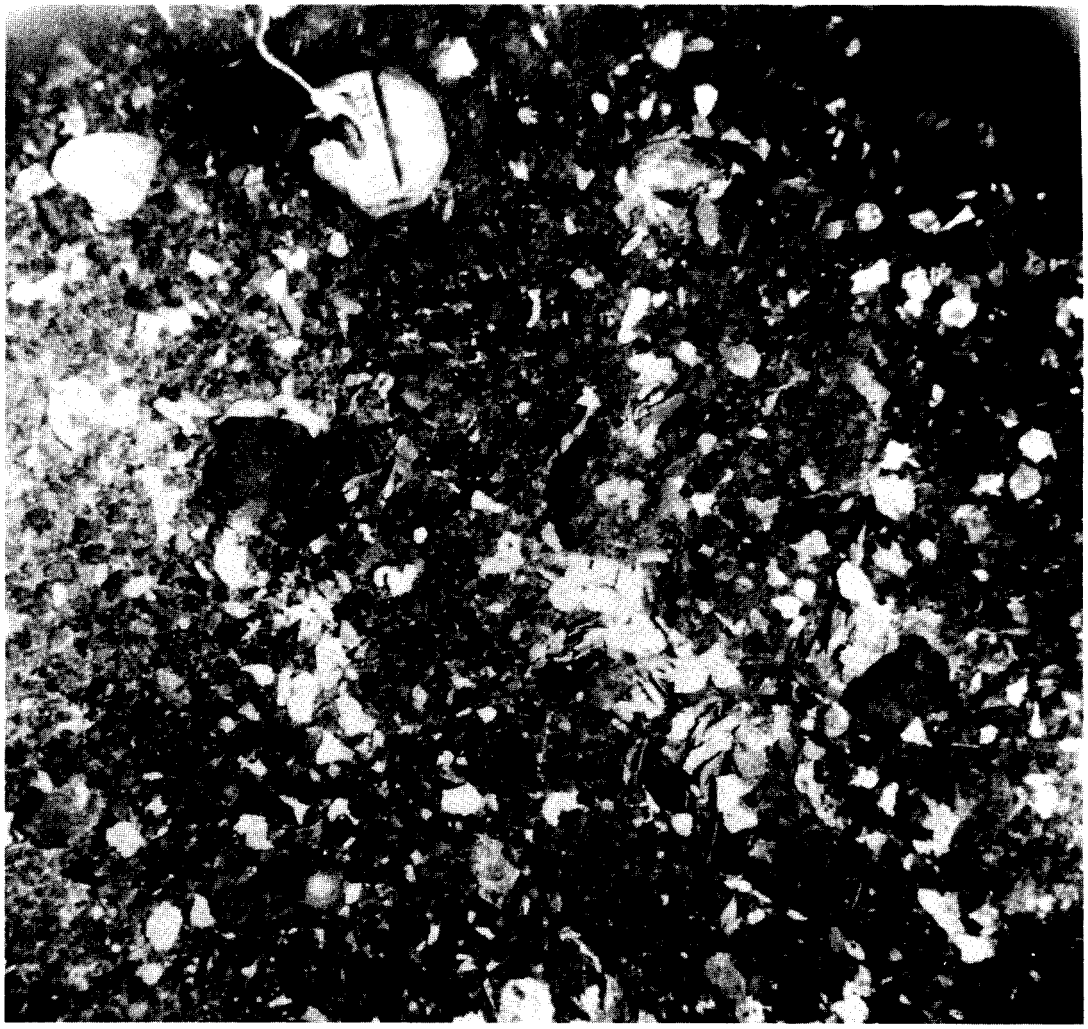


Figure 18
Medium coarse sand bottom at a depth of 87 m on the western Nova Scotia shelf. This locality also contains some fine angular to rounded gravel to 7 cm in size. Bivalve shell fragments litter the bottom; an intact mussel valve is visible in the upper right-center portion of the frame. The camera tripping weight is visible at upper left-center. Photograph was taken at station 1165c, located at lat. 44°09' N., long. 66°29' W.

The percentage occurrence of each taxonomic group in samples in each sediment type is presented in Table 20.

Photographs of the sea bottom (Figs. 18 to 24) taken with the photographic system in the Campbell Grab show the sediment surface and associated fauna in different bottom types in different subareas within the New England region. Sediment types range from coarse (gravels and cobbles) to fine (silty sands). The camera-tripping weight, visible in each photograph, serves as a possible indicator of the amount of silt-clay contained in the sediment depending on the quantity of material disturbed and entering into suspension upon disturbance.

Relation to Water Temperature

The abundance of the New England region macrobenthos, in general, was related directly to the annual range in water temperature. In areas with a small annual range in water temperature, the density of animals was low and the biomass small. Conversely, where the annual range in water temperature was large, the density of animals was high (Tables 21, 22; Fig. 25), and biomass large (Tables 23, 24; Fig. 25). In areas subject to annual water temperature ranges of less than 4°C, average density was only 431/m^2 and biomass only 46 g/m^2. Although there are some inconsistencies, in

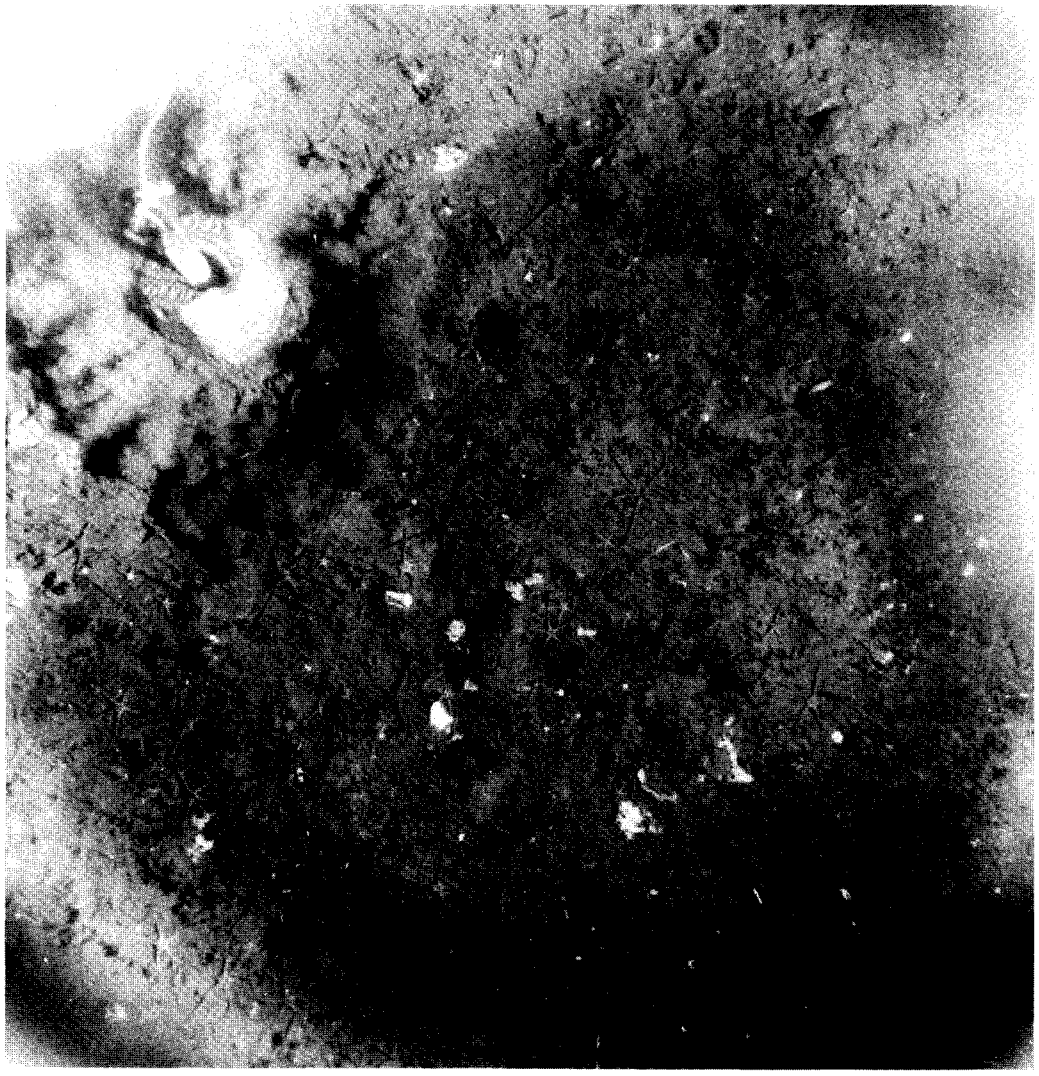


Figure 19
Brown silty sand bottom at 116 m depth southwest of Grand Manan Island. A substantial number of brittlestars (Ophiuroidea) of various sizes are clearly visible, as are several burrow holes. The fine nature of the bottom at this locality is indicated by the cloud of sediment raised by the camera tripping weight striking the bottom at upper left. Photograph was taken at station 1173, located at lat. 44°28' N., long. 67°15' W.

general, density increased to 4,038/m^2 where the temperature range was greater than 20°C, and biomass rose to 467 g/m^2 where the range was 16 to 19.9°C. This close relationship of sparse fauna in stable temperature areas and rich fauna in unstable areas undergoing wide temperature fluctuations is not necessarily a direct cause-and-effect relationship of temperature alone but is the result of a combination of temperature and other environmental factors. Water masses that remain relatively constant in temperature and are unchanging in most other physical and chemical properties also tend to have more uniform biological components. In the New England region these water masses tend to be deeper, and therefore colder, darker, and lower in nutrients, plankton, nekton, as well as benthos.

The percentage occurrence of each taxonomic group in samples in each temperature range class is presented in Table 25.

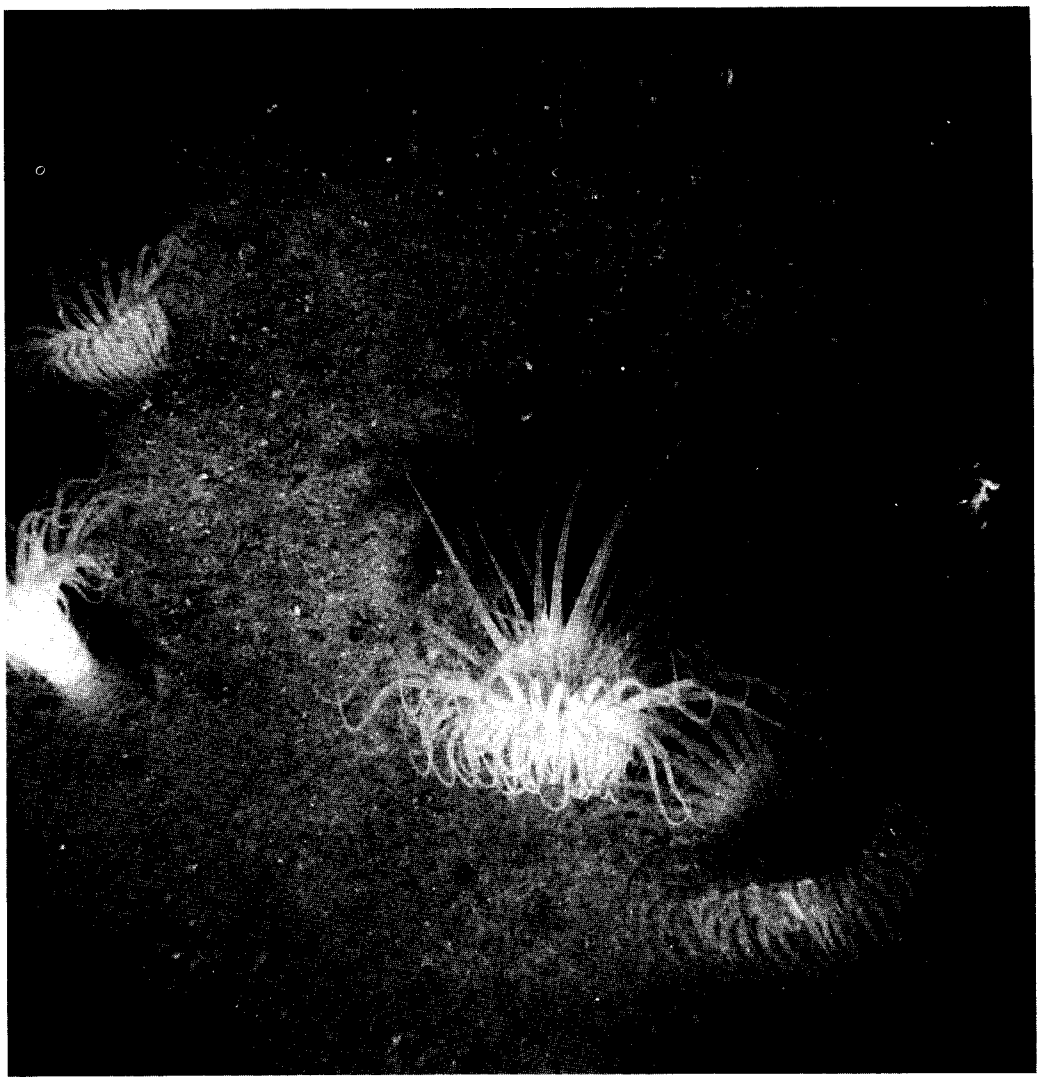


Figure 20
Sand and gravel bottom at 194 m depth in the southwestern Gulf of Maine east of Cape Cod. Sediment contains some pebbles to 8 cm. Five large burrowing sea anemones (Coelenterata, Ceriantharia) are visible. Camera tripping weight is at extreme right-center. Photograph was taken at station 1052, located at lat. 42°09' N., long. 69°14' W.

Relation to Sediment Organic Carbon

Two general cause-and-effect relationships were considered in prompting the analysis of organic carbon content in the sediments. The first was the possibility of a high standing crop of benthic animals in areas of high organic carbon, due to the probability of a greater food supply in those areas; or secondly, the converse could apply, namely that areas containing large standing crops would be high in organic carbon due to biogenic activities (fecal deposits, mortality, etc.). Regardless which prevailed, high organic carbon content would be associated with high abundance.

The analysis did not reveal any clear-cut correlation between sediment organic carbon content and benthic faunal abundance. A few faunal groups exhibited good correlations, some positive and some negative, but by and large they were exceptional.

Highest average densities (Tables 26, 27; Fig. 26) of macrobenthos occurred in areas where the percentage

Figure 21
Medium grained brown sand and shell bottom at 88 m depth on east-central Georges Bank. Shell fraction is composed of whole and broken bivalve and gastropod shells. A large sea scallop (*Placopecten magellanicus*) valve is visible in the center of the frame; a small starfish is at lower right; a small hermit crab (Paguridae) may be seen at lower right-center on a clump of tubes. The camera trip weight is visible in the upper left corner. Photograph was taken at station 1127, located at lat. 41°30' N., long. 66°32' W.

of organic carbon in the sediments ranged from 3.0 to 4.99 (2,588/m^2) and 2.00 to 2.99 (2,042/m^2). In areas containing from 0.01 to 0.49 and from 1.00 to 1.49 percent organic carbon, densities were about 50% lower (1,858/m^2, and 1,015/m^2, respectively). Significantly lower densities occurred in other ranges; lowest densities (44/m^2) were recorded in areas containing the greatest amount of organic carbon (5% and greater). Density values over the whole range of organic carbon content as well as between adjacent classes were too variable to show any definite trends.

Correlations between the distribution of biomass and sediment organic carbon (Tables 28, 29; Fig. 26) were somewhat better but not uniform enough to denote any positive trends. Largest biomass (959 g/m^2) was recorded were organic carbon ranged between 2.00 and 2.99%, and next largest was 809 g/m^2 in the 3.00 to 4.99% range, but biomass was less than 1 g/m^2 in ranges of 5% and over.

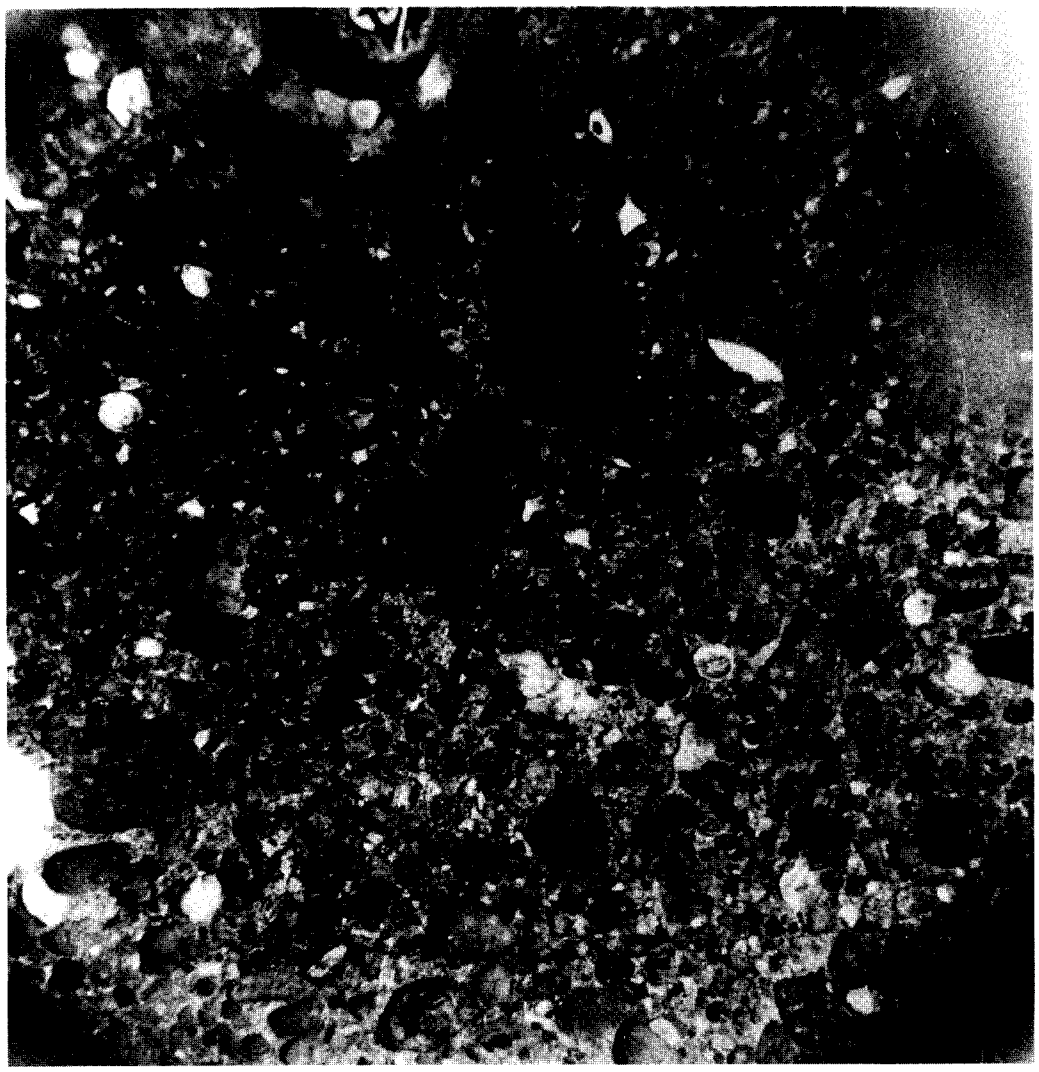


Figure 22
Coarse brown sand with broken shells and gravel, to 15 cm, bottom at 86 m depth on eastern Georges Bank. Camera tripping weight is visible at upper left-center edge of frame. Photograph was taken at station 1130, located at lat. 42°01' N., long. 66°31' W.

Biomass of 218 g/m^2 occurred in the 0.01 to 0.49% range and became rather uniform (89 to 97 g/m^2) in organic carbon contents from 0.5 to 1.99%.

The percentage occurrence of each taxonomic group in samples in each sediment organic content class is presented in Table 30.

A comparison of the similarities and differences between the macrobenthos of the New England region and that of the Middle Atlantic Bight region in relation to the environmental parameters described above is contained in Sherman et al. (1988).

Taxonomic Groups

This section deals, in turn, with each taxonomic component of the New England region macrobenthos arranged in the phylogenetic order presented in Table 4. Included for each taxon are general remarks relating to overall abundance and frequency of occurrence, as well as to aspects of the natural history of some of the common forms encountered; these remarks are followed by discussions dealing with geographic and bathymetric distribution and the quantitative relationship of

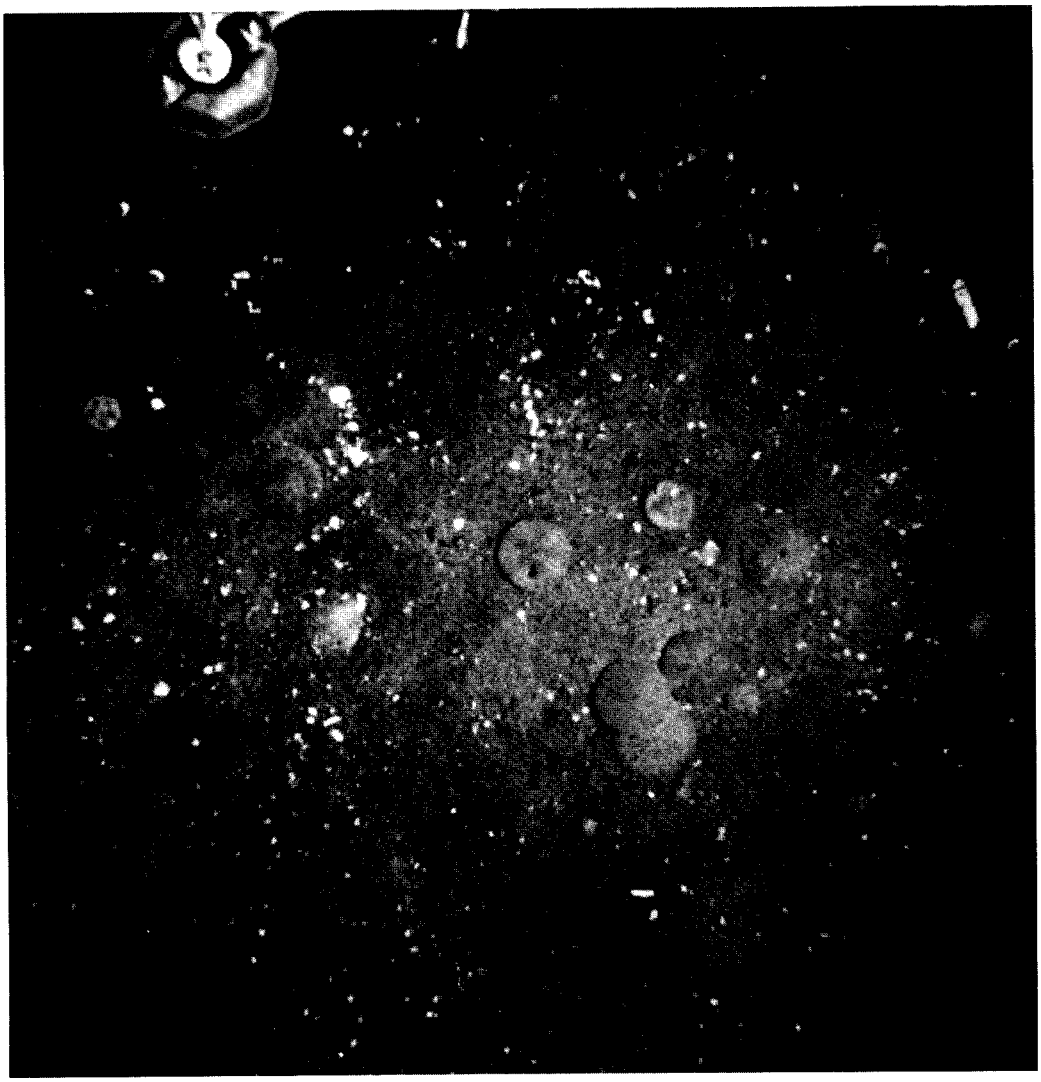


Figure 23
Medium to coarse brown sand bottom at 44 m depth on the continental shelf south of Long Island, New York. Several sand dollars (*Echinarachnius parma*) are visible; the camera tripping weight is in the upper left corner. Photograph was taken at station 1279, located at lat. 40°30' N., long. 72°30' W.

this distribution to bottom sediments, bottom water temperature, and sediment organic carbon content. This arrangement was chosen for ease of reference wherein all the information pertaining to a given taxon is presented in one place, rather than dispersed among several subsections, each dealing with a single abiotic parameter. It is our hope that this arrangement will allow the reader to make comparisons more easily among the various taxonomic groups.

Porifera

Porifera constituted a moderately small proportion of the fauna. They were generally uncommon on the continental shelf and uncommon to rare on the continental slope and rise. Specimens in our samples ranged from small (2-mm) boring species occurring on or in mollusk shells to moderately large (10 to 20 cm) *Polymastia* and *Myxilla* usually found on cobbles and boulders.

Figure 24
Green silty sand and gravel bottom at 450 m depth on the southern New England continental slope. Gravel ranged to 2 cm. The tubes of two soda straw worms (*Hyalinoecia tubicola*) are visible at left edge of the frame, and the tracks created by their movements are also visible. The silty nature of the bottom is evident by the cloud created by the camera tripping weight at right-center. Photograph taken at station 1325, located at lat. 39°20' N., long. 72°09' W.

Porifera were most common in the Nova Scotia region and along the coast of Maine. These areas have stable substrates and moderate to strong water currents.

Colorful species were rare, limited mainly to the red *Microciona*. Shades of browns and grays were the most common colors. The colorless Hexactinellida (glass sponges) occurred only in deep water, greater than 500 m.

Porifera occurred in 71 samples (7% of total); density averaged 1.5/m^2 and biomass averaged 2.2 g/m^2 (Table 5).

Geographic Distribution

Porifera were clearly more abundant off Nova Scotia and in the Gulf of Maine than to the south and west (Fig. 27). They were common along the western coast of Nova Scotia, particularly in the mouth of the Bay of Fundy, along the Maine coast, and in the eastern Gulf of Maine. The scarcity of sponges on the continental shelf between central Georges Bank and New Jersey was especially noteworthy.

Table 21
Mean number of specimens of each taxon per square meter in relation to the annual range in bottom water temperature.

Taxon	Annual range in water temperature (degrees Celsius)						
	0–3.9	4–7.9	8–11.9	12–15.9	16–19.9	20–23.9	All ranges
PORIFERA	1.1	1.7	1.1	2.7	1.9	0.4	1.5
COELENTERATA	6.6	14.7	24.0	105.3	44.8	93.9	32.1
Hydrozoa	0.9	5.0	4.5	4.5	36.8	45.9	6.4
Anthozoa	5.7	9.7	19.5	100.8	8.0	48.0	25.7
Alcyonaria	1.1	1.2	0.2	1.7	—	—	0.8
Zoantharia	2.4	7.9	18.6	98.4	7.2	4.4	22.6
Unidentified	2.1	0.6	0.7	0.7	0.8	43.6	2.2
PLATYHELMINTHES	—	0.2	1.0	0.1	<0.1	0.4	0.4
Turbellaria	—	0.2	1.0	0.1	<0.1	0.4	0.4
NEMERTEA	2.4	4.2	9.0	25.3	4.4	2.9	8.2
ASCHELMINTHES	3.5	2.0	4.3	0.7	0.2	—	2.8
Nematoda	3.5	2.0	4.3	0.7	0.2	—	2.8
ANNELIDA	211.5	513.2	568.2	279.8	370.4	1,697.8	425.0
POGONOPHORA	1.5	0.7	0.1	—	—	—	0.6
SIPUNCULIDA	4.5	9.0	8.5	2.8	2.6	—	5.9
ECHIURA	0.1	0.3	—	—	0.4	—	0.1
PRIAPULIDA	<0.1	—	—	—	—	—	<0.1
MOLLUSCA	84.0	129.2	129.2	344.9	344.5	1,242.2	188.0
Polyplacophora	1.4	0.8	0.8	2.0	7.3	—	1.5
Gastropoda	9.4	15.1	14.8	13.1	84.9	47.4	17.8
Bivalvia	64.4	102.9	110.1	329.0	252.0	1,194.8	163.1
Scaphopoda	8.9	10.3	2.1	0.8	0.2	—	5.1
Cephalopoda	<0.1	0.1	1.1	—	—	—	0.4
Unidentified	<0.1	—	0.3	—	—	—	0.1
ARTHROPODA	64.9	338.0	1,475.6	768.3	1,040.1	903.5	726.2
Pycnogonida	0.1	0.4	0.7	0.1	0.2	1.5	0.3
Arachnida	—	<0.1	—	—	—	—	<0.1
Crustacea	64.8	337.6	1,474.9	768.2	1,039.9	902.0	725.9
Ostracoda	0.1	<0.1	—	—	—	—	<0.1
Cirripedia	0.3	8.7	14.2	14.0	154.4	196.1	21.8
Copepoda	0.1	—	—	0.1	—	—	<0.1
Cumacea	2.3	9.6	56.3	21.3	43.5	19.0	25.8
Tanaidacea	0.1	0.1	—	—	—	—	<0.1
Isopoda	2.6	3.8	15.7	25.1	7.0	67.3	12.1
Amphipoda	58.2	311.6	1,371.9	694.7	808.5	598.2	655.8
Mysidacea	<0.1	0.8	3.4	6.3	3.4	6.1	2.5
Decapoda	0.9	3.2	13.2	6.4	23.2	13.4	7.5
Unidentified	0.5	—	0.2	0.4	—	1.9	0.3
BRYOZOA	3.0	9.5	15.8	35.1	28.3	66.0	15.7
BRACHIOPODA	8.5	5.9	3.0	—	—	—	4.5
ECHINODERMATA	32.9	61.5	104.7	171.2	31.5	21.0	79.3
Crinoidea	<0.1	—	—	—	—	—	<0.1
Holothuroidea	6.3	4.1	3.7	2.8	1.7	3.5	4.3
Echinoidea	1.4	4.9	40.4	93.1	26.8	14.6	29.3
Ophiuroidea	24.8	50.4	57.9	74.1	2.0	2.4	44.2
Asteroidea	0.4	2.2	2.7	1.2	0.9	0.5	1.5
HEMICHORDATA	<0.1	—	0.2	0.2	—	—	0.1
CHORDATA	2.0	2.3	35.1	6.0	58.5	4.3	16.3
Ascidiacea	2.0	2.3	35.1	6.0	58.5	4.3	16.3
UNIDENTIFIED	5.6	5.7	6.6	4.2	6.6	5.2	5.8
Total	432.2	1,097.9	2,386.2	1,746.4	1,934.2	4,037.5	1,512.2

Table 22

The number of specimens of each taxon, expressed as a percentage of the total benthic invertebrate fauna, in relation to the annual range in bottom water temperature.

	Annual range in water temperature (degrees Celsius)						
Taxon	0–3.9	4–7.9	8–11.9	12–15.9	16–19.9	20–23.9	All ranges
PORIFERA	0.3	0.2	<0.1	0.2	0.1	<0.1	0.1
COELENTERATA	1.5	1.3	1.0	6.0	2.3	2.3	2.1
Hydrozoa	0.2	0.4	0.2	0.3	1.9	1.1	0.4
Anthozoa	1.3	0.9	0.8	5.7	0.4	1.2	1.7
Alcyonaria	0.3	0.1	<0.1	0.1	—	—	0.1
Zoantharia	0.6	0.7	0.8	5.6	0.4	0.1	1.5
Unidentified	0.5	0.1	<0.1	<0.1	<0.1	1.1	0.2
PLATYHELMINTHES	—	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Turbellaria	—	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NEMERTEA	0.6	0.4	0.4	1.4	0.2	0.1	0.5
ASCHELMINTHES	0.8	0.2	0.2	<0.1	<0.1	—	0.2
Nematoda	0.8	0.2	0.2	<0.1	<0.1	—	0.2
ANNELIDA	48.9	46.7	23.8	16.0	19.2	42.0	28.1
POGONOPHORA	0.3	0.1	<0.1	—	—	—	<0.1
SIPUNCULIDA	1.0	0.8	0.4	0.2	0.1	—	0.4
ECHIURA	<0.1	<0.1	—	—	<0.1	—	<0.1
PRIAPULIDA	<0.1	—	—	—	—	—	<0.1
MOLLUSCA	19.4	11.8	5.4	19.8	17.8	30.8	12.4
Polyplacophora	0.3	0.1	<0.1	0.1	0.4	—	0.1
Gastropoda	2.2	1.4	0.6	0.8	4.4	1.2	1.2
Bivalvia	14.9	9.4	4.6	18.8	13.0	29.6	10.8
Scaphopoda	2.0	0.9	0.1	<0.1	<0.1	—	0.3
Cephalopoda	<0.1	<0.1	<0.1	—	—	—	<0.1
Unidentified	<0.1	—	<0.1	—	—	—	<0.1
ARTHROPODA	15.0	30.8	61.8	44.0	53.8	22.4	48.0
Pycnogonida	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arachnida	—	<0.1	—	—	—	—	<0.1
Crustacea	15.0	30.8	61.8	44.0	53.8	22.3	48.0
Ostracoda	<0.1	<0.1	—	—	—	—	<0.1
Cirripedia	0.1	0.8	0.6	0.8	8.0	4.9	1.4
Copepoda	<0.1	—	—	<0.1	—	—	<0.1
Cumacea	0.5	0.9	2.4	1.2	2.2	0.5	1.7
Tanaidacea	<0.1	<0.1	—	—	—	—	<0.1
Isopoda	0.6	0.3	0.7	1.4	0.4	1.7	0.8
Amphipoda	13.5	28.4	57.5	39.8	41.8	14.8	43.4
Mysidacea	0.1	0.1	0.1	0.4	0.2	0.2	0.2
Decapoda	0.2	0.3	0.6	0.4	1.2	0.3	0.5
Unidentified	0.1	—	<0.1	<0.1	—	<0.1	<0.1
BRYOZOA	0.7	0.9	0.7	2.0	1.5	1.6	1.0
BRACHIOPODA	2.0	0.5	0.1	—	—	—	0.3
ECHINODERMATA	7.6	5.6	4.4	9.8	1.6	0.5	5.2
Crinoidea	<0.1	—	—	—	—	—	<0.1
Holothuroidea	1.5	0.4	0.2	0.2	0.1	0.1	0.3
Echinoidea	0.3	0.4	1.7	5.3	0.6	0.4	1.9
Ophiuroidea	5.8	4.6	2.4	4.2	0.1	0.1	2.9
Asteroidea	0.1	0.2	0.1	0.1	<0.1	<0.1	0.1
HEMICHORDATA	<0.1	—	<0.1	<0.1	—	—	<0.1
CHORDATA	0.5	0.2	1.5	0.3	3.0	0.1	1.1
Ascidiacea	0.5	0.2	1.5	0.3	3.0	0.1	1.1
UNIDENTIFIED	1.3	0.5	0.3	0.2	0.3	0.1	0.4
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 23

Mean wet weight of specimens of each taxon (grams per square meter) in relation to the annual range in bottom water temperature.

	Annual range in water temperature (degrees Celsius)						
Taxon	0–3.9	4–7.9	8–11.9	12–15.9	16–19.9	20–23.9	All ranges
PORIFERA	0.86	2.50	4.63	1.08	0.10	<0.01	2.24
COELENTERATA	9.10	6.74	8.74	2.85	5.15	2.47	7.33
Hydrozoa	0.01	2.02	0.15	0.45	1.54	0.68	0.52
Anthozoa	9.09	4.72	8.59	2.40	3.61	1.79	6.81
Alcyonaria	0.42	0.11	0.04	0.31	—	—	0.20
Zoantharia	8.17	4.59	8.49	2.00	3.57	0.86	6.39
Unidentified	0.48	0.02	0.07	0.09	0.05	0.93	0.22
PLATYHELMINTHES	—	0.01	0.01	<0.01	<0.01	0.09	0.01
Turbellaria	—	0.01	0.01	<0.01	<0.01	0.09	0.01
NEMERTEA	0.22	0.53	0.89	1.22	1.38	1.11	0.71
ASCHELMINTHES	0.01	0.01	0.01	0.01	<0.01	—	0.01
Nematoda	0.01	0.01	0.01	0.01	<0.01	—	0.01
ANNELIDA	9.69	14.75	24.31	13.39	28.48	39.74	17.41
POGONOPHORA	0.01	<0.01	<0.01	—	—	—	<0.01
SIPUNCULIDA	0.73	1.01	0.97	0.34	0.33	—	0.75
ECHIURA	0.90	0.02	—	—	0.39	—	0.30
PRIAPULIDA	0.01	—	—	—	—	—	<0.01
MOLLUSCA	7.57	22.13	128.83	109.06	340.39	87.55	83.64
Polyplacophora	0.12	0.09	0.01	0.04	1.33	—	0.14
Gastropoda	0.26	1.32	3.75	2.67	4.96	4.09	2.23
Bivalvia	6.76	19.79	124.94	106.26	334.10	83.46	80.95
Scaphopoda	0.43	0.92	0.11	0.08	<0.01	—	0.32
Cephalopoda	<0.01	0.02	0.02	—	—	—	0.01
Unidentified	<0.01	—	<0.01	—	—	—	<0.01
ARTHROPODA	1.22	3.42	16.45	12.52	16.04	24.65	9.41
Pycnogonida	<0.01	0.03	0.01	<0.01	<0.01	0.01	0.01
Arachnida	—	<0.01	—	—	—	—	<0.01
Crustacea	1.22	3.39	16.44	12.52	16.04	24.64	9.40
Ostracoda	<0.01	<0.01	—	—	—	—	<0.01
Cirripedia	0.05	0.22	6.39	3.52	5.32	20.32	3.39
Copepoda	<0.01	—	—	<0.01	—	—	<0.01
Cumacea	0.02	0.04	0.26	0.07	0.09	0.06	0.11
Tanaidacea	<0.01	<0.01	—	—	—	—	<0.01
Isopoda	0.27	0.08	0.42	0.34	0.07	0.41	0.29
Amphipoda	0.41	2.02	8.12	5.31	6.27	2.56	4.16
Mysidacea	<0.01	<0.01	0.02	0.02	0.03	0.02	0.01
Decapoda	0.47	1.02	1.23	3.24	4.26	1.25	1.43
Unidentified	<0.01	—	<0.01	<0.01	—	0.02	<0.01
BRYOZOA	0.28	0.56	2.10	2.43	0.87	2.45	1.29
BRACHIOPODA	1.93	0.73	0.57	—	—	—	0.89
ECHINODERMATA	12.24	31.35	35.48	172.83	59.63	263.42	55.00
Crinoidea	<0.01	—	—	—	—	—	<0.01
Holothuroidea	3.10	7.77	11.75	18.65	18.15	127.96	12.87
Echinoidea	6.00	14.29	17.63	148.09	37.65	134.46	36.75
Ophiuroidea	3.05	5.82	3.28	2.77	0.22	0.53	3.26
Asteroidea	0.09	3.48	2.82	3.33	3.61	0.46	2.13
HEMICHORDATA	<0.01	—	0.04	0.03	—	—	0.02
CHORDATA	0.55	4.14	7.28	1.43	14.40	0.56	4.10
Ascidiacea	0.55	4.14	7.28	1.43	14.40	0.56	4.10
UNIDENTIFIED	0.16	0.22	0.36	0.42	0.26	0.09	0.27
Total	45.48	88.11	230.67	317.62	467.42	422.12	183.39

Table 24

The wet weight of specimens of each taxon, expressed as a percentage of the total benthic invertebrate fauna, in relation to the annual range in bottom water temperature.

	Annual range in water temperature (degrees Celsius)						
Taxon	0–3.9	4–7.9	8–11.9	12–15.9	16–19.9	20–23.9	All ranges
PORIFERA	1.9	2.8	2.0	0.3	<0.1	<0.1	1.2
COELENTERATA	20.0	7.6	3.8	0.9	1.1	0.6	4.0
Hydrozoa	<0.1	2.3	0.1	0.1	0.3	0.2	0.3
Anthozoa	20.0	5.3	3.7	0.8	0.8	0.4	3.7
Alcyonaria	0.9	0.1	<0.1	0.1	—	—	0.1
Zoantharia	18.0	5.2	3.7	0.6	0.8	0.2	3.5
Unidentified	1.1	<0.1	<0.1	<0.1	<0.1	0.2	0.1
PLATYHELMINTHES	—	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Turbellaria	—	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NEMERTEA	0.5	0.6	0.4	0.4	0.3	0.3	0.4
ASCHELMINTHES	<0.1	<0.1	<0.1	<0.1	<0.1	—	<0.1
Nematoda	<0.1	<0.1	<0.1	<0.1	<0.1	—	<0.1
ANNELIDA	21.3	16.8	10.5	4.2	6.1	9.4	9.5
POGONOPHORA	<0.1	<0.1	<0.1	—	—	—	<0.1
SIPUNCULIDA	1.6	1.2	0.4	0.1	0.1	—	0.4
ECHIURA	2.0	<0.1	—	—	0.1	—	0.2
PRIAPULIDA	<0.1	—	—	—	—	—	<0.1
MOLLUSCA	16.6	25.1	55.8	34.3	72.8	20.7	45.6
Polyplacophora	0.3	0.1	<0.1	<0.1	0.3	—	0.1
Gastropoda	0.6	1.5	1.6	0.8	1.1	1.0	1.2
Bivalvia	14.9	22.5	54.2	33.4	71.5	19.8	44.1
Scaphopoda	1.0	1.0	<0.1	<0.1	<0.1	—	0.2
Cephalopoda	<0.1	<0.1	<0.1	—	—	—	<0.1
Unidentified	<0.1	—	<0.1	—	—	—	<0.1
ARTHROPODA	2.7	3.9	7.1	3.9	3.4	5.8	5.1
Pycnogonida	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arachnida	—	<0.1	—	—	—	—	<0.1
Crustacea	2.7	3.8	7.1	3.9	3.4	5.8	5.1
Ostracoda	<0.1	<0.1	—	—	—	—	<0.1
Cirripedia	0.1	0.2	2.8	1.1	1.1	4.8	1.8
Copepoda	<0.1	—	—	<0.1	—	—	<0.1
Cumacea	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.1
Tanaidacea	<0.1	<0.1	—	—	—	—	<0.1
Isopoda	0.6	0.1	0.2	0.1	<0.1	0.1	0.2
Amphipoda	0.9	2.3	3.5	1.7	1.3	0.6	2.3
Mysidacea	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Decapoda	1.0	1.2	0.5	1.0	0.9	0.3	0.8
Unidentified	<0.1	—	<0.1	<0.1	—	<0.1	<0.1
BRYOZOA	0.6	0.6	0.9	0.8	0.2	0.6	0.7
BRACHIOPODA	4.2	0.8	0.2	—	—	—	0.5
ECHINODERMATA	26.9	35.6	15.4	54.4	12.8	62.4	30.0
Crinoidea	<0.1	—	—	—	—	—	<0.1
Holothuroidea	6.8	8.8	5.1	5.9	3.9	30.3	7.0
Echinoidea	13.2	16.2	7.6	46.6	8.1	31.8	20.0
Ophiuroidea	6.7	6.6	1.4	0.9	<0.1	0.1	1.8
Asteroidea	0.2	4.0	1.2	1.0	0.8	0.1	1.2
HEMICHORDATA	<0.1	—	<0.1	<0.1	—	—	<0.1
CHORDATA	1.2	4.7	3.2	0.4	3.1	0.1	2.2
Ascidiacea	1.2	4.7	3.2	0.4	3.1	0.1	2.2
UNIDENTIFIED	0.4	0.2	0.2	0.1	0.1	<0.1	0.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

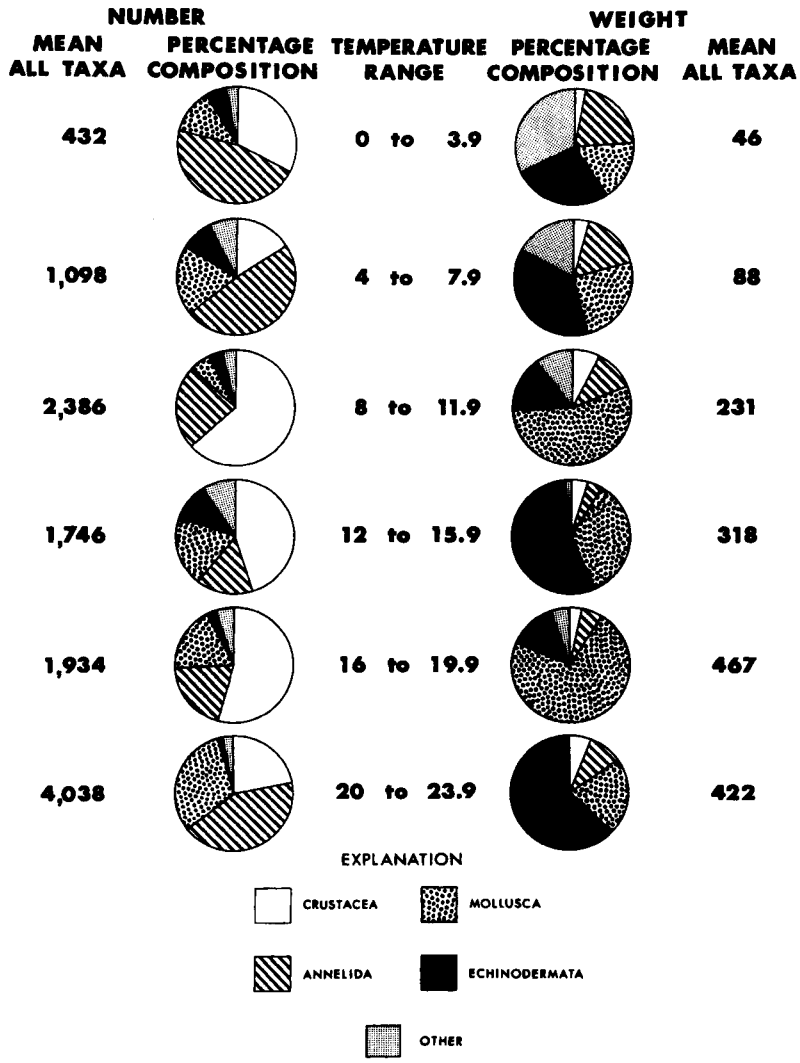


Figure 25
Quantitative composition of the total macrobenthic invertebrate fauna in relation to the annual range in bottom water temperature. Mean number of individuals and mean wet weight, per square meter of bottom area, and percentage composition, by density and biomass, for the major taxonomic groups are shown.

A pronounced decrease in abundance of sponges in each geographic region from Nova Scotia southwestward to Southern New England was evident in weight, number, and frequency of occurrence (Tables 5–10; Fig. 28). Porifera were particularly scarce in the Southern New England subarea.

Bathymetric Distribution

Porifera were moderately common to scarce on the continental shelf and upper continental slope (to 500 m), 1 to 3 individuals/m^2, and were very scarce (<0.4/m^2) at depths >500 m (Table 11; Fig. 29). Biomass also was moderate on the continental shelf and upper slope and small on the middle and lower slope and continen-

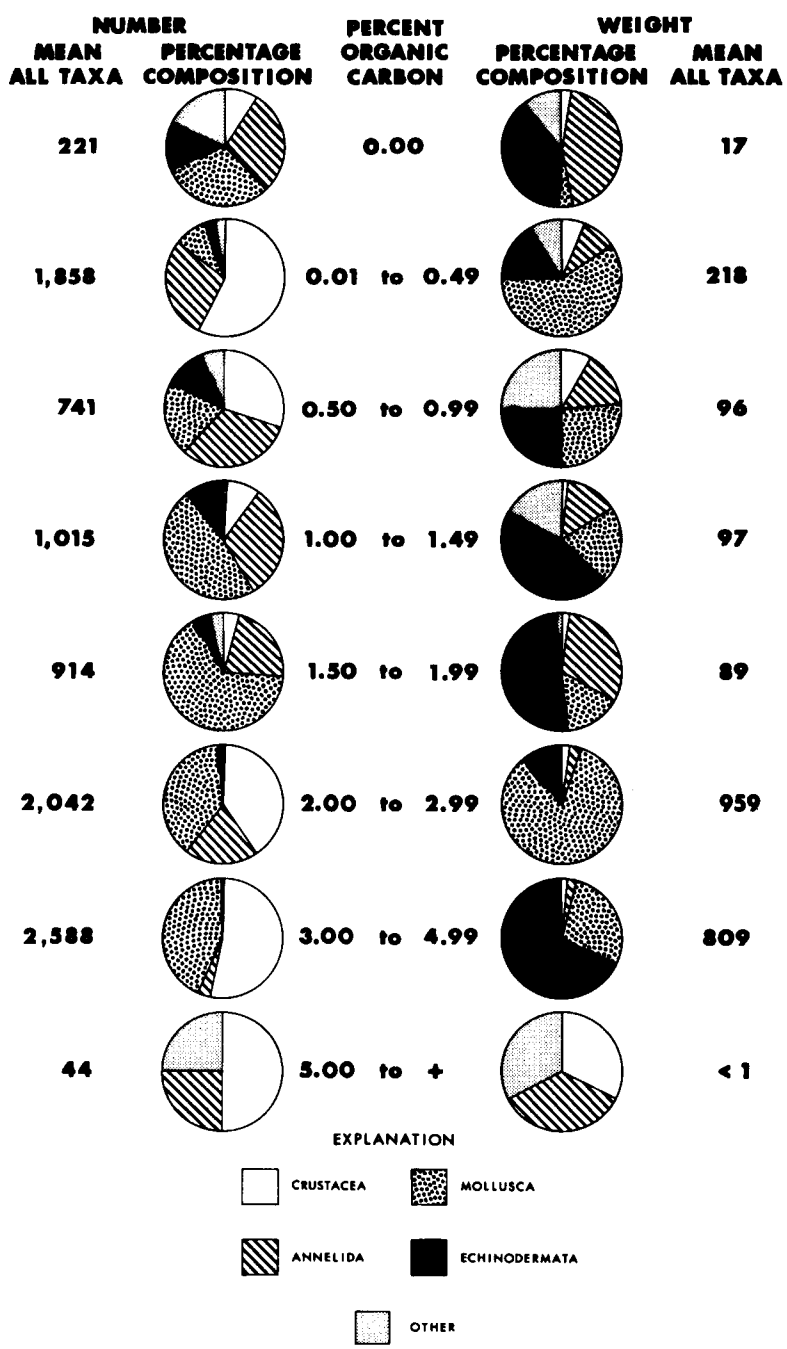


Figure 26
Quantitative composition of the total macrobenthic invertebrate fauna in relation to organic carbon in the sediments. Mean number of individuals and mean wet weight, per square meter of bottom, and percentage composition, by density and biomass, for the major taxonomic groups are shown.

tal rise (Table 13; Fig. 29). In the various depth classes average biomass ranged from 0.02 to 3.1 g/m^2. In deeper water the average weights were only 0.02 to 0.6 g/m^2.

In all depths Porifera accounted for a small percentage (<1%) of the total number of benthic animals (Table 12). The percentage of the total weight of the

Table 25

Frequency of occurrence (%) of each taxonomic group in the samples in each temperature range class.

Taxon	Annual range in water temperature (degrees Celsius)					
	0–3.9	4–7.9	8–11.9	12–15.9	16–19.9	20–23.9
PORIFERA	8	15	4	2	8	4
COELENTERATA	36	42	45	45	49	29
Hydrozoa	4	13	15	14	26	18
Anthozoa	32	29	30	31	23	11
Alcyonaria	11	5	2	8	—	—
Zoantharia	17	29	30	28	24	14
PLATYHELMINTHES	—	1	3	1	2	4
Turbellaria	—	1	3	1	2	4
NEMERTEA	25	28	49	50	52	11
ASCHELMINTHES	17	6	7	5	2	—
Nematoda	17	6	7	5	2	—
ANNELIDA	97	95	97	92	97	96
POGONOPHORA	15	3	<1	—	—	—
SIPUNCULIDA	25	29	29	12	5	—
ECHIURA	4	1	—	—	3	—
PRIAPULIDA	1	—	—	—	—	—
MOLLUSCA	91	83	87	87	94	93
Polyplacophora	10	10	6	7	5	—
Gastropoda	44	46	44	38	57	43
Bivalvia	87	75	81	83	90	93
Scaphopoda	36	37	10	3	2	—
Cephalopoda	<1	2	<1	—	—	—
ARTHROPODA	70	89	98	98	90	86
Pycnogonida	1	4	3	1	2	4
Arachnida	—	1	—	—	—	—
Crustacea	70	89	98	98	90	86
Ostracoda	1	1	—	—	—	—
Cirripedia	2	4	4	4	5	18
Copepoda	1	—	—	1	—	—
Cumacea	19	37	54	38	31	36
Tanaidacea	4	1	—	—	—	—
Isopoda	20	27	46	61	31	43
Amphipoda	57	83	97	92	82	71
Mysidacea	<1	2	3	9	13	18
Decapoda	6	15	35	31	53	18
BRYOZOA	8	13	11	11	21	18
BRACHIOPODA	10	8	2	—	—	—
ECHINODERMATA	77	78	72	71	45	43
Crinoidea	1	—	—	—	—	—
Holothuroidea	25	20	14	18	8	21
Echinoidea	16	26	33	44	24	14
Ophiuroidea	64	62	35	29	15	11
Asteroidea	6	16	21	12	11	4
HEMICHORDATA	<1	—	1	1	—	—
CHORDATA	12	11	24	17	19	11
Ascidiacea	12	11	24	17	19	11

Table 26
Mean number of specimens of each taxon per square meter in relation to sediment organic carbon content.

	Sediment organic carbon content (percent)								
Taxon	0.00	0.01–0.49	0.50–0.99	1.00–1.49	1.50–1.99	2.00–2.99	3.00–4.99	5.00+	All ranges
PORIFERA	2.6	2.7	0.5	0.4	0.2	—	—	—	1.7
COELENTERATA	—	17.8	26.8	10.1	5.3	5.3	—	—	17.7
Hydrozoa	—	8.7	9.2	3.4	0.6	2.5	—	—	7.5
Anthozoa	—	9.1	17.6	6.7	4.7	2.8	—	—	10.2
Alcyonaria	—	0.6	1.2	0.4	—	—	—	—	0.6
Zoantharia	—	7.4	6.8	4.4	4.6	2.8	—	—	6.6
Unidentified	—	1.1	9.6	1.9	0.1	—	—	—	3.0
PLATYHELMINTHES	—	0.6	0.1	—	—	0.9	—	—	0.4
Turbellaria	—	0.6	0.1	—	—	0.9	—	—	0.4
NEMERTEA	10.8	5.5	4.4	4.4	3.5	1.7	—	—	4.9
ASCHELMINTHES	—	3.1	1.0	2.8	0.4	—	—	—	2.3
Nematoda	—	3.1	1.0	2.8	0.4	—	—	—	2.3
ANNELIDA	64.0	503.6	234.7	319.1	195.9	406.9	81.3	11.0	395.7
POGONOPHORA	—	0.2	2.2	1.2	0.1	—	—	—	0.8
SIPUNCULIDA	2.2	6.9	7.3	1.0	0.1	—	—	—	5.7
ECHIURA	—	<0.1	0.3	0.1	—	—	—	—	0.1
PRIAPULIDA	—	<0.1	<0.1	0.1	—	—	—	—	<0.1
MOLLUSCA	68.8	139.1	146.7	481.7	602.1	794.7	1,119.5	—	223.3
Polyplacophora	—	2.5	0.7	1.2	0.1	—	—	—	1.7
Gastropoda	2.4	20.1	12.6	25.7	44.9	39.4	—	—	20.6
Bivalvia	64.2	113.7	125.6	442.3	545.2	750.7	1,119.5	—	195.5
Scaphopoda	2.2	2.7	5.7	12.5	11.9	4.6	—	—	5.0
Cephalopoda	—	0.1	2.1	—	—	—	—	—	0.5
Unidentified	—	—	<0.1	—	—	—	—	—	<0.1
ARTHROPODA	21.0	1,066.3	220.3	86.0	34.4	818.3	1,357.1	22.0	690.4
Pycnogonida	—	0.4	0.3	0.1	—	—	—	—	0.3
Arachnida	—	<0.1	—	—	—	—	—	—	<0.1
Crustacea	21.0	1,065.9	220.0	85.9	34.4	818.3	1,357.1	22.0	690.1
Ostracoda	—	<0.1	0.1	—	—	—	—	—	<0.1
Cirripedia	—	19.1	39.3	—	—	612.8	83.8	—	31.1
Copepoda	—	<0.1	<0.1	0.1	—	—	—	—	<0.1
Cumacea	2.6	25.2	6.1	3.8	6.2	122.8	—	—	18.7
Tanaidacea	—	<0.1	0.2	—	—	—	—	—	0.1
Isopoda	8.6	13.3	5.0	3.5	0.8	7.9	17.8	—	9.4
Amphipoda	9.8	1,000.1	164.1	78.0	24.4	66.0	1,255.5	22.0	624.4
Mysidacea	—	1.6	0.8	—	1.8	0.9	—	—	1.2
Decapoda	—	6.4	3.4	0.5	1.2	7.9	—	—	4.7
Unidentified	—	0.2	1.0	—	—	—	—	—	0.3
BRYOZOA	7.8	21.4	1.2	1.7	35.1	—	26.5	—	14.9
BRACHIOPODA	16.0	5.6	5.1	2.8	—	—	—	—	4.7
ECHINODERMATA	28.0	57.8	79.6	90.5	33.5	6.6	3.3	—	63.6
Crinoidea	—	<0.1	<0.1	—	—	—	—	—	<0.1
Holothuroidea	18.2	4.2	6.1	7.7	2.2	1.7	3.3	—	4.9
Echinoidea	2.6	23.8	0.8	0.6	1.0	—	—	—	13.8
Ophiuroidea	7.2	28.7	71.7	80.6	29.9	4.9	—	—	43.7
Asteroidea	—	1.1	1.0	1.6	0.4	—	—	—	1.0
HEMICHORDATA	—	0.2	0.2	0.1	—	—	—	—	0.1
CHORDATA	—	21.3	3.8	6.4	—	4.4	—	—	13.8
Ascidiacea	—	21.3	3.8	6.4	—	4.4	—	—	13.8
UNIDENTIFIED	—	6.3	6.6	6.8	3.1	3.0	—	11.0	6.1
Total	221.2	1,858.4	740.7	1,015.2	913.8	2,041.5	2,587.5	44.0	1,446.3

Table 27

The number of specimens of each taxon, expressed as a percentage of the total benthic invertebrate fauna, in relation to sediment organic carbon content.

	Sediment organic carbon content (percent)								
Taxon	0.00	0.01–0.49	0.50–0.99	1.00–1.49	1.50–1.99	2.00–2.99	3.00–4.99	5.00+	All ranges
PORIFERA	1.2	0.1	0.1	<0.1	<0.1	—	—	—	0.1
COELENTERATA	—	1.0	3.6	1.0	0.6	0.3	—	—	1.2
Hydrozoa	—	0.5	1.2	0.3	0.1	0.1	—	—	0.5
Anthozoa	—	0.5	2.4	0.7	0.5	0.1	—	—	0.7
Alcyonaria	—	<0.1	0.2	<0.1	—	—	—	—	<0.1
Zoantharia	—	0.4	0.9	0.4	0.5	0.1	—	—	0.5
Unidentified	—	0.1	1.3	0.2	<0.1	—	—	—	0.2
PLATYHELMINTHES	—	<0.1	<0.1	—	—	<0.1	—	—	<0.1
Turbellaria	—	<0.1	<0.1	—	—	<0.1	—	—	<0.1
NEMERTEA	4.9	0.3	0.6	0.4	0.4	0.1	—	—	0.3
ASCHELMINTHES	—	0.2	0.1	0.3	0.1	—	—	—	0.2
Nematoda	—	0.2	0.1	0.3	0.1	—	—	—	0.2
ANNELIDA	28.9	27.1	31.7	31.4	21.4	19.9	3.1	25.0	27.4
POGONOPHORA	—	<0.1	0.3	0.1	<0.1	—	—	—	0.1
SIPUNCULIDA	1.0	0.4	1.0	0.1	<0.1	—	—	—	0.4
ECHIURA	—	<0.1	<0.1	<0.1	—	—	—	—	<0.1
PRIAPULIDA	—	<0.1	<0.1	<0.1	—	—	—	—	<0.1
MOLLUSCA	31.1	7.5	19.8	47.5	65.9	38.9	43.3	—	15.4
Polyplacophora	—	0.1	0.1	0.1	<0.1	—	—	—	0.1
Gastropoda	1.1	1.1	1.7	2.5	4.9	1.9	—	—	1.4
Bivalvia	29.0	6.1	17.0	43.6	59.7	36.8	43.3	—	13.5
Scaphopoda	1.0	0.2	0.8	1.2	1.3	0.2	—	—	0.4
Cephalopoda	—	<0.1	0.3	—	—	—	—	—	<0.1
Unidentified	—	<0.1	—	—	—	—	—	—	<0.1
ARTHROPODA	9.5	57.4	29.8	8.5	3.8	40.1	52.5	50.0	47.8
Pycnogonida	—	<0.1	0.1	<0.1	—	—	—	—	<0.1
Arachnida	—	<0.1	—	—	—	—	—	—	<0.1
Crustacea	9.5	57.4	29.7	8.5	3.8	40.1	52.5	50.0	47.8
Ostracoda	—	<0.1	<0.1	—	—	—	—	—	<0.1
Cirripedia	—	1.0	5.3	—	—	30.0	3.3	—	2.2
Copepoda	—	<0.1	<0.1	<0.1	—	—	—	—	<0.1
Cumacea	1.2	1.4	0.8	0.4	0.7	6.0	—	—	1.3
Tanaidacea	—	<0.1	<0.1	—	—	—	—	—	<0.1
Isopoda	3.9	0.7	0.7	0.3	0.1	0.4	0.7	—	0.7
Amphipoda	4.4	53.8	22.2	7.7	2.7	3.2	48.5	50.0	43.2
Mysidacea	—	0.1	0.1	—	0.2	<0.1	—	—	0.1
Decapoda	—	0.3	0.5	0.1	0.1	0.4	—	—	0.3
Unidentified	—	<0.1	0.1	—	—	—	—	—	<0.1
BRYOZOA	3.5	1.1	0.2	0.2	3.9	—	1.0	—	1.0
BRACHIOPODA	7.2	0.3	0.7	0.3	—	—	—	—	0.3
ECHINODERMATA	12.7	3.1	10.7	8.9	3.7	0.3	0.1	—	4.4
Crinoidea	—	<0.1	<0.1	—	—	—	—	—	<0.1
Holothuroidea	8.2	0.2	0.8	0.8	0.2	0.1	0.1	—	0.3
Echinoidea	1.2	1.3	0.1	0.1	0.1	—	—	—	1.0
Ophiuroidea	3.3	1.5	9.7	7.9	3.3	0.2	—	—	3.0
Asteroidea	—	0.1	0.1	0.2	0.1	—	—	—	0.1
HEMICHORDATA	—	<0.1	<0.1	<0.1	—	—	—	—	<0.1
CHORDATA	—	1.1	0.5	0.6	—	0.2	—	—	1.0
Ascidiacea	—	1.1	0.5	0.6	—	0.2	—	—	1.0
UNIDENTIFIED	—	0.3	0.9	0.7	0.3	0.2	—	25.0	0.4
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 28
Mean wet weight of specimens of each taxon (grams per square meter) in relation to sediment organic carbon content.

	Sediment organic carbon content (percent)								
Taxon	0.00	0.01–0.49	0.50–0.99	1.00–1.49	1.50–1.99	2.00–2.99	3.00–4.99	5.00+	All ranges
PORIFERA	0.03	5.19	0.12	0.01	<0.01	—	—	—	2.98
COELENTERATA	—	6.33	18.48	14.57	1.80	0.06	—	—	9.57
Hydrozoa	—	1.06	0.16	0.01	<0.01	0.02	—	—	0.64
Anthozoa	—	5.27	18.32	14.56	1.80	0.04	—	—	8.93
Alcyonaria	—	0.26	0.32	0.13	—	—	—	—	0.24
Zoantharia	—	4.91	17.21	14.07	1.79	0.04	—	—	8.42
Unidentified	—	0.10	0.79	0.36	0.01	—	—	—	0.28
PLATYHELMINTHES	—	<0.01	<0.01	—	—	0.19	—	—	0.01
Turbellaria	—	<0.01	<0.01	—	—	0.19	—	—	0.01
NEMERTEA	0.53	0.79	0.79	0.38	0.94	0.48	—	—	0.74
ASCHELMINTHES	—	0.01	<0.01	0.02	<0.01	—	—	—	0.01
Nematoda	—	0.01	<0.01	0.02	<0.01	—	—	—	0.01
ANNELIDA	7.43	15.93	14.88	12.92	26.92	22.60	11.31	0.11	16.01
POGONOPHORA	—	<0.01	0.01	0.01	<0.01	—	—	—	<0.01
SIPUNCULIDA	0.02	0.93	1.13	0.07	<0.01	—	—	—	0.79
ECHIURA	—	0.01	1.25	1.35	—	—	—	—	0.44
PRIAPULIDA	—	<0.01	0.02	0.01	—	—	—	—	0.01
MOLLUSCA	0.80	132.21	25.23	19.95	13.38	811.54	226.87	—	99.58
Polyplacophora	—	0.25	0.03	0.02	<0.01	—	—	—	0.15
Gastropoda	0.02	3.83	0.56	0.28	1.09	10.42	—	—	2.59
Bivalvia	0.67	127.81	24.42	19.17	12.05	801.02	226.87	—	96.54
Scaphopoda	0.11	0.31	0.19	0.48	0.24	0.10	—	—	0.29
Cephalopoda	—	0.01	0.03	—	—	—	—	—	0.01
Unidentified	—	—	<0.01	—	—	—	—	—	<0.01
ARTHROPODA	0.31	13.28	6.46	1.22	1.02	18.99	9.44	0.11	9.62
Pycnogonida	—	0.01	0.01	<0.01	—	—	—	—	<0.01
Arachnida	—	<0.01	—	—	—	—	—	—	<0.01
Crustacea	0.31	13.27	6.45	1.22	1.02	18.99	9.44	0.11	9.61
Ostracoda	—	<0.01	<0.01	—	—	—	—	—	<0.01
Cirripedia	—	6.45	4.11	—	—	14.32	1.10	—	4.86
Copepoda	—	<0.01	<0.01	<0.01	—	—	—	—	<0.01
Cumacea	0.03	0.09	0.03	0.02	0.01	0.24	—	—	0.07
Tanaidacea	—	<0.01	<0.01	—	—	—	—	—	<0.01
Isopoda	0.19	0.27	0.24	0.03	0.14	0.06	0.05	—	0.23
Amphipoda	0.09	5.29	1.76	0.59	0.17	0.21	8.29	0.11	3.54
Mysidacea	—	0.01	0.01	—	0.01	0.01	—	—	0.01
Decapoda	—	1.16	0.30	0.58	0.69	4.15	—	—	0.91
Unidentified	—	<0.01	<0.01	—	—	—	—	—	<0.01
BRYOZOA	0.23	1.95	0.02	0.06	1.21	—	0.18	—	1.19
BRACHIOPODA	1.31	0.96	1.74	0.03	—	—	—	—	0.95
ECHINODERMATA	6.16	35.22	23.25	44.01	43.35	104.47	561.51	—	38.82
Crinoidea	—	<0.01	<0.01	—	—	—	—	—	<0.01
Holothuroidea	5.80	3.97	11.16	30.95	40.90	104.31	561.51	—	15.66
Echinoidea	0.29	27.90	5.44	1.33	0.60	—	—	—	17.29
Ophiuroidea	0.07	2.32	5.23	6.28	0.56	0.16	—	—	3.26
Asteroidea	—	1.03	1.42	5.45	1.29	—	—	—	1.61
HEMICHORDATA	—	0.03	0.03	<0.01	—	—	—	—	0.03
CHORDATA	—	4.38	1.88	2.03	—	0.33	—	—	3.15
Ascidiacea	—	4.38	1.88	2.03	—	0.33	—	—	3.15
UNIDENTIFIED	—	0.33	0.27	0.29	0.10	0.07	—	0.11	0.29
Total	16.82	217.56	95.95	96.93	88.72	958.73	809.31	0.33	183.18

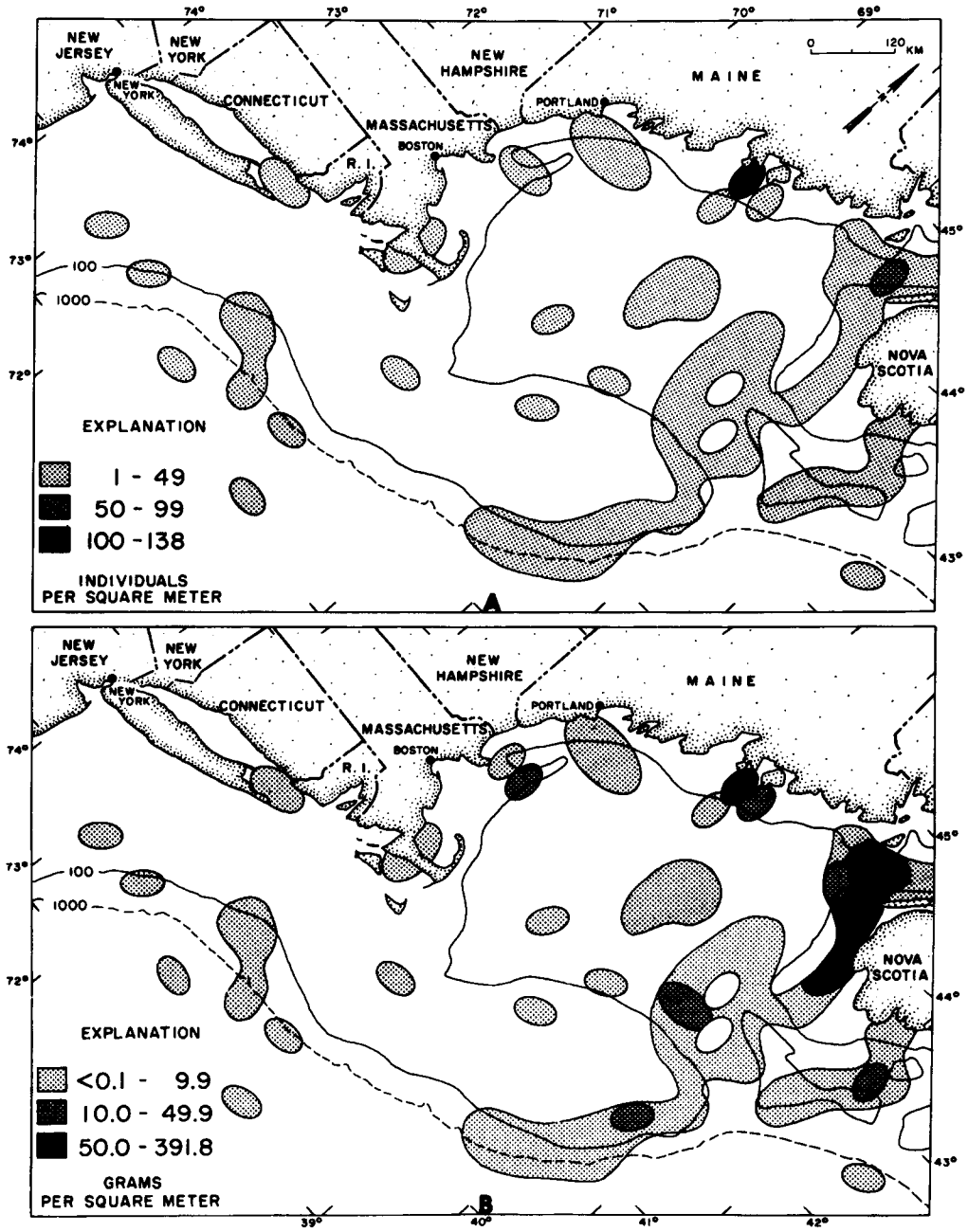
Table 29

The wet weight of specimens of each taxon, expressed as a percentage of the total benthic invertebrate fauna, in relation to sediment organic carbon content.

	Sediment organic carbon content (percent)								
Taxon	0.00	0.01–0.49	0.50–0.99	1.00–1.49	1.50–1.99	2.00–2.99	3.00–4.99	5.00+	All ranges
PORIFERA	0.2	2.4	0.1	<0.1	<0.1	—	—	—	1.6
COELENTERATA	—	2.9	19.3	15.0	2.0	<0.1	—	—	5.2
Hydrozoa	—	0.5	0.2	<0.1	<0.1	<0.1	—	—	0.3
Anthozoa	—	2.4	19.1	15.0	2.0	<0.1	—	—	4.9
Alcyonaria	—	0.1	0.3	0.1	—	—	—	—	0.1
Zoantharia	—	2.3	18.0	14.5	2.0	<0.1	—	—	4.6
Unidentified	—	<0.1	0.8	0.4	<0.1	—	—	—	0.2
PLATYHELMINTHES	—	<0.1	<0.1	—	—	<0.1	—	—	<0.1
Turbellaria	—	<0.1	<0.1	—	—	<0.1	—	—	<0.1
NEMERTEA	3.2	0.4	0.8	0.4	1.1	<0.1	—	—	0.4
ASCHELMINTHES	—	<0.1	<0.1	<0.1	<0.1	—	—	—	<0.1
Nematoda	—	<0.1	<0.1	<0.1	<0.1	—	—	—	<0.1
ANNELIDA	44.2	7.3	15.6	13.3	30.3	2.4	1.4	33.3	8.7
POGONOPHORA	—	<0.1	<0.1	<0.1	<0.1	—	—	—	<0.1
SIPUNCULIDA	0.1	0.4	1.2	0.1	<0.1	—	—	—	0.4
ECHIURA	—	<0.1	1.3	1.4	—	—	—	—	0.2
PRIAPULIDA	—	<0.1	<0.1	<0.1	—	—	—	—	<0.1
MOLLUSCA	4.7	60.8	26.4	20.6	15.1	84.7	28.0	—	54.4
Polyplacophora	—	0.1	<0.1	<0.1	<0.1	—	—	—	0.1
Gastropoda	0.1	1.8	0.6	0.3	1.2	1.1	—	—	1.4
Bivalvia	4.0	58.7	25.6	19.8	13.6	83.6	28.0	—	52.7
Scaphopoda	0.6	0.1	0.2	0.5	0.3	<0.1	—	—	0.2
Cephalopoda	—	<0.1	<0.1	—	—	—	—	—	<0.1
Unidentified	—	—	<0.1	—	—	—	—	—	<0.1
ARTHROPODA	1.8	6.1	6.8	1.3	1.2	1.9	1.2	—	5.2
Pycnogonida	—	<0.1	<0.1	<0.1	—	—	—	—	<0.1
Arachnida	—	<0.1	—	—	—	—	—	—	<0.1
Crustacea	1.8	6.1	6.8	1.3	1.2	1.9	1.2	33.3	5.2
Ostracoda	—	<0.1	<0.1	—	—	—	—	—	<0.1
Cirripedia	—	3.0	4.3	—	—	1.5	0.1	—	2.7
Copepoda	—	<0.1	<0.1	<0.1	—	—	—	—	<0.1
Cumacea	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	—	—	<0.1
Tanaidacea	—	<0.1	<0.1	—	—	—	—	—	<0.1
Isopoda	1.0	0.1	0.3	<0.1	0.2	<0.1	<0.1	—	<0.1
Amphipoda	0.5	2.4	1.8	0.6	0.2	<0.1	1.0	33.3	1.9
Mysidacea	—	<0.1	<0.1	—	<0.1	<0.1	—	—	<0.1
Decapoda	—	0.5	0.3	0.6	0.8	0.4	—	—	0.5
Unidentified	—	<0.1	<0.1	—	—	—	—	—	<0.1
BRYOZOA	1.4	0.9	<0.1	0.1	1.4	—	<0.1	—	0.7
BRACHIOPODA	7.8	0.4	1.8	<0.1	—	—	—	—	0.5
ECHINODERMATA	36.6	16.2	24.4	45.4	48.8	10.9	69.4	—	20.7
Crinoidea	—	<0.1	<0.1	—	—	—	—	—	<0.1
Holothuroidea	34.5	1.8	11.7	31.9	46.0	10.9	69.4	—	8.6
Echinoidea	1.7	12.8	5.7	1.4	0.7	—	—	—	9.4
Ophiuroidea	0.4	1.1	5.5	6.5	0.6	<0.1	—	—	1.8
Asteroidea	—	0.5	1.5	5.6	1.5	—	—	—	0.9
HEMICHORDATA	—	<0.1	<0.1	<0.1	—	—	—	—	<0.1
CHORDATA	—	2.0	2.0	2.1	—	<0.1	—	—	1.7
Ascidiacea	—	2.0	2.0	2.1	—	<0.1	—	—	1.7
UNIDENTIFIED	—	0.2	0.3	0.3	0.1	<0.1	—	33.3	0.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 30
Frequency of occurrence (%) of each taxonomic group in the samples in each sediment organic carbon content class.

	Sediment organic carbon content (percent)							
Taxon	0.00	0.01–0.49	0.50–0.99	1.00–1.49	1.50–1.99	2.00–2.99	3.00–4.99	5.00+
PORIFERA	20	11	6	2	2	—	—	—
COELENTERATA	—	53	57	37	26	30	—	—
Hydrozoa	—	19	5	4	5	15	—	—
Anthozoa	—	35	52	33	21	15	—	—
Alcyonaria	—	5	14	8	—	15	—	—
Zoantharia	—	26	29	23	21	15	—	—
PLATYHELMINTHES	—	2	1	—	—	8	—	—
Turbellaria	—	2	1	—	—	8	—	—
NEMERTEA	40	46	45	39	23	15	—	—
ASCHELMINTHES	—	10	8	17	7	—	—	—
Nematoda	—	10	8	17	7	—	—	—
ANNELIDA	80	98	99	100	98	100	50	100
POGONOPHORA	—	2	21	10	2	—	—	—
SIPUNCULIDA	20	31	28	8	2	—	—	—
ECHIURA	—	<1	7	4	—	—	—	—
PRIAPULIDA	—	<1	1	1	—	—	—	—
MOLLUSCA	100	90	96	98	91	100	75	—
Polyplacophora	—	10	12	8	2	—	—	—
Gastropoda	20	51	47	49	61	31	—	—
Bivalvia	80	85	94	99	88	100	75	—
Scaphopoda	20	17	31	32	28	15	—	—
Cephalopoda	—	1	1	—	—	—	—	—
ARTHROPODA	100	98	85	67	61	77	50	100
Pycnogonida	—	3	2	1	—	—	—	—
Arachnida	—	<1	—	—	—	—	—	—
Crustacea	100	95	83	66	61	77	50	100
Ostracoda	—	1	1	—	—	—	—	—
Cirripedia	—	6	3	—	—	15	25	—
Copepoda	—	1	1	1	—	—	—	—
Cumacea	20	44	29	23	12	31	—	—
Tanaidacea	—	1	7	—	—	—	—	—
Isopoda	20	47	27	11	5	15	25	—
Amphipoda	60	93	72	55	49	62	50	100
Mysidacea	—	5	3	—	7	8	—	—
Decapoda	—	32	9	4	5	23	—	—
BRYOZOA	20	16	7	4	5	—	25	—
BRACHIOPODA	40	6	5	2	—	—	—	—
ECHINODERMATA	100	70	83	76	63	31	25	—
Crinoidea	—	<1	1	—	—	—	—	—
Holothuroidea	40	17	37	27	16	15	25	—
Echinoidea	20	34	14	6	12	—	—	—
Ophiuroidea	60	39	70	66	47	23	—	—
Asteroidea	—	14	17	14	7	—	—	—
HEMICHORDATA	—	1	1	1	—	—	—	—
CHORDATA	—	23	19	13	—	8	—	—
Ascidiacea	—	23	19	13	—	8	—	—



PORIFERA

Figure 27
Geographic distribution of Porifera: A—number of specimens per square meter of bottom; B—biomass in grams per square meter of bottom.

fauna was moderately high (3–5%) along the outer continental shelf and upper continental slope (Table 14). On the inner shelf and in very deep water, sponges made up a small portion of the total biomass.

Sponges were present in 3 to 12% of the collections within each depth class (Table 15). The highest frequency of occurrence was on the continental slope (200 to 2,000 m). These sponges were small, and were frequently attached to polychaete tubes, shell fragments, corals, and other biogenic substrates.

Relation to Sediments

Porifera were generally more numerous and constituted a substantially larger biomass in coarse substrates

(gravel, till, and shell) than in those composed of fine particles (Tables 16–20; Fig. 30). Also, the proportion of samples containing Porifera was higher for the coarse than the fine substrates. Till contained the highest density of specimens, the greatest weight, and highest frequency of occurrence. Gravel ranked second in number and shell ranked second in weight. Sand contained intermediate quantities, and sand-silt and silt-clay contained the smallest quantities.

Relation to Water Temperature

Porifera were generally most numerous in areas where the annual range in bottom water temperature was moderate—4° to 12°C (Tables 21–25; Fig. 31). Where the annual temperature excursions were less than 4° or greater than 12°C the average biomass was markedly lower than at midrange. The frequency of occurrence was highest (15%) in those samples from localities in which the seasonal changes in temperature were between 4° and 8°C.

Two other aspects of the relative density of Porifera and bottom water temperature that were examined, but not tabulated or illustrated here, concern annual maximum and annual minimum temperature. Sponges were more plentiful (2 to 7 g/m^2) in areas where the maximum temperature was moderate, between 6° and 12°C; they were scarce (<1 g/m^2) where the maximum temperature remained below 6° or rose above 12°C. Porifera were abundant (>4 g/m^2) where the minimum temperature was low (0° to 3.9°C) and scarce (<1 g/m^2) where the minimum temperature was high.

Relation to Sediment Organic Carbon

Porifera were found only where sediments contained low to moderate (0.01 to 1.99%) amounts of organic carbon (Tables 26–30; Fig. 32). Both mean density and biomass diminished with increasing organic carbon content. Density ranged from 3 to 0.2/m^2, and biomass from 5 to <0.01 g/m^2.

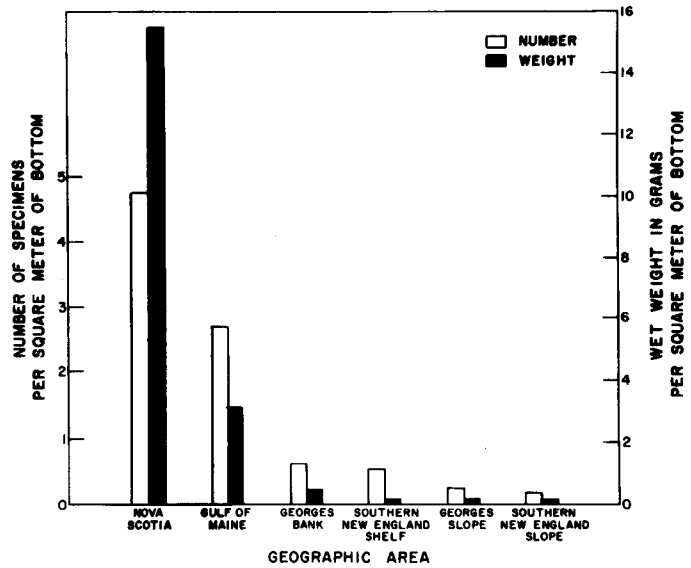


Figure 28
Density and biomass of Porifera in each of the six geographic areas.

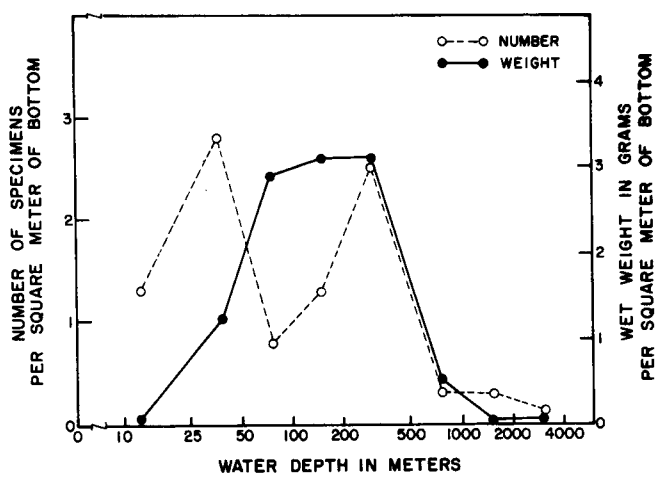


Figure 29
Density and biomass of Porifera in relation to water depth.

Coelenterata

The macrobenthic coelenterate fauna of the New England region is composed of members of two classes: Hydrozoa and Anthozoa. Hydrozoa are treated at the class level, whereas Anthozoa, composed of members from seven orders contained in two subclasses, are discussed at the subclass levels: Alcyonaria and Zoantharia. No discussions are included at the taxonomic levels Coelenterata or Anthozoa; however, the interested reader will find summary data, for all treated parameters, for those taxonomic levels in Tables 5–30.

Hydrozoa—Hydrozoans were common in parts of the New England region, but their limited occurrence and moderately small size severely restricted their contribution to the total biomass. They made up less than 1% of

the benthic biomass (Table 3). Members of this group were most abundant in shallow waters and were attached to firm substrates, frequently where water currents were moderate to strong.

Hydrozoans in our samples were small in size and delicately tinted in white, pink, violet, tan, and brown. They were exclusively carnivores preying on planktonic crustaceans and other small animals carried to them by water currents. In turn, hydrozoans are preyed upon by nudibranchs and, probably, other omnivores and carnivores.

The most common forms encountered were Leptomedusae, represented by the genera *Campanularia, Sertularia, Obelia,* and others. Less common were representatives of Anthomedusae, of which *Hydractinia* is a member. This hydrozoan occurred on live mollusks and on dead shell. Some encrusted gastropod shells were inhabited by hermit crabs.

Hydrozoans occurred in 126 samples (12% of total); their average density was 6.4/m^2 and biomass averaged 0.5 g/m^2 (Table 5).

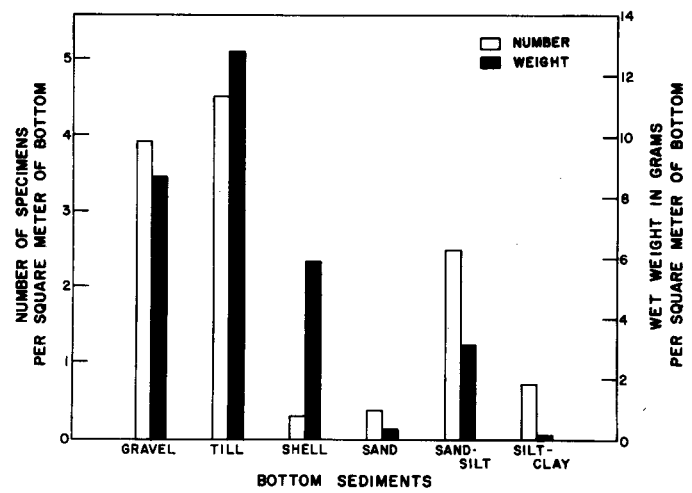


Figure 30
Density and biomass of Porifera in relation to bottom sediments.

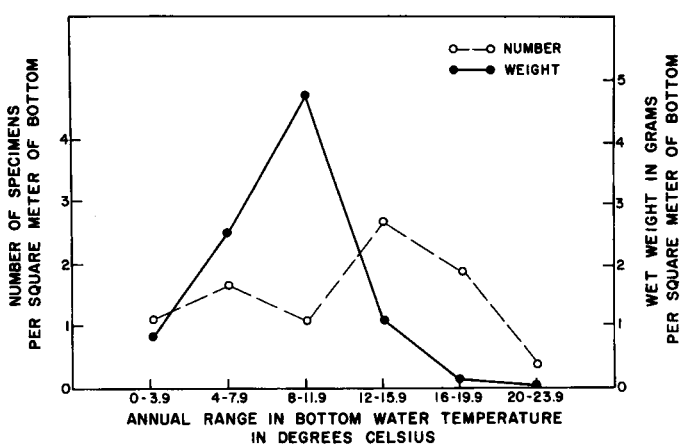


Figure 31
Density and biomass of Porifera in relation to the annual range of bottom water temperature.

Geographic Distribution

Hydrozoans were common in coastal areas and on offshore banks (Fig. 33). They were absent, or present in only small quantities, in much of the central sections of the Gulf of Maine, in large areas of the continental shelf south of Rhode Island, and on the continental slope and rise. High densities, 100 to 500 colonies/m^2, and high biomass, 10 to 45 g/m^2, occurred in only a few scattered localities. Low densities, to 49 colonies/m^2, and average weights less than 1 g/m^2 were much more common and widely distributed.

Three geographic areas contained moderate to large quantities of hydrozoans: Nova Scotia, Georges Bank, and the Southern New England Shelf (Tables 6, 8; Fig. 34). Average densities in these areas ranged from 7 to 12 colonies/m^2; biomass averaged from 0.4 to 1.6 g/m^2. Georges Bank ranked first in terms of weight, and Nova Scotia ranked first in number of specimens. Small quantities of hydrozoans were found in the Gulf of Maine, Georges Slope, and Southern New England Slope. Quantities in these three areas averaged between 3.3 and 0.1 colonies/m^2, and 0.12 and <0.1 g/m^2.

The frequency of occurrence of hydrozoans in the samples (Table 10) indicates the same general trend of abundance as the average number and weight of specimens. Percentages of samples containing hydrozoans ranged from a high of 29% in the Nova Scotia area (8 to 15% in the other shelf areas) to a low frequency (1 to 4%) in the Georges Slope and Southern New England Slope area.

Bathymetric Distribution

Hydrozoans were most abundant in shallow water (0–24 m) where their density averaged 37 colonies/m^2 and they diminished in quantity more or less directly with increased depth (Tables 11, 12; Fig. 35). In deeper waters (25–200 m) that cover the offshore continental shelf, their average density was between 2 and 6 colonies/m^2. They were uncommon to rare on the continental slope and rise.

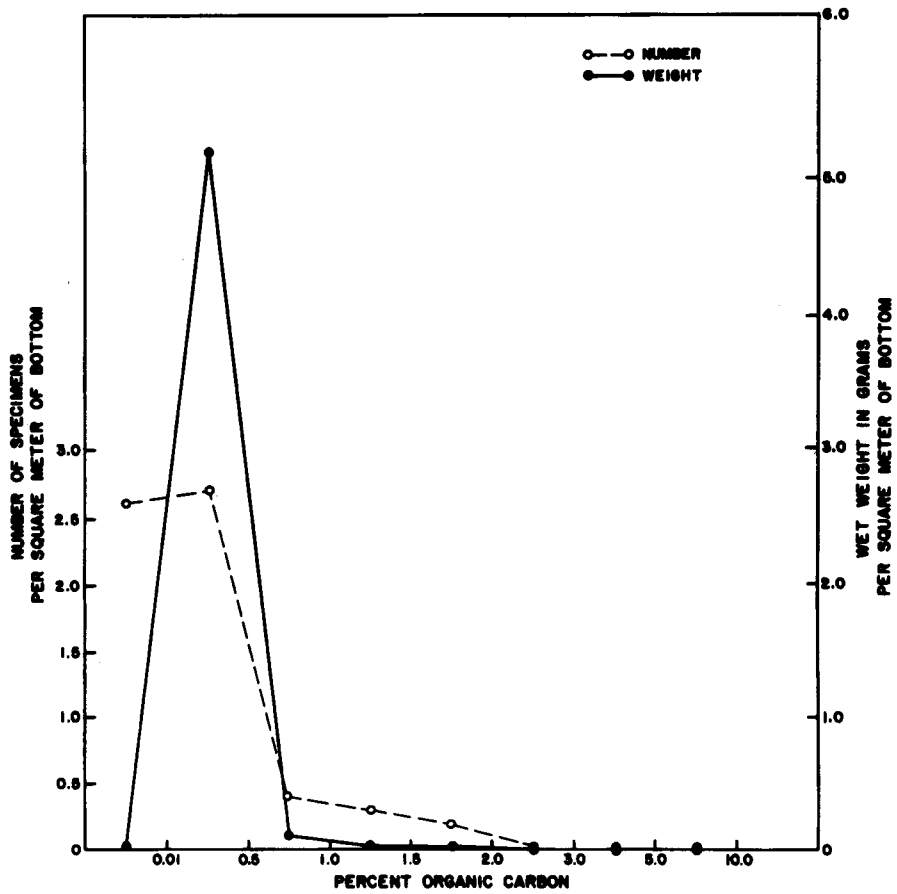


Figure 32
Density and biomass of Porifera in relation to sediment organic carbon.

Biomass trends were the same as those described above for numerical density, with the exception of unusually large quantities between 50 and 100 meters (Tables 13, 14; Fig. 35). In the shallow zone (0–24 m) the average weight was 1.2 g/m^2. In deeper water, at a depth of 1,000 m and greater, the average quantity decreased to <0.01 g/m^2. The extraordinarily large quantity between 50 and 100 m resulted from relatively few very large colonies.

The frequency of occurrence of hydroids in samples was highest (21%) in the shallow water zone (0–24 m), dropping to 3% at depths below 1,000 m (Table 15).

Relation to Bottom Sediments

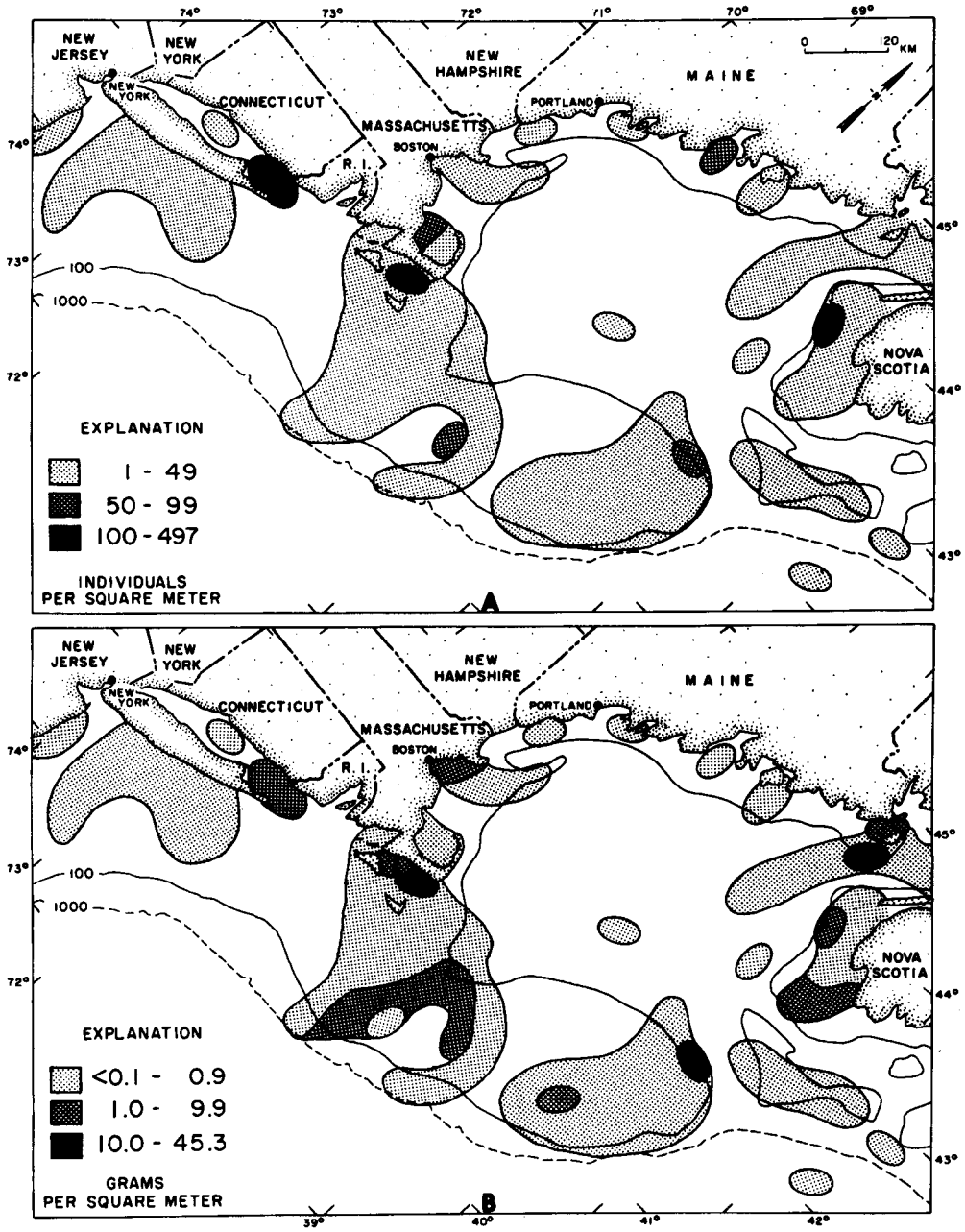
Hydrozoans occurred on all sediment types found in the region; however, they were much more prevalent on gravels than on other types of substrates (Tables 16, 18; Fig. 36). Both numerical density and weight diminished with decreased sediment particle size. Average density dropped from 20 colonies/m^2 in gravel to 2 colonies/m^2 in silt-clay. Wet weight declined from an average of 2.6 g/m^2 in gravel to 0.01 g/m^2 in silt-clay. Intermediate quantities were present on substrates composed of medium-sized particles.

Frequency of occurrence also reflected the general trend of higher densities on coarse substrates and low densities in fine-grained substrates (Table 20). In coarse sediments the percentage of samples containing hydroids ranged from 23 to 33%. The percentage occurrence in sand, an intermediate grade, was 14%. In the fine-grained sediments the frequency of occurrence was only 4 to 6%.

Hydrozoans constituted only a small part (1.4%) of the total benthic fauna, even in the sediment type (gravel) in which they were most abundant (Table 19).

Relation to Water Temperature

The density of hydroids increased as the annual range in bottom water temperature broadened. Average density



HYDROZOA

Figure 33
Geographic distribution of Hydrozoa: A—number of specimens per square meter of bottom; B—biomass in grams per square meter of bottom.

was only 0.9 colonies/m^2 where the temperature range was small, reaching an average of 46 colonies/m^2 where the temperature range was broad (Table 21; Fig. 37), a marked increase in density occurred between the 12–15.9°C and 16–19.9°C classes: in the former the average density was 5 colonies/m^2; in the latter it was 37 colonies/m^2.

The contribution of hydroids to the total faunal density was <0.5% in the middle and low-range classes but was above 1% in the two high-range classes (Table 22).

Hydroid biomass was moderate or low in all temperature range classes and no consistent trend in relation to temperature range was evident (Tables 23, 24; Fig. 37).

Although hydroids did not occur in a large proportion of the samples, there was a general trend of increasing occurrence rate from 4% in the low-range temperature classes to 26 and 18% in the high-range temperature classes (Table 25).

Relation to Sediment Organic Carbon

Hydrozoan abundance was generally negatively correlated to the quantity of organic carbon in the sediments (Fig. 38). Density of hydroids was greatest (9 colonies/m^2) where sediment organic carbon content was low (<1%), declining to moderate levels where carbon content was between 1 and 3% (Tables 26, 27). They were absent in sediments containing the greatest amounts of organic carbon (>3%).

Biomass of hydrozoans paralleled density, diminishing with increasing organic carbon content (Tables 28, 29). Biomass ranged from slightly over 1 g/m^2 to <0.01 g/m^2.

Frequency of occurrence of hydroids in samples ranged from 4 to 19% (Table 30). The trend differed from density and biomass, however, in being parabolic with lowest occurrence in the middle ranges and increasing at each extreme.

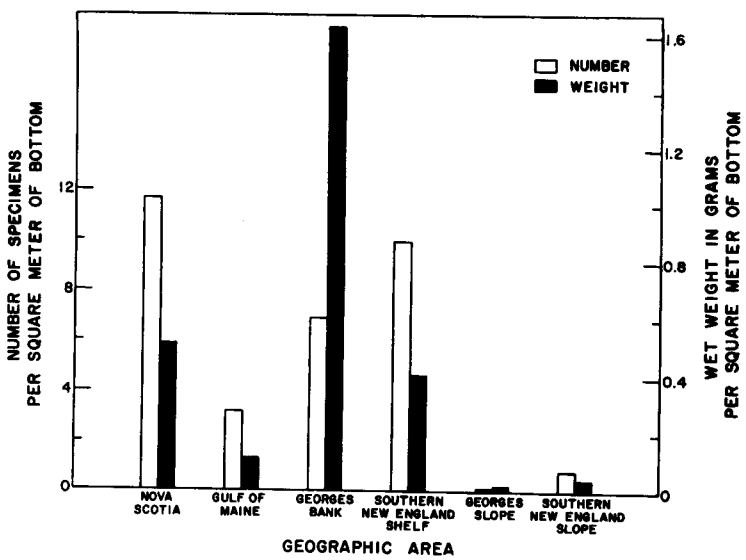


Figure 34
Density and biomass of Hydrozoa in each of the six geographic areas.

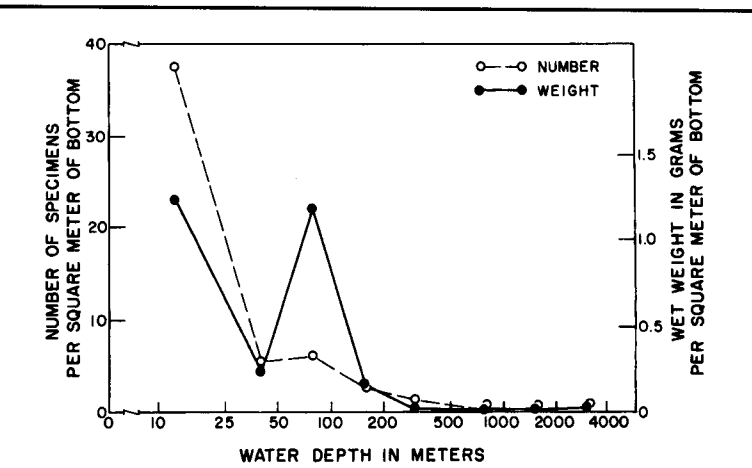


Figure 35
Density and biomass of Hydrozoa in relation to water depth.

Anthozoa—

Alcyonaria—Alcyonarian coelenterates in our samples were composed of soft corals, orders Alcyonacea and Gorgonacea, and sea pens, order Pennatulacea. Because of the limited occurrence of both groups (<0.1% of the number of all organisms), and despite their large size, they also constituted <0.1% of the total benthic biomass (Table 3). None of the alcyonarians in our samples were taken from depths less than 50 m. They were most abundant between 200 and 500 m.

Soft corals are typically bush- or treelike in shape and they attach to hard substrates, usually rock outcrops or gravel. Soft corals range in height from a few millimeters to several meters. Trunk diameters are proportional in size, and in large specimens occasionally exceed 10 cm. Thus, some species of this group may rank as the largest sessile invertebrates in this region. Colors are light tan, pink, or various dark shades of red.

Pennatulacea are feather-shaped animals commonly 10 to 25 cm in length. They characteristically dwell in soft bottom sediments anchored by a peduncle. Color of the majority of specimens in our samples was tan or a combination of light cream (rachis) and deep burgundy (pinnae).

Alcyonarians occurred in 63 samples (6% of total). Their density averaged 0.8/m^2 and biomass averaged 0.2 g/m^2 (Table 5).

Geographic Distribution

Alcyonarians were present along the outer margin of the continental shelf and on the continental slope and rise. They were sparse in all sections and their occurrence was patchy, especially in the northern section

(Fig. 39). They were absent in the samples from Georges Bank. Their average density in all localities was between 1 and 15/m^2. Their average biomass at all localities was 18.9 g/m^2 or less.

Alcyonarians were present in approximately the same quantities in all standard geographic areas, except Georges Bank where they were absent. Average densities in geographic areas where they were present ranged from 0.7 to 1.5/m^2, and average biomasses ranged from 0.03 to 0.43 g/m^2 (Tables 6–9; Fig. 40).

In addition to number and weight per unit area, another reasonably good index of abundance is the percentage of samples containing alcyonarians (Table 10). All shelf areas (Nova Scotia, Gulf of Maine, Georges Bank, and Southern New England Shelf) had a frequency of occurrence of 7% or less. The occurrence rates on Georges Slope and Southern New England Slope were 27% and 17%, respectively. Alcyonarians formed a larger share of the total benthic fauna in the latter two (slope) areas than in the shelf areas.

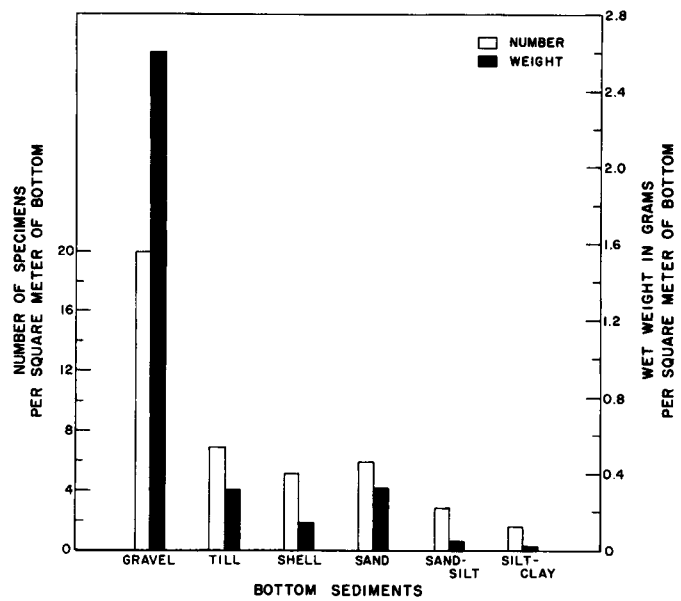


Figure 36
Density and biomass of Hydrozoa in relation to bottom sediments.

Bathymetric Distribution

Alcyonarians were most common in deep water habitats in the New England region. They were not present in any samples taken at depths less than 50 m but were represented in all depths greater than 50 m (Tables 11–14; Fig. 41). Although differences in average density and weight from one depth class to another were small, the larger quantities were most prevalent in deep water (100 to 2,000 m). Highest average density and largest average weight, 1.9/m^2 and 0.47 g/m^2, respectively, occurred at depths from 200 to 500 m.

The frequency of occurrence of alcyonarians in our shallow water (<50 m) samples was zero (Table 15). The occurrence was 5% at moderate depths (50 to 200 m) and increased to moderately high levels (22 to 29%) in deep water areas.

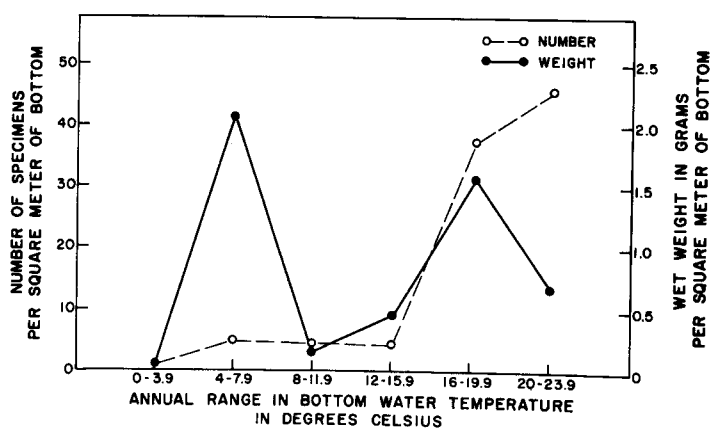


Figure 37
Density and biomass of Hydrozoa in relation to the annual range of bottom water temperature.

Relation to Bottom Sediments

Alcyonarians occurred only in selected types of substrate (Tables 16–19; Fig. 42). The Alcyonacea and Gorgonacea were collected from gravel and rocky outcrops, in contrast to the Pennatulacea, which inhabited sand-silt and silt-clay sediments. No alcyonarians were taken on substrates of till or shell, and they were present in only 5 samples out of a total of 455 from sand bottoms. Frequency of occurrence of this faunal group was highest (10 to 12%) in the silt-clay and sand-silt sediments and substantially lower (4%) in gravel (Table 20).

Relation to Water Temperature

Alcyonarians occurred only in areas where the annual temperature range was moderate or small, and less than 16°C (Tables 21–24; Fig. 43). The trends in both quantitative measures and also in frequency of occurrence exhibited a bimodal relationship.

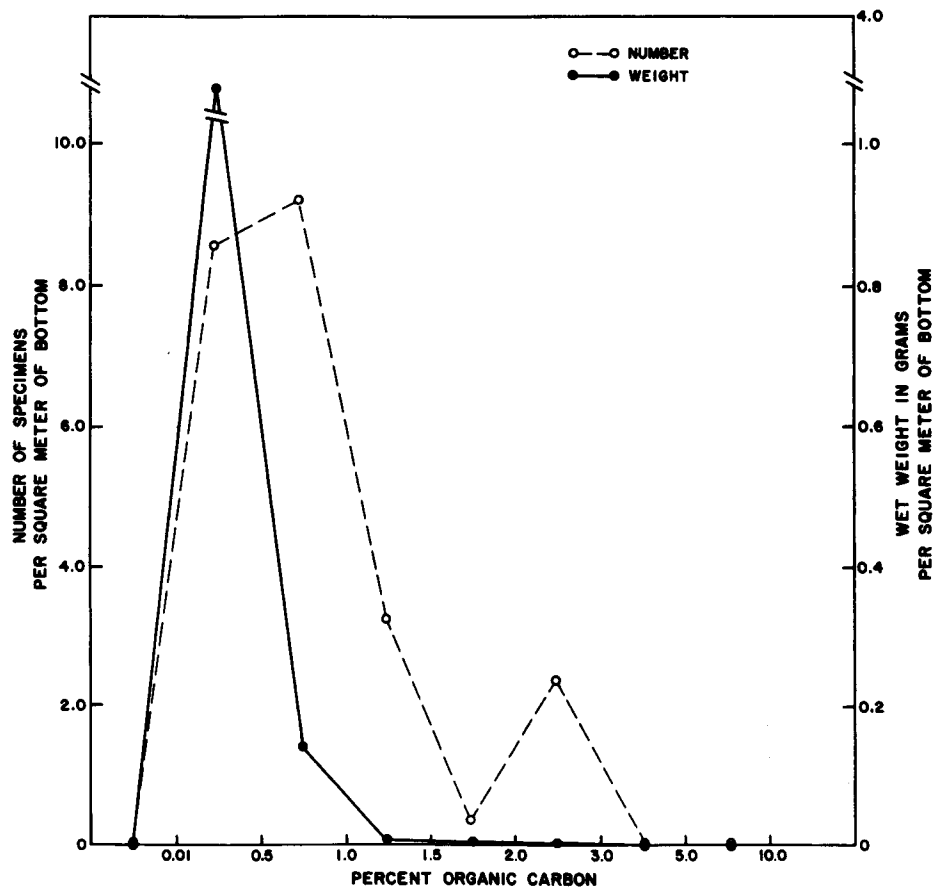


Figure 38
Density and biomass of Hydrozoa in relation to sediment organic carbon.

Alcyonarians were relatively more abundant in both the narrow (less than 4°C) temperature range class and where temperatures were moderately broad (12° to 15.9°C) than in areas of intermediate range. The densities averaged between 1.1 and 1.7/m^2 in the narrow and relatively broad range classes and between 0.2 and 1.2/m^2 in the intermediate range classes. Biomass averaged 0.31 to 0.42 g/m^2 in the narrow and relatively broad range classes and only 0.11 g/m^2 or less in the intermediate classes.

Frequency of occurrence of alcyonarians in samples ranged from 11 to 8% where the temperature was narrow and relatively broad, and only 2 to 5% in areas where the temperature range was intermediate (Table 25).

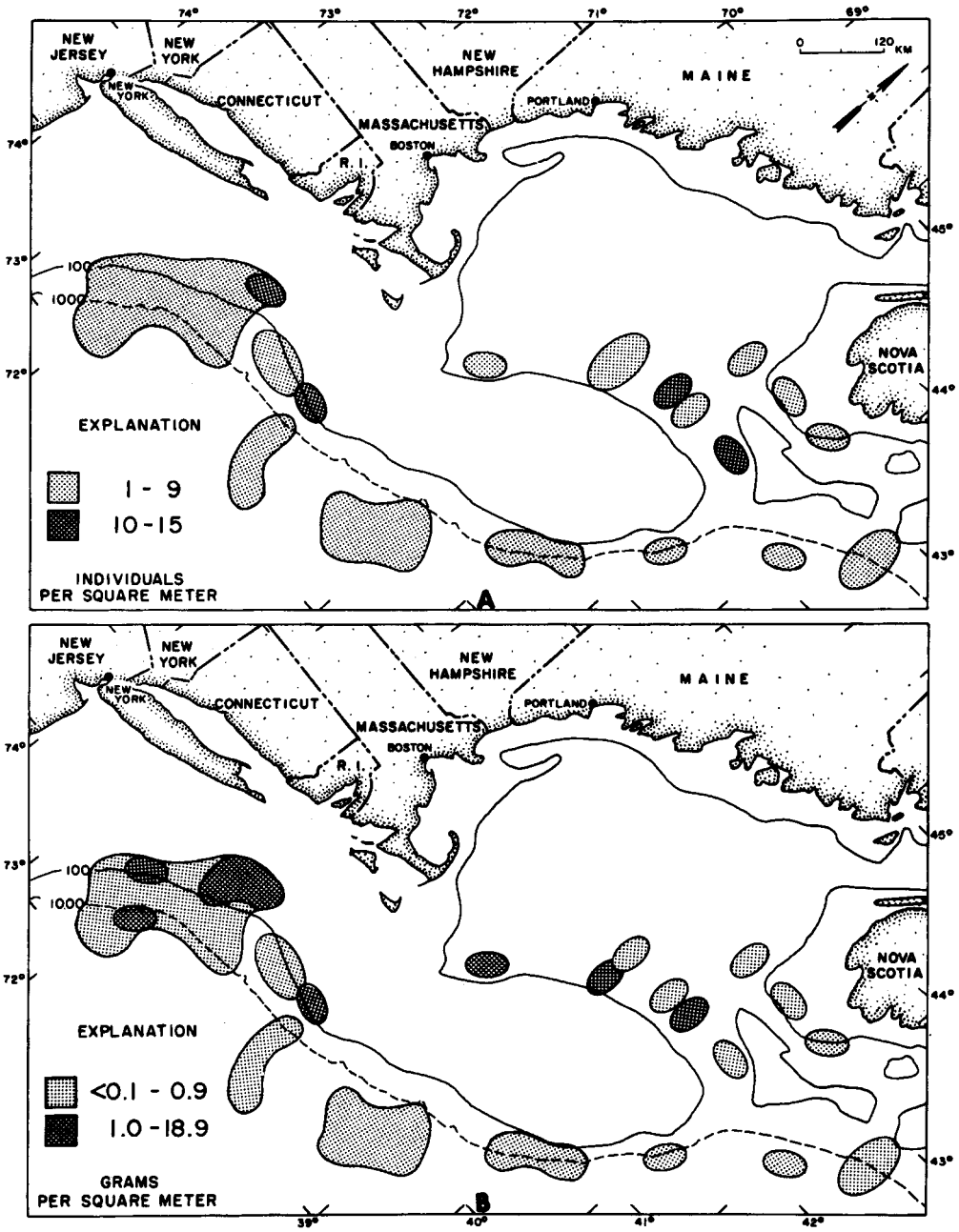
Relation to Sediment Organic Carbon

Alcyonarians occurred only in sediments with low (from 0.01 to 1.5%) organic carbon content; they were absent in areas with no measurable organic carbon, as well as in areas with carbon contents exceeding 1.5% (Fig. 44). The 0.50–0.99% carbon content class contained the highest average density (Tables 26, 27) as well as highest average biomass (Tables 28, 29). The only other carbon content classes in which alcyonarians occurred, 0.01–0.49% and 1.00–1.49%, had reduced measures of abundance.

Frequency of occurrence in samples showed a trend similar to density and biomass (Table 30), highest in the 0.50–0.99% carbon content class and significantly lower in the two adjacent classes.

Zoantharia—Four morphologically diverse orders of Zoantharia were represented in our samples from the New England region: 1) Actiniaria—sea anemones; 2) Ceriantharia—burrowing anemones; 3) Madreporaria—stony corals; and 4) Zoanthidea—colonial anemones. Altogether they contributed 1.5% of the number of animals and 3.5% of the biomass in the total macrofauna (Table 3).

Our samples contained specimens ranging in size from small (1 cm or slightly less) *Edwardsia* and other burrowing anemones to large *Cerianthus* over 30 cm in length.



ALCYONARIA

Figure 39
Geographic distribution of Alcyonaria: A—number of specimens per square meter of bottom; B—biomass in grams per square meter of bottom.

These organisms displayed many variations of color pattern and hue. Some small species and many larger forms had tentacles that were transparent or whitish. Body colors were mostly tan, flesh colored, or reddish-brown; a few were orange, red, or another somewhat similar bright color.

Stony corals of both solitary and colonial types occurred but neither type was common.

Commensalism was common among the Actiniaria and Zoanthidea, particularly in association with hermit crabs and decapod shrimps.

Occupancy of diverse habitats characterized the New England zoantharians. They occurred in a wide variety of substrates, and were distributed over broad ranges of water depth and temperature.

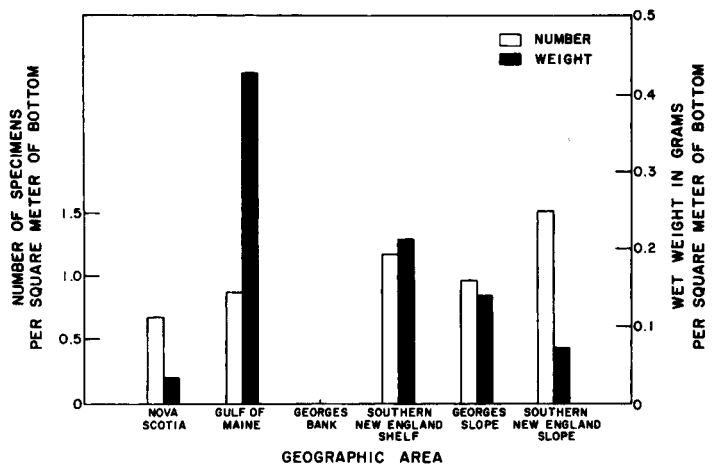


Figure 40
Density and biomass of Alcyonaria in each of the six geographic areas.

Zoantharians occurred in 265 samples (25% of the total). Their density averaged 22.6/m^2, and biomass averaged 6.4 g/m^2 (Table 5).

Geographic Distribution
Zoantharia were widely distributed over most of the marine waters off the northeastern United States (Fig. 45). They were especially common in coastal areas and on the offshore banks. Low and moderately low quantities (1 to 49 individuals, and less than 10 g/m^2 biomass) were most prevalent. Intermediate and high quantities (50 to 572 individuals, and 10 to 1,561 g/m^2 biomass) occurred in scattered patches.

Average numerical density ranged between 3 and 8.2 specimens/m^2 for all standard geographic areas except Georges Bank where the density averaged 92.5/m^2 (Tables 6, 8; Fig. 46). This unusually high abundance on the bank was due mainly to the presence of large quantities of small Ceriantharia and the moderately common Zoanthidea.

Biomass of specimens reflected entirely different patterns of abundance. Average biomass of Zoantharia within geographic areas was greatest (19.5 g/m^2) in Nova Scotia and diminished rather uniformly to the southwest (Tables 8, 9; Fig. 46), terminating with a low quantity of 0.7 g/m^2 in the southern New England Slope area.

Frequency of occurrence was moderate and fairly consistent among the various areas. The percentage of samples containing Zoantharia ranged between 17 and 31%, with the lowest incidence rates in the two slope areas (Table 10).

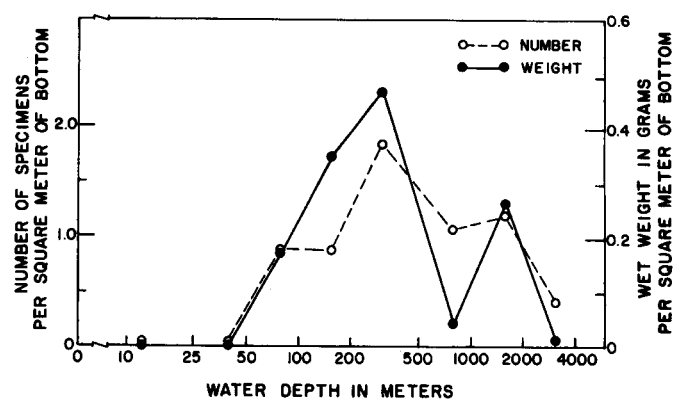


Figure 41
Density and biomass of Alcyonaria in relation to water depth.

Bathymetric Distribution
Zoantharians occurred at depths from 6 to 2,495 m but were most abundant between 25 and 100 m, where their density averaged from 21 to 91/m^2 (Tables 11, 12; Fig. 47). At other depths their density averaged 0.2 to 6.8/m^2. Only a moderate number (5.6/m^2) were present at depths from the shoreline to 24 m. Their density in deeper water progressively diminished from 6.8/m^2 in outer shelf depths to 0.2/m^2 on the continental rise.

In terms of biomass, the relationship between quantity and depth of water was considerably different from that described above for numbers of specimens. At depths of 0 to 100 m the average biomass was moderate

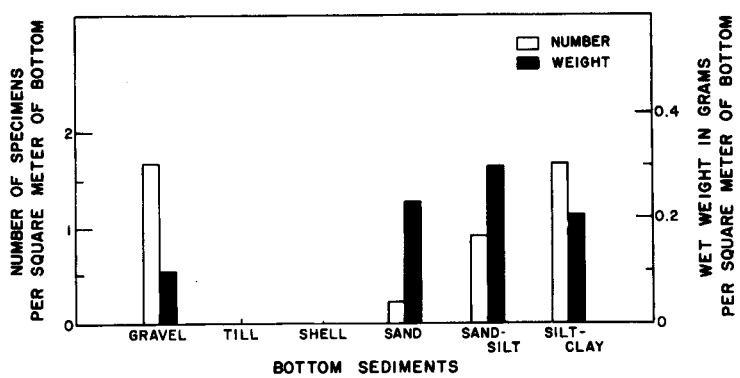


Figure 42
Density and biomass of Alcyonaria in relation to bottom sediments.

(1.2 to 2.1 g/m^2). Relatively high quantities (8 to 18 g/m^2) occurred in outer shelf and upper slope depths (Table 13; Fig. 47). The proportion of the total benthos contributed by Zoantharia was low at all depths except between 100 and 500 m where members of this group made up 13 to 19% of the total biomass (Table 14).

Frequency of occurrence of Zoantharia in samples was moderate (16 to 33%) at depths down to 500 m. At depths greater than 500 m they occurred in only 8 to 18% of the samples (Table 15).

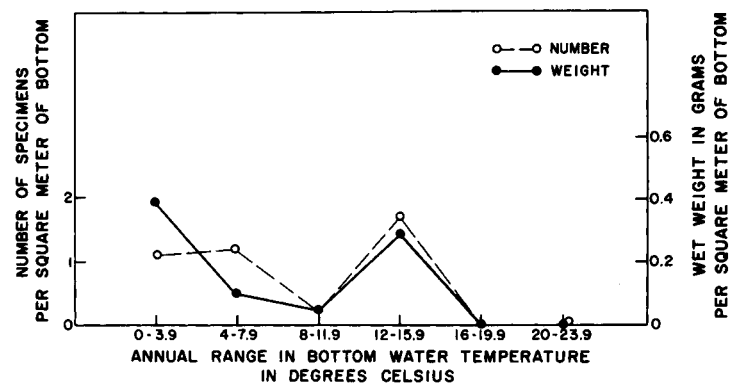


Figure 43
Density and biomass of Alcyonaria in relation to the annual range of bottom water temperature.

Relation to Sediments

Zoantharians were present in all types of bottom sediments sampled (Fig. 48). Highest density (43/m^2) occurred in sand sediments, moderate densities (9 to 14/m^2) in gravel and sand-silt, and low densities (2 to 3/m^2) in all other types (Tables 16, 17).

In terms of biomass the relationship was somewhat different. The largest quantities occurred in sand-silt, which was due mainly to the presence of large burrowing anemones. Rather large quantities, mostly actinarians, were present in gravel. Relatively small biomasses occurred in all other types of bottom sediments (Tables 18, 19).

The frequency of occurrence of this diverse group of animals was moderate and rather uniform in all types of bottom sediments. The percentage of samples containing Zoantharia in each of the different bottom types ranged from 17 to 35 (Table 20).

Relation to Water Temperature

The average density of zoantharians in relation to the annual range of bottom water temperature occurring in different regions of the study area varied from 2 to 98/m^2 (Tables 21, 22; Fig. 49). Density was highest (98/m^2) in areas with a moderate (12°–15.9°C) temperature range, and densities decreased to about 2 to 4/m^2 where the temperature range was both narrow (<4°C) and broad (>20°C).

The relation between zoantharian biomass and temperature range differed from that of density. Generally biomass was high (4 to 8 g/m^2) where the temperature range was narrow or moderately narrow (<12°C), and the general trend was a decrease in biomass associated with a broadening of the temperature range (Table 23). This correlation is revealed more clearly by the percentage of the total benthic fauna that is made up by zoantharians (Table 24). Where the temperature range was less than 4°C, zoantharians contributed 18% of the total benthos. Their contribution decreased as the temperature range broadened, forming only 0.2% of the benthos where the range was >20°C.

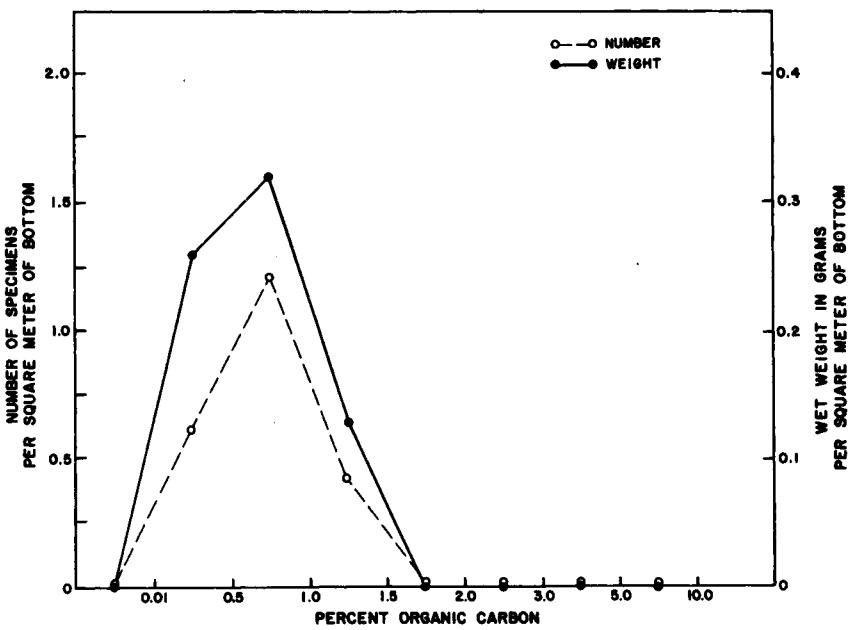


Figure 44
Density and biomass of Alcyonaria in relation to sediment organic carbon.

Frequency of occurrence was moderate under all temperature range conditions. Occurrence rates varied from 14 to 30% (Table 25). They were higher where the temperature range was moderate, and lower in the extreme (lowest and highest) range conditions.

Relation to Sediment Organic Carbon
Zoantharians occurred where sediment organic carbon content was from 0.01 to 3%; they were absent where carbon content was 0 or above 3% (Fig. 50). Density values showed a negative trend of decreasing quantity with increasing carbon content (Tables 26, 27; Fig. 50) with mean number of individuals ranging from 3 to 7/m^2.

Biomass values exhibited a somewhat similar trend with the exception that highest biomass was not in the lowest carbon content class in which they occurred (0.01–0.49%). Moderately high biomass occurred in the two classes between 0.5 and 1.5% with significantly lower levels above and below these values.

Frequency of occurrence of samples in the carbon content classes was fairly uniform, ranging from 15 to 29%, with no discernible trend as evidenced by density and biomass measures (Table 30).

Platyhelminthes

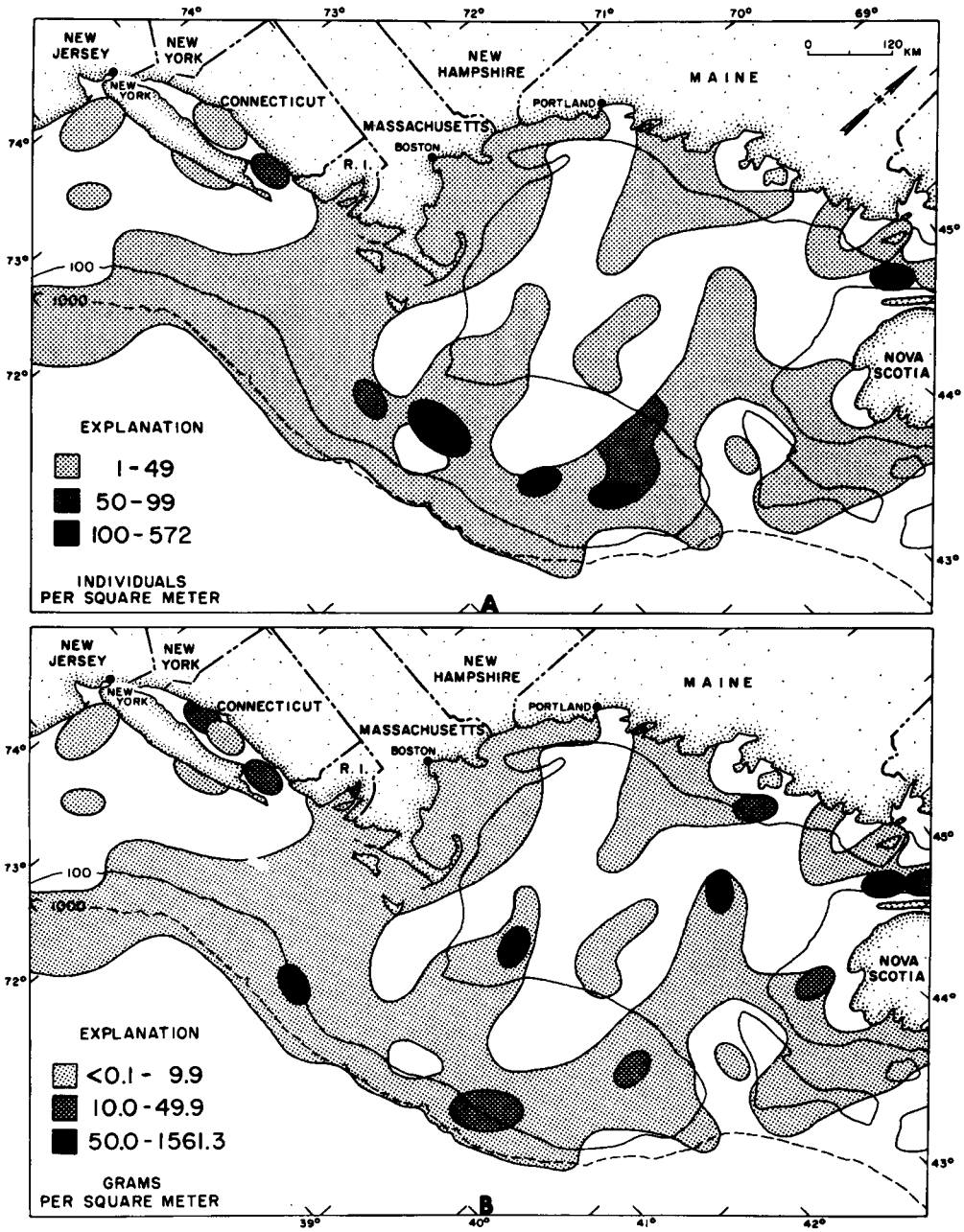
Turbellaria—Tubellarians are free-living members of the phylum Platyhelminthes. They accounted for a very small portion of the total New England benthic macrofauna. In terms of biomass and numbers of individuals they accounted for <0.1% of the total fauna (Table 3). They are small in size and those large enough to be retained on a 1-mm mesh sieving screen were present in very low density. The vast majority of marine tubellarians reported from New England marine waters are less than a few millimeters in length. Specimens in our samples ranged in size from 2 mm to nearly 2 cm in length.

Members of this class of flatworms are free-living, soft-bodied forms and their shape varies from species to species, commonly ovoid and dorsoventrally flattened.

Turbellaria occurred in 16 samples (2% of total). Their density averaged 0.4/m^2, and their biomass averaged 0.01 g/m^2 (Table 5).

Geographic Distribution
The few Turbellaria that were present in our samples were relatively more common in the Southern New England Shelf area than in any other section (Fig. 51). Average densities as high as 59 individuals/m^2 were detected in the vicinity of Nantucket Shoals. Elsewhere densities averaged 9/m^2 or less. Members of this group were absent from large portions of the Nova Scotia Shelf, Gulf of Maine, Georges Bank, and the entire Southern New England Slope area. Average biomasses in all localities were 0.3 g/m^2 or less.

The density of turbellarians in each geographic area (Tables 6, 7; Fig. 52) averaged less than 1/m^2. The



ZOANTHARIA

Figure 45
Geographic distribution of Zoantharia: A—number of specimens per square meter of bottom; B—biomass in grams per square meter of bottom.

southern New England Shelf area contained the highest density (0.9/m^2); Georges Slope ranked second with 0.4/m^2; and all other areas had 0.2 individual or less per square meter.

The average biomass of this group of animals in each of the six geographic areas was nearly the same (Tables 8, 9; Fig. 52). The biomasses averaged 0.01 g/m^2 or less.

Frequency of occurrence also yielded a low index of abundance. Percentage of samples containing turbellarians ranged from 0 to 3% (Table 10).

Bathymetric Distribution

Turbellarians were most plentiful (2.6 specimens/m^2) in shallow water, uncommon at depths from 25 to 500

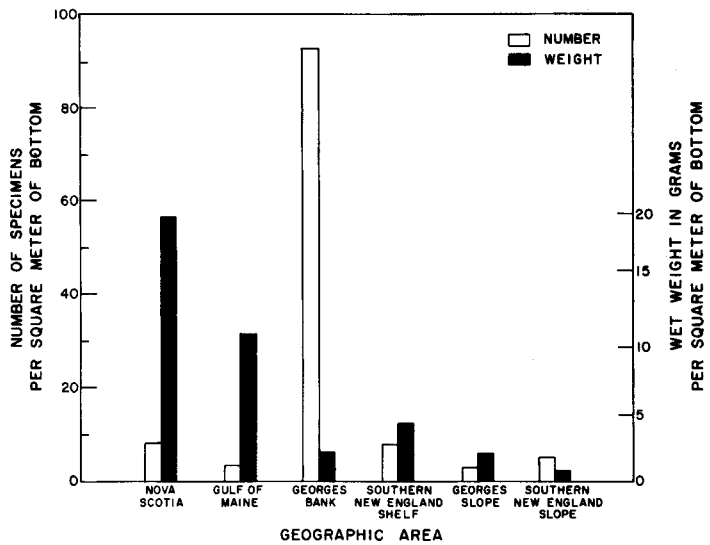


Figure 46
Density and biomass of Zoantharia in each of the six geographic areas.

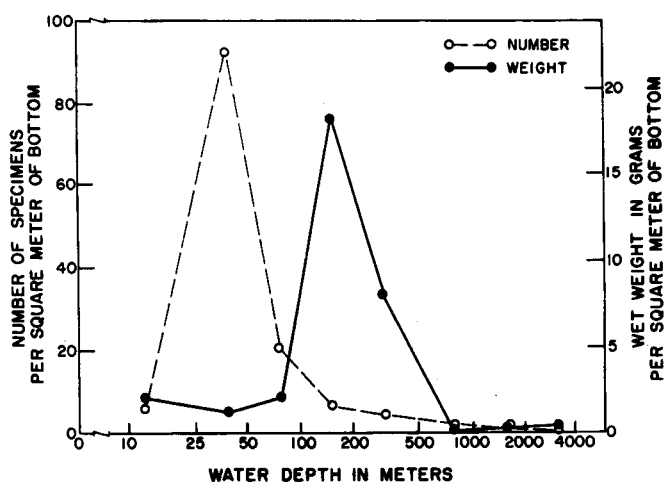


Figure 47
Density and biomass of Zoantharia in relation to water depth.

meters, and not found in depths greater than 500 meters (Tables 11, 12; Fig. 53).

Average biomass revealed a similar trend (Tables 13, 14; Fig. 53): 0.02 g/m^2 in the shallow zone and 0.01 g/m^2 or less in deeper water.

In the depth zones where they were present their incidence ranged from 1 to 4% (Table 15).

Relation to Sediments

Turbellarians were present in only three of the six major sediment types occurring in the study area. They were most common in gravel, where they averaged 1.7 individuals/m^2. In sand and silt-clay their average density was 0.2 and 0.1/m^2 (Tables 16, 17; Fig. 54).

In terms of biomass they were equally sparse (averaging 0.01 g/m^2) in all three sediment types (Tables 18, 19; Fig. 54).

Turbellarians were found in only 1 to 2% of the samples from the three sediment types in which they occurred (Table 20).

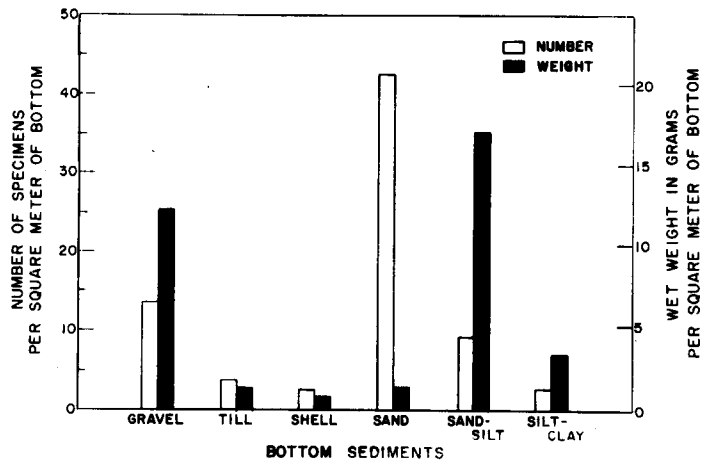


Figure 48
Density and biomass of Zoantharia in relation to bottom sediments.

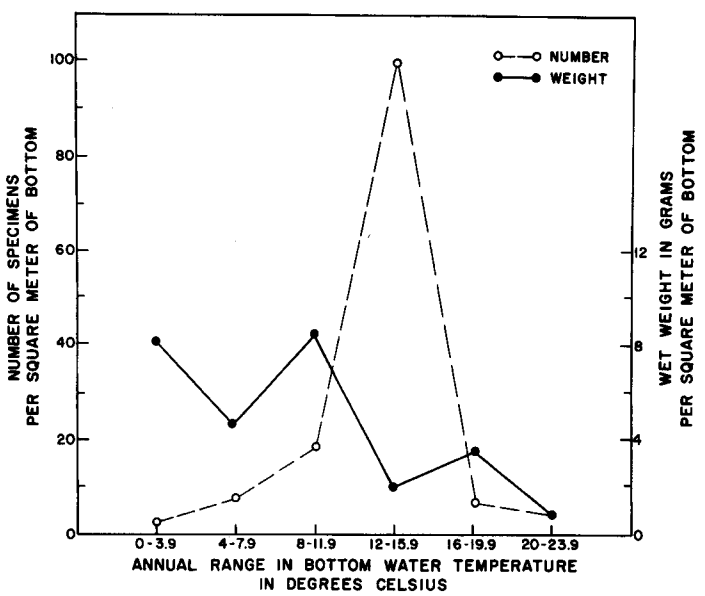


Figure 49
Density and biomass of Zoantharia in relation to the annual range of bottom water temperature.

Relation to Water Temperature
Turbellarians occurred in all temperature range classes except one (Tables 21–25; Fig. 55). They were absent from samples representing areas where the temperature change was less than 4°C. Their density, biomass, and frequency of occurrence in all temperature range classes in which they occurred were quantitatively low and roughly equal from class to class.

Relation to Ssediment Organic Carbon
Turbellarians occurred in three organic carbon content classes, two in the low range and one in the moderately high range (Fig. 56). Densities ranged from 0.1 to 0.9 individual/m^2 (Tables 26, 27), and biomasses ranged from <0.01 to 0.19 g/m^2 (Tables 28, 29). Frequency of occurrence in samples ranged from 1 to 8% (Table 30). In all measures of abundance highest values occurred

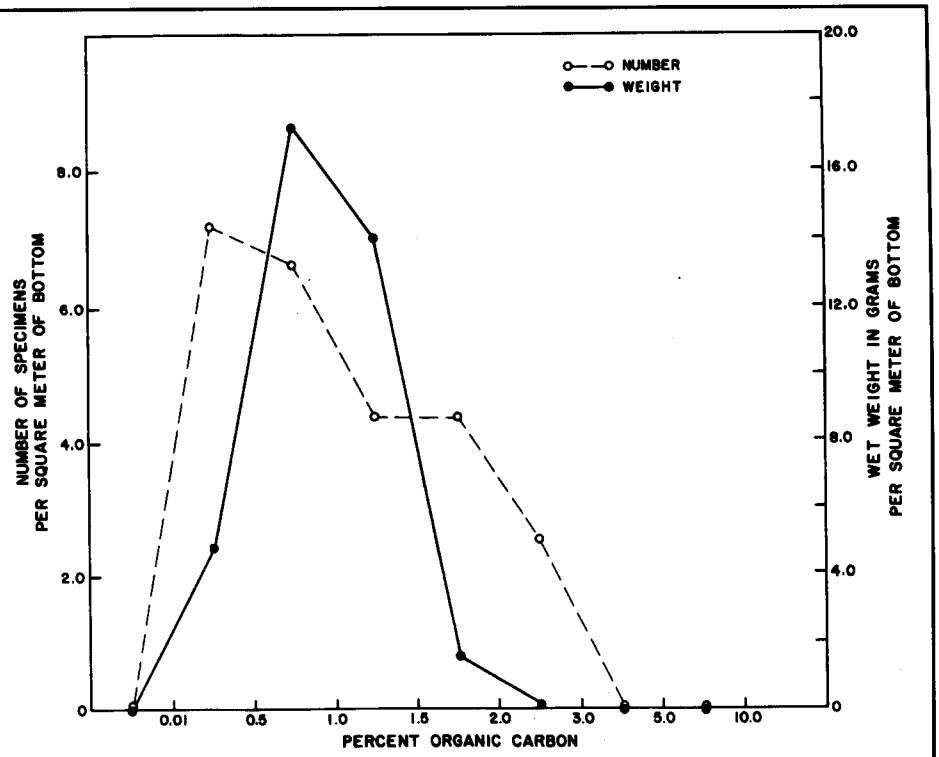


Figure 50
Density and biomass of Zoantharia in relation to sediment organic carbon.

in the moderately high (between the 2 and 3%) content class.

Nemertea

Nemertines, although widely distributed throughout the study area, made up a rather small percentage, only 0.5% of density and 0.4% of biomass, of the total benthic fauna due to their low abundance and the small size of the majority of specimens obtained (Table 3). Their greatest numerical density and biomass occurred on the continental shelf and along the upper portions of the continental slope.

Members of this group are carnivores which characteristically burrow freely in the substrate.

Specimens in our samples ranged in size from about 1 to more than 25 cm in length; however, some of the larger ones, although rare, were not whole, representing only part of an obviously larger animal. These soft-bodied, vermiform organisms easily break during the collecting process and frequently fragment when placed in formalin for preservation.

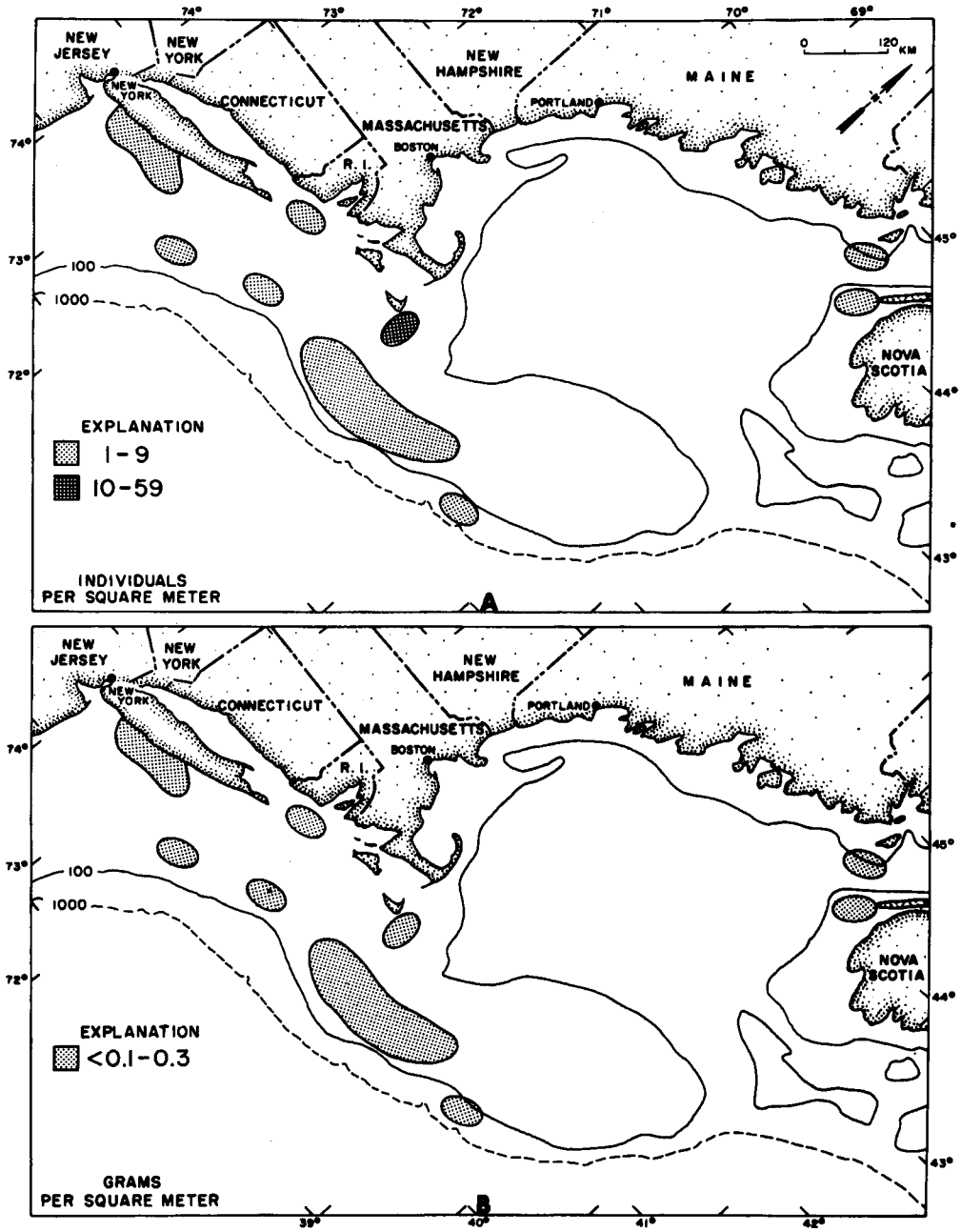
A large proportion of all specimens were uniformly tan or flesh colored. A few individuals had brownish or tan bodies with distinctive bands or stripes of white, yellow, or orange.

Although nemertines were usually represented by one or a few specimens per sample, some samples contained over 100 individuals. They occurred in 405 samples (38% of total). Their density averaged 8.2/m^2, and their biomass averaged 0.71 g/m^2 (Table 5).

Geographic Distribution

Nemertines occurred over nearly the entire study area (Fig. 57). Their numerical abundance was moderately low, averaging between 1 and 9 individuals/m^2 over most of their range. An extensive area of moderate density (10 to 49/m^2) extended along southern Georges Bank, across Great South Channel, and westward to the vicinity of Rhode Island. They were absent in a few deep water sections of the Gulf of Maine and on the continental rise southeast of Long Island, New York. Density (average number of specimens) was greatest (23 individuals/m^2) on Georges Bank (Tables 6, 7; Fig. 58). In all other areas density averaged between 1.2 and 6.8 individuals/m^2.

Over the six standard geographic areas there was a slight increase in biomass of Nemertea in the shelf areas from northeast (about 0.6 g/m^2) to southwest, with the southern New England Shelf having the largest biomass (1 g/m^2). Both slope areas had very small



TURBELLARIA

Figure 51
Geographic distribution of Turbellaria: A—number of specimens per square meter of bottom; B—biomass in grams per square meter of bottom.

quantities, averaging 0.1 and 0.2 g/m^2 (Tables 8, 9; Fig. 58).

Frequency of occurrence of nemertines was moderate in all geographic areas. They were encountered most frequently (52% of the samples) in the Southern New England Shelf. In all other areas they occurred in 25 to 35% of the samples (Table 10).

Bathymetric Distribution

Nemertea were found in water depths ranging from 7 to 3,820 m. Greatest density (27 individuals/m^2) was at depths between 25 and 49 m (Tables 11, 12; Fig. 59). Substantially lower densities (0.5 to 7.8 individuals/m^2) were found at all other depths, with density generally decreasing with increased depth. Lowest densities (0.5

to 1.5/m^2) occurred at depths greater than 500 m.

The relation between average biomass and water depth was very similar to that for numerical density, but the range in values was much more limited. Largest average biomass was 1 g/m^2 in the 25–49 m depth class. At depths greater than 500 m the biomass was very small, averaging 0.12 g/m^2 or less (Tables 13, 14; Fig. 59).

Frequency of occurrence of nemertines in samples from the eight depth classes ranged from 18 to 51% (Table 15). Higher rates of occurrence were most prevalent in the shallow-water classes, and low occurrence was typical of deepwater classes.

Relation to Sediments

Although nemertines were present in all types of sediments, they were common (13 to 28 individuals/m^2) in only two types: shell and sand (Tables 16, 17; Fig. 60). Densities of about 3 to 5 individuals/m^2 occurred in gravel, sand-silt, and silt-clay. Lower density (0.9/m^2) was found in till. Biomass of nemertines in shell bottoms was moderately large in absolute terms (6 g/m^2), but in relative terms it was exceptionally large. In all other sediments types the average biomass was 0.83 g/m^2 or less. An unusually small quantity (0.06 g/m^2) was present in till substrates (Tables 18, 19; Fig. 60).

The percentage of samples within each sediment type in which nemertines occurred was in close agreement with the quantity present. Samples from shell bottoms had the highest incidence of nemertines (50%), till the lowest (14%); their incidence in other sediment types was intermediate (28 to 47%) (Table 20).

Relation to Water Temperature

The average density of nemertines ranged from 2.4 to 25.3 individuals/m^2 throughout the entire temperature range of the study area (Tables 21, 22; Fig. 61). The highest density occurred in areas with an intermediate annual temperature range of 12° to 15.9°C. In areas where the range was either greater or less than this, the densities were substantially lower. Where the range was greater (16° to 23.9°C) density values decreased to 2.9/m^2. Where the range narrowed from 11.9° to 0°C, the values decreased from 9.0 to 2.4/m^2.

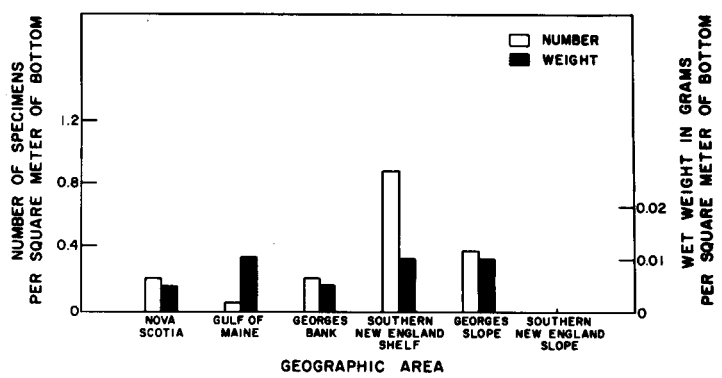


Figure 52
Density and biomass of Turbellaria in each of the six geographic areas.

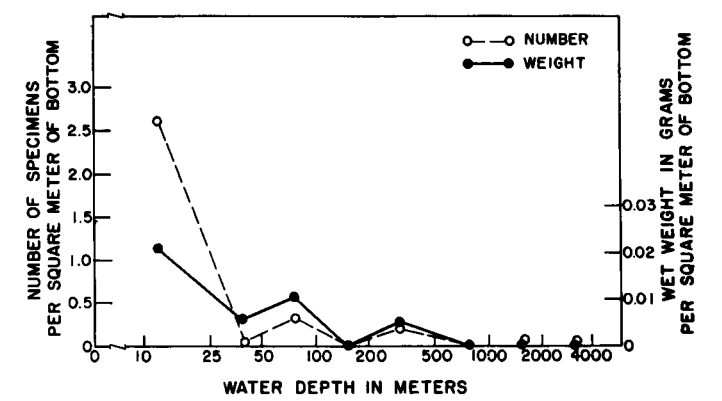


Figure 53
Density and biomass of Turbellaria in relation to water depth.

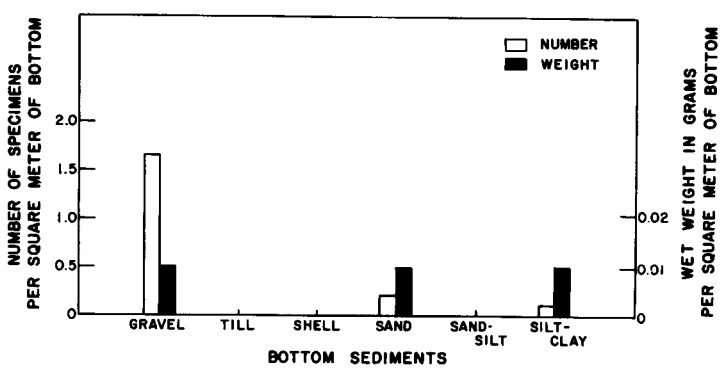


Figure 54
Density and biomass of Turbellaria in relation to bottom sediments.

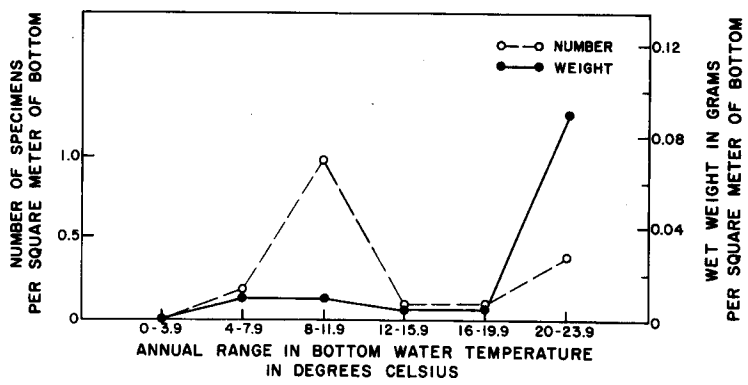


Figure 55
Density and biomass of Turbellaria in relation to the annual range of bottom water temperature.

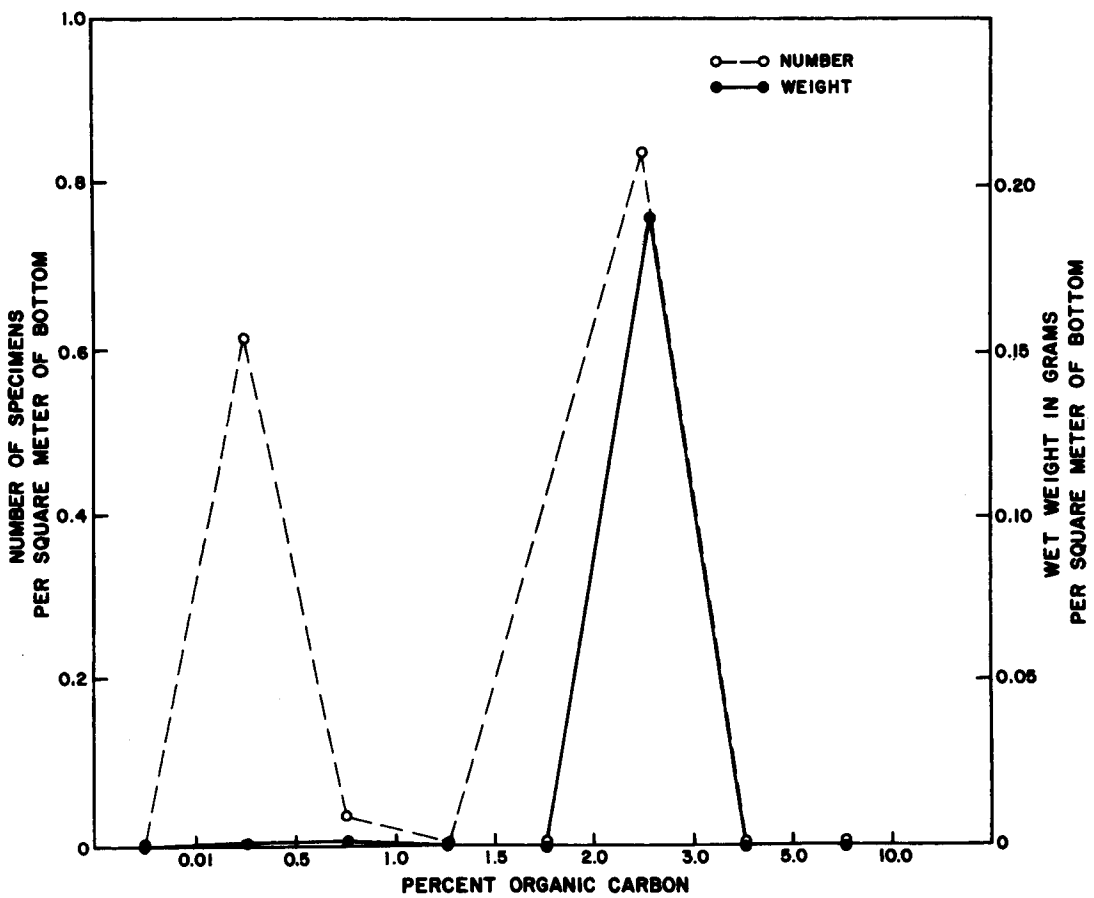
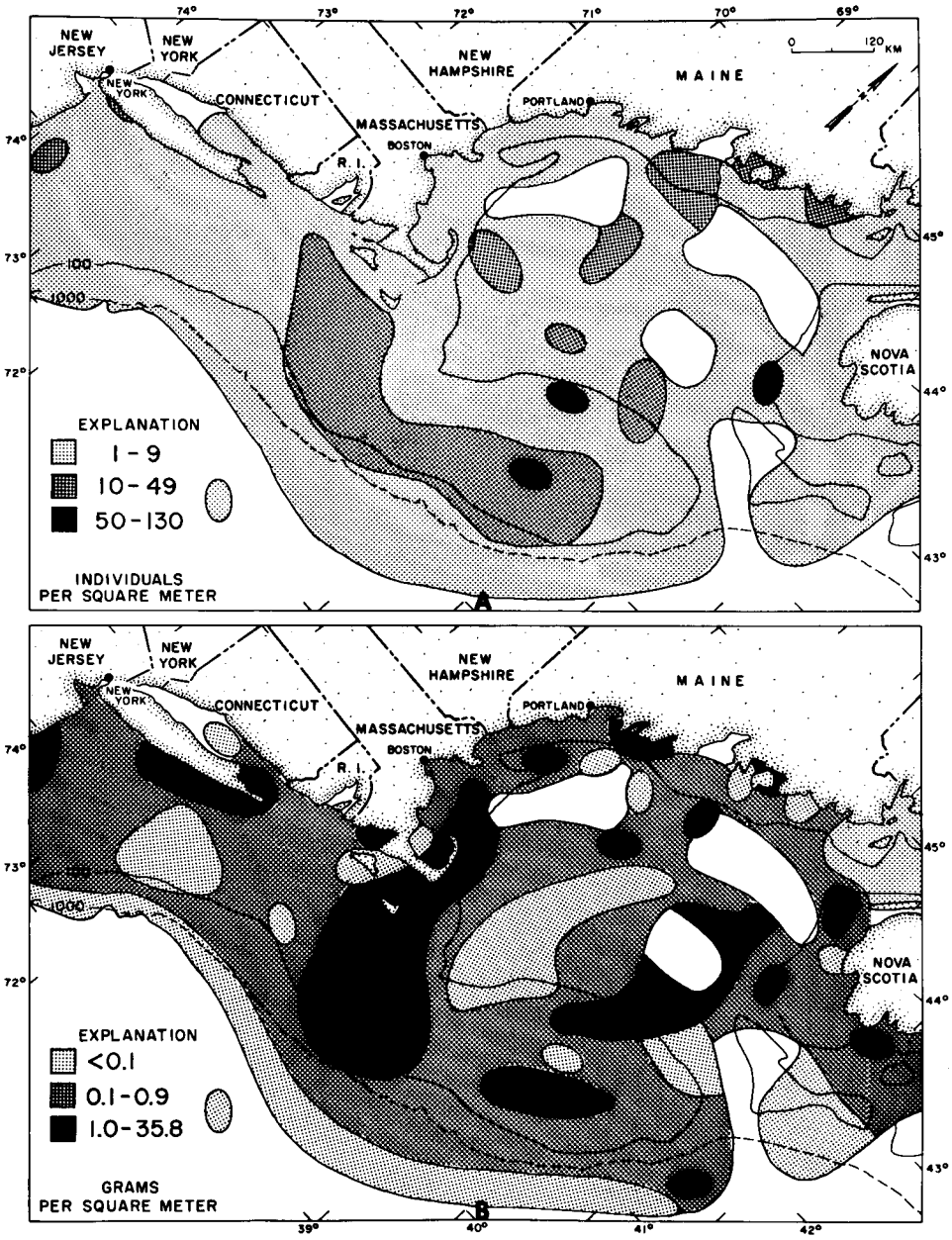


Figure 56
Density and biomass of Turbellaria in relation to sediment organic carbon.



NEMERTEA

Figure 57
Geographic distribution of Nemertea: A—number of specimens per square meter of bottom; B—biomass in grams per square meter of bottom.

The relation of nemertine biomass to temperature range differed from that of density, exhibiting a general increase in biomass (from 0.22 to 1.38 g/m^2) as the temperature range broadened (Tables 23, 24; Fig. 61). Largest average biomass occurred where the range was 16° to 19.9°C, and smallest where it was less than 4°C.

The frequency of occurrence of nemertines in relation to temperature range was similar to their density distribution. The highest percentage (52 to 49%) of samples containing specimens occurred in areas with intermediate temperature ranges. Where the temperature range was narrow or broad, the frequency of occurrence was relatively low (Table 25).

Relation to Sediment Organic Carbon

The average density of nemertines exhibited a rather

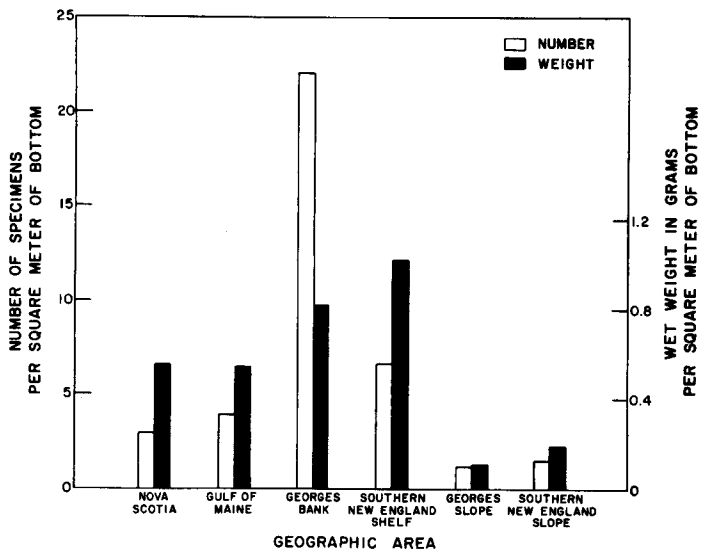


Figure 58
Density and biomass of Nemertea in each of the six geographic areas.

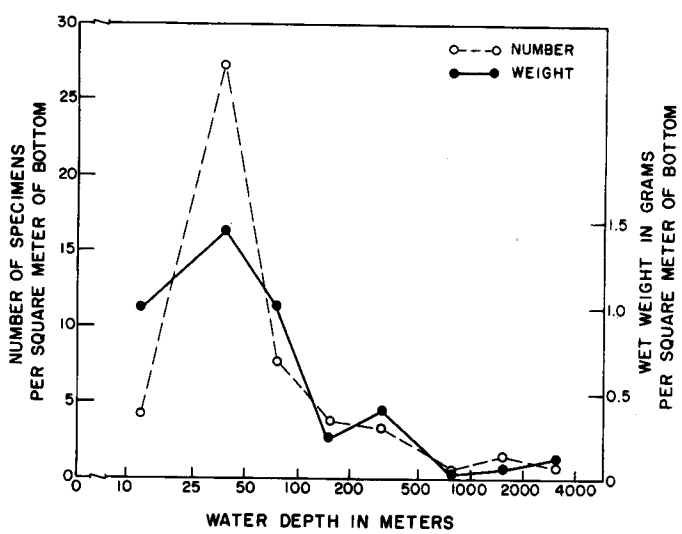


Figure 59
Density and biomass of Nemertea in relation to water depth.

sharp negative correlation to organic carbon content (Tables 26, 27; Fig. 62). Density was highest ($11/m^2$) in areas with extremely little or no organic carbon in the sediment and declined steadily (from 11 to $2/m^2$) as organic carbon content increased. None were found where carbon content exceeded 3%.

The relation of nemertine biomass to organic carbon was distinctly bimodal (Tables 28, 29; Fig. 62). Largest

biomass (0.44 g/m^2) occurred where organic carbon ranged from 1.5 to 2%, declined at higher and moderately lower levels, and showed another somewhat lower peak (0.8 g/m^2) at levels between 0.01 and 1%. Intermediate biomass occurred where carbon was absent.

Frequency of occurrence of nemertines in samples also exhibited a generally negative correlation with organic carbon content (Table 30). In areas with measurable amounts of carbon (between 0.01 and 3%), occurrence diminished from 46 to 15%. In areas with no measurable amounts, occurrence was moderately high (40%).

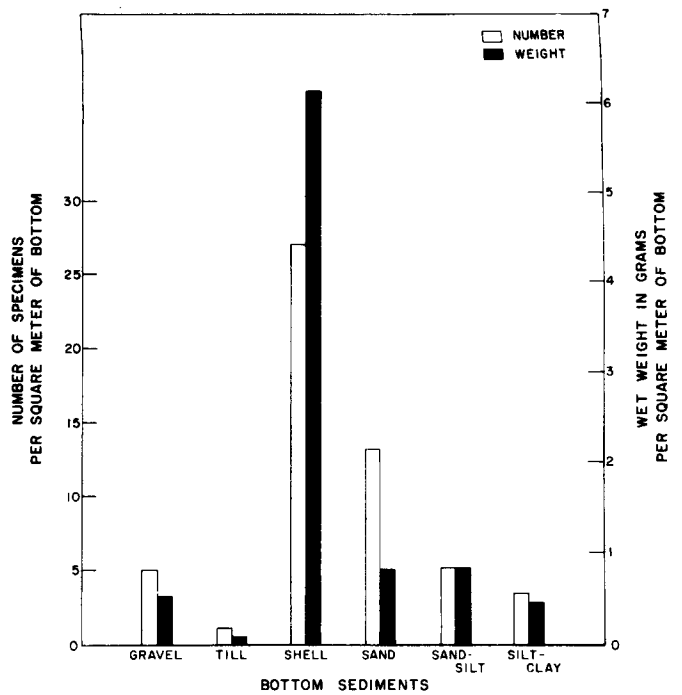


Figure 60
Density and biomass of Nemertea in relation to bottom sediments.

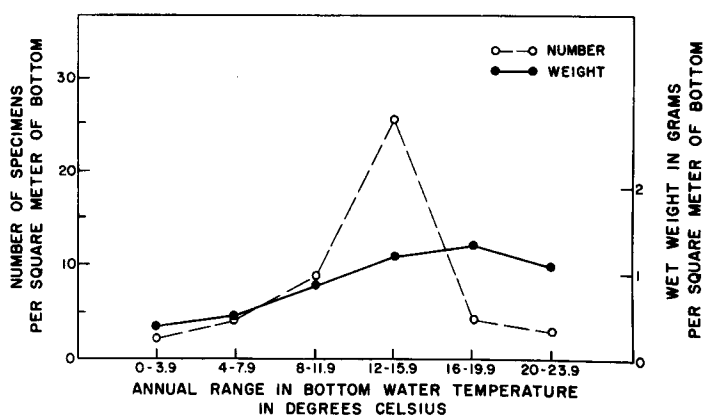


Figure 61
Density and biomass of Nemertea in relation to the annual range of bottom water temperature.

Aschelminthes

Nematoda—Free-living nematodes, members of the phylum Aschelminthes, are one of the most numerous animal groups inhabiting the bottom sediments of the northeastern coast of the United States. Previous studies conducted by Wieser (1960) in shallow coastal habitats off southeastern Massachusetts revealed nematode densities of nearly 800,000 individuals/m^2. Farther offshore, on the southeastern coast of Massachusetts at a depth of 58 m, Wigley and McIntyre (1964) encountered nematodes in densities of nearly 1 million individuals/m^2, and this measure did not include the young stages of numerous species. The vast majority of free-living nematodes are very small, less than 1 or 2 mm in length; consequently only a small portion (the large specimens) of the total population was recovered and treated in the present study. The bulk of the captured specimens were between 0.5 and 2 cm long; however, a small proportion of both larger and smaller specimens was represented. In addition to their great numerical density, this group of animals is also exceedingly profuse in species composition.

Three types of feeding habits are commonly found among free-living nematodes. Some are saprophagous, feeding on detritus and dead and decaying animal material; others are herbivorous, feeding on green plants, particularly diatoms; still others are carnivorous, ingesting rotifers, tardigrades, small annelids, other nematodes, and bryozoans.

Because of the incomplete representation of this group, the quantitative distribution discussed herein refers only to the exceptionally large species.

We found nematodes in 98 samples (9% of total); their density averaged 2.8/m^2, and the biomass averaged 0.01 g/m^2 (Table 5).

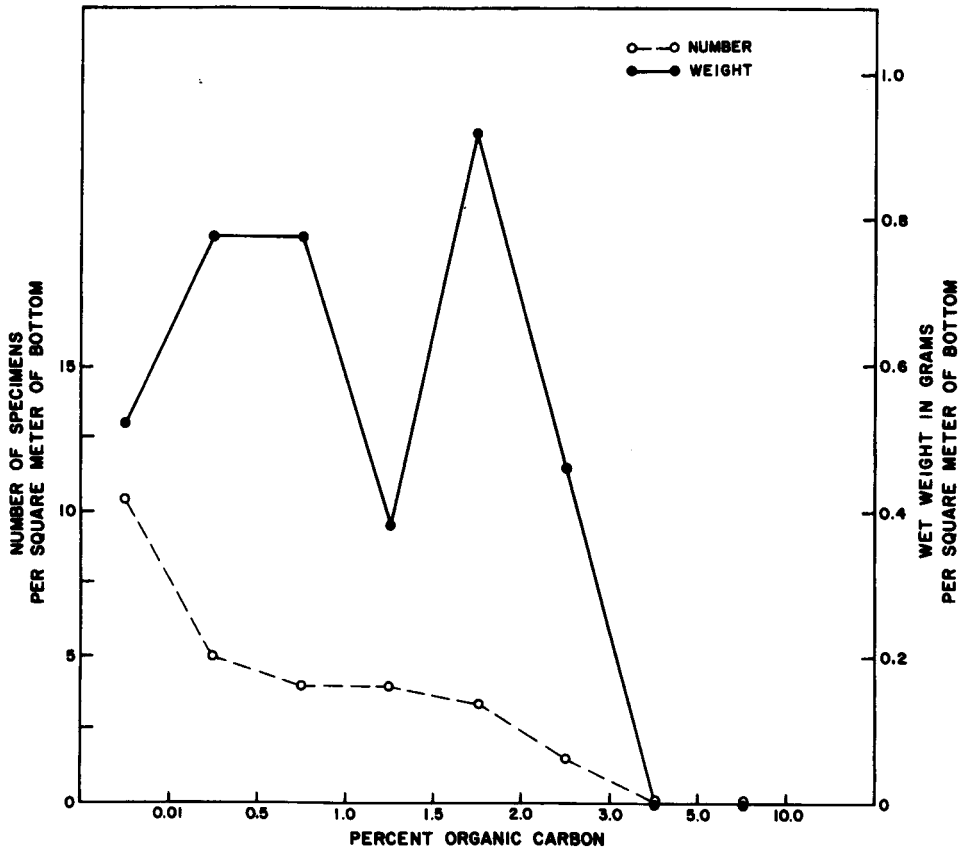


Figure 62
Density and biomass of Nemertea in relation to sediment organic carbon.

Geographic Distribution

The distribution of large free-living nematodes, although occurring in all geographic regions, was patchy (Fig. 63). They were present in coastal areas, on the offshore banks and basins, and on the continental slope and rise. They were commonly absent in samples from a number of areas: parts of the Nova Scotian shelf, large portions of the Gulf of Maine and Georges Bank, as well as many inshore bays and sounds. The pattern of their distribution suggests that they are less common in substrates where the overlying bottom current or wave action is strong, for example, the northern section of Georges Bank and at the mouth of the Bay of Fundy.

The average density of nematodes in each of the six standard geographic areas was roughly similar, ranging from 0.9 to 4.0 individuals/m^2 (Tables 6, 7; Fig. 64). Their average biomass was very low, 0.01 g/m^2 or less (Tables 8, 9; Fig. 64).

The percentage of samples containing nematodes was low (5 to 9%) in the four geographic areas on the continental shelf (Table 10), but their occurrence in the two continental slope areas was comparatively high (15 and 39%).

Bathymetric Distribution

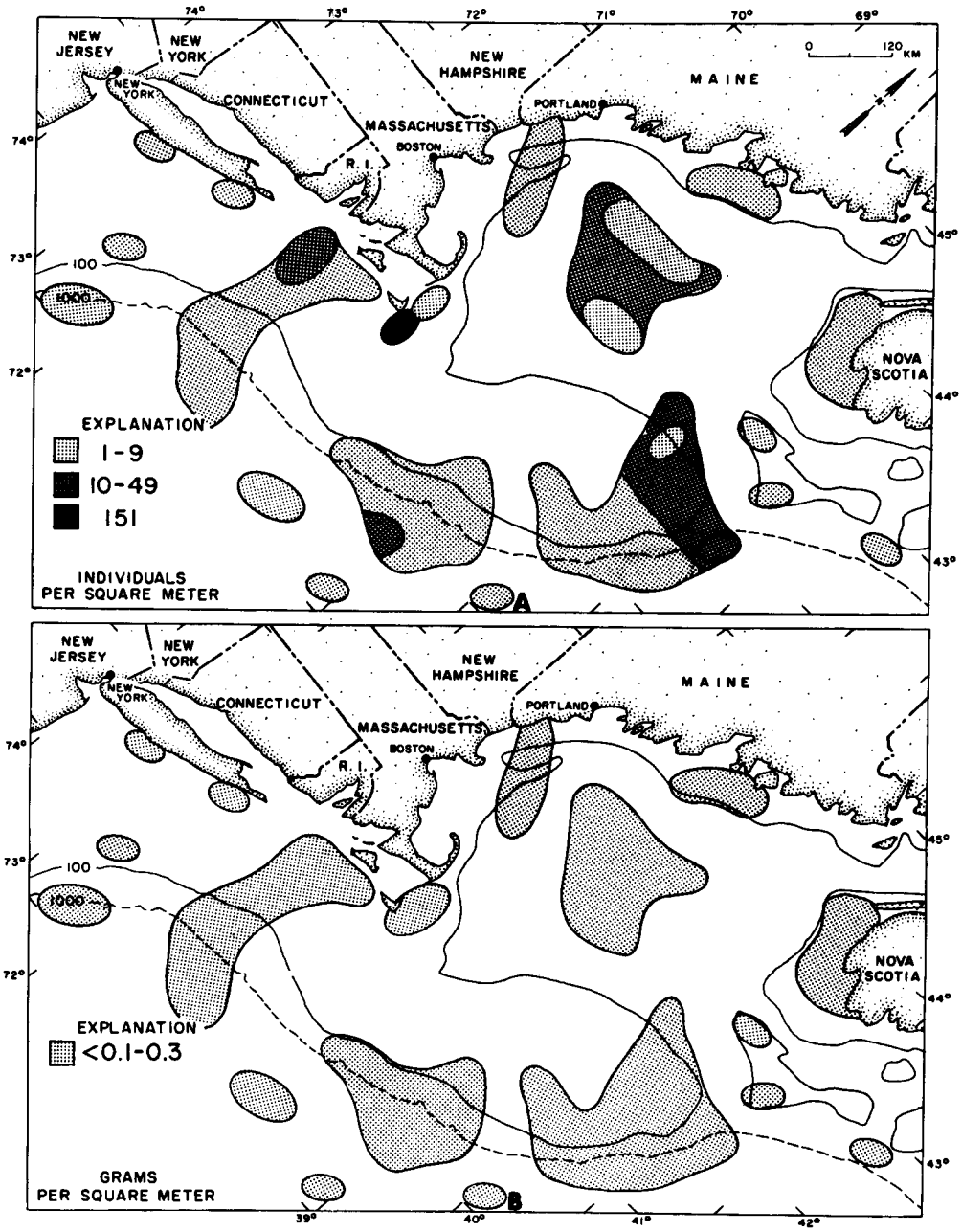
Nematodes were found at depths ranging from 23 to 3,975 m and were present in all depth classes sampled (Tables 11, 12; Fig. 65). Average density was slightly higher in the very shallow (0–24 m) and moderately deep (200–1,000) water than in other zones. Average density values ranged from 0.8 to 6.8 individuals/m^2.

Average biomass values were uniformly low (0.01 g/m^2 or less) at all depths (Tables 13, 14; Fig. 65).

Frequency of occurrence of nematodes in the samples was low (2%) in shallow water and generally increased to moderately high levels (35%) in deep water (Table 15).

Relation to Sediments

Nematodes were present in all bottom types except shell (Tables 16, 17; Fig. 66). Greatest density (8.7 individuals/m^2) occurred in gravel substrates, whereas



NEMATODA

Figure 63
Geographic distribution of Nematoda: A—number of specimens per square meter of bottom; B—biomass in grams per square meter of bottom.

all other bottom types yielded relatively moderate densities (1 to 3 individuals/m^2). Average biomass was small (0.01 g/m^2 or less) in all sediment types (Tables 18, 19; Fig. 66).

The frequency of occurrence of nematodes was moderate (12 to 13%) in gravel, sand-silt, and silt-clay but was low (4 and 5%) in sand and till (Table 20).

Relation to Water Temperature

Nematodes occurred at all temperature ranges except the highest, 20°–23.9°C (Tables 21, 22; Fig. 67). Their numerical density was greatest (2.0 to 4.3 individuals/m^2) in the narrow to intermediate temperature ranges (0°–11.9°C) and declined drastically (0.2 and 0.7/m^2) in the broader ranges.

Biomass was small, averaging only 0.01 g/m^2 or less, in all temperature ranges (Tables 23, 24; Fig. 67).

The frequency of occurrence of nematodes in samples in the various temperature ranges diminished from a high of 17%, where the temperature range was narrow, to zero where the temperature range was 20°C or more (Table 25).

Relation to Sediment Organic Carbon

Nematodes occurred only in the four low to moderate level organic carbon content classes (Tables 26, 27; Fig. 68). They were most abundant (3.1/m^2) in sediments with low organic carbon levels (0.01–0.49%) and least abundant (0.4/m^2) at moderate carbon levels (1.5–1.99%).

Biomass was very low (<0.01 to only 0.02 g/m^2) in all levels of sediment organic carbon in which they were found (Tables 28, 29; Fig. 68).

Frequency of occurrence in samples in the four carbon content classes ranged from 7 to 17% (Table 30).

Annelida

Polychaete worms formed a major component of the benthic fauna in terms of biomass and numbers of individuals. They were present throughout the study area and made up 28% of the total number of individual animals and nearly 10% of the total biomass (Table 3).

Taxonomically diverse as well as abundant, this group of organisms contributed over 300 species from among approximately 170 genera to the New England benthic fauna.

Size differential from the smallest to the largest specimen was moderate compared with that for other taxa. The smallest specimens recovered were 3 to 4 mm in length; the largest were over 200 mm. Although the vast majority of annelids from these collections are elongate and cylindrical in shape (similar to the common earthworm), the species that is largest in terms of weight is *Aphrodita hastata,* the sea mouse. It is ovate in shape, ventrally flattened, convex dorsally, and weighs 75 g or more. The average wet weight of individual annelids in the region is less than 0.05 g. A wide

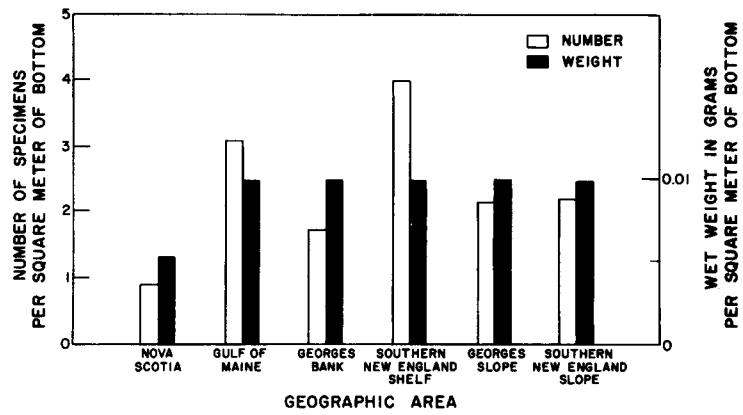


Figure 64
Density and biomass of Nematoda in each of the six geographic areas.

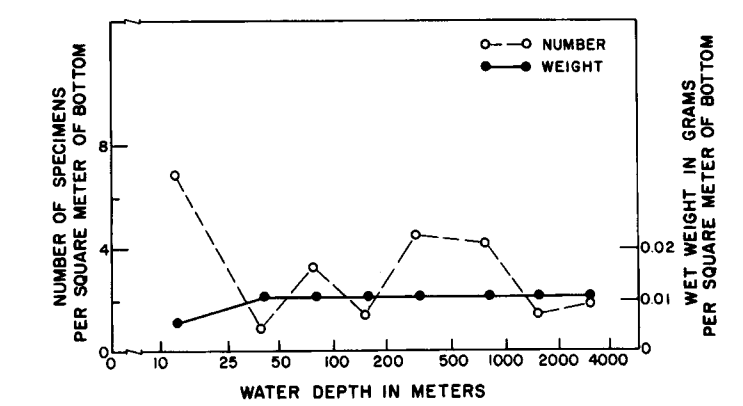


Figure 65
Density and biomass of Nematoda in relation to water depth.

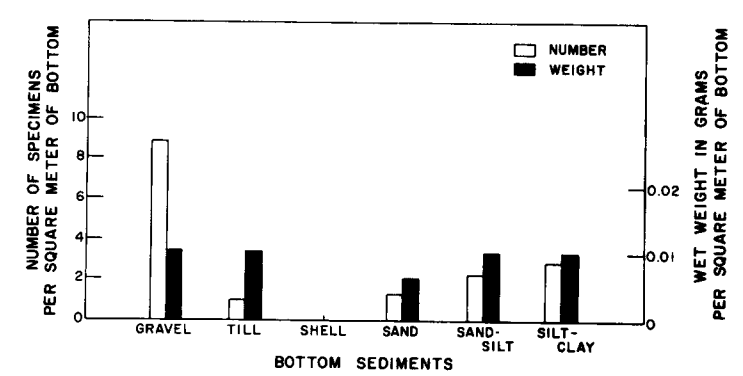


Figure 66
Density and biomass of Nematoda in relation to bottom sediments.

variety of morphologically different forms abound. All the different feeding types—carnivores, suspension feeders, and selective and nonselective deposit feeders—were represented in our samples. Many representatives from the two major life modes, the errant (or free living) and the sedentary (tubicolous) polychaetes were collected.

Coloration of polychaete annelids is extremely diverse, from nearly translucent and white to a dark brown. Predominant hues are light beige, tan, dark brown, and various shades of olive and red. Some annelids displayed a cuticular irridescence that greatly enhanced their appearance. Some forms possessed variegated pat-

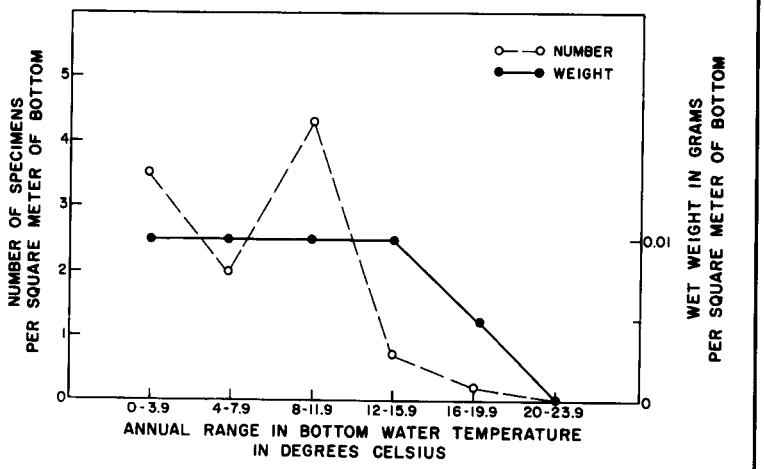


Figure 67
Density and biomass of Nematoda in relation to the annual range of bottom water temperature.

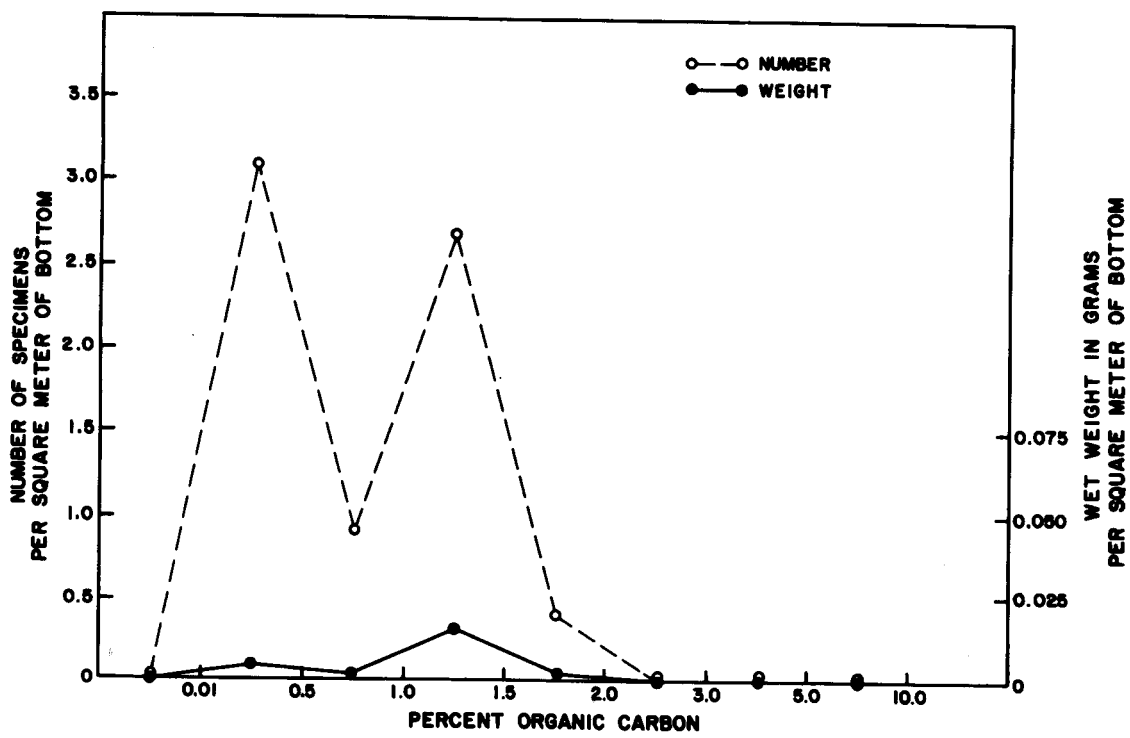
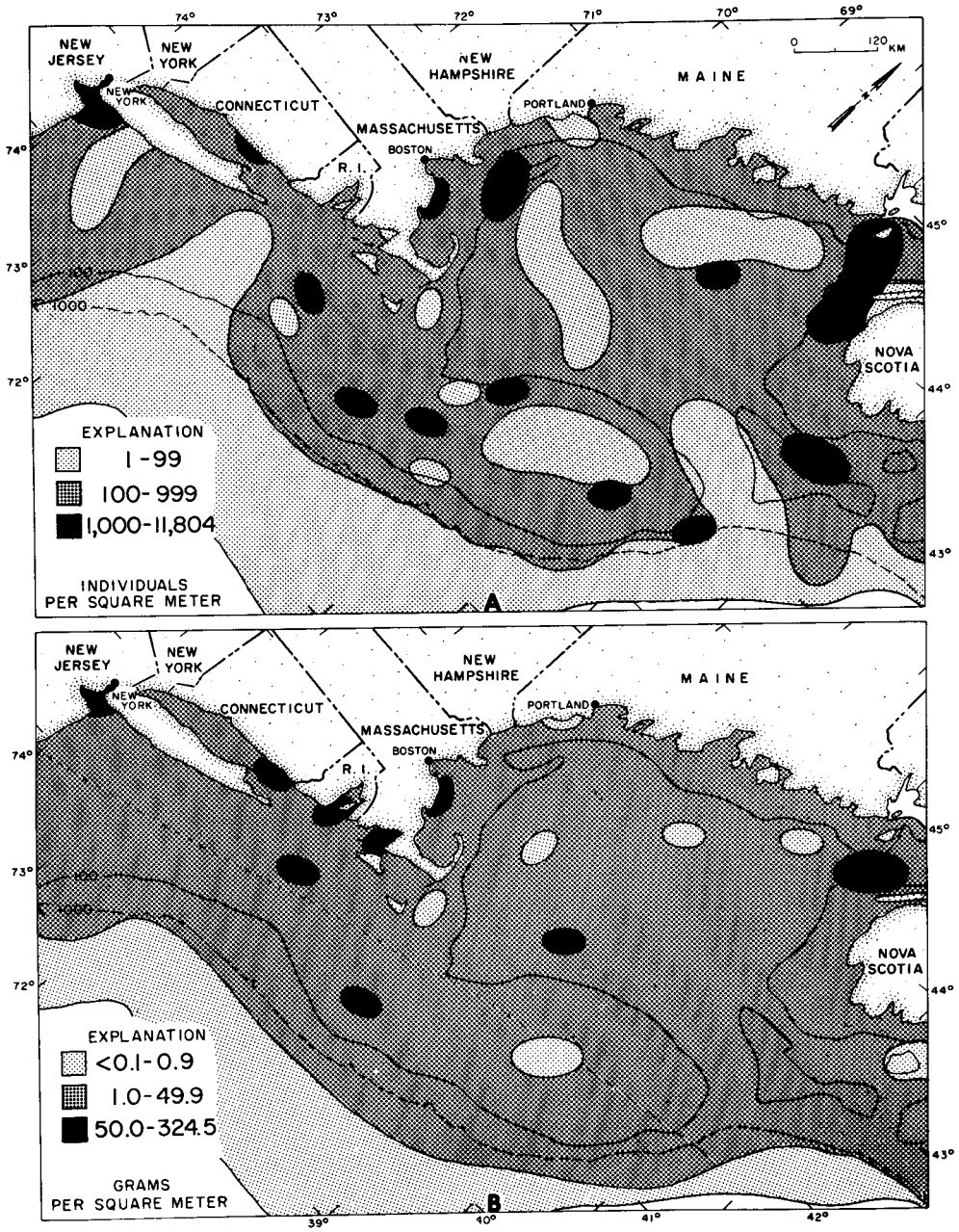


Figure 68
Density and biomass of Nematoda in relation to sediment organic carbon.



ANNELIDA

Figure 69

Geographic distribution of Annelida: A—number of specimens per square meter of bottom; B—biomass in grams per square meter of bottom.

terns of color on various parts of the body, including scarlet branching gills. Tubicolous forms, especially, exhibited a wide range of color patterns on their tentacles and branchiae.

A few species are commensal on sponges and echinoderms, but more often they themselves are the hosts to commensal partners, for example the *Chaetopterus–Pinnixa* (Decapoda) relationship and the *Clymenella–Listriella* (Amphipoda) relationship.

Annelids occurred in 1,034 samples (96% of total), their density averaged 425/m^2,and their biomass averaged 17.4 g/m^2 (Table 5).

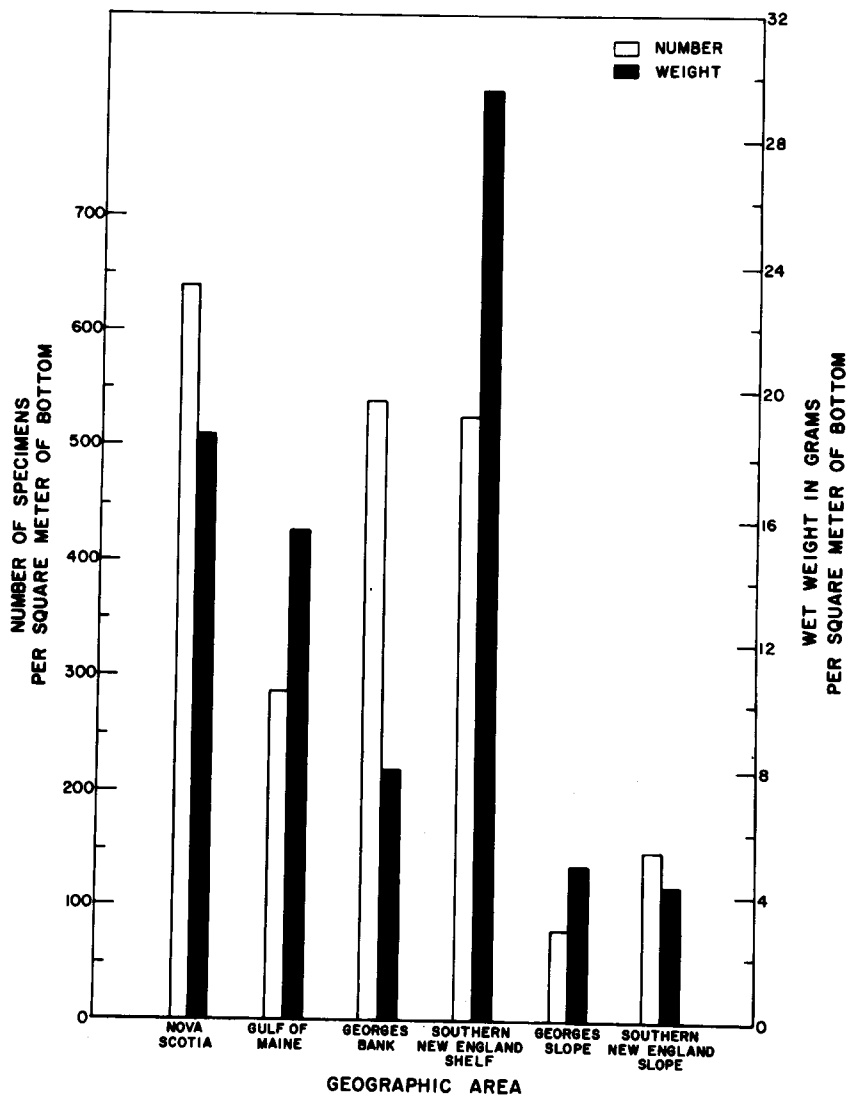


Figure 70
Density and biomass of Annelida in each of the six geographic areas.

Geographic Distribution

Annelid worms were found in all parts of the study area (Fig. 69). Only the Mollusca, Crustacea, and Echinodermata compare with their widespread distribution, and only the Crustacea are more numerous.

The density of annelids on the continental shelf and slope generally averaged between 100 and 1,000 individuals/m^2. Over approximately 10% of the shelf and slope area, the density of annelids was high, 1,000 to 12,000/m^2. About 30% of the shelf and slope area yielded less than 100/m^2. In deepwater regions beyond the continental slope, the density was relatively low, usually less than 100/m^2.

The biomass of annelid worms on the continental shelf and slope, with few exceptions, averaged between 1 and 50 g/m^2 and reached a maximum of 325 gm^2. Among the six standard geographic areas, two slope areas (Georges Slope and Southern New England Slope) had the lowest numerical density and smallest biomass of annelids, 80 to 149 individuals/m^2 and about 4 to 5 g/m^2 (Tables 6–9; Fig. 70).

In the four continental shelf areas the numerical density of annelid worms was high. Average densities ranged from 291 to 648 individuals/m^2 and greatest density was in the Nova Scotia area. Biomass in these areas, also, was moderately high; average values ranged from 8 to 30 g/

m^2. Largest average biomass occurred in the Southern New England Shelf area (Tables 6, 8).

The percentage of the total fauna made up by annelids was high in both biomass and number of individuals (Tables 7, 10). On a numerical basis, annelids accounted for 22 to 56% of the total fauna. In terms of biomass, annelids formed between 3 and 23% of the total fauna. In the two deepwater zones, Georges Slope and Southern New England Slope, the percentage of the total biomass made up by annelids was 22 and 23%, respectively. This is an especially large proportion to be formed by any one faunal group and a much higher proportion than that from the continental shelf areas where the percentages were only 3 to 12.

Annelid worms were present in an exceptionally large proportion of the samples. In all standard geographic areas, except Georges Bank, they were present in 96 to 99% of the samples. On Georges Bank they were present in 89% of the samples (Table 10).

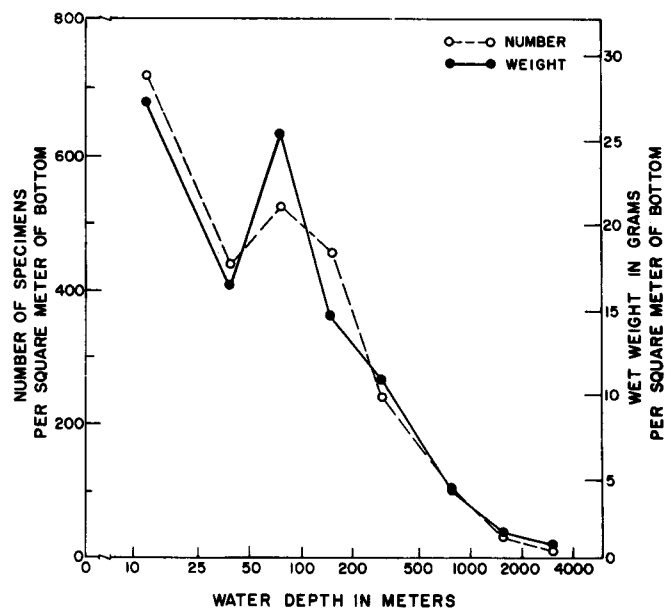


Figure 71
Density and biomass of Annelida in relation to water depth.

Bathymetric Distribution

Annelids occurred over the entire depth range in which samples were collected, 3 to 3,975 m. Numerical density and biomass were highest in shallow water and decreased in quantity rather uniformly with increased water depth (Fig. 71). Average density in the shallowest depth class was 719 individuals/m^2. High densities (437 to 159/m^2) prevailed across the continental shelf and then diminished rather sharply down the slope and on the continental rise, where the average density was only 9/m^2 (Tables 11, 12).

The biomass of annelids followed precisely the same quantitative trend in relation to water depth as was exhibited by numerical density. Average biomass was largest (27 g/m^2) in the shallowest depth zone. Biomass was rather high (15 to 25 g/m^2) on the continental shelf and dropped to 5 g/m^2 at midslope and to 0.76 g/m^2 on the continental rise (Tables 13, 14).

Annelids were present in a very high percentage of the samples from all depth classes. Frequency of occurrence among the eight classes ranged from 93 to 100% (Table 15).

Relation to Sediments

Annelid worms were not only present in all sediment types sampled but occurred in roughly the same density in each of the different sediment types (Tables 16, 17; Fig. 72). Average density from all sediment types ranged from 232 to 558 individuals/m^2. Greatest densities were found in sand and gravel bottoms, lowest densities in silt-clay and till.

Biomass, also, was rather evenly distributed among the various sediment types. Values ranged from 11 to 26 g/m^2. Highest average biomass occurred in sand-silt sediments, and the lowest occurred in till. Intermediate and nearly equal quantities, 15 to 16 g/m^2, were present in the other four bottom types (gravel, shell, sand, and silt-clay) (Tables 18, 19; Fig. 72).

Annelid worms were present in all samples from till, shell, and sand-silt sediments; however in 97% of samples in gravel and silt-clay. Although annelids were present in 94% of the samples from sand sediments, this category of bottom type ranked last in this relationship (Table 20).

Relation to Water Temperature

Annelids were present in greatest quantities (Table 21; Fig. 73) where the annual range in bottom water temperature was broadest, and densities generally declined as the temperature range decreased. Where the temperature range was greater than 20°C, average density of annelids was 1,698 individuals/m^2. At the other extreme, where the temperature range was less than 4°C, average density was 212/m^2. At intermediate levels of temperature range, density was intermediate, 280 to 568 individuals/m^2. The percentage composition of numbers in this group of organisms in relation to the total fauna in the various temperature-range classes varied from 16 to 49% (Table 22). Percentages were highest where temperature ranges were extremely high and low.

Biomass of annelids in relation to range of water temperature was similar to that for density. Biomass was large (about 40 g/m^2), not only in relative terms but in absolute quantities, in areas where the temperature range was broad

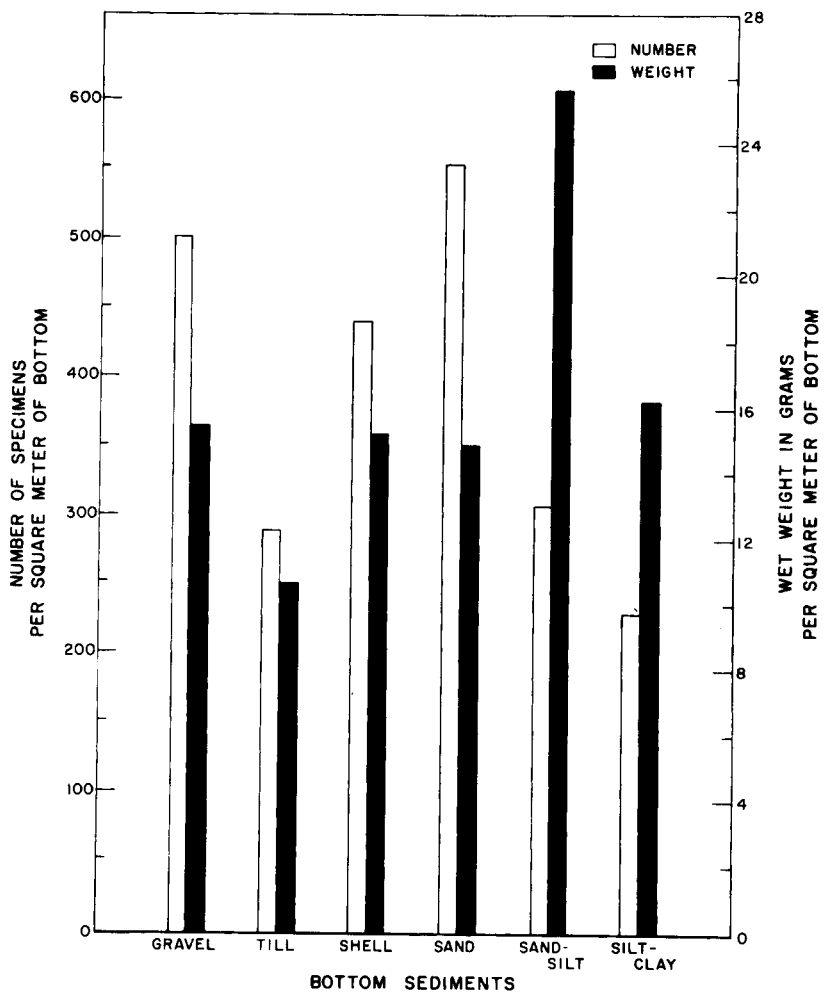


Figure 72
Density and biomass of Annelida in relation to bottom sediments.

(Tables 23, 24; Fig. 73). Conversely, quantities were smaller (about 10 g/m^2) where the temperature range was small. Moderate biomasses were encountered in areas where the temperature range was moderate.

The frequency of occurrence of annelids among the temperature-range classes was high and fairly uniform. They occurred in 92 to 97% of the samples (Table 25).

Relation to Sediment Organic Carbon

Annelids of the New England region exhibited an essentially bimodal relationship to the amount of organic carbon in the sediments (Fig. 74). Greatest density (504/m^2) occurred at low organic carbon levels (between 0.01 and 0.49%); another peak in density (407/m^2) occurred at higher levels (between 2 and 3%); moderate densities prevailed at levels between these two peaks, with smallest densities occurring in both lowest and highest levels (0.00 and 5.00+%) of sediment organic carbon (Tables 26, 27).

Annelid biomass was greatest (27 g/m^2) at organic carbon levels between 1.5 and 2% (Tables 28, 29; Fig. 74) and gradually diminished at levels both above and below these values. As with density, lowest biomass was found in both the lowest (0.00%) and highest (5.00+%) organic carbon levels.

Frequency of occurrence of annelids in the various organic carbon content classes was uniformly high, ranging from 80 to 100% in all classes except one, the 3–5% class, in which only 50% of the samples contained members of this group (Table 30).

Pogonophora

Pogonophora (beard worms) are a minor consituent of the New England benthos. They provided less than 0.1% of the total number of specimens and biomass of organisms in the study area (Table 3). Nevertheless, they contributed some unique records to the study. Chief among them was a proclivity for deep, cold water. These unusual animals were one of only a few taxonomic groups that were more abundant in deep water than in shallow water.

Pogonophores inhabit chitinous tubes buried in the bottom sediments. The tubes in our collections ranged in length from about 5 to 15 cm and had diameters from 0.1 to 0.4 mm. The colors of the tubes varied from very light tan to dark brown, but were most frequently of a greenish-yellow to brownish-green hue. The majority of them exhibited alternating light and dark rings or bands. Embryos were not uncommon in the tubes from our samples. Preserved specimens varied in color from whitish to brown; the most common colors observed were cream to light reddish tan.

The two existing orders of pogonophores, the Athecanephria and Thecanephria, are represented in our collections by species from the genera *Siboglinum*, in the former, and *Diplobranchia* and *Crassibrachia*, in the latter. Six species were obtained; the most common were *Siboglinum ekmani* Jagersten, *S. pholidotum* Southward and Brattegard, and *Diplobrachia similis* Southward and Brattegard. Less common were *Siboglinum holmei* Southward, *S. angustum* Southward and Brattegard, and *Crassibrachia sandersi* Southward. *Siboglinum holmei* was distinctive for its occurrence in the Gulf of Maine and was the only species of this phylum found in the Gulf. Furthermore, it was taken in close proximity to land, at the point nearest land, at station 1171, less than 5 km from Grand Manan Island and 10 km from the mainland coast of the U.S. Water depth at this location is 141 m.

Pogonophora occurred in 56 samples (5% of total); their density averaged 0.6/m^2 and their biomass averaged less than 0.01 g/m^2 (Table 5).

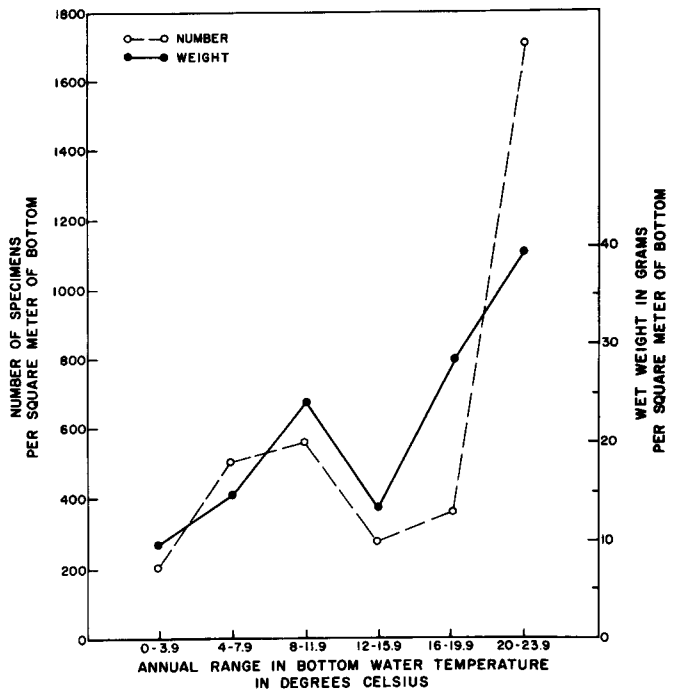


Figure 73
Density and biomass of Annelida in relation to the annual range of bottom water temperature.

Geographic Distribution

Pogonophores were widely distributed along the continental slope and continental rise from New Jersey northward to Nova Scotia but rarely occurred on the continental shelf (Fig. 75). In coastal waters they were encountered in only the most northerly part of the study area, near Grand Manan Island (New Brunswick), Canada, and Eastport, Maine. Their average density throughout the study area was low or moderately low, between 1 and 51/m^2. Because of their small size and low density the average biomass of pogonophores was very small, less than 0.2 g/m^2 in all localities sampled.

Among the six standard geographic areas, pogonophores were present in significant quantities only in the Georges Slope and Southern New England Slope areas (Tables 6–9; Fig. 76) where density in those two areas averaged 3 and 5/m^2, respectively, and biomass 0.01 and 0.03 g/m^2, respectively.

In view of the relatively recent date (Ivanov, 1963) this phylum was first reported from the New England Region, the frequency of occurrence in this series of samples should be considered unexpectedly high. Pogonophores occurred in 35% of the samples from Georges Slope and in 42% of the Southern New England Slope samples (Table 10). In two other geographic areas they were present in 2% or less of the samples. They were absent in the Georges Bank and Southern New England Shelf areas.

Bathymetric Distribution

Pogonophores were found at depths from 141 to 2,870 m. Not only were members of this phylum restricted to deep water, but their density, biomass, and frequency of occurrence were higher in the middle and deeper portions of their range than in shallow parts (Fig. 77).