ATLANTIC CONTINENTAL SHELF AND SLOPE OF THE UNITED STATES—MACROBENTHIC INVERTEBRATE FAUNA OF THE MIDDLE ATLANTIC BIGHT REGION—FAUNAL COMPOSITION AND QUANTITATIVE DISTRIBUTION

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ABSTRACT

In the early 1960's, a quantitative survey of the macrobenthic invertebrate fauna was conducted in the Middle Atlantic Bight region. Purposes of this survey were to obtain a preliminary measure of the macrobenthic standing crop, particularly of biomass, and secondarily, to determine the principal taxonomic components of the fauna and the general features of their distribution. Sampling was conducted at 563 locations; water depths ranged from 4 to 3,080 m. An analysis of faunal composition and of quantitative distributions from the survey is presented in this report. Quantities are expressed in terms of density and biomass.

Dominant taxonomic components in numbers of individuals were (in percentage of total fauna): Arthropoda (46), Mollusca (25), Annelida (21), Echinodermata (4), and Coelenterata (1). Dominant in biomass were (in percentage of total fauna): Mollusca (71), Echinodermata (12), Annelida (7), Arthropoda (5), and Ascidiacea (2). The quantity of fauna, both density and biomass, decreased substantially from shallow to deep water. Another major trend was the marked decrease in quantity from north to south within the Middle Atlantic Bight. Bottom sediment composition strongly influenced both the kind and the quantity of macrobenthic animals. Coarse-grained sediments generally supported the largest quantities of animals, including many sessile forms. Fine-grained sediments usually contained a depauperate fauna; attached organisms were uncommon. No obvious correlations were detected between the amount of organic carbon in bottom sediments and the quantity of benthic animals present. Marked seasonal changes in bottom water temperature were associated with an abundant fauna composed of diverse forms, whereas uniform temperatures throughout the year were associated with a sparse fauna composed of a moderate variety of species. Taxonomic groups that were dominant in a significant number of samples, in terms of number of individuals, were: Bivalvia, Annelida, Echinoidea, Ophiuroidea, Crustacea, and the bathyal assemblage. Groups dominant in terms of biomass were: Bivalvia, Annelida, Echinoidea, Ophiuroidea, Holothuroidea, and the bathyal assemblage.

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INTRODUCTION

This report [2] describes, in quantitative terms, the macrobenthic invertebrate fauna inhabiting the Middle Atlantic Bight region. It deals primarily with faunal (a) taxonomic composition; (b) geographic distribution; and (c) relationships to bathymetric level, bottom sediment composition, sediment organic carbon, and water temperature. Regional differences in faunal composition and quantitative distribution within the Middle Atlantic Bight region are analyzed and documented.[3] Further studies of these data, in addition to the primarily descriptive analyses presented here, are in progress.

RECONNAISSANCE SURVEY

A reconnaissance survey of macrobenthic invertebrates in the Middle Atlantic Bight region was conducted as part of a larger survey of the entire Atlantic coast of the United States (Emery and Schlee, 1963). This survey by the Bureau of Commercial Fisheries (now the National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce) was conducted in cooperation with the Woods Hole Oceanographic Institution, Woods Hole, Mass., and the U.S. Geological Survey. The major objective of the biological phase of this survey was to obtain an overview of the general composition and distribution of the macrobenthos. Sufficient understanding of the

[2] Financial support for the preparation of this report was provided by the National Oceanic and Atmospheric Administration (NOAA), Marine Ecosystems Analysis Prigram, New York Bight Project, Stony Brook, N. Y.

[3] An earlier, unpublished report, "Macrobenthic Invertebrate Fauna of the Middle Atlantic Bight Region: Part 1. Collection Data and Environmental Measurements," by Roland L. Wigley, Roger B. Theroux, and Harriett E. Murray (1976, 34 p.), is available at the Northeast Fisheries Center, Woods Hole, Mass.

fauna, especially the distributional aspects, was desired to permit the rational selection of one or more communities of benthic animals for detailed study. One or two of the more important communities or associations, suitable from both the practical and the theoretical viewpoints, will be selected for detailed study of taxonomic composition, productivity, interspecific competition for food, and related aspects. This latter phase of the investigation is included in the long-range objectives of the National Marine Fisheries Service for studying food-chain dynamics as they pertain to fish production on the Continental Shelf off the Eastern United States. Because of the need for measures of energy flow in the production cycles, emphasis in the benthic survey was placed on measurements of biomass (referred to as wet weight or damp weight), and number of individual animals per unit area (density) was considered secondary.

MIDDLE ATLANTIC BIGHT REGION

The Middle Atlantic Bight region is defined as that body of water overlying the Continental Shelf off the Northeastern United States, bounded on the north by Cape Cod and Nantucket Shoals, Mass., and extending southward to Cape Hatteras, N. C. Its shoreward boundary is the coastline; its seaward boundary is the upper margin of the Continental Slope, the so-called shelf-break or outer edge of the Continental Shelf. The geographic region included in this study consists of the Middle Atlantic Bight proper, plus the adjacent inshore bays and sounds, and the offshore extension that consists of the Continental Slope and the shallower part of the Continental Rise (fig. 1). This larger area is called the Middle Atlantic Bight region. For purposes of comparative description, this region has been divided into three roughly equal geographic subareas: Southern New England, New York Bight, and Chesapeake Bight.

PREVIOUS STUDIES

Although no previous quantitative studies of the macrobenthic fauna encompassed the entire Middle Atlantic region, comprehensive studies of small sections of this region, a few rather large-scale qualitative studies, and numerous reports of an ancillary nature have been made. Altogether, substantial literature exists on this general subject that has been produced at an ever-increasing rate since about the middle of the 19th century. A few examples of the early reports are those by: Adams (1839), on new species of mollusks; Agassiz and Agassiz (1865), on echinoderm morphology and development; Desor (1848), on the natural history of benthic invertebrates from Nantucket Shoals; Leidy (1855), on the invertebrates from coastal waters of Rhode Island and New Jersey; and Verrill (1866), on new species and ecological observations on New England coelenterates and echinoderms. Early studies provide some of the basic taxonomic framework for this fauna, provide clues to the pattern of geographic distribution, and give a preliminary insight to regional ecology. Two classic reports in the early literature that deal with major surveys of invertebrate animals within the Middle Atlantic Bight region are: (1) the U.S. Fish Commission survey of Vineyard Sound and adjacent waters, conducted in 1871–73 (Verrill, 1873) and (2) the U.S. Bureau of Fisheries survey of the waters of Woods Hole and vicinity, conducted in 1903–05 (Summer, Osburn, and Cole, 1913). Both surveys dealt mainly with epibenthic invertebrates and covered much the same area—primarily Vineyard Sound and Buzzards Bay in southeastern Massachusetts.

Six published indexes and bibliographies provide good coverage of the general literature pertaining to the benthic invertebrates (and related subjects) of this region. The citations in these bibliographies include many old and new reports. The six reference works are:

(1) "Publications of the United States Bureau of Fisheries 1871–1940" (Aller, 1958).
(2) "A Preliminary Bibliography with KWICK Index on the Ecology of Estuaries and Coastal Areas of the Eastern United States" (Livingstone, 1965).
(3) "Marine and Estuarine Environments, Organisms and Geology of the Cape Cod Region, an Indexed Bibliography, 1665–1965" (Yentsch, Carriker, Parker, and Zullo, 1966).
(4) "The Effects of Waste Disposal in the New York Bight" (sections 8 and 9) (U.S. National Marine Fisheries Service, Middle Atlantic Coastal Fisheries Center, 1972).
(5) "Coastal and Offshore Environmental Inventory, Cape Hatteras to Nantucket Shoals" (Saila, 1973).
(6) "Bibliography of the New York Bight: Part 1 —List of Citations; Part 2—Indexes" (U.S. National Oceanic and Atmospheric Administration, 1974).

A sizable part of this benthic invertebrate literature deals with topics having little relevance to the present quantitative study. Reports consisting of species descriptions, many of the studies of physio-

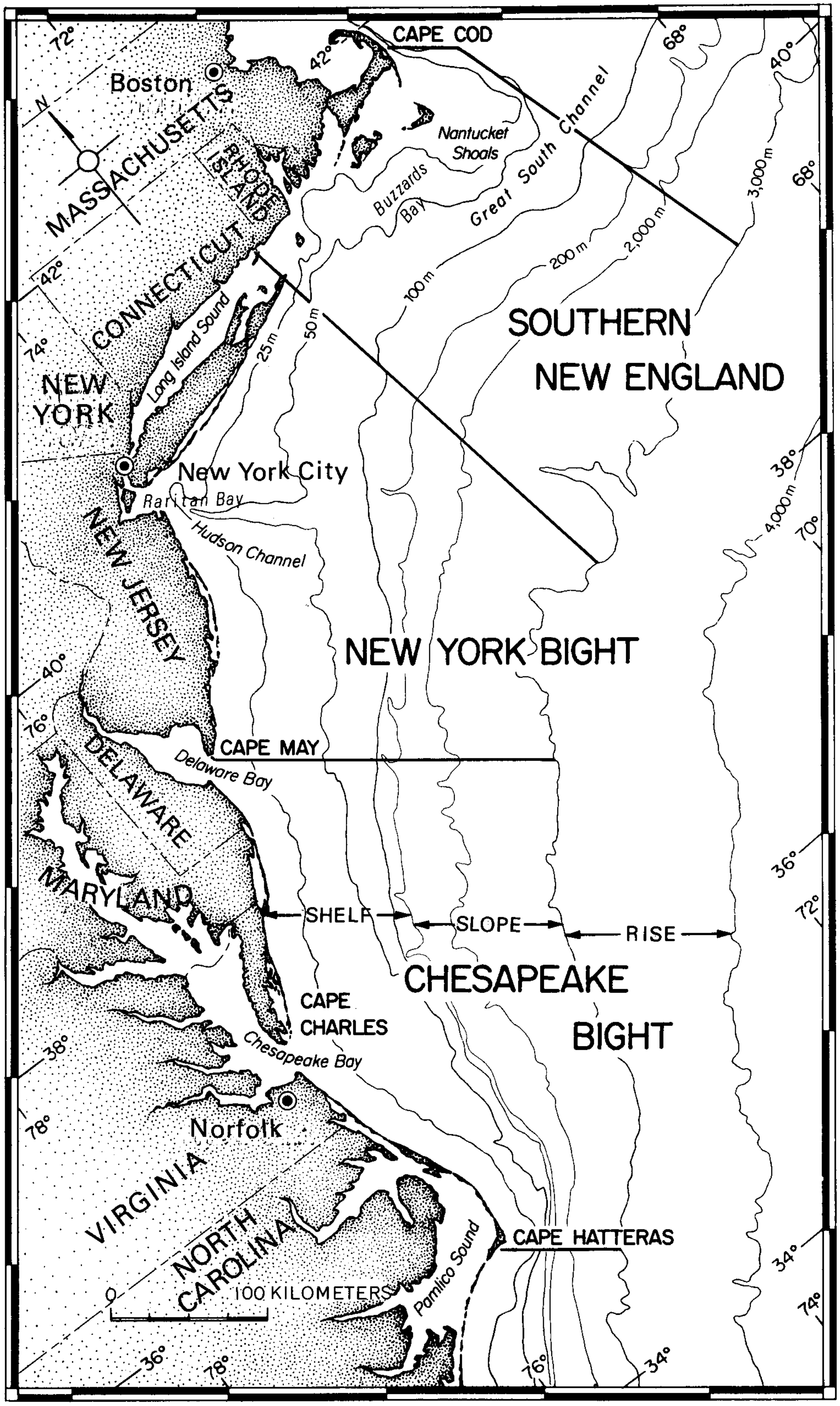

FIGURE 1.—Chart of the Middle Atlantic Bight region showing the location of geographical features and the three subarea divisions: Southern New England, New York Bight, and Chesapeake Bight.

logical processes, morphology, habits and behavior, parasites, diseases, growth rates, and similar topics are peripheral to the central theme of quantitative distribution. Another large segment of the literature (also only marginally pertinent to the present study) pertains to pelagic larval stages of benthic invertebrates, intertidal fauna, some aspects of fishery resources, predation, commensalism, and other related subjects.

Quantitative studies of the benthos have been conducted at various locations throughout the region in more recent years, particularly within the last two decades. Most of these studies were made on inshore and coastal regions, few on the Continental Shelf, and fewer still on the Continental Slope and Rise. The principal quantitative reports that we consulted in evaluating distribution and relative densities and (or) biomass are listed separately (although there is some overlap) for the following three zones: (1) inshore and coastal waters; (2) Continental Shelf; and (3) Continental Slope and Rise.

(1) **Inshore and coastal waters.**—Southern Massachusetts, Rhode Island, and Connecticut: Lee (1944), Sanders (1956, 1958, 1960), Stickney and Stringer (1957), Phelps (1964), Rhoads (1963), and Parker (1974); New York-New Jersey: Dean and Haskin (1964), Franz and Hendler (1971), Phillips (1972), O'Connor (1972), D'Agostino and Colgate (1973), Kaplan, Welker, and Kraus (1974), McGrath (1974), and Dean (1975); Delaware to Cape Hatteras, North Carolina: Stone (1963), Tenore (1972), Boesch (1972, 1973), Leathem and others (1973), Palmer and Lear (1973), Maurer and others (1974), Watling and others (1974), and Watling and Maurer (1975).

(2) **Continental Shelf.**—Wigley and McIntyre (1964), Emery, Merrill, and Trumbull (1965), Emery and Uchupi (1972), Pearce (1972), Rowe (1973), and Steimle and Stone (1973). An up-to-date review of the major species and faunal associations inhabiting the Middle Atlantic Bight was prepared by Pratt (1973).

(3) **Continental Slope and Continental Rise.**—Sanders, Hessler, and Hampson (1965), Wigley and Emery (1967), Rowe and Menzies (1969), Rowe and Menzel (1971), Emery and Uchupi (1972), George and Menzies (1973), Menzies, George, and Rowe (1973), and Haedrich, Rowe, and Polloni (1975).

Several ecologically oriented reports based entirely, or in part, on the samples used in this study have been published. Macrobenthos from a series of stations across the Continental Shelf south of Martha's Vineyard, Mass., was included in a report by Wigley and McIntyre (1964). A description of sea-bottom photographs and grab-sample contents taken concurrently by the Campbell sampler (Emery and Merrill, 1964) was based partly on samples collected for the present study. An investigation encompassing a large offshore area, extending from Nova Scotia, Canada, southward to New Jersey, that dealt mainly with the quantity of macrobenthic invertebrates in relation to bottom sediment types was published by Emery, Merrill, and Trumbull (1965). The quantity of benthic invertebrates in grab samples from the Continental Slope off the Middle Atlantic region was compared with quantities observed in associated sea-bottom photographs (Wigley and Emery, 1967). A report by Wigley and Stinton (1973) on the remains of dead marine animals, particularly mollusks, in a part of the Middle Atlantic Bight off Southern New England, was also based on samples collected for the present study.

Several quantitative studies of the macrobenthos are in progress. Many of these studies are being conducted in coastal areas, and most of the studies pertain directly to assessments of environmental quality. In addition, two large-scale offshore investigations are underway. One is in the Chesapeake-New Jersey region in anticipation of petroleum exploration, and possible production, in this region, and another is in the New York-New Jersey area. Impetus for this work is directly related to ocean dumping and waste disposal from the New York-New Jersey metropolitan area.

A large volume of up-to-date benthic fauna information is currently being issued in the so-called gray literature in which the results of recently completed field studies are issued as contract completion reports, environmental impact statements, public agency (or private corporation) investigation reports, annual reports, or other similar special documents. Many of these reports are issued in Xerographic or mimeographic form, often in irregular series or as a one-of-a-kind report, and, as a consequence, they often are not listed in the usual literature sources.

Hydrography of the Middle Atlantic Bight region is rather well known, at least the general features of circulation, tides, the annual cycle of temperature, patterns of salinity distribution, and other major aspects. Also, some inshore waters, such as Long Island Sound, Raritan Bay, and Chesapeake Bay, have been studied in some detail. However, detailed information concerning chemical properties, water currents, meteorological influences, and related aspects, particularly as they pertain to offshore bottom waters, is lacking.

A bibliography of early (prior to 1951) hydrographic studies is included in the report by Ayers (1951). Rather broad consideration of the hydrography of the entire Bight is given by Bigelow (1933), Emery and Uchupi (1972), and Bumpus, Lynde, and Shaw (1973). Information on water temperature was reported by Walford and Wicklund (1968), Colton and Stoddard (1972, 1973), Churgin and Halminski (1974), and others. Salinity and its bathymetric and geographic distribution are included in the reports by Bigelow and Sears (1935) and Churgin and Halminski (1974). Water circulation and related aspects have been reported by Chase (1959), Ketchum and Corwin (1964), Bumpus (1965), and Bumpus and Lauzier (1965).

Geological information about the Middle Atlantic Bight region is copious and up-to-date. A few major references on this subject are: Emery (1966, 1968), Hülsemann (1967), Ross (1970), Schlee and Pratt (1970), Emery and Uchupi (1972), Trumbull (1972), Hollister (1973), Milliman (1973), Schlee (1973), Swift, Duane, and McKinney (1973), and Stubblefield, Dicken, and Swift (1974).

MATERIALS AND METHODS

MACROFAUNA SAMPLES

This report is based on the analyses of 667 quantitative samples of benthic invertebrates collected at 563 locations (stations) primarily between 1962 and 1965. Three samples collected in 1957 were inadvertently included in the analysis of this suite. The basic sampling strategy was to plot an 18-km (10-mi) grid whose base orientation was roughly perpendicular to the depth gradient. Station locations for all samples are shown in figure 2. Basic station data is given in an unpublished report by Wigley, Theroux, and Murray (see footnote 1 in "Introduction"). The even distribution of stations imparted by the grid is evident, but is masked in some places by additional samples between grid lines.

Samples were obtained during 16 research cruises (table 1). Five research vessels were used, three of which, *Albatross III*, *Delaware I*, and *Albatross IV*, were operated by the National Marine Fisheries Service of the National Oceanic and Atmospheric Administration in the Department of Commerce and its predecessor agency, the Bureau of Commercial Fisheries, then in the Department of the Interior. Two vessels, *Gosnold* and *Asterias*, were operated by the Woods Hole Oceanographic Institution, Woods Hole, Mass.

TABLE 1.—*Research vessels, cruise identification and dates, and number of stations sampled*

Vessel and cruise	Cruise date	Number of stations
ALB III-101	Aug 21–30, 1957	3
DEL-62-7	Jun 13–20, 1962	63
GOS-10	Apr 26, 1963	6
GOS-11	Apr 30, 1963	3
GOS-12	May 2–7, 1963	4
GOS-13	May 9–14, 1963	25
GOS-20	Jul 16, 1963	1
GOS-22	Aug 5–17, 1963	10
GOS-28	Oct 3–6, 1963	9
GOS-29	Oct 8–27, 1963	130
GOS-45	May 15–Jun 30, 1964	53
GOS-49	Aug 1–29, 1964	129
AST-64-1	Apr 22–23, 1964	6
AST-64-2	Jul 1–Aug 9, 1964	74
AST-65-1	May 4–Jun 12, 1965	33
ALB IV-65-11	Aug 17–27, 1965	14
Total		563

Quantitative samples were obtained from inshore estuarine areas, the Continental Shelf, Slope, and certain parts of the Continental Rise throughout the Middle Atlantic Bight region, encompassing an area of 303,521 km² (121,408 mi²). The region was divided into geographic subareas designated: Southern New England, New York Bight, and Chesapeake Bight. These subareas (fig. 1) contain 94,700, 82,749, and 126,072 km² (37,880, 33,100, and 50,428 mi²), respectively. More detailed data on the areal expanse of various subunits within the region are listed in table 2. A nearly equal number of samples came from such subarea: Southern New England—186 samples; New York Bight—187 samples; Chesapeake Bight—190 samples.

TABLE 2.—*Areas of several bathymetric zones within each subarea and total area of Middle Atlantic Bight region*

[In square kilometers]

Bathymetric zone	Subarea: Southern New England	Subarea: New York Bight	Subarea: Chesapeake Bight	Total
Bays and Sounds [1]	2,674	[2] 3,788	17,401	23,863
Continental Shelf				
0–24 m	5,495	8,035	12,015	25,545
25–49 m	8,253	15,045	15,488	38,786
50–99 m	16,986	17,604	6,987	41,577
100–199 m	4,826	3,228	1,930	9,984
Total	35,560	43,912	36,420	115,892
Continental Slope				
220–499 m	1,853	1,129	1,222	4,204
500–999 m	1,917	1,515	1,813	5,245
1,000–1,999 m	3,667	3,514	8,598	15,779
Total	7,437	6,158	11,633	25,228
Continental Rise				
2,000–3,999 m	49,029	28,891	60,618	138,538
Grand total	94,700	82,749	126,072	303,521

[1] Based on areas reported by Bumpus, Lynde, and Shaw (1973).
[2] Includes the Gardiners Bay complex (1,078 km²).

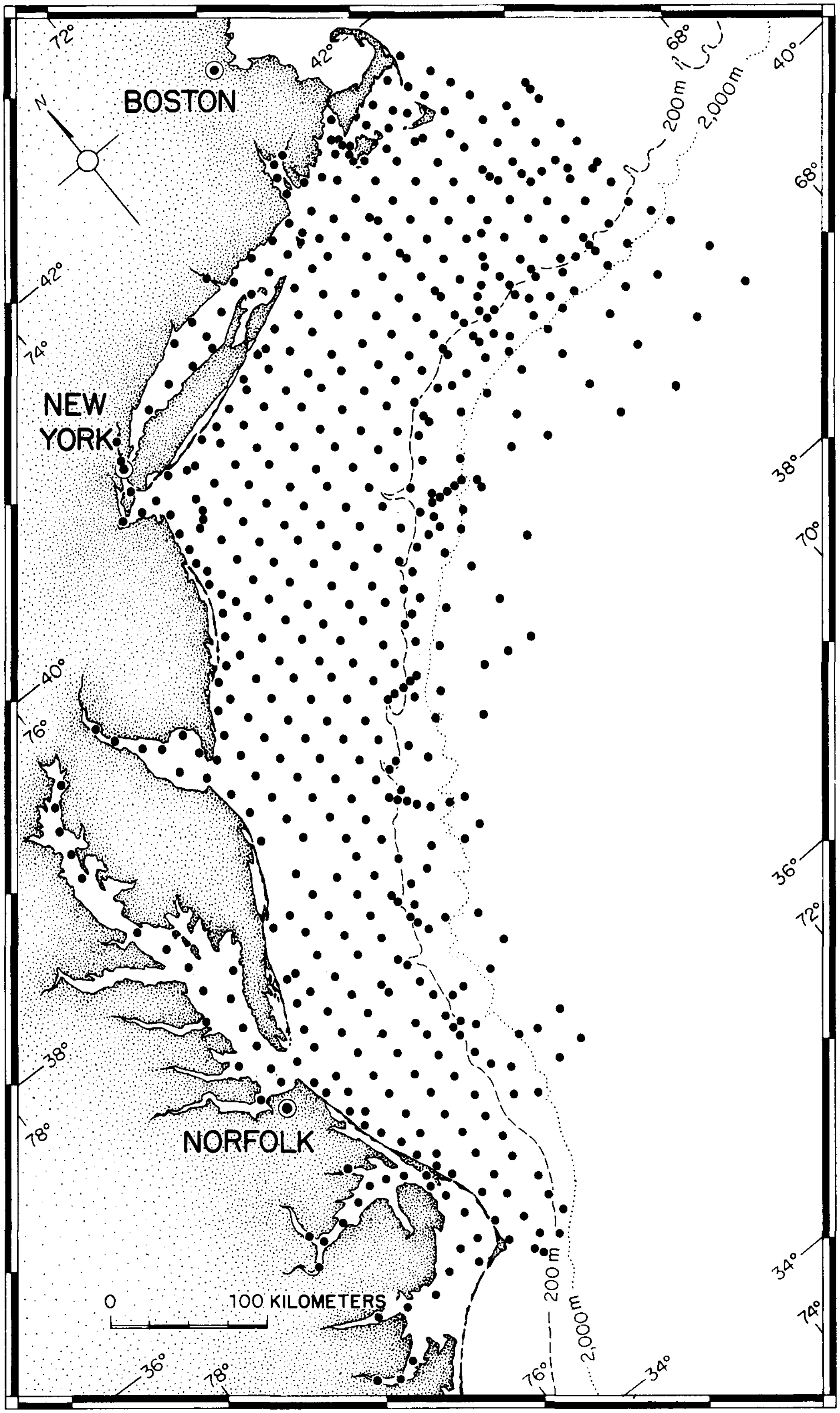

Figure 2.—Chart showing station locations where quantitative samples of macrobenthic invertebrates were obtained.

BENTHOS SAMPLING GEAR

Three different quantitative grab-type bottom samplers were used: the Van Veen grab[4] (Holme and McIntyre, 1971); the Smith-McIntyre sampler (fig. 3) (Smith and McIntyre, 1954); and the Campbell grab (fig. 4) (Menzies, Smith, Emery, 1963). All three are reliable devices for obtaining quantitative samples with relative ease under a wide variety of working conditions. A small vessel was used in sampling inshore waters, and this restricted the use of bottom samplers to the two smaller ones—Van Veen and Smith-McIntyre. Thirteen samples (2 percent), each representing an area of 0.1 m^2, were taken with the Van Veen grab; 195 samples (35 percent) were taken with a 0.1 m^2-size Smith-McIntyre grab; and 355 (63 percent) samples were taken with the 250–kg Campbell grab, each sample representing an area of 0.56 m^2. These devices provided enough material for both biological and geological analyses.

The Campbell grab was equipped with an automatic camera and electronic light source (Emery, Merrill, Trumbull, 1965; Emery and Merrill, 1964), which provided a photograph of the sea bottom that was taken immediately prior to bottom contact. The camera housing, fastened within one of the buckets of the grab (fig. 4), contained two 35-mm motorized cameras spaced to provide stereo separation, if desired. Usually, each camera was loaded with a different type of film; one contained black and white negative material and the other reversal (positive), high-speed daylight color film. The opposite bucket held the electronic strobe light that illuminated the area to be photographed. The device was activated at about 1 m above the bottom by means of a tripweight suspended below the grab. Approximately 200 simultaneous photographs and bottom samples were obtained within the study area. Of this total, 180 photographs were in black and white (examples in figs. 89 to 94) and 20 were in color.

SAMPLE PROCESSING

Processing of samples depended on the size of the equipment and the method of determining sediment volume. Contents of the grab were emptied into a watertight receptacle large enough to hold all the collected substratum. Substrate receptacles for the Van Veen and Smith-McIntyre samplers were 20-liter graduated pails; the receptacle for the Campbell grab was a large rectangular steel tub, which also served as the washing container. The volume of the samples was determined, prior to any treatment. The graduated pails used with Van Veen and Smith-McIntyre samplers gave a direct reading of volume, and precalibrated brass dipsticks were used to determine the volume of Campbell grab samples. Volumes were recorded to the nearest whole liter.

All samples were washed on a sieving screen having 1-mm mesh openings to remove unwanted sediments and retain specimens. The Van Veen and Smith-McIntyre samples were first washed in a specially designed washstand that had adjustable-flow shower heads trained onto the mound of sediment samples. Waterflow gently flooded the organisms out of the sediments and transported them to the sorting sieve where everything greater than 1 mm in size was retained. The Campbell grab samples were washed in the same receptacle that received the sample. Water from hoses with variable nozzles floated sediments and organisms through openings in the container to the sieving screens.

Coarse substrate fractions, such as pebbles and cobbles, that were retained on the screen required further treatment. These larger fractions were sorted out by hand and examined. If clean (no attached organisms), they were discarded; those with attached organisms were retained for later treatment. Organisms and sediments retained by the screen were preserved in a 5 percent buffered seawater solution of formaldehyde in glass containers, labeled, and stored for transport to the laboratory.

Laboratory treatment of preserved specimens involved: (1) rinsing in freshwater to flush off formalin solution; (2) sorting and identifying to the lowest accurate taxonomic level; (3) recording counts of individuals in each taxonomic group; and (4) obtaining damp or wet weights (excess superficial fluids removed with blotting paper) of each group. Included in the weight measurements are skeletal structures that form an integral part of the living animal. This, of course, includes shells of mollusks, brachiopods, crustaceans, echinoderms, and all other organisms having a shell-like skeleton. Weights do not include hermit crab "houses," amphipod or polychaete tubes, or other such accessory structures. After the above treatment, all specimens were preserved in 70 percent ethanol and stored in labeled containers.

DATA REDUCTION

Certain adjustments to the raw data were required to make one sample comparable with another. The criterion of comparability chosen was a unit area of 1 m^2. Adjustments were made to account for

[4] Any trade names in this publication are used for descriptive purposes only and do not constitute endorsement by the U.S. Geological Survey.

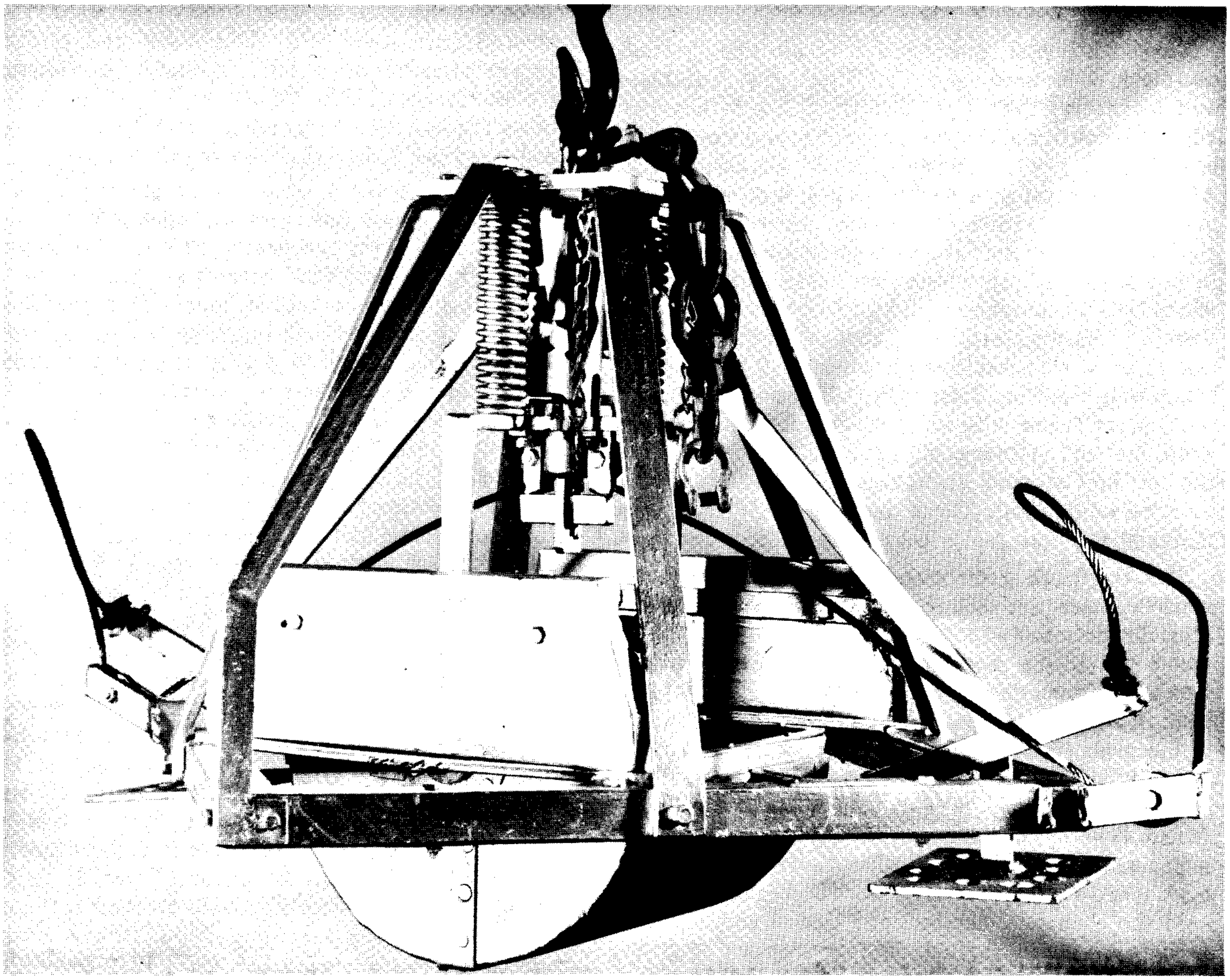

FIGURE 3.—Side view of the Smith-McIntyre spring-loaded bottom sampler in the closed position. Lead weights on each side are set vertically to impede rotation of the sampler during descent and ascent. Vertical distance from frame base to top plate is 52 cm.

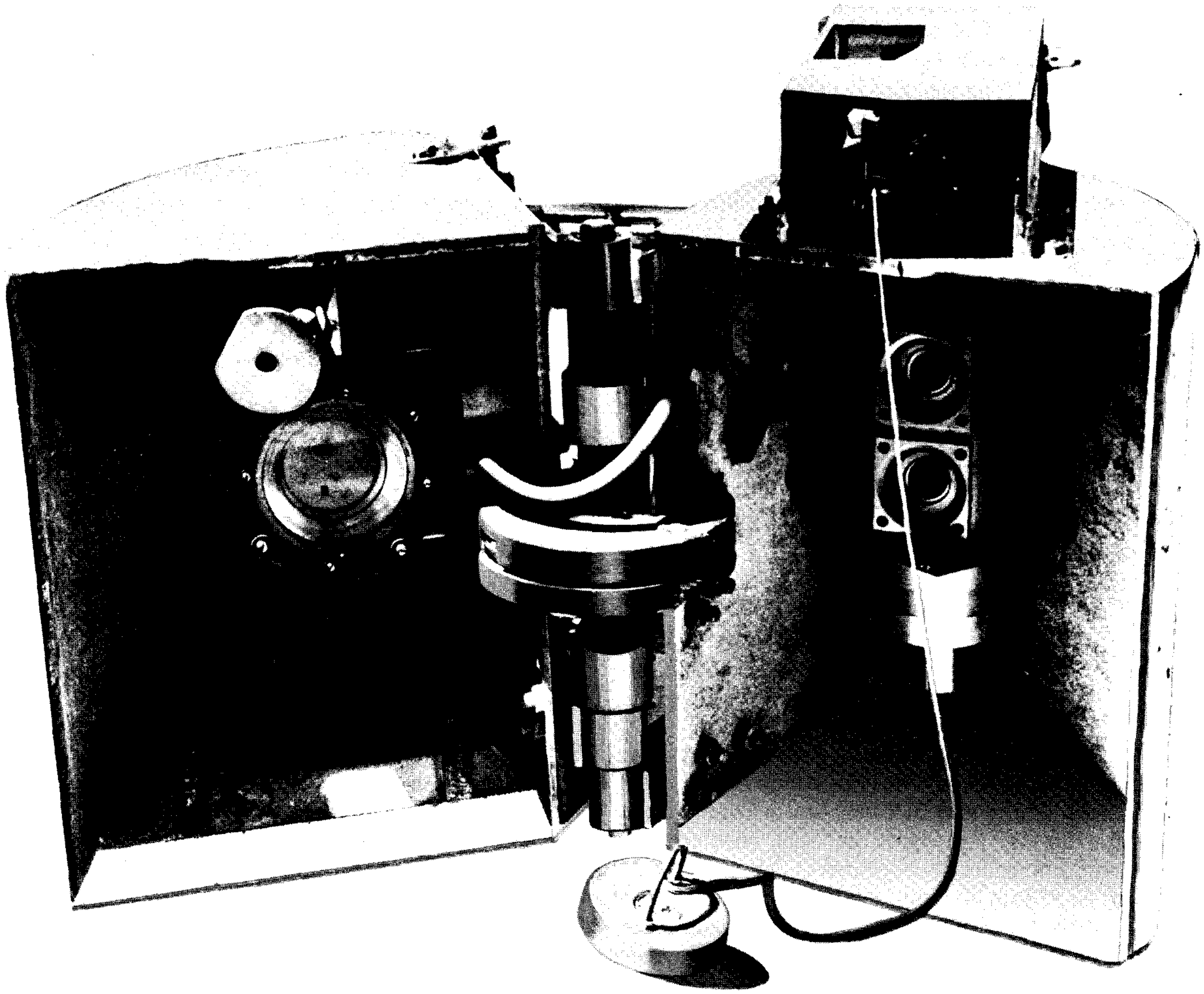

FIGURE 4.—Bottom view of Campbell grab sampler. Camera is installed in right-hand bucket and strobe light is in the left-hand bucket. Width of the buckets (vertical dimension in photograph) is 57 cm.

sampling gear size (area of bottom sampled) and material removed (such as sediment samples for geological analyses), prior to processing.

A MESA (Marine Ecosystems Analysis) formated, IBM compatible, magnetic computer tape of benthic data was made and submitted to MESA, New York Bight project office. A major difference between our data processing system and that of MESA's is the coding schemes used to identify the various taxonomic components. The system we (Demersal Food Chain Investigation at the Northeast Fisheries Center, Woods Hole, Mass.) used was an 11-digit code developed by us in 1962, and it differs substantially from the 10-digit code used by MESA. Our code is divided as follows: Phylum (2 digits); Class (1); Order (2); Family (2); Genus (2); Species (2). At present, our taxonomic code data-file contains approximately 6,000 names from the U.S. east coast.

BATHYMETRY

Water depths, in meters, were obtained by means of echo sounders and corrected for hydrophone depth and temperature effects on the velocity of sound.

TEMPERATURE

Owing to a lack of information on bottom-water temperature, especially in the southeastern part of New York Bight and in Chesapeake Bight, a means of determining temperatures was required. Minimum and maximum temperatures for each sampling site were obtained from various published sources (see "Introduction") and from measurements obtained by the Northeast Fisheries Center. The ranges in temperature were determined by subtracting the minimum from the maximum; they were then grouped into ranges which were used in the temperature analyses.

GEOLOGICAL SAMPLES

A sample of bottom sediment was collected from each macrobenthic sample. A lithological description was made at the time of collection and was based on field-analysis techniques. The sample was placed in a cardboard container, air-dried, and brought to the laboratory ashore for detailed determination of grain-size composition, a measure of organic carbon, and analyses of other chemical and minerological components by geologists of the U.S. Geological Survey and the Woods Hole Oceanographic Institution. Analysis results are on file in Woods Hole Oceanographic Institution Reference No. 71–15, Data File, Continental Margin Program Atlantic Coast of the United States, volumes 1 and 2, compiled and edited by John C. Hathaway, U.S. Geological Survey, Woods Hole, Mass. Data pertaining to bottom sediments and quantity of organic carbon used in our analyses are listed in this document.

FAUNAL COMPOSITION

ENTIRE MIDDLE ATLANTIC BIGHT REGION

The faunal composition in the Middle Atlantic Bight region is moderate—the number of species and higher taxa are neither very abundant nor very sparse. The different species in the samples numbered 435; they represented 17 phyla. This modest variation in taxonomic diversity is typical of a temperate marine fauna. However, to some extent, the observed variation resulted from our knowledge of particular taxonomic groups and our facility (and that of cooperating scientists) in identifying the components of the various groups. This is evident from the relatively large numbers of species in Arthropoda, Annelida, and Mollusca. Also, our priorities in establishing taxonomic work assignments resulted in relatively small effort being devoted to identifying the species composition of the less important (in terms of abundance or biomass) groups, such as Porifera, Platyhelminthes, Hemichordata, Nemertea, and Aschelminthes.

In evaluating the total fauna (all taxonomic groups from all samples), we found that four groups dominated: Arthropoda, Annelida, Mollusca, and Echinodermata. Dominance of these groups was apparent in both number and biomass; however, the order of importance differed substantially between the two measures (table 3; fig. 5). Numerical dominance, here indicated by mean density per square meter and percentage of the total fauna they constituted, was as follows: Arthropoda, 641, (45 percent); Mollusca, 346, (25 percent); Annelida, 298, (21 percent); Echinodermata, 55, (4 percent); and all other groups combined, 65, (5 percent). Biomass, which is here expressed as mean wet weight or damp weight in grams per square meter and percentage of the total fauna, was even more heavily dominated by a few taxonomic groups than was numerical density. Principal components in terms of biomass were: Mollusca, 136, (71 percent); Echinodermata, 23, (12 percent); Annelida, 14, (7 percent); Arthropoda, 9, (5 percent). Minor groups listed here in order of decreasing biomass were: Chordata, Coelenterata, Sipunculida, Nemertea, Bryozoa, Echiura, Porifera, Hemichordata, Pogonophora, Priapulida, Platyhelminthes, Aschelminthes, and Brachiopoda.

TABLE 3.—*Quantitative taxonomic composition of the macrobenthic invertebrate fauna, in both number of individuals and biomass, representing the entire Middle Atlantic Bight region*

Taxonomic group	Number of individuals			Biomass		
	Mean	Percent	Phylum rank	Mean	Percent	Phylum rank
	No./m^2			g/m^2		
PORIFERA	0.56	0.04	13	0.058	0.03	11
COELENTERATA	17.76	1.26	5	2.975	1.56	6
Hydrozoa	9.57	0.68		0.296	0.16	
Anthozoa	8.19	0.58		2.680	1.41	
Alcyonacea	0.51	0.04		0.091	0.05	
Zoantharia	3.81	0.27		2.425	1.27	
Unidentified	3.87	0.28		0.164	0.09	
PLATYHELMINTHES	0.64	0.05	12	0.007	0.004	15
Turbellaria	0.64	0.05		0.007	0.004	
NEMERTEA	4.51	0.32	8	0.619	0.32	8
ASCHELMINTHES	2.60	0.18	10	0.005	0.002	16
Nematoda	2.60	0.18		0.005	0.002	
ANNELIDA	297.77	21.18	3	13.814	7.24	3
POGONOPHORA	1.91	0.14	11	0.012	0.01	13
SIPUNCULIDA	3.94	0.28	9	0.689	0.36	7
ECHIURA	0.15	0.01	14	0.249	0.13	10
PRIAPULIDA	0.01	0.001	16	0.009	0.005	14
MOLLUSCA	346.29	24.63	2	136.131	71.38	1
Polyplacophora	0.45	0.03		0.144	0.08	
Gastropoda	35.79	2.55		3.081	1.62	
Bivalvia	308.27	21.93		132.878	69.68	
Scaphopoda	1.26	0.09		0.022	<0.001	
Cephalopoda	0.33	0.02		0.004	0.002	
Unidentified	0.19	0.01		0.001	<0.001	
ARTHROPODA	640.51	45.56	1	9.013	4.73	4
Pycnogonida	0.54	0.04		0.003	0.002	
Arachnida	0.05	0.004		<0.001	<0.001	
Crustacea	639.92	45.52		9.010	4.72	
Ostracoda	0.22	0.02		0.002	0.001	
Cirripedia	30.02	2.14		3.747	1.96	
Copepoda	0.04	0.003		<0.001	<0.001	
Nebaliacea	0.01	0.001		<0.001	<0.001	
Cumacea	15.92	1.13		0.071	0.04	
Tanaidacea	0.06	0.004		<0.001	<0.001	
Isopoda	12.31	0.88		0.290	0.15	
Amphipoda	572.09	40.70		3.675	1.93	
Mysidacea	2.06	0.15		0.009	0.005	
Decapoda	7.19	0.51		1.214	0.64	
BRYOZOA	12.22	0.87	7	0.329	0.17	9
BRACHIOPODA	<0.01	0.03	17	<0.001	<0.001	17
ECHINODERMATA	54.64	3.89	4	22.775	11.94	2
Holothuroidea	2.15	0.15		5.386	2.82	
Echinoidea	23.09	1.64		13.641	7.15	
Ophiuroidea	28.50	2.03		1.798	0.94	
Asteroidea	0.90	0.06		1.949	1.02	
HEMICHORDATA	0.13	0.01	15	0.029	0.01	12
CHORDATA	14.69	1.05	6	3.721	1.95	5
Ascidiacea	14.69	1.05		3.721	1.95	
UNIDENTIFIED	7.40	0.53		0.274	0.14	

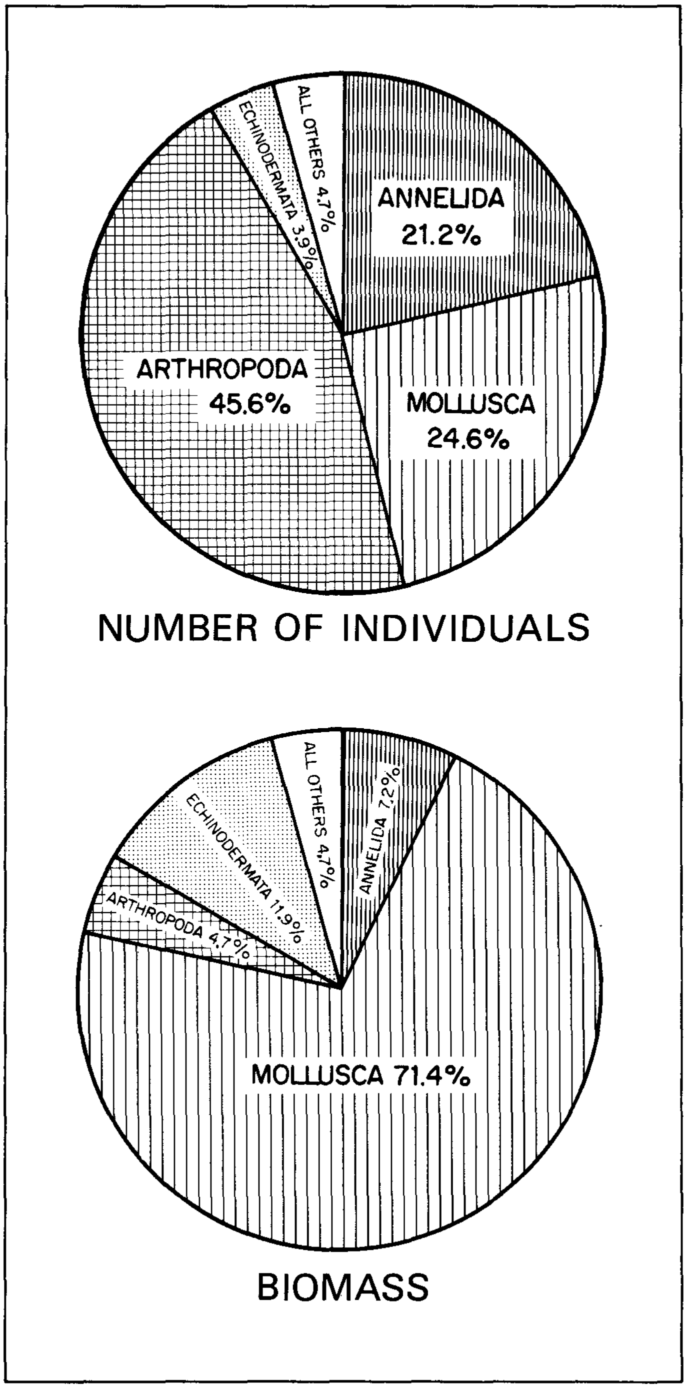

FIGURE 5.—Pie charts illustrating the taxonomic composition of the total macrobenthic fauna in the entire Middle Atlantic Bight region. Number of individuals expressed as a percentage of the total fauna; and biomass, also expressed as a percentage of the total.

Because of the exceptionally large biomass formed by Mollusca, we would like to focus attention on the biomass determination procedures. It has long been standard practice to obtain wet weight biomass values by weighing the entire animal—including shells and all other intregal body parts (Thorson, 1957). This, of course, is to provide consistency in dealing with enormously varied taxonomic assemblages that have different proportions of skeletal structures and water content, both of which are exceedingly low in nutritive value. Some of the Echinoidea, Cirripedia, and other groups possess higher proportions of skeletal structure than mollusks; Brachiopods, Brachyurans, and other groups generally have about the same or slightly smaller proportions of skeletal structure than mollusks; and many Holothuroidea, Annelida, and other soft-bodied groups commonly have a very small proportion of skeletal structure. Water content also varies substantially from group to group, and is particularly high in Ascidiacea and some Coelenterata. Because of these and other variations in body composition, measures other than wet weight biomass must be used to show nutrient value. For purposes of energy pathway studies and dynamic modeling, ecologists often require measures of energy, such as caloric value.

Our determinations of conversion coefficients for converting wet weights to dry weights are incomplete at present. However, by using our conversion values supplemented by values obtained from published reports, we made a preliminary comparison of the percentage composition of the macrobenthic fauna in terms of wet weight and calculated ash-free dry weight. Only modest differences in relative standing of the taxonomic groups were revealed by this comparison. Thus, the major biomass position occupied by mollusks in this region results from their relatively large size combined with rather high numerical abundance.

Dominance of the fauna by a relatively few groups of organisms was also apparent at more specific taxonomic levels—genera and species. In the taxonomic list of species given in table 4 are 441 species that were represented in samples within the Middle Atlantic Bight region. Of this number, less 10 percent are considered important in terms of number and (or) biomass. In number of specimens, some of the more important forms were: *Scalibregma, Nephtys, Maldane, Sabella, Spiophanes* (Annelida); *Alvania, Cylichna, Nassarius* (Gastropoda); *Nucula, Cyclocardia, Astarte, Thyasira* (Bivalvia); *Balanus* (Cirripedia); *Trichophoxus, Leptocheirus, Ampelisca, Unciola* (Amphipoda); *Cirolana* (Isopoda); *Echinarachnius* (Echinoidea).

Important as major contributors to the biomass were: *Cerianthus* (Coelenterata); *Nephtys, Streblosoma, Maldane, Lumbrineris* (Annelida); *Arctica, Astarte, Cyclocardia, Mulinia, Ensis* (Bivalvia); *Buccinum, Nassarius* (Gastropoda); *Trichophoxus,*

TABLE 4.—*Invertebrate species contained in quantitative samples taken within the Middle Atlantic Bight region*

- Coelenterata (Cnidaria)
  - Hydrozoa
    - *Hydractinia echinata* Fleming, 1828
  - Anthozoa
    - Alcyonacea
      - *Pennatula aculeata* Danielson and Koren, 1858
    - Zoantharia
      - Zoanthidea
        - *Epizoanthus incrustatus* (Verrill) 1864
      - Actiniaria
        - *Anthaloba perdix* Verrill, 1882
        - *Edwardsia* sp.
        - *Haliplanella luciae* (Verrill) 1898
        - *Haloclava producta* Stimpson, 1856
        - *Paranthus rapiformis* Lesueur, 1817
      - Madreporaria
        - *Astrangia danae* Agassiz, 1847
      - Ceriantharia
        - *Cerianthus borealis* Verrill, 1873
        - *Cerianteopsis americanus* Verrill, 1866
- Annelida
  - Polychaeta
    - Phyllodocida
      - Phyllodocidae
        - *Eteone* sp.
        - *Eumida sanguinea* (Oersted) 1843
        - *Phyllodoce arenae* Webster, 1879
        - *Phyllodoce mucosa* Oersted, 1843
        - *Phyllodoce* sp.
      - Aphroditidae
        - *Aphrodita hastata* Moore, 1905
      - Polynoidae
        - *Harmothoe extenuata* (Grube) 1840
      - Sigalionidae
        - *Lean-ira* sp.
        - *Pholoe minuta* (Fabricius) 1780
        - *Sigalion arenicola* Verrill, 1879
        - *Sthenelais limicola* (Ehlers) 1864
      - Glyceridae
        - *Glycera americana* Leidy, 1855
        - *Glycera capitata* Oersted, 1843
        - *Glycera dibranchiata* Ehlers, 1868
        - *Glycera robusta* Ehlers, 1868
        - *Glycera tesselata* Grubé, 1863
      - Goniadidae
        - *Goniada brunnea* Treadwell, 1906
        - *Goniada maculata* (Oersted) 1843
        - *Goniadella gracilis* (Verrill) 1873
      - Sphaerodoridae
        - *Sphaerodorum gracilis* (Rathke) 1843
      - Nephtyidae
        - *Aglaophamus circinata* (Verrill) 1874
        - *Aglaophamus* sp.
        - *Nephtys bucera* Ehlers, 1868
        - *Nephtys incisa* Malmgren, 1865
        - *Nephtys picta* Ehlers, 1868
      - Syllidae
        - *Exogone verugera* (Clarapede) 1868
      - Pilgaridae
        - *Ancistrosyllis* sp.
      - Nereidae
        - *Ceratocephale loveni* Malmgren, 1867
        - *Nereis pelagica* Linnaeus, 1758
        - *Nereis* sp.
    - Capitellida
      - Capitellidae
        - *Capitella* sp.
      - Scalibregmidae
        - *Scalibregma inflatum* Rathke, 1843
      - Maldanidae
        - *Asychis biceps* (Sars), 1861
        - *Maldane* sp.
      - Opheleidae
        - *Ammotrypane aulogaster* Rathke, 1843
        - *Ammotrypane* sp.
        - *Ophelia denticulata* Verrill, 1875
        - *Travisia* sp.

TABLE 4.—*Invertebrate species contained in quantitative samples taken within the Middle Atlantic Bight region*—Continued

- Annelida—Continued
  - Polychaeta—Continued
    - Sternaspida
      - Sternaspidae
        - *Sternaspis scutata* (Renier) 1807
    - Spionida
      - Spionidae
        - *Dispio uncinata* Hartman, 1951
        - *Laonice cirrata* (Sars) 1851
        - *Prionospio* sp.
        - *Polydora concharum* Verrill, 1880
        - *Polydora* sp.
        - *Spio setosa* Verrill, 1873
        - *Spiophanes bombyx* (Clarapede) 1870
      - Paraonidae
        - *Aricidea jeffreysii* (McIntosh) 1879
        - *Paraonis fulgens* (Levinsen) 1883
        - *Paraonis neapolitana* Cerruti, 1909
      - Chaetopteridae
        - *Chaetopterus* sp.
        - *Spiochaetopterus* sp.
    - Eunicida
      - Onuphidae
        - *Diopatra cuprea* (Bosc) 1802
        - *Hyalinoecia tubicola* (Müller) 1776
        - *Onuphis conchylega* Sars, 1835
        - *Onuphis eremita* Audoin and Milne-Edwards, 1833
        - *Onuphis opalina* (Verrill) 1873
        - *Onuphis quadricuspis* Sars, 1872
        - *Paradiopatra* sp.
      - Eunicidae
        - *Eunice pennata* (Müller) 1776
        - *Marphysa belli* (Audoin and Milne-Edwards) 1883
      - Lumbrineridae
        - *Lumbrineris acuta* (Verrill) 1875
        - *Lumbrineris fragilis* (Müller) 1776
        - *Lumbrineris tenuis* (Verrill) 1873
        - *Ninoe nigripes* Verrill, 1873
      - Arabellidae
        - *Arabella iricolor* (Montagu) 1804
        - *Drilonereis longa* Webster, 1879
        - *Notocirrus* sp.
    - Amphinomida
      - Amphinomidae
        - *Paramphinome pulchella* Sars, 1872
    - Magelonida
      - Magelonidae
        - *Magelona* sp.
    - Ariciida
      - Orbiniidae
        - *Orbinia ornata* (Verrill) 1873
        - *Orbinia swani* Pettibone, 1957
        - *Scoloplos robustus* (Verrill) 1873
    - Cirratulida
      - Cirratulidae
        - *Chaetozone* sp.
        - *Cirratulus* sp.
        - *Cossura longocirrata* Webster and Benedict, 1883
        - *Tharyx* sp.
    - Oweniida
      - Oweniidae
        - *Owenia fusiformis* delle Chiaje, 1844
    - Terebellida
      - Pectinariidae
        - *Pectinaria gouldii* (Verrill) 1873
      - Ampharetidae
        - *Ampharete acutifrons* (Grube) 1860
        - *Ampharete arctica* Malmgren, 1866
        - *Asabellides oculata* Webster, 1879
        - *Melinna cristata* (Sars) 1851
      - Terebellidae
        - *Amphitrite* sp.
        - *Streblosoma spiralis* (Verrill) 1874

TABLE 4.—*Invertebrate species contained in quantitative samples taken within the Middle Atlantic Bight region*—Continued

- Annelida—Continued
  - Polychaeta—Continued
    - Flabelligerida
      - Flabelligeridae
        - *Brada* sp.
        - *Flabelligera* sp.
        - *Pherusa* sp.
    - Sabellida
      - Sabellidae
        - *Chone infundibuliformis* Kröyer, 1856
        - *Euchone* sp.
        - *Potamilla reniformis* (Linnaeus) 1788
        - *Sabella* sp.
- POGONOPHORA
  - Oligobrachiidae
    - *Oligobrachia floridana* Nielsen, 1965
  - Siboglinidae
    - *Siboglinum angustum* Southward and Brattegard, 1968
    - *Siboglinum bayeri* Southward, 1971
    - *Siboglinum ekmani* Jagerston, 1956
    - *Siboglinum gosnoldae* Southward and Brattegard, 1968
    - *Siboglinum holmei* Southward, 1963
    - *Siboglinum longicollum* Southward and Brattegard, 1968
    - *Siboglinum pholidotum* Southward and Brattegard, 1968
  - Polybrachiidae
    - *Crassibrachia sandersi* Southward, 1968
    - *Diplobrachia similis* Southward and Brattegard, 1968
    - *Diplobrachia* sp.
    - *Polybrachia lepida* Southward and Brattegard, 1968
    - *Polybrachia* sp.
- SIPUNCULIDA
  - *Aspidosiphon spinalis* Ikeda, 1904
  - *Aspidosiphon zinni* Cutler, 1969
  - *Golfingia catharinae* Müller, 1789
  - *Golfingia constricticervix* Cutler, 1969
  - *Golfingia elongata* (Keferstein) 1869
  - *Golfingia eremita* (Sars) 1851
  - *Golfingia flagrifera* (Selenka) 1885
  - *Golfingia margaritacea* (Sars) 1851
  - *Golfingia minuta* (Keferstein) 1865
  - *Golfingia murinae murinae* Cutler, 1969
  - *Golfingia trichocephala* (Sluiter) 1902
  - *Onchnesoma steenstrupi* Koren and Danielsson, 1875
  - *Phascolion strombi* (Montague) 1804
  - *Sipunculus norvegicus* Koren and Danielsson, 1875
- ECHIURA
  - Bonellidae
    - *Bonellia thomensis* Fisher, 1922
    - *Ikedella achaeta* (Zenkevitch, 1958)
    - *Prometor grandis* (Zenkevitch, 1957)
    - *Sluiterina sibogae* (Sluiter, 1902)
    - *Sluiterina* sp.
- MOLLUSCA
  - Gastropoda
    - Prosobranchia
      - Archaegastropoda
        - *Acmaea testudinalis* (Müller) 1776
        - *Calliostoma bairdi* Verrill and Smith, 1880
        - *Calliostoma occidentale* (Mighels and Adams) 1842
      - Mesogastropoda
        - *Alvania brychia* (Verrill) 1884
        - *Alvania carinata* Mighels and Adams, 1842
        - *Crepidula fornicata* Linnaeus, 1767
        - *Crepidula plana* Say, 1822
        - *Crucibulum striatum* Say, 1824
        - *Epitonium dallianum* Verrill and Smith, 1880

TABLE 4.—*Invertebrate species contained in quantitative samples taken within the Middle Atlantic Bight region*—Continued

- Mollusca—Continued
  - Gastropoda—Continued
    - Prosobranchia—Continued
      - Mesogastropoda—Continued
        - *Epitonium greenlandicum* (Perry) 1811
        - *Epitonium multistriatum* (Say) 1826
        - *Fossarus elegans* Verrill and Smith, 1882
        - *Lunatia heros* (Say) 1822
        - *Lunatia triseriata* (Say) 1826
        - *Melanella intermedia* (Cantraine) 1835
        - *Natica clausa* Bowderup and Sowerby, 1829
        - *Natica pusilla* Say, 1822
        - *Polinices duplicatus* (Say) 1822
        - *Polinices immaculatus* (Totten) 1835
        - *Turritellopsis acicula* (Stimpson) 1851
      - Neogastropoda
        - *Anachis* sp.
        - *Buccinum undatum* Linnaeus, 1758
        - *Busycon carica* (Gmelin) 1791
        - *Colus pubescens* Verrill, 1882
        - *Colus pygmaeus* (Gould) 1841
        - *Eupleura caudata* (Say) 1822
        - *Mitrella lunata* (Say) 1826
        - *Mitrella zonalis* Gould, 1848
        - *Nassarius trivittatus* (Say) 1822
        - *Neptunea decemcostata* (Say) 1826
        - *Taranis cirrata* (Brugnone) 1822
    - Euthyneura
      - Pyramidelloida
        - *Odostomia gibbosa* Bush, 1909
        - *Turbonilla interrupta* (Totten) 1835
      - Cephalapsida
        - *Cylichna alba* (Brown) 1827
        - *Cylichna gouldi* (Couthouy) 1839
        - *Haminoea solitaria* (Say) 1822
        - *Retusa obtusa* (Montagu) 1807
        - *Scaphander punctostriatus* Mighels, 1841
      - Notapsida
        - *Pleurobranchia tarda* Verrill, 1880
- Bivalvia
  - Paleotaxodonta
    - Nuculoida
      - Nuculidae
        - *Nucula delphinodonta* Mighels and Adams, 1842
        - *Nucula proxima* Say, 1822
        - *Nucula tenuis* Montagu, 1808
      - Malletiidae
        - *Malletia obtusata* G.O. Sars, 1872
      - Nuculanidae
        - *Nuculana acuta* (Conrad) 1831
        - *Nuculana tenuisulcata* (Couthouy) 1838
        - *Portlandia inflata* (Verrill and Bush) 1897
        - *Portlandia iris* (Verrill and Bush) 1897
        - *Yoldia limatula* (Say) 1831
        - *Yoldia sapotilla* (Gould) 1841
  - Cryptodonta
    - Solemyoida
      - Solemyacidae
        - *Solemya velum* Say, 1822
  - Pteriomorphia
    - Arcoida
      - Arcidae
        - *Anadara ovalis* (Brugiere) 1789
        - *Bathyarca anomala* (Verrill and Bush) 1898
        - *Bathyarca pectunculoides* (Scacchi) 1833
      - Limopsidae
        - *Limopsis minuta* Philippi, 1836
        - *Limopsis sulcata* Verrill and Bush, 1898
    - Mytiloida
      - Mytilidae
        - *Crenella decussata* (Montagu) 1808
        - *Crenella glandula* (Totten) 1834
        - *Crenella pectinula* (Gould) 1841
        - *Dacrydium vitreum* (Holboll and Müller) 1842
        - *Modiolus modiolus* (Linnaeus) 1758

TABLE 4.—*Invertebrate species contained in quantitative samples taken within the Middle Atlantic Bight region*—Continued

- Bivalvia—Continued
  - Pteriomorphia—Continued
    - Mytiloida—Continued
      - Mytilidae—Continued
        - *Musculus corrugatus* (Stimpson) 1851
        - *Musculus discors* (Linnaeus) 1767
        - *Musculus niger* (Gray) 1824
        - *Mytilus edulis* Linnaeus, 1758
    - Pteroidea
      - Pectinidae
        - *Aequipecten glyptus* (Verrill) 1882
        - *Pecten thalassinus* Dall, 1886
        - *Placopecten magellanicus* (Gmelin) 1791
      - Anomiidae
        - *Anomia aculeata* Linnaeus, 1758
        - *Anomia simplex* Orbigny, 1842
      - Limidae
        - *Limatula subauriculata* (Montagu) 1808
  - Heterodonta
    - Veneroida
      - Lucinidae
        - *Lucinoma filosa* (Stimpson) 1851
      - Leptonidae
        - *Aligena elevata* (Stimpson) 1851
      - Thyasiridae
        - *Thyasira ferruginosa* Forbes, 1844
        - *Thyasira flexuosa* (Montagu) 1803
        - *Thyasira ovata* Verrill and Bush, 1898
        - *Thyasira pygmaea* Verrill and Bush, 1898
        - *Thyasira trisinuata* Orbigny, 1842
      - Carditidae
        - *Cyclocardia borealis* (Conrad) 1831
      - Astartidae
        - *Astarte borealis* (Schumacher) 1817
        - *Astarte castanea* (Say) 1822
        - *Astarte elliptica* (Brown) 1827
        - *Astarte quadrans* Gould, 1841
        - *Astarte subequilatera* Sowerby, 1854
        - *Astarte undata* Gould, 1841
      - Cardiidae
        - *Cerastoderma pinnulatum* (Conrad) 1831
        - *Laevicardium mortoni* (Conrad) 1830
      - Mactridae
        - *Mulinia lateralis* (Say) 1822
        - *Spisula solidissima* (Dillwyn) 1817
      - Solenidae
        - *Ensis directus* Conrad, 1843
        - *Siliqua costata* Say, 1822
      - Tellinidae
        - *Macoma balthica* (Linnaeus) 1758
        - *Macoma tenta* (Say) 1834
        - *Tellina agilis* Stimpson, 1857
      - Semelidae
        - *Abra longicallis* Verrill and Bush, 1898
      - Arcticidae
        - *Arctica islandica* (Linnaeus) 1767
      - Veneridae
        - *Liocyma fluctuosa* (Gould) 1841
        - *Mercenaria mercenaria* (Linnaeus) 1758
        - *Pitar morrhuanus* Linsley, 1848
      - Mesodesmatidae
        - *Mesodesma arctatum* (Conrad) 1830
      - Petricolidae
        - *Petricola pholadiformis* (Lamarck) 1818
    - Myoida
      - Myidae
        - *Mya arenaria* Linnaeus, 1758
      - Corbulidae
        - *Corbula contracta* Say, 1822
      - Hiatellidae
        - *Cyrtodaria siliqua* (Spengler) 1793
        - *Hiatella arctica* (Linnaeus) 1767
        - *Panomya arctica* (Lamarck) 1818
  - Analodesmacea
    - Pholadomyoida
      - Lyonsiidae
        - *Lyonsia hyalina* Conrad, 1831

TABLE 4.—*Invertebrate species contained in quantitative samples taken within the Middle Atlantic Bight region*—Continued

Bivalvia—Continued
  Analodesmacea—Continued
    Pholadomyoida—Continued
      Pandoridae
        Pandora gouldiana Dall, 1886
        Pandora inflata Boss and Merrill, 1965
        Pandora inornata Verrill and Bush, 1898
      Thraciidae
        Thracia conradi Couthouy, 1838
        Thracia myopsis (Möller) 1842
      Periplomatidae
        Periploma afinis Verrill and Bush, 1898
        Periploma fragile (Totten) 1835
        Periploma leanum (Conrad) 1831
        Periploma papyratium (Say) 1822
    Septibranchoida
      Poromyidae
        Poromya granulata (Nyest and Westendorp) 1839
      Cuspidariidae
        Cardiomya perrostrata Dall, 1881
        Cardiomya striata (Jeffreys) 1876
        Cuspidaria parva Verrill and Bush, 1898
        Myonera limatula Dall, 1881
  Scaphopoda
    Cadulus pandionis Verrill and Smith, 1880
    Cadulus verrilli Henderson, 1920
    Dentalium occidentale Stimpson, 1851
ARTHROPODA
  Pycnogonida
    Achelia spinosa (Stimpson) 1853
    Anoplodactylus parvus Giltay, 1934
    Nymphon sp.
    Crustacea
      Ostracoda
        Cycloberis sp.
        Pseudophilomedes ferulanus Kornicker, 1959
      Cirripedia
        Balanus balanus (Linnaeus) 1758
        Balanus crenatus Brugiere, 1789
        Balanus venustus niveus Darwin, 1854
      Nebaliacea
      Cumacea
        Diastylis polita S.I. Smith, 1879
        Diastylis quadrispinosa G.O. Sars, 1871
        Diastylis sculpta G.O. Sars, 1871
        Eudorella emarginata (Kröyer) 1846
        Eudorellopsis sp.
        Leptostylis sp.
        Petalosarsia declivis (G.O. Sars) 1864
      Tanaidacea
        Anorthura sp.
        Neotanais sp.
      Isopoda
        Calathura sp.
        Chiridotea arenicola Wigley, 1960
        Chiridotea tuftsi (Stimpson) 1883
        Cirolana polita (Stimpson) 1853
        Cyathura polita (Stimpson) 1855
        Edotea triloba (Say) 1818
        Erichsonella filiformis (Say) 1818
        Idotea sp.
        Ptilanthura tenuis Harger, 1879
  Amphipoda
    Gammaridea
      Gammaridae
        Gammarus annulatus Smith, 1873
        Gammarus mucronatus Say, 1818
        Gammarus palustris Bousfield, 1969
      Crangonycidae
        Crangonyx pseudogracilis Bousfield, 1958
      Melitidae
        Casco bigelowi (Blake) 1929
        Elasmopus levis Smith, 1873
        Maera danae Stimpson, 1853
        Maera loveni (Bruzelius) 1859

TABLE 4.—*Invertebrate species contained in quantitative samples taken within the Middle Atlantic Bight region*—Continued

Amphipoda—Continued
  Gammaridea—Continued
        Melita dentata (Kröyer) 1842
        Melita palmata (Montagu) 1894
      Haustoriidae
        Acanthohaustorius millsi Bousfield, 1965
        Amphiporeia virginiana Shoemaker, 1933
        Bathyporeia parkeri Bousfield, 1973
        Bathyporeia quoddyensis Shoemaker, 1949
        Protohaustorius wigleyi Bousfield, 1965
        Pseudohaustorius borealis Bousfield, 1965
      Phoxocephalidae
        Harpinia propinqua Sars, 1895
        Phoxocephalus holbolli Kröyer, 1842
        Trichophoxis epistomus (Shoemaker) 1938
      Pontogeneidae
        Pontogeneia inermis (Kröyer) 1842
      Pleustidae
        Stenopleustes gracilis (Holmes) 1905
        Stenopleustes inermis Shoemaker, 1949
      Ampeliscidae
        Ampelisca abdita Mills, 1967
        Ampelisca aequicornis Bruzelius, 1859
        Ampelisca agassizi Judd, 1896
        Ampelisca macrocephala Liljeborg, 1852
        Ampelisca vadorum Mills, 1963
        Ampelisca verrilli Mills, 1967
        Byblis gaimardi (Kröyer) 1846
        Byblis serrata Smith, 1873
      Liljeborgiidae
        Liljeborgia sp.
        Listriella sp.
      Lysianassidae
        Anonyx liljeborgi Boeck, 1870
        Anonyx sp.
        Hippomedon propinquus Sars, 1870
        Hippomedon serratus Holmes, 1905
        Orchromenella groenlandica (Hansen) 1887
        Orchromenella pinguis (Boeck) 1861
        Psammonyx nobilis (Stimson) 1853
      Aoridae
        Lembos sp.
        Leptocheirus pinguis (Stimpson) 1853
        Leptocheirus plumulosus Shoemaker, 1932
        Pseudunciola obliquua (Shoemaker) 1949
        Unciola inermis Shoemaker, 1942
        Unciola irrorata Say, 1818
        Unciola leucopis (Kröyer) 1845
      Photidae
        Photis macrocoxa Shoemaker, 1945
        Photis reinhardi Kröyer, 1842
        Protomedia fasciata Kröyer, 1842
      Ischyroceridae
        Ischyrocerus anguipes Kröyer, 1838
      Corophiidae
        Cerapis tubularis Say, 1818
        Corophium insidiosum Crawford, 1937
        Corophium volutator (Pallas) 1766
        Corophium sp.
        Erichthonius brasiliensis (Dana) 1853
        Erichthonius rubricornis Smith, 1873
        Siphonoectes smithianus Rathbun, 1908
      Podoceridae
        Dulichia porrecta (Bate) 1857
    Caprellidea
      Caprellidae
        Aeginina longicornis (Kröyer) 1842–43
        Caprella penantis Leach, 1814
        Caprella septentrionalis Kröyer, 1838
        Caprella unica Mayer, 1903
        Caprella sp.
        Luconatia incerta Mayer, 1903
  Mysidacea
    Bowmaniella portoriciensis Bacescu, 1968

TABLE 4.—*Invertebrate species contained in quantitative samples taken within the Middle Atlantic Bight region*—Continued

- ARTHROPODA—Continued
  - Amphipoda—Continued
    - Mysidacea—Continued
      - *Erythrops erythropthalma* (Goes) 1864
      - *Heteromysis formosa* S.I. Smith, 1873
      - *Mysidopsis bigelowi* Tattersall, 1926
      - *Neomysis americana* (S.I. Smith) 1873
      - *Promysis atlantica* Tattersall, 1923
    - Decapoda
      - Caridea
        - *Crangon septemspinosus* Say, 1818
        - *Dichelopandalus leptocerus* (Smith) 1881
      - Anomura
        - *Axius serratus* Stimpson, 1852
        - *Callichirus atlanticus* (Smith) 1874
        - *Munida* sp.
        - *Pagurus acadianus* Benedict, 1901
        - *Pagurus arcuatus* Squires, 1964
        - *Pagurus pubescens* (Kröyer) 1838
        - *Upogebia affinis* (Say) 1817
      - Brachyura
        - *Cancer borealis* Stimpson, 1859
        - *Cancer irroratus* Say, 1817
        - *Hyas coarctatus* Leach, 1815
        - *Libinia emarginata* Leach, 1815
        - *Ocypode quadrata* (Fabricius) 1787
        - *Pinnixa sayana* Stimpson, 1860
- BRYOZOA
  - Ctenostomata
    - Alcyonidiidae
      - *Alcyonidium* sp.
  - Cyclostomata
    - Crisiidae
      - *Crisia eburnea* (Linnaeus) 1758
  - Cheilostomata
    - Scrupraridae
      - *Eucratea loricata* (Linnaeus) 1758
      - *Haplota clavata* (Hincks) 1857
    - Membraniporidae
      - *Conopeum reticulum* (Linnaeus) 1767
      - *Membranipora tenuis* Desor, 1848
      - *Membranipora tuberculata* (Bosc) 1802
    - Electridae
      - *Electra hastingsae* Marcus, 1938
      - *Electra pilosa* (Linnaeus) 1767
    - Calloporidae
      - *Amphiblestrum flemingii* (Bush) 1854
      - *Callopora aurita* (Hincks) 1877
      - *Callopora lineata* (Linnaeus) 1767
    - Bugulidae
      - *Bugula turrita* (Desor) 1848
      - *Dendrobeania murrayana* (Johnston) 1847
    - Cribrilinidae
      - *Cribrilina punctata* (Hassall) 1841
    - Schizoporellidae
      - *Schizoporella unicornis* (Johnston) 1847
    - Microporellidae
      - *Microporella ciliata* (Pallas) 1766
    - Hippoporinidae
      - *Hippoporina americana* (Verrill) 1875
      - *Hippoporina porosa* (Esper) 1796
    - Smittinidae
      - *Rhamphostomella costata* Lorenz, 1886
    - Cheiloporinidae
      - *Cryptosula palasiana* (Moll) 1803
- ECHINODERMATA
  - Holothuroidea
    - Dendrochirodota
      - *Cucumaria planci* Marenzeller, 1893
      - *Havelockia scabra* (Verrill) 1873
      - *Psolus fabricii* (Duben and Koren) 1846
      - *Stereoderma unisemita* (Stimpson) 1851
      - *Thyone fusus* (Müller) 1788
    - Apodida
      - *Chirodota wigleyi* Pawson, 1976
      - *Synapta* sp.

TABLE 4.—*Invertebrate species contained in quantitative samples taken within the Middle Atlantic Bight region*—Continued

- ECHINODERMATA—Continued
  - Holothuroidea—Continued
    - Molpadiida
      - *Caudina arenata* Gould, 1841
      - *Molpadia musculus* Risso, 1826
      - *Molpadia oolitica* (Pourtales) 1857
  - Echinoidea
    - Cideroidea
      - *Stylocidaris affinis* Phillips, 1845
    - Arbacioidea
      - *Arbacia punctulata* (Lamarck) 1816
    - Temnopleuroidea
      - *Genocidaris maculata* Agassiz, 1869
    - Clypeasteroidea
      - *Echinarachnius parma* (Lamarck) 1816
      - *Encope* sp.
      - *Mellita quinquiesperforata* (Leske) 1778
    - Spatangoidea
      - *Aceste bdellifera* Wyville Thompson, 1877
      - *Aeropsis rostrata* Norman, 1876
      - *Brisaster fragilis* (Duben and Koren) 1844
      - *Brissopsis atlantica* Mortensen, 1907
      - *Echinocardium cordatum* Pennant, 1777
      - *Schizaster orbignyanus* A. Agassiz, 1883
  - Ophiuroidea
    - Ophiuridae
      - *Ophiocten scutatem* Koehler, 1896
      - *Ophiocten sericeum* (Forbes) 1852
      - *Ophiomusium lymani* Thompson, 1873
      - *Ophiura acenata*
      - *Ophiura ljungmani* (Lyman) 1878
      - *Ophiura sarsi* Lütken, 1858
    - Ophiocanthidae
      - *Amphilimna olivacea* (Lyman) 1869
    - Ophiactidae
      - *Ophiopholus aculeata* (Linnaeus) 1788
    - Amphiuridae
      - *Amphioplus abdita* (Verrill) 1872
      - *Amphioplus tumidus* (Lyman) 1878
      - *Amphiura fragilis* (Verrill) 1885
      - *Amphiura otteri* Ljungman, 1871
      - *Axiognathus squamatus* (delle Chiaje) 1828
      - *Micropholis atra*
    - Amphilepidae
      - *Amphilepis ingolfiana* Mortensen, 1933
  - Asteroidea
    - *Asterias forbesii* (Desor) 1848
    - *Asterias vulgaris* Verrill, 1866
    - *Astropecten americana* (Verrill) 1880
    - *Astropecten articulatus* Say, 1825
    - *Leptasterias* sp.
- HEMICHORDATA
  - Enteropneusta
    - *Balanoglossus* sp.
- CHORDATA
  - Ascidiacea
    - *Bostrichobranchus pilularis* (Verrill) 1871
    - *Ciona intestinalis* (Linnaeus) 1767
    - *Cnemidocarpa mollis* (Stimpson) 1852
    - *Craterostigma singulare* (Van Name) 1912
    - *Molgula citrina* Adler and Hancock, 1848
    - *Molgula complanata* Alder and Hancock, 1870
    - *Molgula siphonalis* Sars, 1859

Leptocheirus, Unciola (Amphipoda); *Cancer* (Decapoda); *Cirolana* (Isopoda); *Astropecten* (*Asteroidea*); *Echinarachnius, Brisaster* (Echinoidea).

SUBAREA DIFFERENCES IN COMPOSITION

The macrobenthic fauna in all three subareas of the Middle Atlantic Bight region was dominated by the same four major taxonomic groups—Arthropoda, Mollusca, Annelida, and Echinodermata (tables 5, 6, 7; and fig. 6). However, there were pronounced variations in absolute and proportional quantities within these groups.

Number of individuals.—Striking diversity in proportional makeup of the fauna was evident in all four dominant taxonomic groups. Arthropoda were particularly abundant in Southern New England, where they constituted 62 percent of the total number of specimens. Southward, they decreased in nearly equal amounts, and accounted for 42 percent of the total fauna in New York Bight and 21 percent in Chesapeake Bight. Nearly the opposite trend was seen in the abundance of Mollusca. In Southern New England, they accounted for about 10 percent of the number of animals, but increased southward to 18 percent in New York Bight and 57 percent in Chesapeake Bight. Annelida showed a somewhat different trend in percentage composition. They formed approximately equal proportions in Southern New England (18 percent) and Chesapeake Bight (15 percent), but constituted a substantially larger proportion of the fauna in New York Bight (33 percent). Echinodermata made up a moderately small (2–5 percent) share of the fauna in all areas, but the number present in Southern New England (4.6 percent of the total fauna) and in New York Bight (4.2 percent) was double the proportion present in Chesapeake Bight (2.3 percent).

Biomass.—Proportional composition of the biomass was more consistent than the number of specimens from one subarea to another. Furthermore, the components had a different order of dominance. Mollusca constituted 64 percent of the biomass in both Southern New England and Chesapeake Bight, and the extra-ordinarily high quantity of 80 percent in New York Bight. Echinodermata ranked second and had roughly equal proportions, between 11 and 13 percent in all subareas. Annelida ranked third and accounted for 9 percent of the biomass in Southern New England, 5 percent in New York Bight, and 10 percent in Chesapeake Bight. Arthropoda, which ranked first in number of specimens, ranked fourth in biomass. They were substantially more important in Southern New England (where they formed 7.5 percent of the fauna) than in the two more southern subareas where they made up 3.2 and 3.1 percent of the biomass, respectively. Miscellaneous taxonomic groups (Ascidiacea, Coelenterata, Bryozoa, Nemertea, and nine additional groups) were moderately important in Southern New England (6.9 percent) and Chesapeake Bight (10.0 percent), whereas in New York Bight they accounted for only 1.3 percent of the biomass.

The relationship between faunal composition and geographic distribution, water depth, bottom sediments, sediment organic content, and water temperature are analyzed in subsequent sections. Quantitative geographic distribution of dominant faunal components is discussed in the section "Dominant Faunal Components."

GEOGRAPHIC DISTRIBUTION

Before ecological communities or associations of a particular region can be ascertained, the distribution of the important taxonomic groups in that region must be known.

The graphic presentation, in the form of charts, of the quantitative geographic distribution of various major taxonomic components of the benthic fauna is one of the more useful methods of expressing quantitative occurrence for the purpose of determining ecological communities. Throughout this report where the phrase "major taxonomic component" is used, we are referring to the higher taxa—phyla, classes, and orders—as listed in tables 12 and 13. The charts permit the reader to visually integrate relationships between other organisms and between the numerous abiotic factors that may influence the occurrence of a particular species or faunal group. With these aspects in mind, we prepared two quantitative distribution charts for each major taxonomic group found in the Middle Atlantic Bight region. One chart presents the number of individuals (density) and the second presents their weight (biomass); both are expressed in terms of $1m^2$ of bottom area.

TOTAL MACROBENTHIC FAUNA OF ALL TAXONOMIC GROUPS

The density distribution of benthic animals, all taxonomic groups combined, in the Middle Atlantic Bight region showed two major trends. One trend pertains to density in relation to inshore-offshore location. High densities generally prevailed in the coastal areas, moderate densities on the Continental Shelf, and low densities in the offshore, deep waters. A second trend in density distribution pertains to latitudinal differences. In the northern part of the Middle Atlantic Bight region, especially those areas off southern Massachusetts and Rhode Island, there are extensive tracts where the density of benthic animals was high (greater than $1,000/m^2$) or very

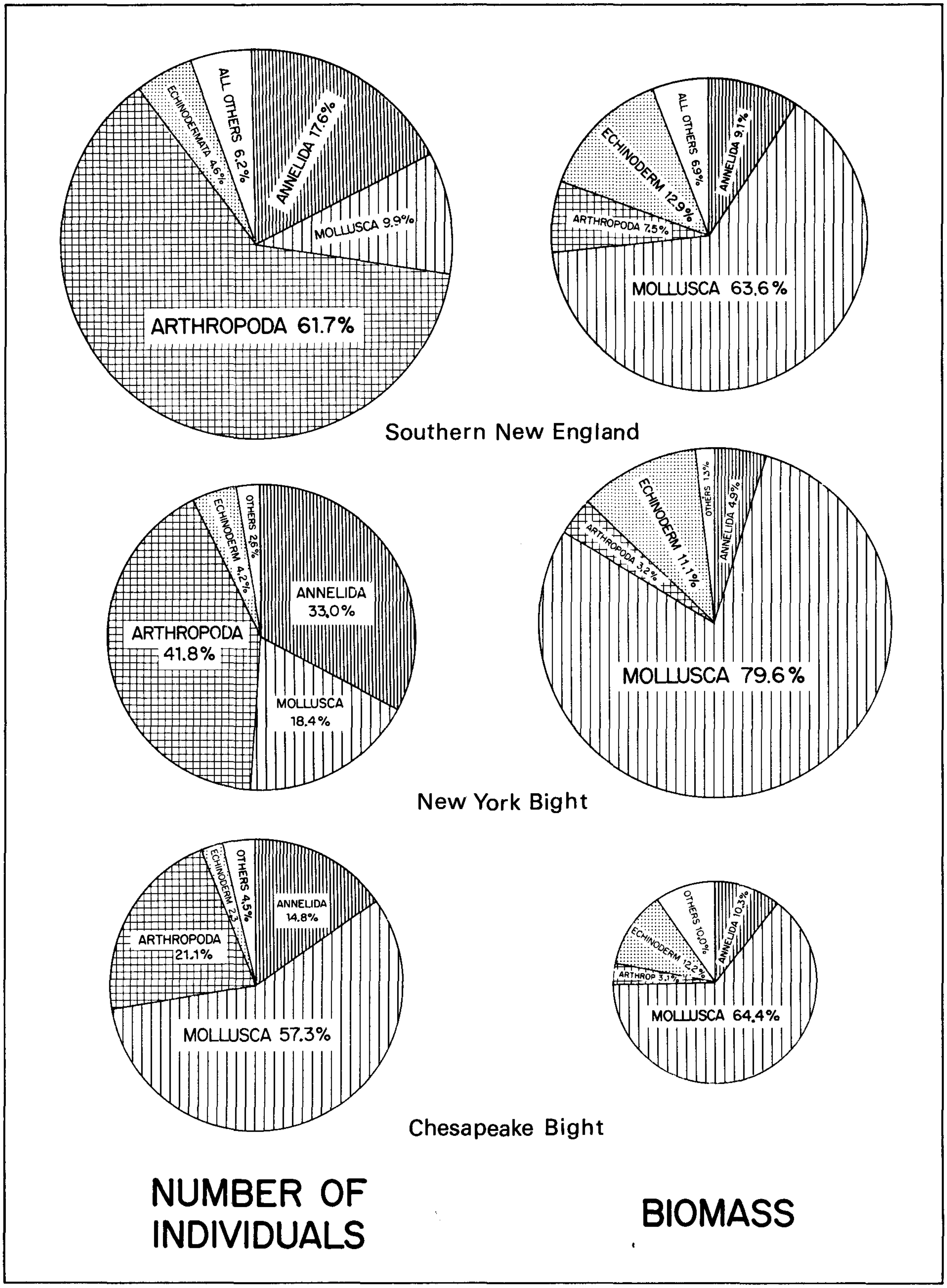

FIGURE 6.—Pie charts illustrating the taxonomic composition of the total macrobenthic fauna for each subarea in the Middle Atlantic Bight region. Numbers of individuals are shown on the left side, and biomasses are shown on the right side. The area of each circle is proportional to the mean density or mean biomass.

TABLE 5.—*Quantitative taxonomic composition of the macrobenthic invertebrate fauna, in both number of individuals and biomass, representing the Southern New England subarea*

Taxonomic group	Number of individuals			Biomass		
	Mean	Percent	Phylum rank	Mean	Percent	Phylum rank
	No./m²			g/m²		
PORIFERA	0.75	0.04	13	0.113	0.05	10
COELENTERATA	29.26	1.50	6	4.617	2.19	6
Hydrozoa	14.52	0.74		0.624	0.30	
Anthozoa	14.74	0.75		3.993	1.90	
Alcyonacea	0.80	0.04		0.165	0.08	
Zoantharia	6.31	0.32		3.566	1.69	
Unidentified	7.63	0.39		0.262	0.12	
PLATYHELMINTHES	1.46	0.07	11	0.012	0.01	14
Turbellaria	1.46	0.07		0.012	0.01	
NEMERTEA	5.99	0.31	10	0.781	0.37	8
ASCHELMINTHES	6.06	0.31	9	0.007	<0.01	16
Nematoda	6.06	0.31		0.007	<0.01	
ANNELIDA	343.92	17.60	2	19.051	9.05	3
POGONOPHORA	1.27	0.06	12	0.009	<0.01	15
SIPUNCULIDA	9.31	0.48	8	1.369	0.65	7
ECHIURA	0.09	<0.01	15	0.051	0.02	11
PRIAPULIDA	0.03	<0.01	16	0.021	0.01	13
MOLLUSCA	193.67	9.91	3	133.869	63.58	1
Polyplacophora	1.06	0.05		0.428	0.20	
Gastropoda	39.75	2.03		3.489	1.66	
Bivalvia	150.40	7.69		129.924	61.70	
Scaphopoda	0.90	0.05		0.014	<0.01	
Cephalopoda	0.99	0.05		0.013	<0.01	
Unidentified	0.57	0.03		0.002	<0.01	
ARTHROPODA	1206.10	61.71	1	15.746	7.48	4
Pycnogonida	0.49	0.03		0.002	<0.01	
Arachnida	-	-		-	-	
Crustacea	1205.61	61.68		15.744	7.48	
Ostracoda	0.32	0.02		0.002	<0.01	
Cirripedia	20.57	1.05		7.339	3.49	
Copepoda	0.09	<0.01		0.001	<0.01	
Nebaliacea	-	-		-	-	
Cumacea	29.00	1.48		0.135	0.06	
Tanaidacea	0.11	<0.01		0.001	<0.01	
Isopoda	9.76	0.50		0.218	0.10	
Amphipoda	1136.87	58.17		7.023	3.34	
Mysidacea	1.34	0.07		0.009	<0.01	
Decapoda	7.55	0.39		1.017	0.48	
BRYOZOA	26.47	1.35	7	0.774	0.37	9
BRACHIOPODA	-	-		-	-	
ECHINODERMATA	90.00	4.60	4	27.276	12.95	2
Holothuroidea	4.83	0.25		14.038	6.67	
Echinoidea	9.97	0.51		6.397	3.04	
Ophiuroidea	73.39	3.75		4.612	2.19	
Asteroidea	1.81	0.09		2.231	1.06	
HEMICHORDATA	0.27	0.01	14	0.050	0.02	12
CHORDATA	32.13	1.64	5	6.364	3.02	5
Ascidiacea	32.13	1.64		6.364	3.02	
UNIDENTIFIED	7.75	0.40		0.445	0.21	

TABLE 6.—*Quantitative taxonomic composition of the macrobenthic invertebrate fauna, in both number of individuals and biomass, representing the New York Bight subarea*

Taxonomic group	Number of individuals			Biomass		
	Mean	Percent	Phylum rank	Mean	Percent	Phylum rank
	No./m²			g/m²		
PORIFERA	0.53	0.04	11	0.027	0.01	11
COELENTERATA	8.82	0.74	5	1.386	0.50	5
Hydrozoa	4.42	0.37		0.064	0.02	
Anthozoa	4.40	0.37		1.321	0.50	
Alcyonacea	0.62	0.05		0.064	0.02	
Zoantharia	3.11	0.26		1.166	0.42	
Unidentified	0.67	0.06		0.092	0.03	
PLATYHELMINTHES	0.06	0.01	15	0.003	<0.01	14
Turbellaria	0.06	0.01		0.003	<0.01	
NEMERTEA	2.65	0.22	8	0.740	0.27	6
ASCHELMINTHES	0.13	0.01	13	0.001	<0.01	15
Nematoda	0.13	0.01		0.001	<0.01	
ANNELIDA	391.67	33.00	2	13.393	4.88	3
POGONOPHORA	0.84	0.07	10	0.004	<0.01	13
SIPUNCULIDA	2.00	0.17	9	0.324	0.12	7
ECHIURA	0.18	0.02	12	0.282	0.10	9
PRIAPULIDA	-	-		-	-	
MOLLUSCA	218.98	18.45	3	218.634	79.60	1
Polyplacophora	0.06	0.01		0.001	<0.01	
Gastropoda	22.01	1.85		2.352	0.86	
Bivalvia	195.32	16.46		216.253	78.74	
Scaphopoda	1.59	0.13		0.028	0.01	
Cephalopoda	-	-		-	-	
Unidentified	-	-		-	-	
ARTHROPODA	496.15	41.81	1	8.719	3.17	4
Pycnogonida	0.06	0.01		0.001	<0.01	
Arachnida	0.14	0.01		0.001	<0.01	
Crustacea	495.95	41.79		8.717	3.17	
Ostracoda	0.28	0.02		0.002	<0.01	
Cirripedia	69.75	5.88		3.979	1.45	
Copepoda	0.02	<0.01		<0.001	<0.01	
Nebaliacea	0.01	<0.01		<0.001	<0.01	
Cumacea	8.58	0.72		0.045	0.02	
Tanaidacea	0.02	<0.01		<0.001	<0.01	
Isopoda	10.58	0.89		0.356	0.13	
Amphipoda	396.58	33.42		2.547	0.93	
Mysidacea	0.95	0.08		0.005	<0.01	
Decapoda	9.18	0.77		1.782	0.65	
BRYOZOA	4.93	0.42	7	0.103	0.04	10
BRACHIOPODA	-	-		-	-	
ECHINODERMATA	49.48	4.17	4	30.446	11.09	2
Holothuroidea	0.86	0.07		0.513	0.19	
Echinoidea	40.24	3.39		25.801	9.39	
Ophiuroidea	7.66	0.65		0.552	0.20	
Asteroidea	0.72	0.06		3.581	1.30	
HEMICHORDATA	0.07	0.01	14	0.004	<0.01	12
CHORDATA	5.43	0.46	6	0.340	0.12	8
Ascidiacea	5.43	0.46		0.340	0.12	
UNIDENTIFIED	4.81	0.41		0.245	0.09	

TABLE 7.—*Quantitative taxonomic composition of the macrobenthic invertebrate fauna, in both number of individuals and biomass, representing the Chesapeake Bight subarea*

Taxonomic group	Number of individuals			Biomass		
	Mean	Percent	Phylum rank	Mean	Percent	Phylum rank
	No./m²			g/m²		
PORIFERA	0.42	0.04	12	0.037	0.04	11
COELENTERATA	15.26	1.41	5	2.933	3.31	5
Hydrozoa	9.78	0.90		0.202	0.23	
Anthozoa	5.48	0.51		2.731	3.08	
Alcyonacea	0.12	0.01		0.045	0.05	
Zoantharia	2.04	0.19		2.549	2.87	
Unidentified	3.32	0.31		0.138	0.16	
PLATYHELMINTHES	0.39	0.04	13	0.007	0.01	14
Turbellaria	0.39	0.04		0.007	0.01	
NEMERTEA	4.88	0.45	8	0.342	0.39	9
ASCHELMINTHES	1.64	0.15	10	0.006	0.01	15
Nematoda	1.64	0.15		0.006	0.01	
ANNELIDA	160.16	14.78	3	9.102	10.27	3
POGONOPHORA	3.59	0.33	9	0.022	0.02	13
SIPUNCULIDA	0.59	0.05	11	0.383	0.43	8
ECHIURA	0.18	0.02	14	0.411	0.46	7
PRIAPULIDA	0.01	<0.01	16	0.005	0.01	16
MOLLUSCA	620.97	57.29	1	57.144	64.45	1
Polyplacophora	0.24	0.02		0.006	0.01	
Gastropoda	45.46	4.19		3.400	3.83	
Bivalvia	573.98	52.95		53.713	60.58	
Scaphopoda	1.29	0.12		0.025	0.03	
Cephalopoda	-	-		-	-	
Unidentified	-	-		-	-	
ARTHROPODA	228.88	21.12	2	2.711	3.06	6
Pycnogonida	1.06	0.10		0.006	0.01	
Arachnida	-	-		-	-	
Crustacea	227.82	21.02		2.705	3.05	
Ostracoda	0.05	<0.01		<0.001	0.05	
Cirripedia	0.18	0.02		0.003	<0.01	
Copepoda	-	-		-	-	
Nebaliacea	0.03	<0.01		<0.001	<0.01	
Cumacea	10.35	0.95		0.035	0.04	
Tanaidacea	0.04	<0.01		<0.001	<0.01	
Isopoda	16.53	1.53		0.297	0.33	
Amphipoda	191.93	17.71		1.509	1.70	
Mysidacea	3.84	0.35		0.013	0.02	
Decapoda	4.87	0.45		0.848	0.96	
BRYOZOA	5.45	0.50	7	0.115	0.13	10
BRACHIOPODA	0.01	<0.01	17	<0.001	<0.01	17
ECHINODERMATA	25.07	2.31	4	10.818	12.20	2
Holothuroidea	0.80	0.07		1.714	1.93	
Echinoidea	19.04	1.76		8.766	9.89	
Ophiuroidea	5.06	0.47		0.271	0.31	
Asteroidea	0.17	0.02		0.067	0.08	
HEMICHORDATA	0.06	<0.01	15	0.030	0.03	12
CHORDATA	6.74	0.62	6	4.461	5.03	4
Ascidiacea	6.74	0.62		4.461	5.03	
UNIDENTIFIED	9.61	0.89		0.135	0.15	