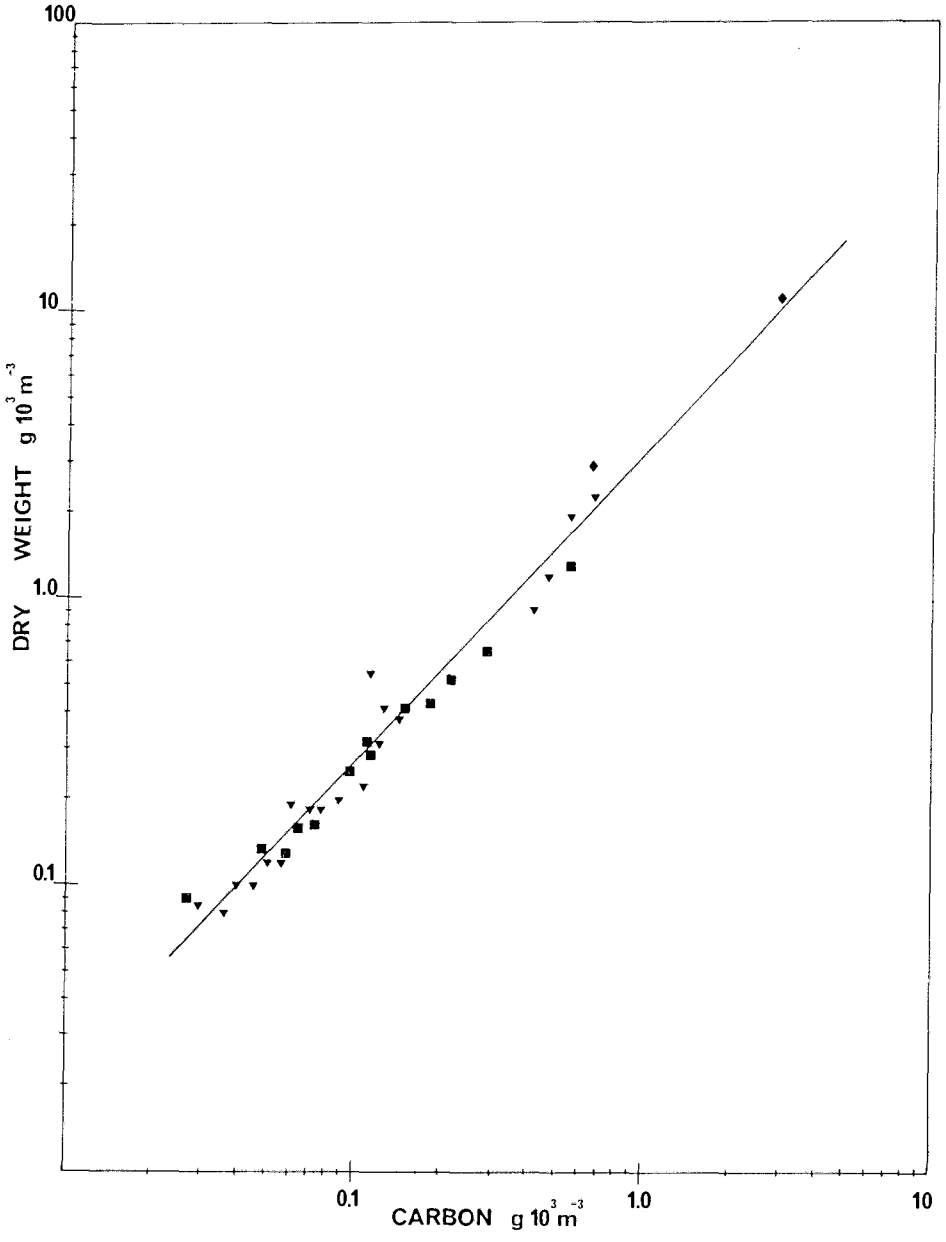


FIGURE 9. Allometric plot showing dry weight with respect to carbon content for 1.0-4.5mm sized samples.

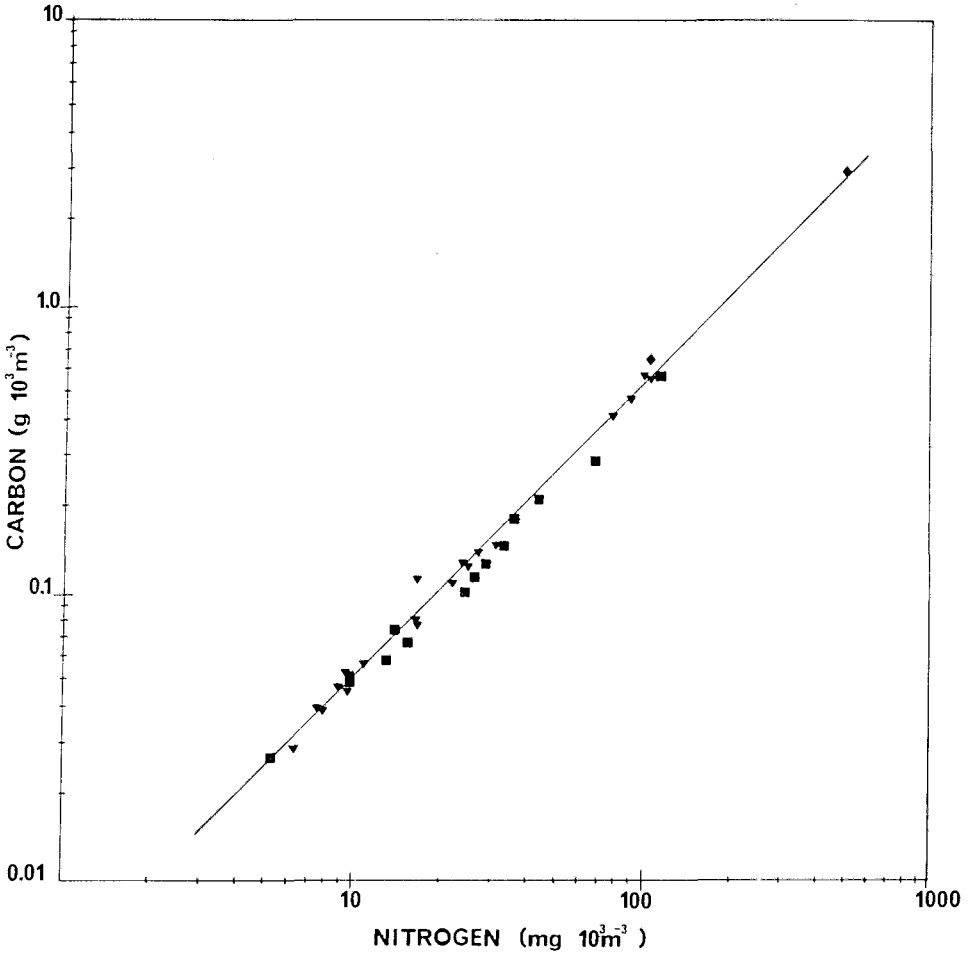


FIGURE 10. Allometric plot showing carbon content with respect to nitrogen content for 1.0-4.5mm sized samples.

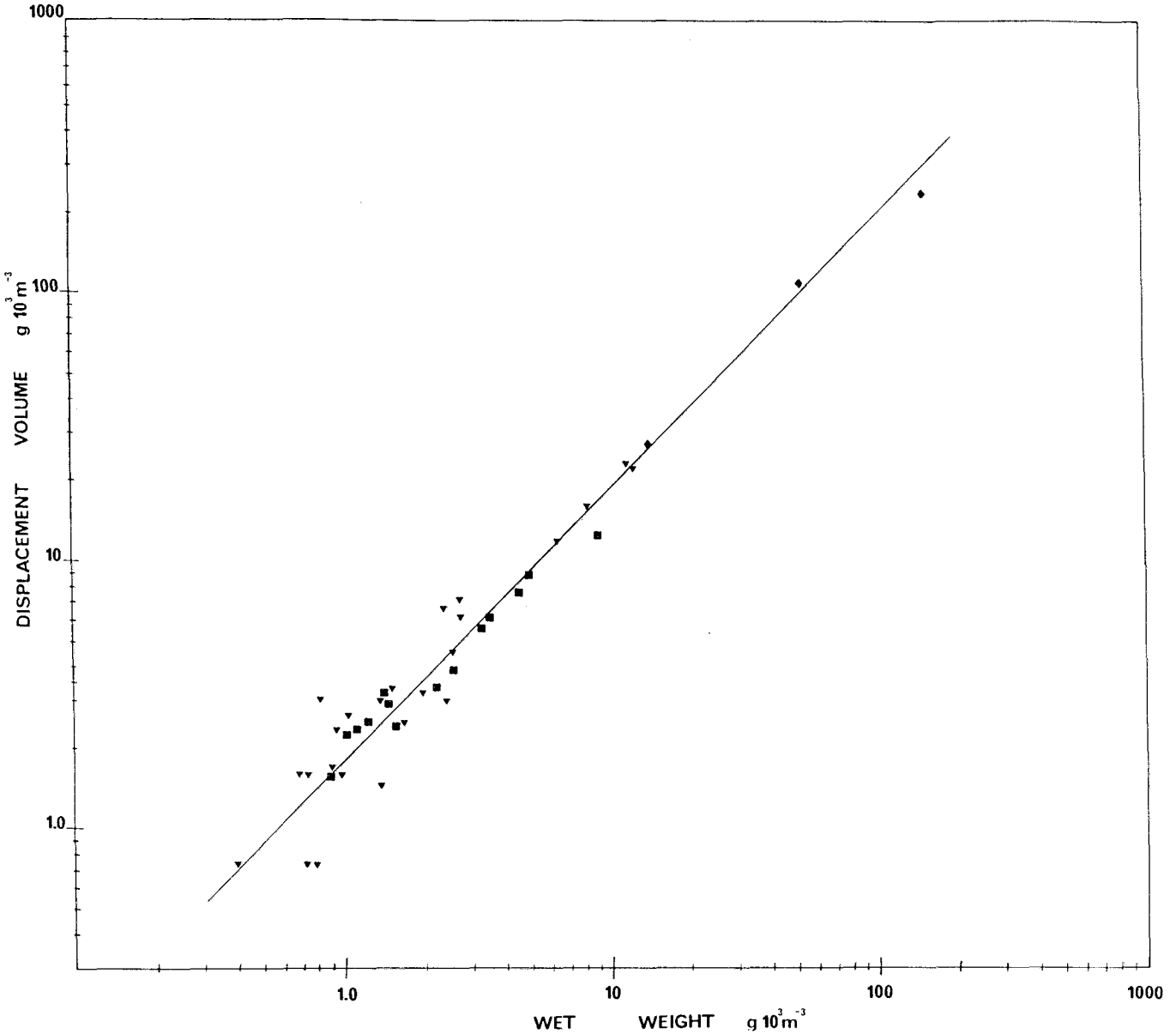


FIGURE 11. Allometric plot showing displacement volume with respect to wet weight for 0.32-4.5mm sized samples.

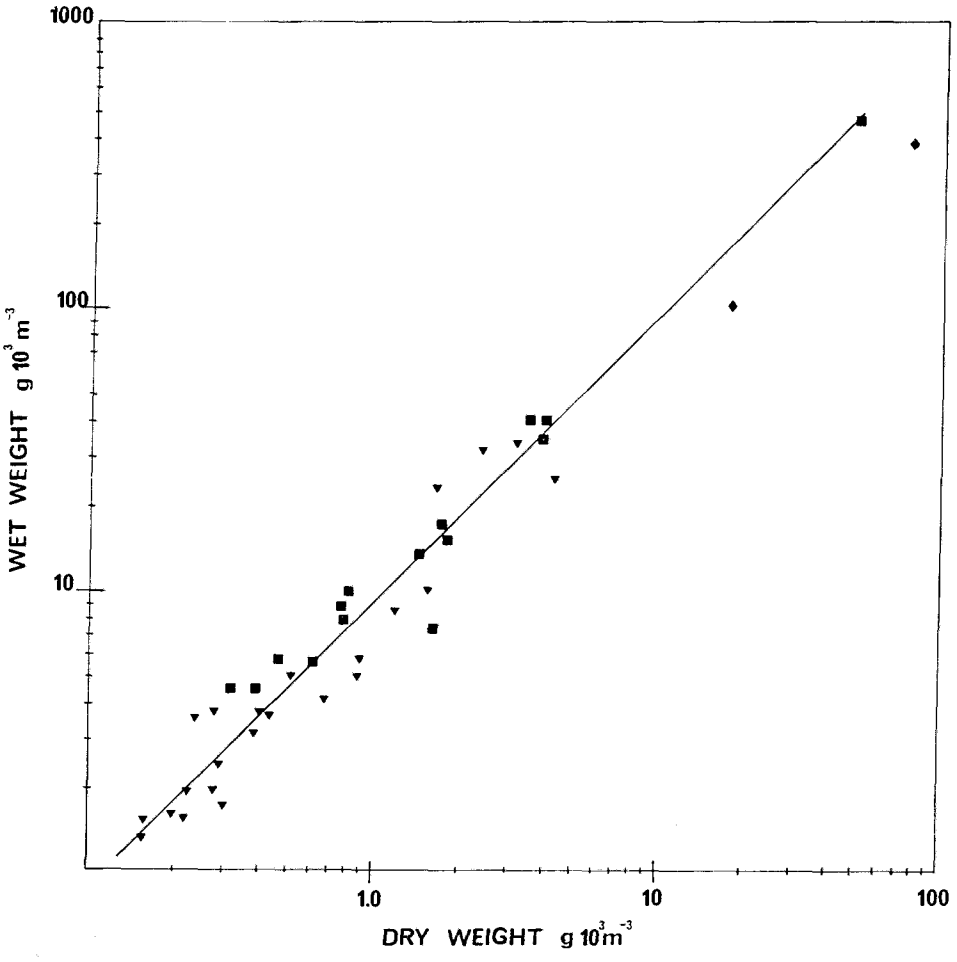


FIGURE 12. Allometric plot showing wet weight with respect to dry weight for 0.32-4.5mm sized samples.

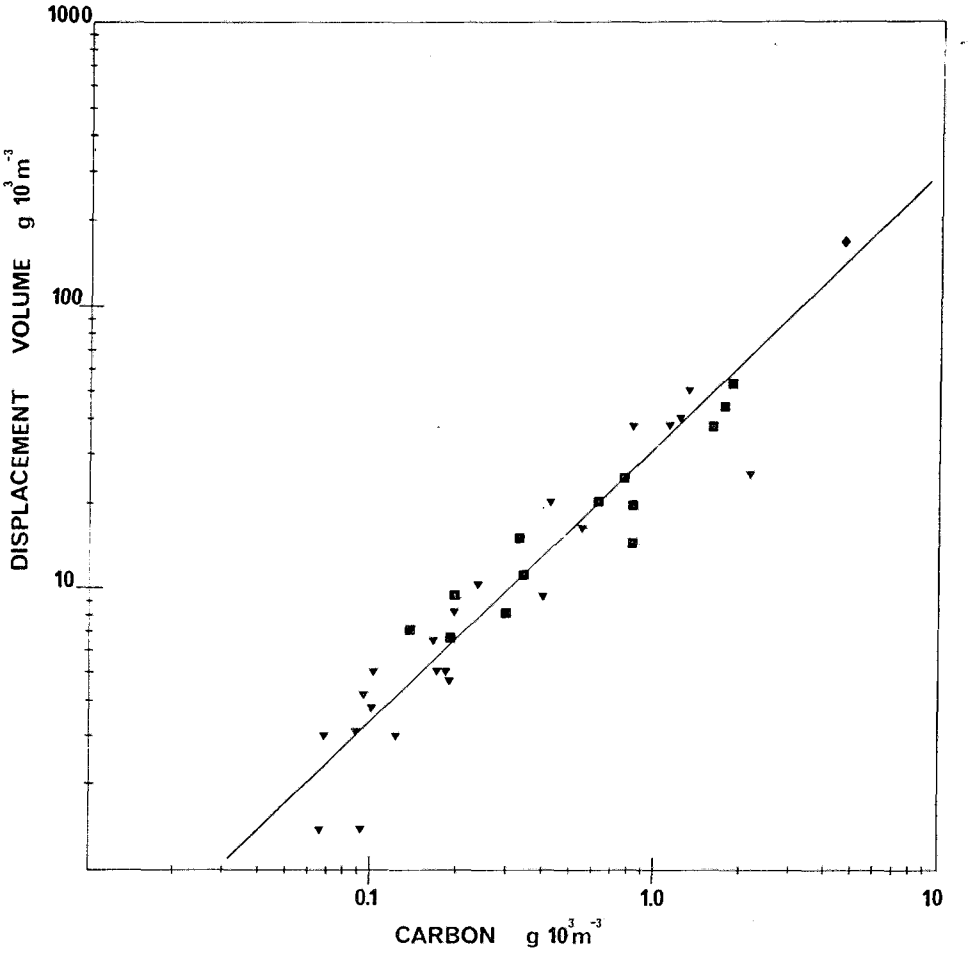


FIGURE 13. Allometric plot showing displacement volume with respect to carbon content for 0.32-4.5mm sized samples.

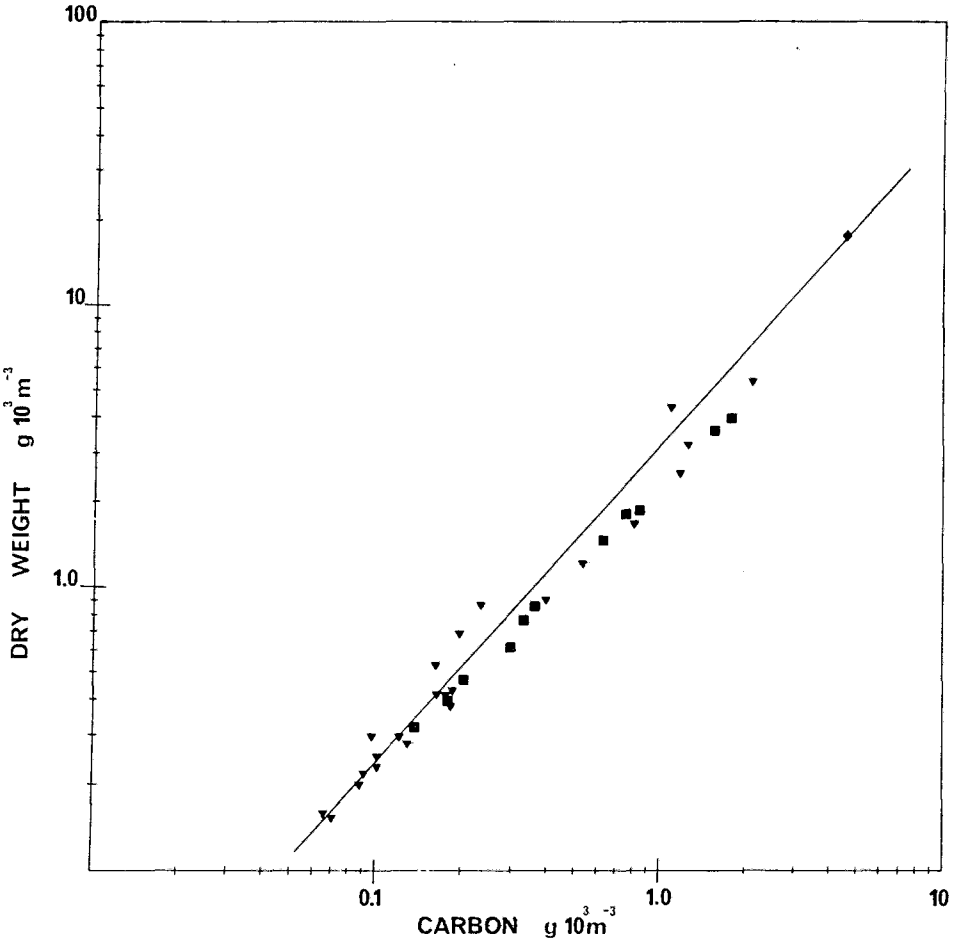


FIGURE 14. Allometric plot showing dry weight with respect to carbon content for 0.32-4.5mm sized samples.

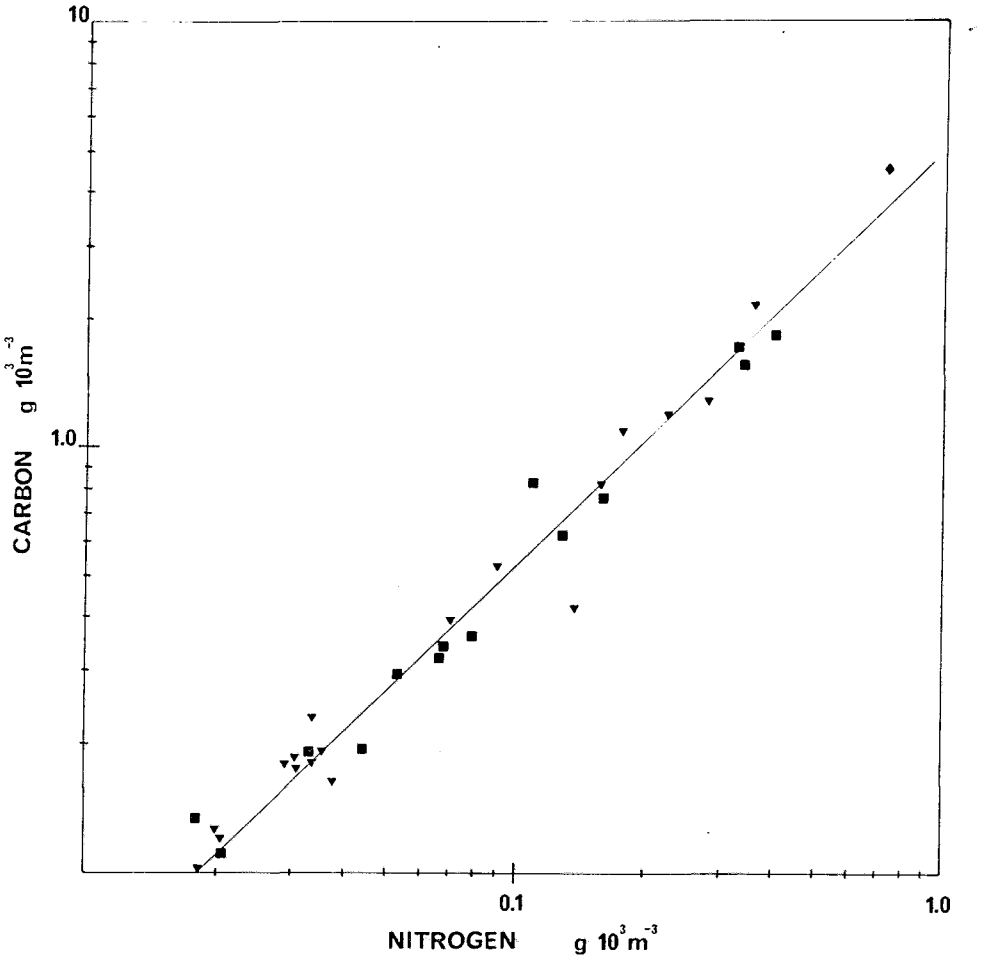
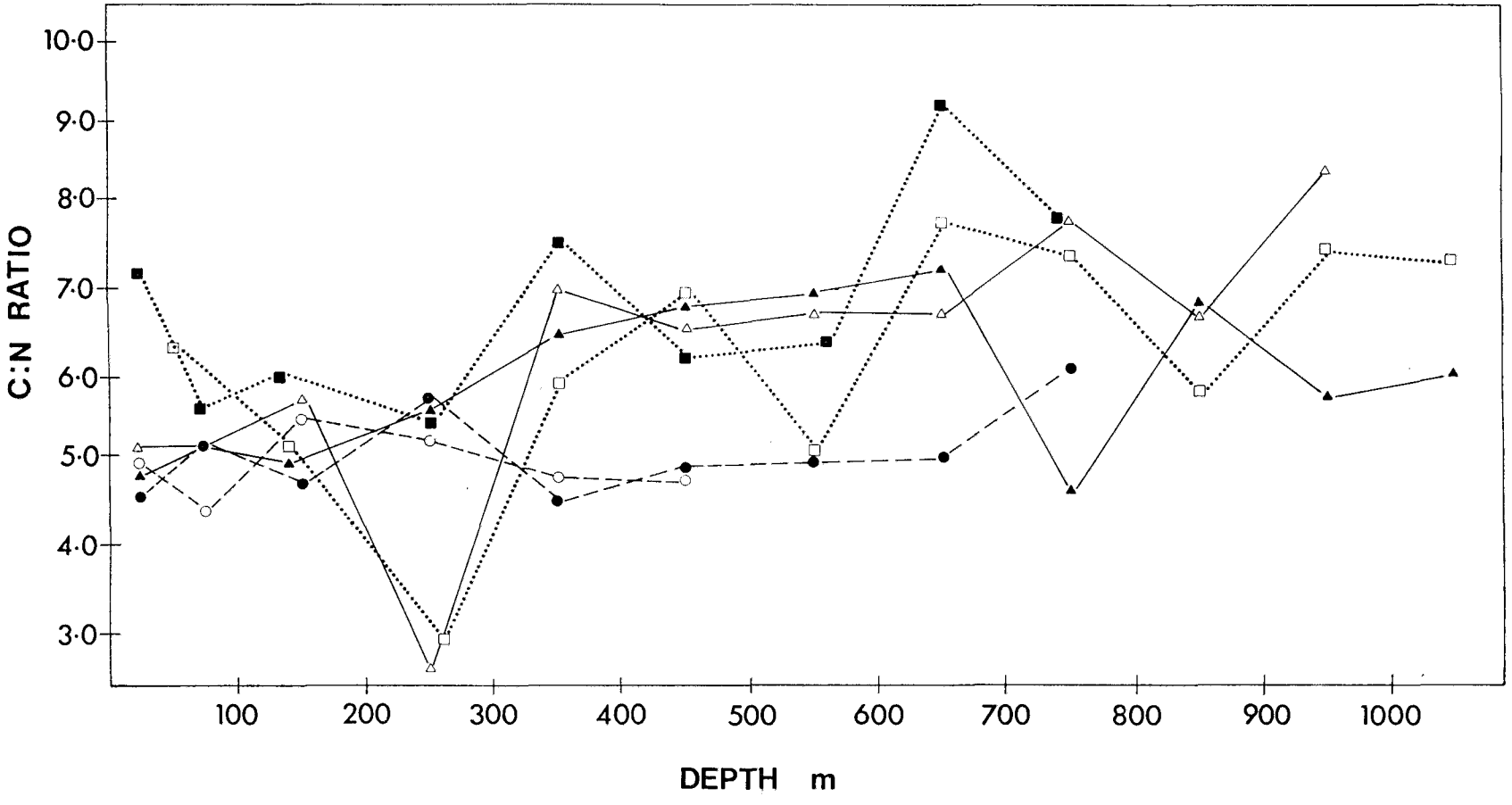


FIGURE 15. Allometric plot showing carbon content with respect to nitrogen content for 0.32-4.5mm sized samples.

FIGURE 16. Graph showing C:N ratio with respect to depth for material sized 0.32-1.0mm.



KEY: ○ = Northern Station (Day) □ = 1st Southern Station (Day) △ = 2nd Southern Station (Day)
● = Northern Station (Night) ■ = 1st Southern Station (Night) ▲ = 2nd Southern Station (Night)

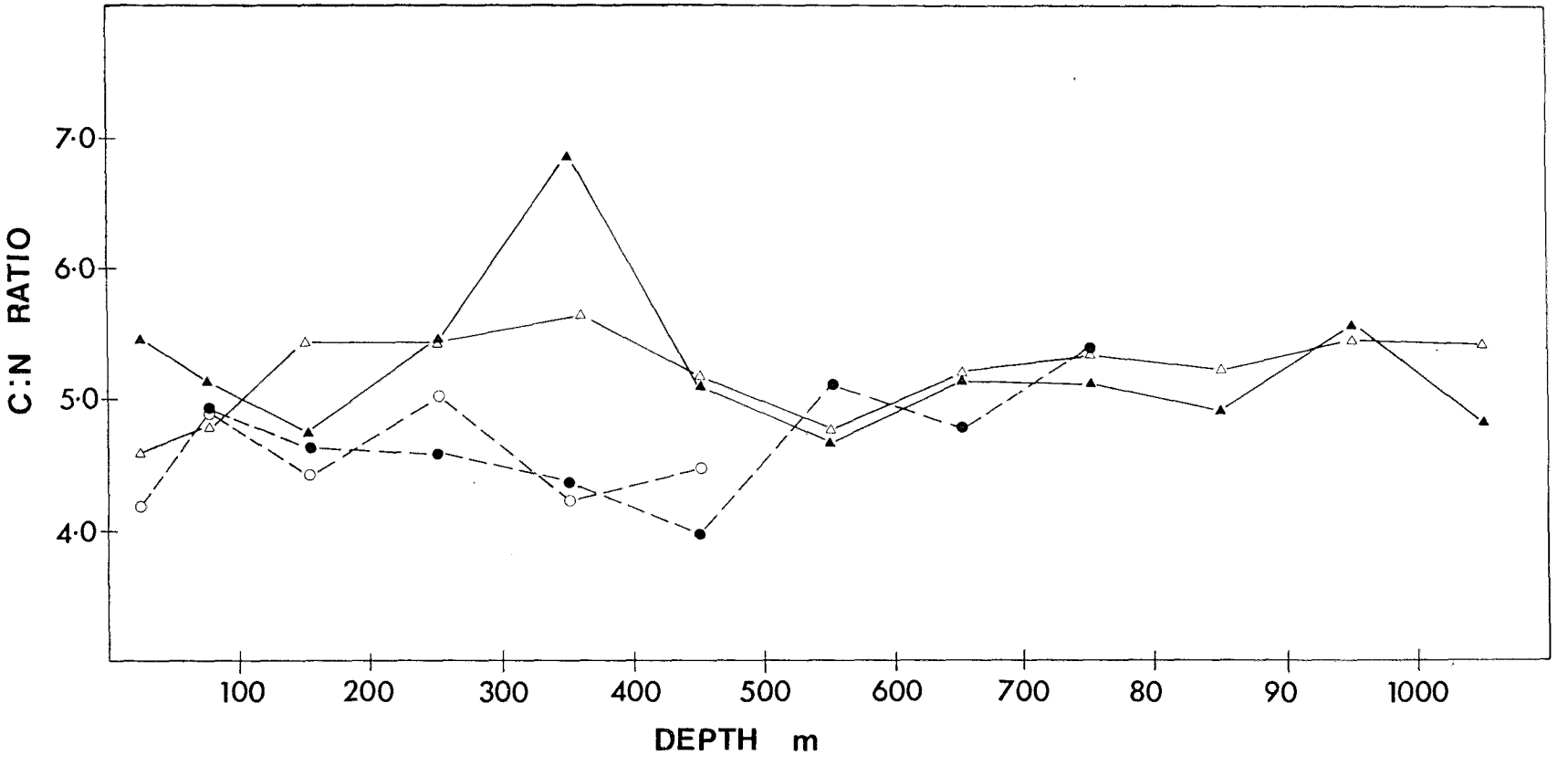


FIGURE 17. Graph showing C:N ratio with respect to depth for material sized 1.0-4.5mm. Key as for fig: 16.

APPENDIX I

ADDITIONAL NOTES FOR THE ANALYSIS OF CARBON AND NITROGEN

I. Instructions for the use of the Carlo Erba Elemental Analyser.

1. Release standby mode by pressing button marked 'STBY' on right hand side (rhs) of front panel.
2. Switch on the detector current located inside the rhs panel.
3. Turn on the oxygen cylinder spindle valve.
4. Turn on the cooling water, if necessary.
5. Carry out leak checks.
   - 5.1 Unscrew nozzles from helium vents marked 'O/S' and CHN on 1 hs, and oxygen vent marked 'OUT' at rear.
     Screw on blanking plugs.
   - 5.2 Set pressures to 1.5 Kg/cm^2 on pressure guages by screwing in the control valves (clockwise) marked 'O2', 'CHN' and 'O/S'.
     When pressures are set, fully unscrew valves.
   - 5.3 Do not alter the 'AIR' pressure.
   - 5.4 Pressures should hold for 5 minutes with no detectable change.
6. Carry out flow checks:
   - 6.1 Remove blanking plugs and refit nozzles.
   - 6.2 Set pressures on gauges using control valves to:

O/S	0.4	Kg/cm^2
CHN	0.45	"
O2	1.0	"

   - 6.3 Using the control valve and a bubble flow meter connected to the appropriate outlet nozzle adjust flow to:

     O/S)
     to 30 ml/min
     CHN)

   - 6.4 Using needle valve at rear adjust O2 to 25-30 ml/min

7. Temperature check: it takes 20-30 m for temperatures to stabilize after releasing the STBY button. Read temperatures by pressing appropriate button and observing digital display at upper rhs of front panel:

   CHN 1 1025°C ± 5°C
   CHN 2 620°C ± 5°C
   OVEN 105°C ± 2°C

8. Fit sample carousel taking care to locate the fixed and movable pins so as to position it at the required number.
9. Switch on the Chart recorder if required (Chart speed: 600/hr, 10 mv full scale).
10. Switch on the Minigrator using the ON/OFF switch on the rhs of the unit. This is a single channel computing integrator. It is programmable but the default program is suitable for normal use. Ensure that event marker is on.
11. Set Zero: Type SHIFT SLOPE on Minigrator.
    If necessary adjust ZERO control (on rhs of front panel) until printed value = 500 DL.
12. Peak Sensor.

    The switch for this is located on the lower rhs of the front panel. If this is ON the automatic sampler will stop if no peak greater than 1.5mv (7000 peak area units) is recorded. If the peak sensor is switched OFF the sampler will continue to advance whatever the peak size.
13. To start running:

    13.1 Ensure RUN light on Minigrator is off by pressing RUN key if necessary.

    13.2 Ensure CHN button on rhs of front panel is depressed (light on).

    13.3 Simultaneously press RUN button on Minigrator and START button on rhs of front panel.

    13.4 To set the sample number printed by the Minigrator type the require number followed by ID.

    13.5 The attenuator switch on the Minigrator can be used to vary the Chart recorder output. The integrated peak area output is not affected b varying this switch.

14. To stop Analyser.

14.1 If the peak sensor switch is ON the analyser will continue until al the samples are processed. It will then analyse one blank and stop.

14.2 The analyser may be halted by pressing the STOP button on the rhs o the front panel. The current analytical cycle will be completed (1 mins) before it stops.

If the STOP button is pressed before the autosampler has advanced after releasing the current sample, the current sample position will be retained when the analyser stops

14.3 The Minigrator and Chart recorder are not switched off automatically. This can be done by feeding the power supplies for these units Through a timer switch.

14.4 When all the samples are completed turn off cooling water, lower oxygen pressure to 0.2 Kg/cm^2, and switch off Minigrator and Char Recorder. Do NOT turn off or reduce Helium carrier gas or air pressure. Do not turn off detector current. If the instrument is not required for a week or more the standby mode may be selected.

15. Standby Mode (if required):

15.1 Press STBY switch

15.2 Turn oxygen off at cylinder spindle valve.

15.3 Reduce CHN, O/S pressures to 0.2 Kg/cm^2n.

15.4 Switch OFF detector current.

15.5 Turn OFF cooling water.

15.6 Do NOT turn off or reduce AIR pressure.

15.7 Switch off Minigrator and Chart recorder.

16. Record total number of samples run (including blanks and standards) on the daily log sheet so that the working life of the combustion and reduction tubes can be estimated.

II. Calculation of the Results

The peak areas and retention times for nitrogen and carbon are shown in the form of a print out. Any background noise is corrected before the following factor, calculated from standard data, for each element is found. This factor is calculated using the formula:

$$K_C = \frac{\text{theoretical \%C in standard x Wt (mg)}}{\text{Peak Area}}$$

SAMPLE WT (mg)	NITROGEN	CARBON
1495.0	3.18	1.21
1641.0	3.15	1.21
993.0	3.22	1.20
2014.0	3.17	1.22
555.0	3.22	1.19
797.0	3.22	1.20
578.0	3.24	1.19
1729.0	3.16	1.21
MEAN	3.20	1.20
%SD	1.02	0.19

Finally, the concentration of each element in the sample is calculated using the formula:

$$\% C = \frac{K_C \text{ x Peak Area}}{\text{Wt (mg)}}$$

APPENDIX II

LIST OF COMPUTER FILE NAMES

FILE NAME	STATION(S)	SIZE
BIOMAS32	Northern, 1st Southern and 2nd Southern	0.32-1.0mm
BIOMASN	Northern	"
BIOMASS1	1st Southern	"
BIOMASS2	2nd Southern	"
BIOMAS10	Northern, 1st Southern and 2nd Southern	1.0-4.5mm
BIOMAS1N	Northern	"
BIOMAS1S	2nd Southern	"
BIOMASC	Northern, 1st Southern and 2nd Southern	0.32-4.5mm

ACKNOWLEDGEMENTS

Many thanks to Dr. M. Fasham for all his kind help and advice needed to compile the report, with special thanks to Bobbie Allen and Pam Talbot for the typing of this manuscript.