RELATION WITH SEDIMENT ORGANIC CARBON

This section contains an analysis of the relationships between the quantity of organic matter in bottom sediments and the quantity of benthic organisms. Prior to making the analysis we considered two general cause-and-effect relationships. First we considered the possibility that where organic carbon was more abundant it might provide a greater quantity of food, and thus support a larger standing crop of benthic animals. Secondly we considered the converse of the preceding--the possibility that where animals were more abundant they might produce a larger amount of organic matter (fecal deposits, for example) in the sediments. In either case, high abundance would be associated with high carbon content.

Results of the analyses, as described below, revealed no general correlation between sediment organic carbon and the quantity of benthic animals. A few taxonomic groups exhibited good correlations--some direct and some inverse--between abundance and organic content, but they were the rare exception.

The results are presented in four sub-sections: (1) geographic distribution of sediment organic content; (2) total macrobenthic fauna in relation to carbon content; (3) major taxonomic groups in the entire Middle Atlantic Bight Region in relation to carbon content; and (4) major taxonomic groups in Southern New England in relation to carbon content.

Distribution of Sediment Organic Carbon

The geographic distribution of organic carbon in the bottom sediments of the Middle Atlantic Bight Region is depicted in figure 105. Sediments blanketing almost the entire continental shelf throughout this Region contained only a small amount (0.01 to 0.49% weight class) of organic carbon. Slightly larger quantities (0.5 to 0.99%) were broadly distributed in sediments on the continental slope and rise, plus a moderately large area on the outer continental shelf off Southern New England. Moderate quantities of organic carbon (1.0 to 1.99%) were widely distributed along the continental slope, with some incursions onto the shelf and onto the continental rise. The largest quantities of organic carbon (2.00 to 7.16%) occurred most commonly in sediments in the bays and sounds, plus one small area on the upper continental slope northeast of Cape Hatteras. Sediments in some inshore waters such as Buzzards Bay, Long Island Sound, Delaware Bay, Chesapeake Bay and Pamlico Sound also contained patches of small and moderate quantities of organic carbon.

Total Macrobenthic Fauna--All Taxonomic Groups Combined

Mean quantities of benthic animals were calculated for seven sediment organic carbon classes within each of the three subareas and for the entire Middle Atlantic Bight Region. These data, for both density and biomass, are listed in table 28 and illustrated in figures 106 and 107. The values for density range from 182/m^2 to 5,236/m^2, with no apparent trends. There were no correlations between density of organisms and the quantity of organic carbon in any of the subareas or for the Region as a whole. Mean

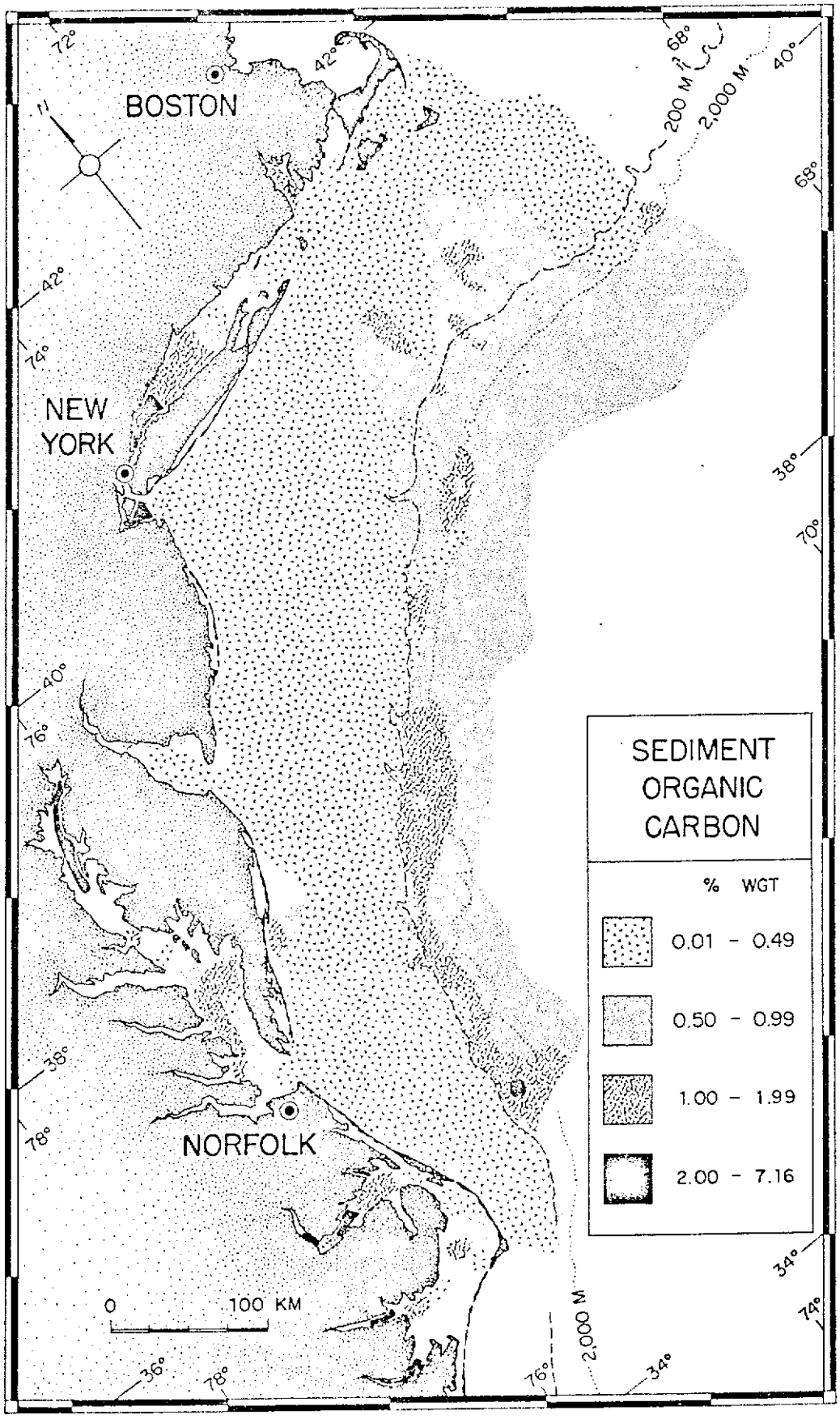

Figure 105.--Geographic distribution of sediment organic carbon in the Middle Atlantic Bight Region.

Table 28.--Mean number of individuals and biomass of the macrobenthic invertebrate fauna in relation to percent organic carbon in bottom sediments. Values are listed separately for each subarea and for the entire Middle Atlantic Bight Region.

Organic carbon	Mean number of individuals				Mean biomass			
	SNE	NYB	CHB	Entire area	SNE	NYB	CHB	Entire area
%	No./m^2	No./m^2	No.m^2	No./m^2	g/m^2	g/m^2	g/m^2	g/m^2
0.01-0.4	2643	1226	1372	1653	326	130	77	164
0.5 -0.9	903	750	623	796	80	79	143	94
1.0 -1.4	902	1208	596	841	65	2223	66	551
1.5 -1.9	2052	1061	707	1007	116	61	63	71
2.0 -2.9	5236	3126	182	2052	218	2657	14	1211
3.0 -4.9	-	-	597	597	-	-	156	156
5.0 +	-	-	2244	2244	-	-	555	555

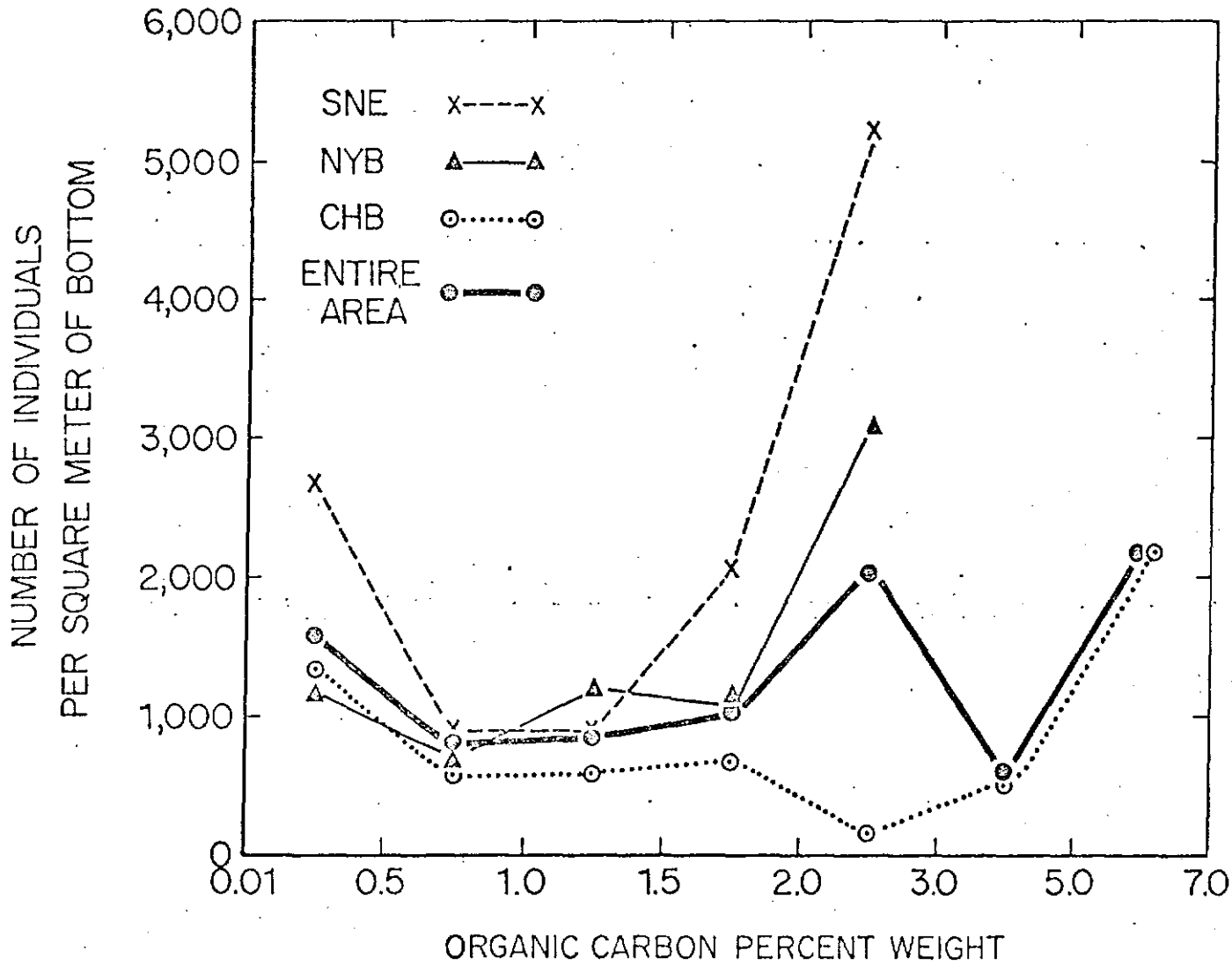

Figure 106.--Relation between number of individuals and sediment organic carbon. Values represent all taxonomic groups combined for each subarea and for the entire Middle Atlantic Bight Region.

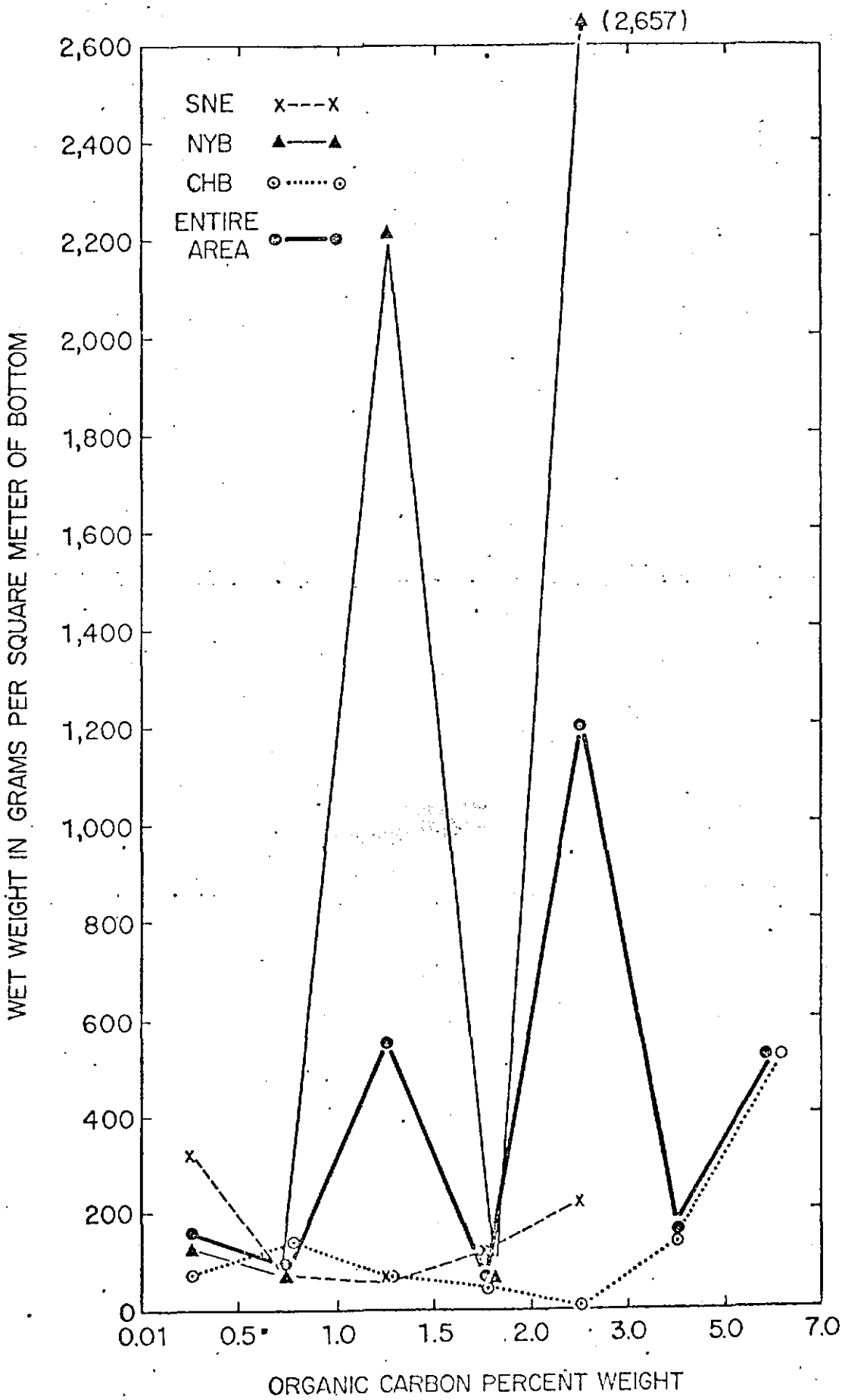

Figure 107.--Relation between biomass and sediment organic carbon. Values represent all taxonomic groups combined for each subarea and for the entire

biomasses for the seven organic carbon classes in the various subareas and the entire Region ranged from 14 g/m^2 to 2,657 g/m^2. There were no correlations between biomass and the quantity of sediment organic carbon. Because of the erratic values within carbon classes and between adjacent carbon classes in both density and biomass, we consider the minimum trend to be spurious.

Taxonomic Groups

Entire Middle Atlantic Bight Region

The analysis in this section is based on the density and biomass of each major taxonomic group in the seven classes of sediment organic carbon from the entire Middle Atlantic Bight Region. Density values are listed in table 29 and biomass values are listed in table 30; these data are illustrated in figures 108 through 113. It is clear that neither the density nor biomass values correlated in a general way with the amount of sediment organic carbon. The majority of taxonomic groups showed erratic trends in both density and biomass in relation to carbon. However, a few individual groups revealed good correlations. In terms of density (table 29), the groups that showed a direct relation were Porifera (fig. 108), Pycnogonida (fig. 110) and Copepoda (fig. 111); Nematoda (fig. 109) revealed an inverse relation. In terms of biomass (table 30), Cirripedia (fig. 111) showed a direct relation with carbon, and Cumacea (fig. 111) and Echinoidea (fig. 113) showed an inverse relation. The weight of evidence indicates that when higher taxa (such as phyla, classes, and orders) are grouped from a broad geographical area and evaluated in terms of quantitative relationships with sediment organic carbon, there is little evidence of interdependence between the two.

Table 29.--Mean number of individuals of each taxonomic group listed by sediment organic carbon content class, representing the entire Middle Atlantic Bight Region.

Taxonomic group	Sediment organic carbon content (percent)						
	0.01-0.4	0.5-0.9	1.0-1.4	1.5-1.9	2.0-2.9	3.0-4.9	5.0+
	No./m²	No./m²	No./m²	No./m²	No./m²	No./m²	No./m²
PORIFERA	0.65	0.17	0.12	-	-	1.22	32.00
COELENTERATA	12.59	43.41	8.00	7.56	-	10.78	-
Hydrozoa	8.09	22.99	-	0.08	-	-	-
Anthozoa	4.50	20.42	8.00	7.48	-	10.78	-
Alcyonacea	0.19	1.15	1.20	0.24	-	-	-
Zoantharia	2.32	6.64	6.08	5.28	-	10.78	-
Unidentified	1.99	12.63	0.72	1.96	-	-	-
PLATYHELMINTHES	0.89	0.05	0.52	-	-	-	-
Turbellaria	0.89	0.05	0.52	-	-	-	-
NEMERTEA	4.43	3.39	2.95	10.36	0.22	1.22	-
ASCHELMINTHES	2.99	2.11	1.50	0.68	0.44	-	-
Nematoda	2.99	2.11	1.50	0.68	0.44	-	-
ANNELIDA	355.38	204.20	139.12	137.48	135.22	36.56	548.00
POGONOPHORA	0.01	3.25	14.50	2.68	3.33	-	-
SIPUNCULIDA	3.75	5.58	2.22	0.84	0.22	-	-
ECHIURA	0.01	0.47	0.20	0.08	-	-	-
PRIAPULIDA	-	0.02	0.15	-	-	-	-
MOLLUSCA	362.00	147.63	485.02	656.24	909.33	403.33	730.00
Polyplacophora	0.44	0.35	0.62	0.24	1.22	-	-
Gastropoda	27.40	14.25	18.22	260.24	52.22	112.11	-
Bivalvia	333.36	129.13	463.98	394.60	853.67	291.22	730.00
Scaphopoda	0.79	2.28	2.20	1.16	2.22	-	-
Cephalopoda	0.01	1.63	-	-	-	-	-
Unidentified	-	-	-	-	-	-	-
ARTHROPODA	823.82	308.14	88.62	123.64	994.78	94.22	537.00
Pycnogonida	0.36	0.39	0.28	-	3.11	5.33	-
Arachnida	0.07	-	-	-	-	-	-
Crustacea	823.39	307.74	88.35	123.64	991.67	88.89	537.00
Ostracoda	0.26	0.29	-	-	-	-	-
Cirripedia	10.90	46.32	-	-	885.11	-	-
Copepoda	0.03	0.05	0.12	-	-	-	-
Nebaliacea	0.02	0.01	-	-	-	-	-
Cumacea	19.54	3.12	3.05	0.44	1.22	-	-
Tanaidacea	0.02	0.23	-	-	-	-	-
Isopoda	14.36	4.70	0.40	28.72	10.11	12.11	140.00
Amphipoda	767.29	244.73	83.92	86.00	84.22	76.78	397.00
Mysidacea	2.56	1.89	-	2.20	-	-	-
Decapoda	8.42	6.40	0.85	6.28	11.00	-	-
BRYOZOA	8.98	1.45	3.80	60.00	-	-	-
BRACHIOPODA	0.01	-	-	-	-	-	-
ECHINODERMATA	53.02	56.26	80.82	2.72	0.67	-	-
Holothuroidea	1.62	3.36	4.02	2.28	-	-	-
Echinoidea	35.79	0.39	0.12	-	-	-	-
Ophiuroidea	14.85	51.93	75.48	0.36	0.67	-	-
Asteroidea	0.74	0.58	1.20	0.08	-	-	-
HEMICHORDATA	0.14	0.14	0.25	-	-	-	-
CHORDATA	18.64	11.00	7.00	0.44	6.33	-	-
Ascidiacea	18.64	11.00	7.00	0.44	6.33	-	-
UNIDENTIFIED	5.34	8.99	5.72	4.32	1.22	49.67	397.00

Table 30.--Mean biomass of each taxonomic group listed by sediment organic carbon content class, representing the entire Middle Atlantic Bight Region.

Taxonomic group	Sediment organic carbon content (percent)						
	0.01-0.4	0.5-0.9	1.0-1.4	1.5-1.9	2.0-2.9	3.0-4.9	5.0+
	g/m²	g/m²	g/m²	g/m²	g/m²	g/m²	g/m²
PORIFERA	0.056	0.007	0.002	-	-	0.012	0.110
COELENTERATA	2.175	5.252	4.687	3.050	-	0.620	-
Hydrozoa	0.403	0.225	-	0.001	-	-	-
Anthozoa	1.772	5.027	4.687	3.049	-	0.620	-
Alcyonacea	0.026	0.186	0.347	0.148	-	-	-
Zoantharia	1.643	4.375	4.274	2.847	-	0.620	-
Unidentified	0.103	0.466	0.066	0.054	-	-	-
PLATYHELMINTHES	0.009	<0.001	0.003	-	-	-	-
Turbellaria	0.009	<0.001	0.003	-	-	-	-
NEMERTEA	0.674	0.531	0.239	1.081	0.010	0.012	-
ASCHELMINTHES	0.004	0.006	0.006	0.006	0.004	-	-
Nematoda	0.004	0.006	0.006	0.006	0.004	-	-
ANNELIDA	12.449	15.851	11.415	14.018	18.834	3.023	9.770
POGONOPHORA	<0.001	0.022	0.094	0.009	0.007	-	-
SIPUNCULIDA	0.469	1.116	0.132	2.486	0.004	-	-
ECHIURA	0.005	0.883	0.471	0.695	-	-	-
PRIAPULIDA	-	0.031	0.039	-	-	-	-
MOLLUSCA	108.172	39.215	509.982	45.543	1164.252	151.494	540.870
Polyplacophora	0.225	0.012	0.022	0.004	0.004	-	-
Gastropoda	2.987	3.599	0.390	6.410	11.398	0.052	-
Bivalvia	104.948	35.532	509.534	39.113	1152.831	151.442	540.870
Scaphopoda	0.012	0.050	0.036	0.016	0.019	-	-
Cephalopoda	<0.001	0.022	-	-	-	-	-
Unidentified	-	-	-	-	-	-	-
ARTHROPODA	10.299	8.568	0.567	1.550	26.347	0.462	2.250
Pycnogonida	0.002	0.002	0.006	-	0.031	0.027	-
Arachnida	<0.001	-	-	-	-	-	-
Crustacea	10.296	8.566	0.561	1.550	26.316	0.435	2.250
Ostracoda	0.002	0.003	-	-	-	-	-
Cirripedia	3.912	5.076	-	-	20.679	-	-
Copepoda	<0.001	<0.001	0.001	-	-	-	-
Nebaliacea	<0.001	<0.001	-	-	-	-	-
Cumacea	0.073	0.022	0.012	0.004	0.012	-	-
Tanaidacea	<0.001	0.002	-	-	-	-	-
Isopoda	0.393	0.099	0.004	0.074	0.076	0.109	1.500
Amphipoda	4.589	2.212	0.518	0.320	0.258	0.326	0.750
Mysidacea	0.015	0.014	-	0.004	-	-	-
Decapoda	1.312	1.137	0.026	1.148	5.291	-	-
BRYOZOA	0.219	0.020	0.071	2.080	-	-	-
BRACHIOPODA	<0.001	-	-	-	-	-	-
ECHINODERMATA	26.393	14.647	21.929	0.200	0.306	-	-
Holothuroidea	2.656	9.097	8.532	0.091	-	-	-
Echinoidea	21.102	1.805	0.825	-	-	-	-
Ophiuroidea	0.909	3.083	6.224	0.107	0.306	-	-
Asteroidea	1.726	0.662	6.348	0.002	-	-	-
HEMICHORDATA	0.034	0.024	0.039	-	-	-	-
CHORDATA	3.212	8.139	1.000	0.009	0.479	-	-
Ascidiacea	3.212	8.139	1.000	0.009	0.479	-	-
UNIDENTIFIED	0.255	1.920	0.376	0.125	1.062	0.229	1.830

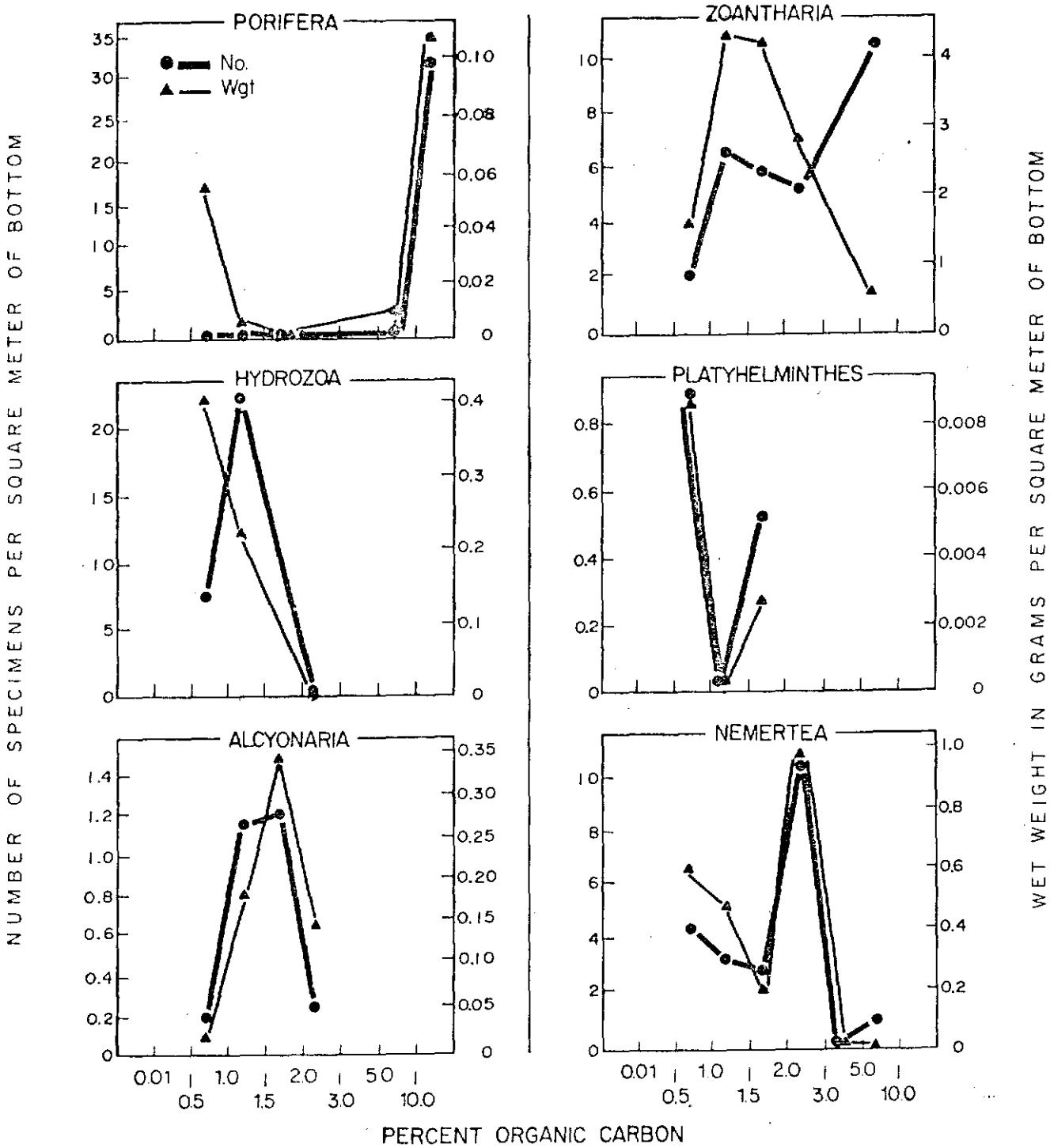

Figure 108.--Density and biomass in relation to sediment organic carbon in the entire Middle Atlantic Bight Region for: Porifera, Hydrozoa, Alcyonaria, Zoantharia, Platyhelminthes, and Nemertea.

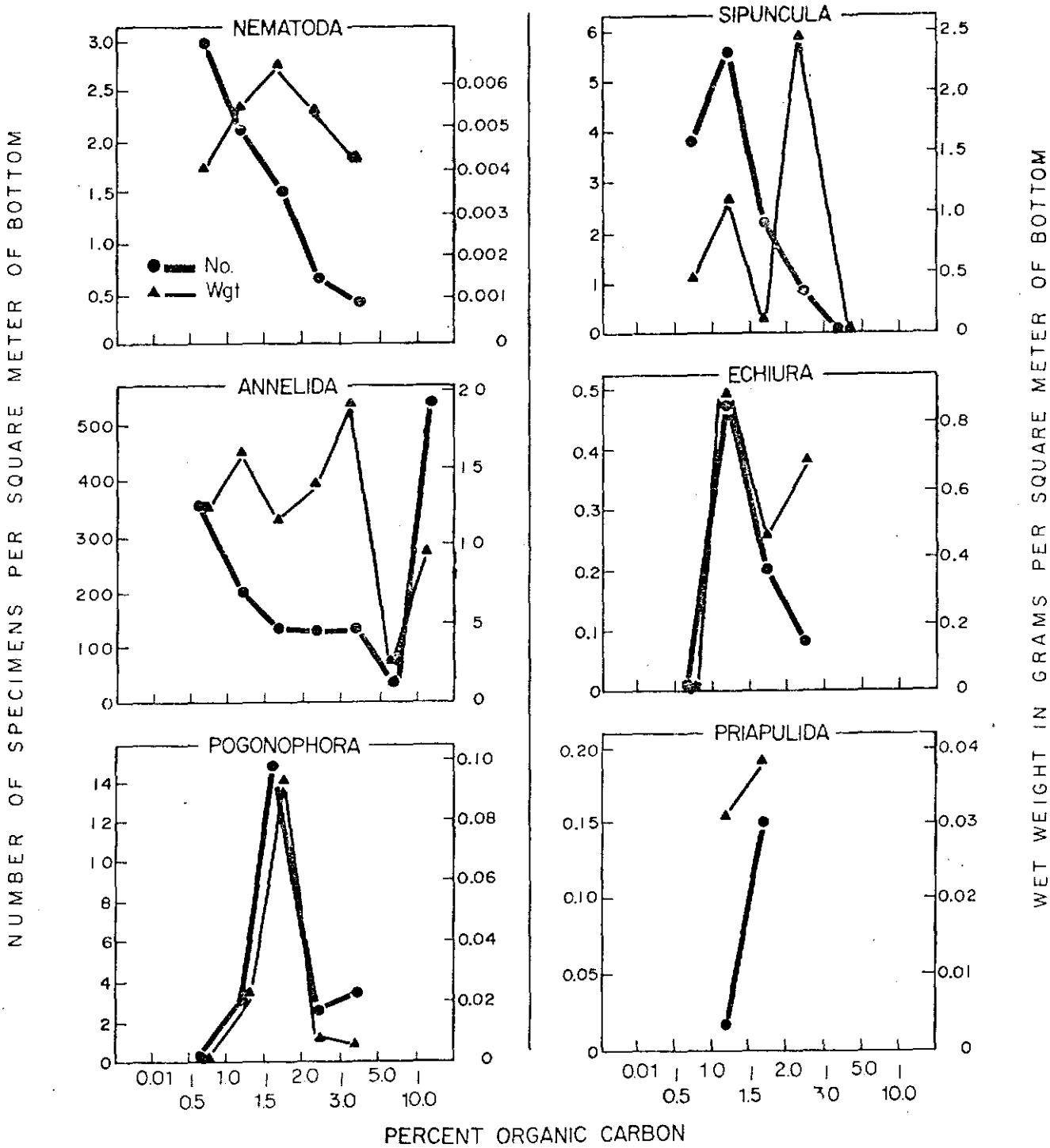

Figure 109.--Density and biomass in relation to sediment organic carbon in the entire Middle Atlantic Bight Region for: Nematoda, Annelida, Pogonophora, Sipuncula, Echiura, and Priapulida.

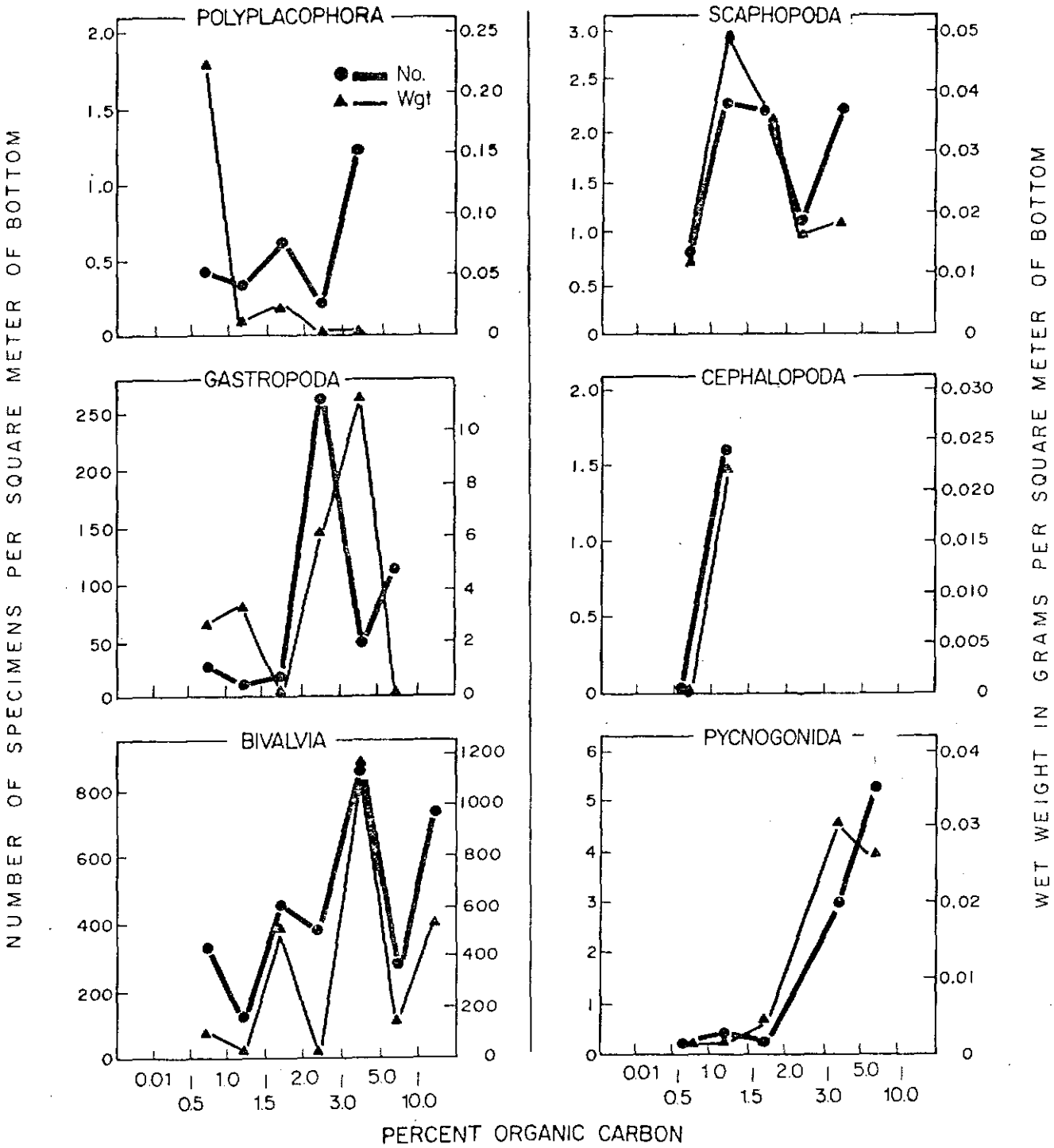

Figure 110.--Density and biomass in relation to sediment organic carbon in the entire Middle Atlantic Bight Region for: Polyplacophora, Gastropoda, Bivalvia, Scaphopoda, Cephalopoda, and Pycnogonida.

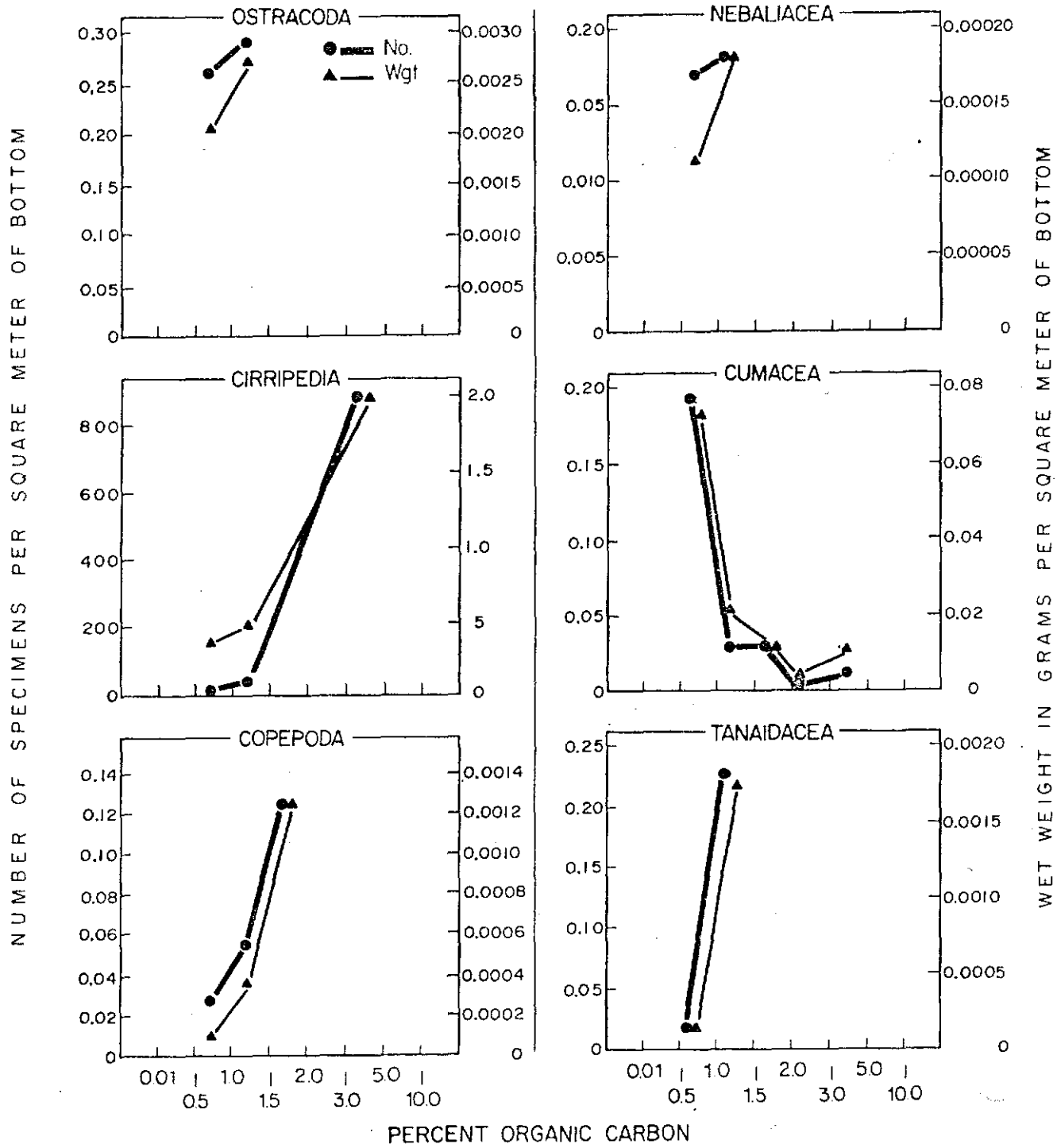

Figure 111.--Density and biomass in relation to sediment organic carbon in the entire Middle Atlantic Bight Region for: Ostracoda, Cirripedia, Copepoda, Nebaliacea, Cumacea, and Tanaidacea.

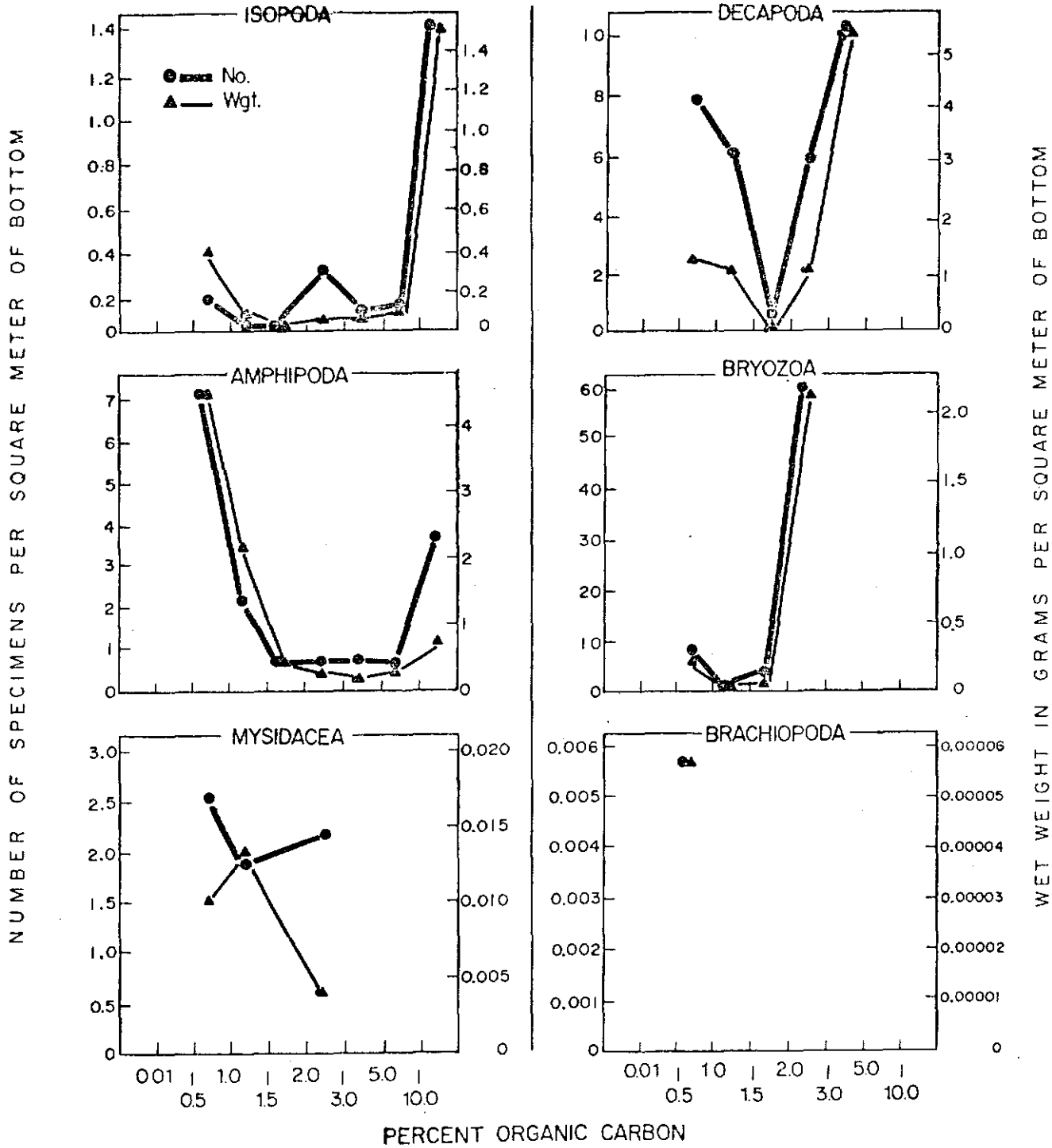

Figure 112.--Density and biomass in relation to sediment organic carbon in the entire Middle Atlantic Bight Region for: Isopoda, Amphipoda, Mysidacea, Decapoda, Bryozoa, and Brachiopoda.

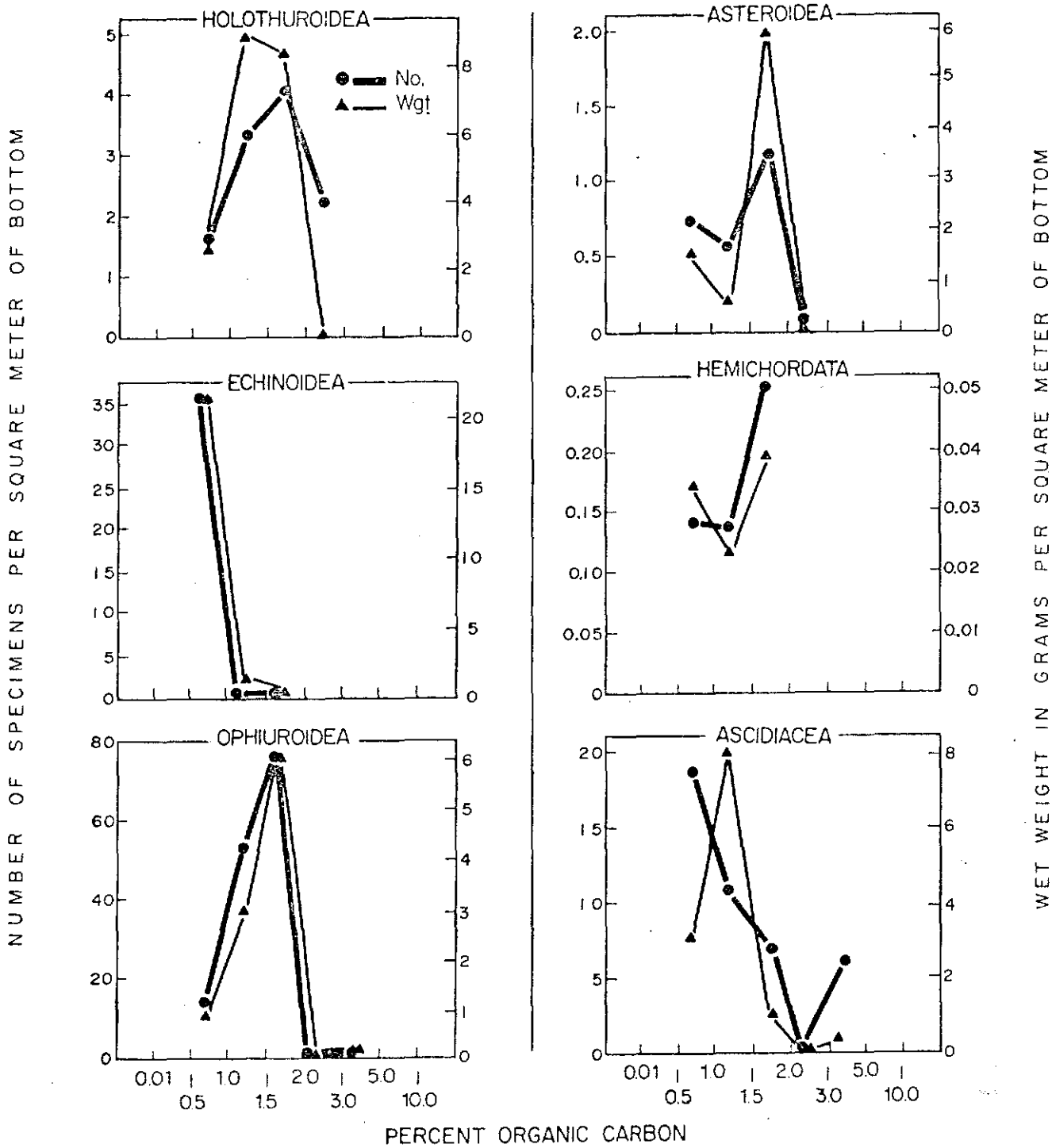

Figure 113.--Density and biomass in relation to sediment organic carbon in the entire Middle Atlantic Bight Region for: Holothuroidea, Echinoidea, Ophiuroidea, Asteroidea, Hemichordata, and Ascidiacea.

In the following section we have examined the same parameters from a much smaller geographic area.

Southern New England

The analysis in this section is based on the density and biomass of each major taxonomic group in the seven classes of sediment organic carbon from the Southern New England subarea. Density values are listed in table 31, and biomass values are listed in table 32. The range of values and their fluctuations resemble those described above (table 29 and 30) for the entire Middle Atlantic Bight Region. In terms of density, one group (Copepoda) was directly correlated with quantity of organic carbon, and two groups (Sipunculida and Amphipoda) showed inverse relations with carbon content. In the vast majority of taxonomic groups, however, the quantity of animals varied in irregular patterns in relation to carbon content. The wide fluctuations and inconsistencies between similar groups indicate that in this subarea there is no general correlation between higher groups of macrobenthic animals and the quantity of organic carbon in the bottom sediments. Similar fluctuations and inconsistencies were apparent in the analyses of data from both the New York Bight and the Chesapeake Bight.

Table 31.--Mean number of individuals of each taxonomic group listed by sediment organic carbon content class, representing the Southern New England subarea.

Taxonomic group	Sediment organic carbon content (percent)						
	0.01-0.4	0.5-0.9	1.0-1.4	1.5-1.9	2.0-2.9	3.0-4.9	5.0+
	No./m²	No./m²	No./m²	No./m²	No./m²	No./m²	No./m²
PORIFERA	1.13	0.07	0.36	-	-	-	-
COELENTERATA	24.02	48.58	16.43	22.00	-	-	-
Hydrozoa	17.11	19.58	-	-	-	-	-
Anthozoa	6.92	29.00	16.43	22.00	-	-	-
Alcyonacea	0.36	1.11	1.00	-	-	-	-
Zoantharia	5.54	4.20	14.93	22.00	-	-	-
Unidentified	1.02	23.70	0.50	-	-	-	-
PLATYHELMINTHES	2.61	0.09	-	-	-	-	-
Turbellaria	2.61	0.09	-	-	-	-	-
NEMERTEA	6.04	4.38	6.00	-	-	-	-
ASCHELMINTHES	9.17	1.96	3.71	-	-	-	-
Nematoda	9.17	1.96	3.71	-	-	-	-
ANNELIDA	375.12	264.82	219.79	345.25	131.00	-	-
POGONOPHORA	0.06	3.05	3.71	-	-	-	-
SIPUNCULIDA	10.64	9.58	2.36	-	-	-	-
ECHIURA	-	0.18	0.43	-	-	-	-
PRIAPULIDA	-	0.04	0.29	-	-	-	-
MOLLUSCA	160.92	87.40	200.98	1078.25	5094.00	-	-
Polyplacophora	1.59	0.31	0.71	-	-	-	-
Gastropoda	53.10	17.31	21.48	217.00	33.00	-	-
Bivalvia	105.74	65.11	178.64	861.25	5061.00	-	-
Scaphopoda	0.44	1.42	0.14	-	-	-	-
Cephalopoda	0.05	3.25	-	-	-	-	-
Unidentified	-	-	-	-	-	-	-
ARTHROPODA	1908.70	381.66	195.28	217.25	11.00	-	-
Pycnogonida	-	0.78	-	-	-	-	-
Arachnida	-	-	-	-	-	-	-
Crustacea	1908.70	380.87	195.28	217.25	11.00	-	-
Ostracoda	0.37	0.47	-	-	-	-	-
Cirripedia	40.48	0.38	-	-	-	-	-
Copepoda	0.06	0.11	0.36	-	-	-	-
Nebaliacea	-	-	-	-	-	-	-
Cumacea	36.57	3.82	8.00	2.75	-	-	-
Tanaidacea	0.09	0.24	-	-	-	-	-
Isopoda	13.91	2.76	0.86	6.25	-	-	-
Amphipoda	1804.69	368.36	185.35	182.00	11.00	-	-
Mysidacea	0.80	2.18	-	13.75	-	-	-
Decapoda	11.73	2.55	0.71	12.50	-	-	-
BRYOZOA	15.90	0.16	-	375.00	-	-	-
BRACHIOPODA	-	-	-	-	-	-	-
ECHINODERMATA	68.91	79.20	225.50	13.75	-	-	-
Holothuroidea	4.26	4.29	11.07	13.75	-	-	-
Echinoidea	14.64	0.56	0.36	-	-	-	-
Ophiuroidea	48.57	73.33	213.07	-	-	-	-
Asteroidea	1.44	1.02	1.00	-	-	-	-
HEMICHORDATA	0.28	0.27	0.71	-	-	-	-
CHORDATA	55.87	5.93	17.43	-	-	-	-
Ascidiacea	55.87	5.93	17.43	-	-	-	-
UNIDENTIFIED	3.77	15.45	8.57	0.50	-	-	-

Table 32.--Mean biomass of each taxonomic group listed by sediment organic carbon content class, representing the Southern New England subarea.

Taxonomic group	Sediment organic carbon content (percent)						
	0.01-0.4	0.5-0.9	1.0-1.4	1.5-1.9	2.0-2.9	3.0-4.9	5.0+
	g/m²	g/m²	g/m²	g/m²	g/m²	g/m²	g/m²
PORIFERA	0.090	<0.001	0.007	-	-	-	-
COELENTERATA	2.962	8.334	2.994	3.458	-	-	-
Hydrozoa	1.030	0.348	-	-	-	-	-
Anthozoa	1.932	7.986	2.994	3.458	-	-	-
Alcyonacea	0.063	0.200	0.704	-	-	-	-
Zoantharia	1.774	7.102	2.185	3.458	-	-	-
Unidentified	0.095	0.684	0.105	-	-	-	-
PLATYHELMINTHES	0.014	<0.001	-	-	-	-	-
Turbellaria	0.014	<0.001	-	-	-	-	-
NEMERTEA	0.956	0.599	0.378	-	-	-	-
ASCHELMINTHES	0.008	0.005	0.014	-	-	-	-
Nematoda	0.008	0.005	0.014	-	-	-	-
ANNELIDA	18.383	14.718	9.650	45.445	37.440	-	-
POGONOPHORA	<0.001	0.027	0.014	-	-	-	-
SIPUNCULIDA	1.139	2.032	0.196	-	-	-	-
ECHIURA	-	0.079	0.366	-	-	-	-
PRIAPULIDA	-	0.062	0.038	-	-	-	-
MOLLUSCA	241.154	26.045	4.883	44.446	180.130	-	-
Polyplacophora	0.843	0.004	0.051	-	-	-	-
Gastropoda	6.246	1.073	0.043	5.888	1.960	-	-
Bivalvia	234.057	24.776	4.785	38.558	178.170	-	-
Scaphopoda	0.008	0.017	0.004	-	-	-	-
Cephalopoda	<0.001	0.175	-	-	-	-	-
Unidentified	-	-	-	-	-	-	-
ARTHROPODA	26.777	2.723	1.415	8.501	0.110	-	-
Pycnogonida	-	0.004	-	-	-	-	-
Arachnida	-	-	-	-	-	-	-
Crustacea	26.777	2.719	1.415	8.501	0.110	-	-
Ostracoda	0.002	0.005	-	-	-	-	-
Cirripedia	14.674	0.008	-	-	-	-	-
Copepoda	<0.001	<0.001	0.004	-	-	-	-
Nebaliacea	-	-	-	-	-	-	-
Cumacea	0.124	0.027	0.028	0.028	-	-	-
Tanaidacea	<0.001	0.002	-	-	-	-	-
Isopoda	0.248	0.122	0.010	0.062	-	-	-
Amphipoda	10.344	2.368	1.369	1.278	0.110	-	-
Mysidacea	0.002	0.024	-	0.008	-	-	-
Decapoda	1.382	0.162	0.004	7.125	-	-	-
BRYOZOA	0.434	0.001	-	13.000	-	-	-
BRACHIOPODA	-	-	-	-	-	-	-
ECHINODERMATA	23.653	19.749	43.389	0.548	-	-	-
Holothuroidea	8.467	13.620	22.195	0.548	-	-	-
Echinoidea	10.847	1.167	2.356	-	-	-	-
Ophiuroidea	2.830	4.918	15.930	-	-	-	-
Asteroidea	1.509	0.044	2.908	-	-	-	-
HEMICHORDATA	0.055	0.048	0.111	-	-	-	-
CHORDATA	9.428	4.599	1.461	-	-	-	-
Ascidiacea	9.428	4.599	1.461	-	-	-	-
UNIDENTIFIED	0.544	0.280	0.156	0.538	-	-	-