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A QUANTITATIVE SURVEY OF THE INVERTEBRATE BOTTOM FAUNA IN MENEMSHA BIGHT

RICHARD E. LEE

(*The Woods Hole Oceanographic Institution*,[1, 2] *Woods Hole; Washington Square College, New York University, New York*)

Extensive qualitative surveys of the marine invertebrate bottom dwelling organisms in the Woods Hole area have been carried out by Verrill (1873), Sumner, Osborn, and Cole (1911), Allee (1923), and several other investigators, but quantitative methods have not been used in the study of the fauna of this region. A study was therefore begun in order to examine in a quantitative manner the more common marine invertebrate organisms occurring within a restricted area of the bottom of the Woods Hole region.

For the purposes of this evaluation, it was decided to examine the bottom fauna of Menemsha Bight. There are two primary reasons for this choice. In the first place, Menemsha Bight is a relatively well defined body of water formed by an indentation of the western shore of Martha's Vineyard island between Gay Head and Cape Higgon, near the western end of Vineyard Sound (Chart 1). Secondly, the flounder which are captured in the Bight during the months of July, August, and September are of considerable economic importance. Therefore, it is of interest to know in what manner the bottom fauna enters into the general food cycle of the area. Either the direct or the indirect food relationships of this fish may be influenced by changes in the number and type of smaller animals living on and in the bottom. This may in turn affect the length of season when the fish are present in the region and perhaps underlie annual fluctuations which occur in their abundance.

The present survey is a preliminary attempt to investigate these problems in a quantitative manner. In addition to determining the various common species of animals present in the bottom fauna, an attempt is made to establish their numerical distribution over the area. The wet weight of each catch and dry weight of the combustible organic matter that it contained are also determined as a rough index of the possible potential food supply which the different categories of animals represent.

[1] Contribution No. 330.

[2] It is a pleasure to thank Dr. George L. Clarke for his aid in this problem. His stimulating interest was a source of much encouragement to the author.

Quantitative studies of the invertebrate marine bottom fauna in flounder fishing grounds have been made by several European investigators. The work of Petersen (1911, 1915, 1918), Jensen (1919), Blegvad (1914, 1925), and others in the Danish fishing grounds is well known. Davis (1923, 1925) has made several quantitative studies of the bottom fauna in the deep water fishing areas of the North Sea, while Idelson (1930) has carried out comparable investigations on the Spitzbergen

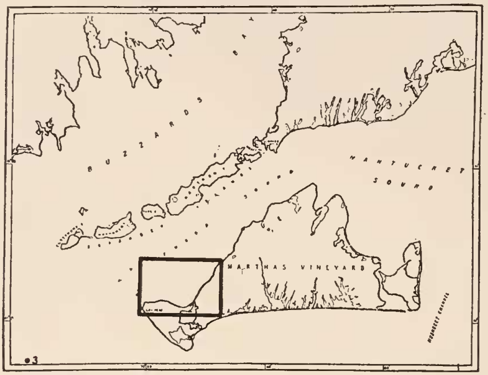


CHART 1. Map of Vineyard Sound and the adjacent islands. Menemsha Bight is the area enclosed by a heavy black line on the western end of Martha's Vineyard.

Banks. In the western hemisphere, however, the extensive quantitative studies of marine bottom fauna have been restricted chiefly to the Pacific coastal regions (Shelford and Towler, 1925; Shelford, Weese, *et al.*, 1935; Weese and MacNab, 1930) while the several investigations of bottom animals along the Atlantic coastline have been largely of a qualitative nature.

METHODS

Apparatus

Many previous investigators have found that the Petersen dredge (Petersen, 1911) was the most satisfactory bottom sampler devised to date for the purposes of their work. Preliminary trials of this instrument on sand, mud, gravel, and stony bottoms in Vineyard Sound, however, reveal that this dredge is highly unsatisfactory for quantitative sampling in this region, for it is relatively small and due to its lack of weight the jaws of the bucket frequently fail to penetrate the bottom deeply enough to obtain a sample or to capture other than organisms living upon the surface of the bottom. For these reasons, a larger and heavier dredge of the so-called "clam shell" design was purchased from the Hayward Company of New York. This instrument, made of special rust-resistant steel, weighs over 300 pounds when empty and covers a section of the bottom 101 × 56 cms. in area with its jaws open. It digs to a maximum depth of 23 cms. and holds 56 liters of material (wet sand) when level full. The single cable used in operating the bucket is tightly fastened to and winds about a counter-balanced revolving drum in the frame of the instrument. When the cable is hauled taut, the drum rotates and closes the jaws of the bucket. The drum turns in the opposite direction and opens the jaws when strain is removed from the closing cable. Thus a releasing hook inserted into the cable at a suitable point supports the weight of the instrument, with the terminal closing cable slack and the jaws open, during the descent to the bottom.

When removing animals from samples of bottom material of the size which this dredge obtains, manual sorting of the entire contents is impractical. Therefore, the material was poured into a hopper provided with a set of three removable screens which had pore spaces of 18.0, 10.0, and 1.8 mm. respectively. The sample was washed down through the screens, each of which withheld a fraction of the catch and thus prevented the coarser material from collecting in the final screen to crush the smaller, more delicate, organisms. A comparable method of removing animals from samples of bottom material has been used with success by Petersen (1911, 1913), Blegvad (1925, 1928), and Davis (1923, 1925).

The plan of the survey

It was considered impractical, due to strong tidal currents in Menemsha Bight, to attempt a grid-work of stations over the area. Instead, the stations were made in a series of five profiles extending offshore from the 2.5 meter depth contour along a compass course, with the samples taken at definite intervals. Two additional lines of stations were made roughly parallel to the shoreline (Chart 2). The close spacing of stations along such profiles gives more accurate information on the variability of bottom types and faunal aggregations than would be obtained from a series of stations scattered over the area; and it also permits ready location and resampling at any desired station. This "contour" method has been employed by Davis (1923) who found it especially useful where the organisms existed in patches or restricted regions of the bottom.

TABLE I

Variation among 13 20-liter samples taken at 4-meter intervals in Zone 2

	Average number	Standard deviation
Total number of species	14	24%
Clymenella torquata	12	26%
Ampelisca macrocephala	19	18%

In order to establish the variations in catches which might be due to the sampling process, 13 samples of comparable size (20 liters in volume) were taken from a uniform area (Zone 2) at intervals of only 4 meters. It was found that the total number of species in each catch varied 24 per cent from the average of 14 per sample. The number of *Clymenella torquata* captured were 12 per average sample, with a standard deviation of 26 per cent; and the number of *Ampelisca macrocephala* averaged 19 per sample, with a standard deviation of 18 per cent (Table I). It is possible that these quantitative differences in the catch were due to an actual variation in the distribution of the animals over the bottom. In view of the restricted size of the region tested, however, it is assumed that the variations were caused by the sampling process itself. The average quantitative differences between the faunas of the various zones are much greater than these standard deviations of the catches in a restricted uniform area (Tables II and III). Therefore, it is believed that the quantitative data are reliable. Throughout the survey, single samples were taken at each station. Deevey (1941) found that the use of single sample stations offered satisfactory results in his studies of Connecticut lakes.

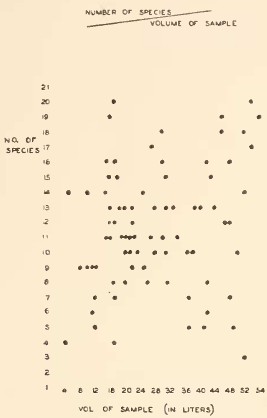
Analysis of material

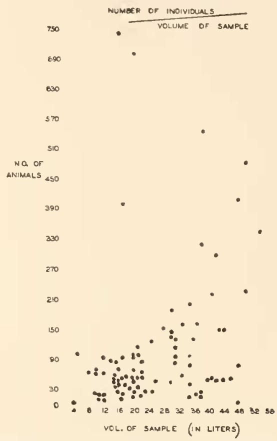
The catch from each station was brought into the laboratory where the organisms were identified and counted. The carapace of each large crustacean and the shells of all molluscs were removed and the wet weight of each catch was recorded (Davis, 1923; Berg, 1938). The estimated weight of all echinoderm tests was also subtracted from the weight of animals captured. The dry weight of the entire catch was obtained by drying the organisms to constant weight at approximately 120° C. The dried material was then ashed at approximately 650° C. By deducting the ash weight from the dry weight, an expression of the combustible organic matter present in the catch was obtained (Table III). The determination of organic content by this method is a customary procedure (Petersen, 1911; Juday, 1921; Birge and Juday, 1934).

Method of presentation of data

As in previous investigations of this nature by other investigators (Juday, 1921; Berg, 1938) it was found that the amount of bottom material obtained in the samples varied considerably, depending upon the relative hardness of the bottom and other conditions which affected the depth to which the dredge penetrated the bottom. However, there was no correlation between the size of the sample and the number of different species caught (Graph 1). In general, the larger samples of bottom material contained the greatest number of organisms (Graph 2). These facts support the assumption that the animals tend to be relatively uniformly distributed in the bottom material, at least down to the levels of the deepest grab of the dredge.

The invertebrate bottom organisms may be distributed vertically in the bottom sands in three different ways: 1. they may be restricted to a level at the surface of the bottom; 2. they may be uniformly distributed vertically throughout the bottom (down to the deepest grabs of the dredge); or 3. they may exist in greatest abundance at a level beneath the surface of the bottom material. If the first situation occurs, the quantitative data on the distribution of the organisms are best expressed on an area basis. This method has been used widely in quantitative marine studies, in spite of the variations in size of the samples obtained and although the vertical distribution of the organisms is not established. If the second situation obtains, the data should be expressed on a volumetric basis. This would eliminate variables introduced by samples of differing volume. If the third situation occurs, the choice between the area and the volumetric basis depends largely upon the numbers of animals existing between the levels of their greatest concentration and the surface of the bottom. In the present survey, the data presented in Graphs 1 and 2 support the second assumption. Therefore, the quantitative values for numbers of animals, wet weight of the catch, and the dry weight of the organic content obtained at each station have been calculated and expressed on the volumetric basis, using 20 liters of bottom material as the standard unit since most of the samples were of this size. The relative significance of the catch from samples of less than 10 liters or more than 40 liters in volume, when compared to that from samples more nearly approximating the standard size, is regarded as questionable, due to the large differences in volume. The data from such samples are not treated. The factor necessary to convert the data to expressions of the standard volume varied between the limits 0.5 and 2.0. Thus possible errors, should the uniform





Graph 1. The total number of species obtained in each sample, plotted against the volume of the sample in liters. It is apparent that there is no correlation between the size of the sample and the number of different species captured.

Graph 2. The total number of animals of all species in each sample, plotted against the size of the samples. In general, the larger samples contained the greater number of organisms.

vertical distribution of organisms not occur at certain stations, would be relatively small in comparison with the variations in abundance of animals from station to station and from zone to zone.

In making comparisons with other investigations, it should be remembered that this standard unit (20 liters) represents a portion of the ocean bottom 0.5 sq. meters in area, and 10.0 cms. in maximum depth. It is assumed that organisms in the bottom material below this level are of questionable importance as components of fish diet.

Inclusion of the weight of large bivalve and gastropod molluscs in the data, in view of their probable insignificance as fish food (Blegvad, 1925), would produce distortion of the results if one wishes to determine the amount of food material available to bottom-dwelling fishes. Therefore, in order to give complete values for the catches in each zone, as well as to indicate their relative significance as a source of food to fishes, the data for each zone have been expressed in two ways: 1. with all organisms included (shells and estimated weight of echinoderm tests removed); and 2. with the weights of large molluscs (*Cyprina islandica, Polynices immaculata*), molluscs possessing thick shells (*Venericardia borealis, Astarte* sp.) and all echinoderms omitted. A somewhat comparable method of expressing data was used by Berg (1938) who presented his results with all organisms included, and also with molluscs omitted.

Results

The ocean floor in Menemsha Bight can be divided into five major zones arranged approximately coincident with definite depth contours. Each zone is characterized by a distinct type of bottom material, and a distinctive faunal aggregation is associated with four of these types of bottom. Table II contains a list of the

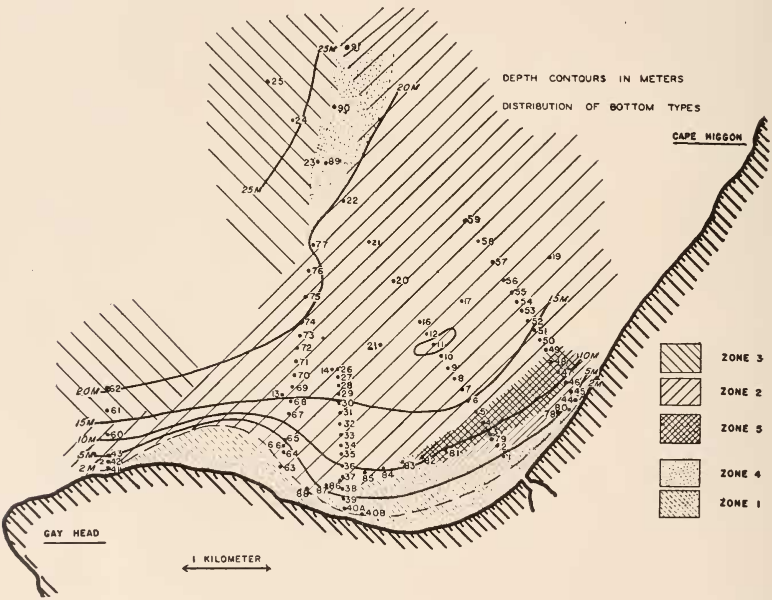


Chart 2. The number and location of each station, and the extent of the five zones in Menemsha Bight. The depth contours, in meters, are indicated by solid lines, with the exception of the 2-meter contour which is shown by a line of dashes.

catch at two stations in each zone, per standard volume of bottom material. Table III shows the predominant types of bottom (and average values for the catches) in each zone. Table IV is a list of the most common animals found in the bottom sands of Menemsha Bight and their average number in standard samples from each zone.

TABLE II

Typical catches from each zone

Zone 1.

Station 40-B

Clymenella torquata	1 specimen
Glycera dibranchiata	6 specimens
Nephthys incisa	1 specimen
Ninoe nigripes	1 specimen
Scolopolus fragilis	3 specimens
Tellina tenera	10 specimens

Station 41

Ampelisca macrocephala	1 specimen
Echinarachnius parma	1 specimen
Emerita talpoida	21 specimens
Nephthys bucera	1 specimen
Tellina tenera	19 specimens

Zone 2.

Station 26

Astarte undata	3 specimens
Clymenella torquata	27 specimens
Gammarus locusta	6 specimens
Glycera dibranchiata	6 specimens
Lumbrinereis hebes	1 specimen
Maldane sp.	3 specimens
Unciola irrorata	4 specimens
Venericardia borealis	1 specimen

Station 27

Ampelisca macrocephala	2 specimens
Clymenella torquata	9 specimens
Dolichoglossus Kowalevski	1 specimen
Gammarus locusta	3 specimens
Glycera dibranchiata	5 specimens
Lumbrinereis hebes	1 specimen
Maldane sp.	2 specimens
Nephthys incisa	1 specimen
Nephthys bucera	1 specimen
Ostrea virginica	1 specimen

Zone 3.

Station 24

Ampelisca macrocephala	31 specimens
Callocardia morrhuana	3 specimens
Cirolana concharum	2 specimens
Clymenella torquata	1 specimen
Cyprina islandica	2 specimens
Echinarachnius parma	12 specimens
Nassa trivitata	1 specimen
Polynices immaculata	1 specimen
Scolopolus fragilis	1 specimen
Unciola irrorata	1 specimen
Venericardia borealis	4 specimens

Station 25

Ampelisca macrocephala	22 specimens
Astarte quadrans	1 specimen
Cirolana concharum	1 specimen
Cyprina islandica	1 specimen
Echinarachnius parma	1 specimen
Marphysa sp.	1 specimen
Nephthys bucera	1 specimen
Polynices immaculata	1 specimen
Scalibregma sp.	1 specimen
Venericardia borealis	3 specimens

Zone 4.

The fauna of this zone was essentially similar to that of zone 3, in its quantitative and qualitative aspects.

Zone 5.

Station 48

Amphitrite ornata	1 specimen
Astarte castanea	2 specimens
Astarte undata	1 specimen
Asterias forbesi	2 specimens
Callocardia morrhuana	1 specimen
Cancer irroratus	1 specimen
Chaetopleura apiculata	2 specimens
Cirratulus grandis	1 specimen
Crepidula fornicata	692 specimens
Lepidonotus squamatus	1 specimen
Marphysa sp.	1 specimen
Pagurus longicarpus	1 specimen
Phascolosoma gouldi	2 specimens
Pinnixia cylindrica	1 specimen
Trophonia affinis	10 specimens
Venericardia borealis	19 specimens

Station 81

Arabella opalina	1 specimen
Arca transversa	2 specimens
Callocardia morrhuana	3 specimens
Cancer irroratus	1 specimen
Chaetopleura apiculata	1 specimen
Crepidula fornicata	353 specimens
Gammarus locusta	1 specimen
Lepidonotus squamatus	1 specimen
Libinia emarginata	1 specimen
Nereis virens	1 specimen
Pagurus longicarpus	7 specimens
Phascolosoma gouldi	1 specimen
Scalibregma sp.	1 specimen
Trophonia affinis	16 specimens

TABLE III

The wet weight of the catch, and the dry weight of the organic matter it contained, in the average standard-sized samples from each zone

Zone	Most numerous animals	Average wet weight of the catch in 20 liters of bottom material		Average dry weight of the organic content of the catch in 20 liters of bottom material	
		A[3]	B[4]	A[3]	B[4]
1	*Emerita Tellina Ampelisca*	5.6 gms.	1.9 gms.	0.9 gms.	0.33 gms.
2	*Clymenella Ampelisca*	27.2 gms.	10.0 gms.	2.6 gms.	1.3 gms.
3	*Ampelisca Cyprina*	164.0 gms.	9.8 gms.	29.4 gms.	1.0 gms.
4	*Ampelisca Echinarachnius*	73.0 gms.	6.3 gms.	10.7 gms.	0.5 gms.
5	*Crepidula*	364.0 gms.	360.0 gms.(?)	36.2 gms.	30.9 gms.(?)

Zone 1

Between the 2.5- and the 5-meter depth contours, the bottom is of a medium coarse yellow sand, containing a few small stones of pea size. An average standard unit of bottom material from this zone possessed five different species and a total of 32 animals of all species. *Emerita talpoida* and *Tellina tenera* were the most numerous organisms in this zone. The location of stations in this as well as in remaining zones is shown in Chart 2.

Zone 2

The coarser sands of Zone 1 graded rather abruptly (as shown by observations at stations 63–64; 38–39; 1–2; etc.) into fine mixed sands of white, yellow, and black color. This bottom material, called "Zone 2," was situated largely between the 5- and 20-meter depth contours, and extended over 80 per cent of the floor of the Bight. Annelids, small amphipods, and other organisms of known value as food for fishes were most numerous in this region, with *Ampelisca Macrocephala* and *Clymenella torquata* occurring in greatest numbers (Charts 2 and 4). The larger molluscs, however, such as *Cyprina islandica* and *Callocardia morrhuana* were more prominant by virtue of their relatively greater weight. The stations from this region which are shown in Table II illustrate the fact that the number of animals of a single common species (*Clymenella torquata*) may fluctuate 50 to 80 per cent from the average value in adjoining stations, when the number of such individuals caught is relatively low. It is seen in Table III that this zone was characterized by a heavier catch of organisms known to be of value as food for bottom dwelling fishes, than were the remaining zones.

[3] Including all organisms.

[4] With the weight of large molluscs, molluscs with thick shells, and the estimated weight of echinoderms omitted.

The number of species taken in samples from this and from the remaining zones varied from six or seven at stations 32, 33, and 34, to 19 or 20 species at stations 76, 77, 21, 70, 71, 11, 58, 59, and 52. In general, however, the regions containing the greatest number of different species were found in Zone 2. By comparing Chart 3 with Chart 4, it is evident that these regions are also generally character-

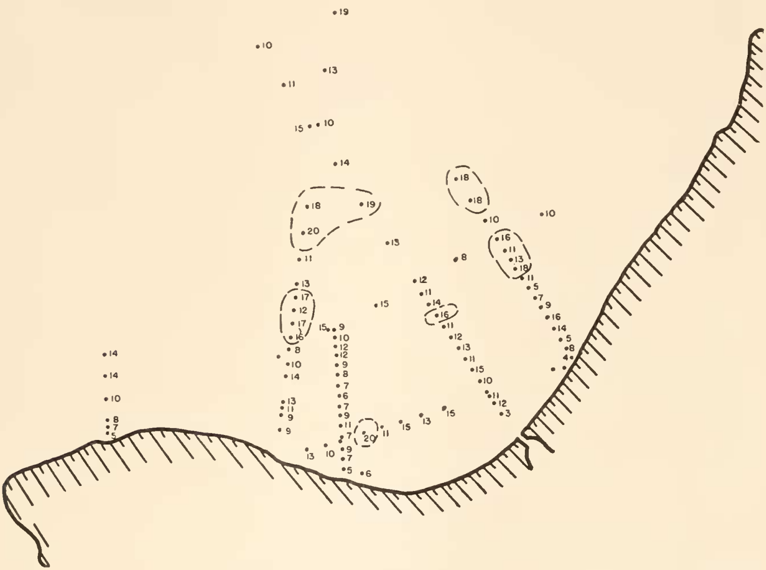


CHART 3. The number of different species captured at each station. A line of dashes encloses each region where the number of species obtained was greater than 15/sample.

ized by a great number of Ampelisca and Clymenella. In other words, in Menemsha Bight the individuals of a common species are generally more abundant in those areas where a large number of different species are found. Some of the possible factors which may determine the distribution of these organisms in Menemsha Bight will be treated in the discussion.

Zone 3

Beyond the 20-meter depth contour, the bottom was composed of loose, coarse sand, as shown by observations at stations 62, 24, and 25, which also contained shell fragments and small pebbles of various sizes. This zone contained a mixed fauna with amphipods and annelids present in each sample (Table II) but with no single species attaining numerical prominence. The large bivalve molluscs, such as Cyprina and Callocardia, composed the great bulk of each catch. It is interesting to note that *Cirolana concharum* and *Astarte quadrans* were found only at stations in this zone; whereas several organisms (*Echinarachnicus parma, Unciola irrorata, Scolopolos fragilis*) were also found in the coarse sand bottom of Zone 1, at much shallower depths.

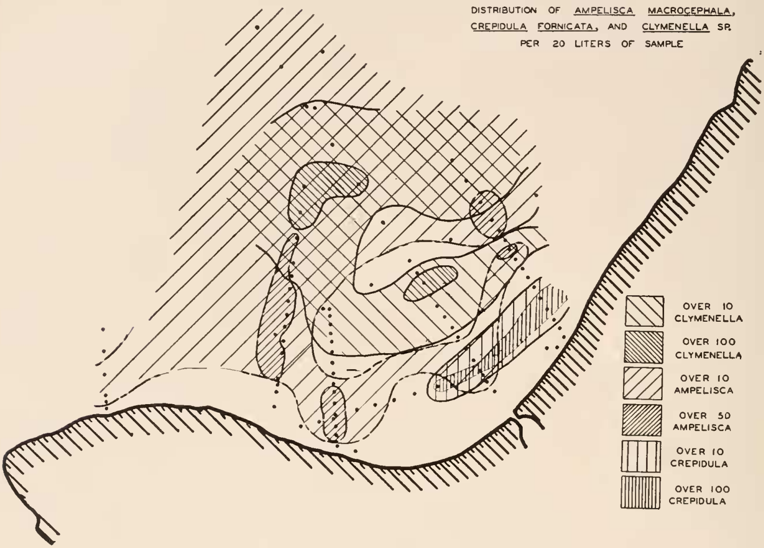


CHART 4. The distribution of the three most numerous invertebrate animals in Menemsha Bight. The regions in which a common organism is most abundant are likewise characterized by a relatively greater number of different species (cf. Chart 3).

Zone 4

In the region about stations 89 and 90, a patch of medium grained white sand was discovered. There was little qualitative difference between the fauna of this zone and that found in Zone 3 (Table II). There was a slight quantitative difference, however, for the catches from Zone 3 were somewhat greater than those obtained from Zone 4 (Table III).

Zone 5

This zone was found between the 10- and the 14-meter depth contours along the eastern shoreline of the Bight (Chart 2). The bottom material of this region was of a soft fine clay, containing stones of walnut size and a considerable amount of nitrogenous matter near its surface. Mr. H. C. Stetson[5] informs me that this bottom deposit is probably of glacial origin, and contains very little marine sedi-

[5] The author is indebted to Mr. Henry Stetson, Marine Geologist at the Oceanographic Institution, for his identification of the bottom material in the major zones of Menemsha Bight.

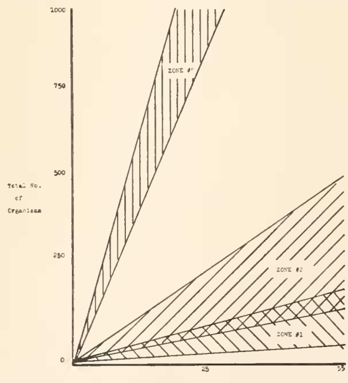
TABLE IV

The distribution of the eight most common organisms in Menemsha Bight
(number of organisms/sample)

	Zone 1 15 stations	Zone 2 63 stations	Zone 3 5 stations	Zone 4 3 stations	Zone 5 5 stations
Ampelisca macrocephala	9	33	15	12	3
Clymenella torquata	0	35	1	0	0
Crepidula fornicata	0	0	0	0	423
Echinarachnius parma	3	1	4	6	0
Callocardia morruhuana	0	2	1	1	3
Cyprina islandica	0	0	4	1	0
Tellina tenera	9	0	0	0	0
Emerita talpoidia	8	0	0	0	0

ment. The bottom fauna of this region was composed of several types of crustaceans, annelids and molluscs; and the latter were predominant by number as well as by weight (Table II). *Crepidula fornicata* was exceptionally numerous and was restricted to this zone. *Trophonia affinis,* a burrowing annelid, was likewise found only in this bottom material. None of the remaining organisms was relatively abundant. The wet weight and the organic matter contained in the large numbers of Crepidula were included in the data presented in Table II although the relative importance of this organism as an article of fish diet has not yet been established. For this reason, the value for catches obtained from this zone is unusually high (Charts and Table II).

Table 4 shows the average number of the eight most common organisms obtained per 20 liters of bottom material in each zone. From these data it is possible



GRAPH 3. The total number of animals taken in each sample from the three major Zones, plotted against the volume of the sample in liters. (Fifty-five liters, the size of the largest sample, is the linear equivalent of 750 organisms.) The values for each of the Zones tend to occur within discreet regions.

to establish: 1. the numerical distribution of any one of these most abundant animals over the area; 2. the qualitative and quantitative aspects of the fauna of each zone, with respect to these organisms; and 3. the probability of capturing one or several of these organisms in a particular locality or type of bottom. The relative abundance within the zones of such organisms as Ampelisca and Clymenella and the restricted occurrence of Crepidula, Tellina and Emerita are clearly shown.

When the volume of bottom material obtained in each sample is plotted against the total number of organisms captured in that sample, it is evident that the larger samples tended to contain the greatest number of organisms (Graph 2). Graph 3 shows the relationship between the volume of the sample and the numbers of animals it contained, in the three major zones. It is interesting to note that the ratio between the size of the sample and the number of animals taken from it follows a distinctive trend in each region. The ratio ranges from 0.083 to 0.30 in Zone 1, with an average value of 0.11 (Graph 3). Similarly, the ratios for Zone 2 and 5 are 0.47 and 1.30 respectively. These figures afford a rapid means of comparing the relative abundance of organisms in each zone. In addition to their comparative value within Menemsha Bight, they offer a new method of expressing quantitative numerical relationships or comparisons between fauna of similar bottom types which may obtain in other localities. Other aspects of the bottom fauna of different regions (wet weight, content of organic matter, etc.) can likewise be compared in this fashion.

Discussion

It is apparent from a study of Charts 3 and 4 that the abundance of various species and the abundance of individuals of a single species varies considerably over the Bight. In general, the regions containing a large number of individuals of a single common species are also characterized by numerous different species. It can therefore be assumed that these regions probably offer an optimum of the conditions which determine the occurrence of these organisms. On the basis of this assumption, a closer study of these particular areas where the common animals in the Bight, such as *Crepidula fornicata* and *Clymenella torquata* are most numerous, should reveal certain of the factors which influence their abundance and distribution. Such a study is of particular importance, since many of these areas occur within that zone (2) which is by far the largest in the Bight, and which also contains the greatest numbers of animals known to be of value as food for bottom fishes.

The distribution of *Crepidula fornicata* apparently illustrates the role which the substratum may assume in determining the occurrence of an animal. This gastropod requires some relatively large hard object, such as a stone or shell, to which it fastens itself by the broad muscular foot. Such objects were found only in Zone 5, and these organisms were restricted solely to this region.

Another instance where the nature of the bottom material undoubtedly is of importance in governing the distribution of an animal, is shown by the occurrence of *Clymenella torquata* (Chart 4). This annelid is found largely in Zone 2, although a slight overlap exists to a coarser sand bottom at station 39, and to a softer bottom (which may also contain some fine sand) at stations 2, 79, 3, 4, and 5 (Charts 4 and 2). This organism constructs small tubes of the sand particles. From a comparison of the occurrence of the animal with the existence of a fine sand bottom, it would seem that these annelids may be limited to those regions of Menemsha Bight where the bottom material contains at least a certain amount of the optimum size sand particles.

The distribution of Clymenella in the Bight also suggests that its abundance in certain regions is associated in some manner with the depth of the water. At stations 76, 77, and 21, a standard unit of bottom material contained over 100 specimens, while at station 22 they were just below this number (Chart 4). These stations border the 20-meter depth contour, which is also the outermost (deeper) boundary of the fine bottom in Zone 2. At station 11, where the depth of water increased relatively suddenly from 15 to 21 meters, the number of Clymenella is over 10 times greater than that found at adjacent stations, where the depth was 15 meters. Thus it is possible that the depth of the water, in addition to the nature of the bottom, may influence the abundance of this organism. The relative scarcity of Clymenella at stations 15, 16, and 20, however, cannot be due either to the depth of water or the nature of the bottom material. Additional factors such as prevailing tidal currents, which are at present undetermined, may also influence the occurrence of this animal.

In addition to the qualitative and quantitative variation in the fauna of different zones and of different regions of the same zone, a fluctuation was also found in the numbers and species present in the fauna of adjacent stations over a uniform bottom (Chart 3). This variation is due primarily to two causes. In the first place, many of the organisms in the Bight are widespread, but they are also sparsely distributed (Cirratulus, Cancer, Callocardia, Libinis, Polynices, Limulus, etc.). The capture of several of these animals at one location, and their absence at the next, produced a considerable fluctuation in the number of species taken in each sample. As these organisms are also relatively large, their occasional occurrence likewise produced a variation of 10 to 20 grams in the wet weight and of 1 to 2 grams in the dry weight of the organic matter contained in the catches at adjoining stations. Secondly, it has been shown that the abundance of a single common species (*Clymenella torquata*) at two adjacent stations may vary 50 to 80 per cent from an average value, when the numbers of such organisms present in the region are relatively low (Table II). This fluctuation cannot be associated with any obvious characteristics of the environment, such as the depth of the water, or the nature of the substratum. It may represent an inherent tendency of the organisms to aggregate in certain arbitrary regions of the bottom, or it may be caused by environmental factors small enough to be completely overlooked in a survey of this general nature.

The bottom fauna of Menemsha Bight was similar to that found in European flounder fishing grounds, in that molluscs, annelids, and small crustaceans were the most numerous organisms. The molluscs of the European fisheries served as the chief article of food for the bottom dwelling teleosts in the region, with the annelids and the crustaceans as the next most preferred diet (Jensen, 1919; Davis, 1923; Blegvad, 1925, 1928, 1930). However, the actual food relationships which exist between the flounder and the bottom invertebrate fauna in Menemsha Bight have not been determined at present. During two trips over the region with a commercial fishing trawler, it was found that the flounder are taken in greatest number from two widely separated belts at maximum distances of 1.0 and 3.0 kilometers from the shore (Chart 5). It is evident that the abundance of flounder and that of Clymenella and Ampelisca (Chart 4) occur in relatively the same regions, but the actual nature of this relation remains to be established by further studies.

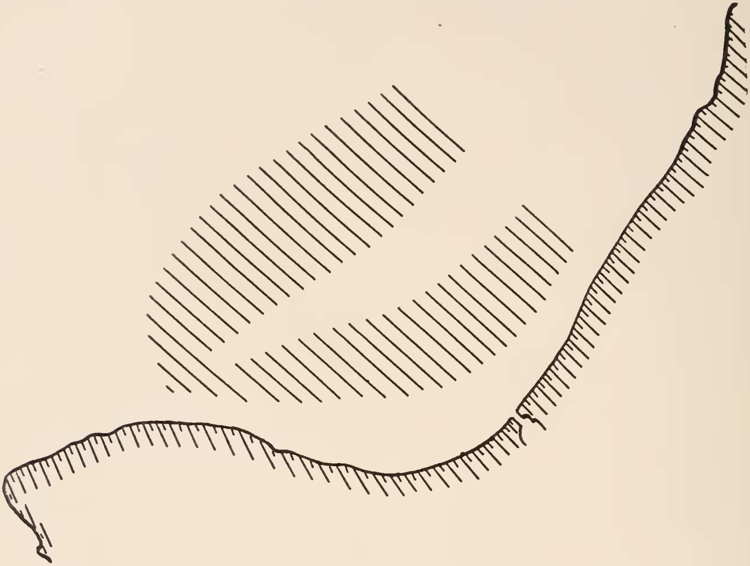


CHART 5. The diagonal lines indicate the regions of Menemsha Bight where the flounder are captured in greatest abundance. By comparing this chart with Chart 4, it is seen that these regions coincide in general with those areas where *Ampelisca macrocephala* and *Clymenella torquata* occur in large numbers.

SUMMARY

1. A dredge which is larger and heavier than those employed previously in quantitative marine bottom sampling has been used with a specially designed screening device to facilitate the removal of organisms from the relatively large samples of bottom material.

2. The bottom of Menemsha Bight, a flounder fishing grounds in Vineyard Sound, is divisable into five zones on a basis of the bottom material. Four of the zones possessed a distinct faunal aggregation.

3. The zone which extended from the 5- to the 20-meter depth contour and contained a fine sand bottom occupied 80 per cent of the area of the Bight. This zone contained the greatest quantity of the animals (per unit volume of bottom material) that are generally known to serve as food for fishes. *Clymenella torquata* and *Ampelisca macrocephala* were the most common organisms. Flounders are caught in greatest numbers in the regions where these animals are most abundant.

4. The numerical distributions of *Clymenella torquata* and *Crepidula fornicata* are correlated with distinct characteristics of the bottom.

5. In general, the regions of the Bight containing an abundance of individuals of a common species also contain a large number of different species.

6. The fauna of adjacent stations in a relatively uniform area (Zone 2) may differ considerably in both qualitative and quantitative fashion. This variation is not associated with any observed environmental differences, such as the nature of the bottom material or the depth of water. It may represent the influence of minor factors, or of mechanical aggregation.

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