A BENTHIC COMMUNITY IN THE SHEEPSCOT RIVER ESTUARY, MAINE [1]

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ABSTRACT

The benthos in two selected areas of the Sheepscot River estuary, Maine, was surveyed quantitatively as part of a research program of the Bureau of Commercial Fisheries. A Petersen-type grab obtained 78 one-tenth square meter samples from the soft mud sediments. Samples were screened through openings of 1.5 mm., to separate the macrofauna from microfauna and sediments.

The 108 species collected conformed to the description of a *Nephtys incisa-Nucula proxima* community. Fifteen species accounted for 80 percent of the total number of organisms. Variations within the community are described, and some factors that may control size composition in the community are discussed. The Sheepscot infaunal community is compared with the faunal composition of two previously described *Nephtys-Nucula* communities.

In the summer of 1954, Gunnar Thorson of the University of Copenhagen invited the Fish and Wildlife Service to cooperate in quantitative surveys of the level sea bottom [2] fauna. Interest in the benthos has increased considerably in recent years, and studies of the level-bottom fauna are widely established. A benthic survey of the Atlantic coast of the United States and Canada could contribute valuable information on coastal ecology, particularly if the survey methods were comparable with European studies. Knowledge of benthic populations also contributes to a better understanding of the ecological factors affecting commercial species of fish and shellfish. It was agreed to undertake an initial program at the Bureau of Commercial Fisheries Biological Laboratory in Boothbay Harbor. The primary objective was to quantitatively survey the benthic fauna in limited areas. Sampling methods were to be established for future shallow-water benthic studies by the Bureau.

Benthic marine animals are divided into two ecologically different groups described by Petersen (1913) and further defined by Thorson (1951, 1956, 1957). The epifauna are those animals living above or on the bottom surface, sometimes attached to rocks, algae, logs, and other solid objects. These organisms are most abundant in the shallow coastal waters, especially in the intertidal zones, and are subject to great variations in environmental conditions. They are usually found in local groups and depend upon the occurrence of suitable substrata for their establishment. The diverse habitat available supports many species within the epifauna. The infauna are those animals that live in the substratum of the gradually sloping (level bottom) portions of the ocean floor. They occupy ". . . more than half the surface of the globe . . ." (Thorson, 1957) and reach their fullest development below the intertidal zone. The infaunal environment is more stable than the epifaunal environment. Characteristically, the

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[1] This paper is based on a thesis submitted to the University of New Hampshire in partial fulfillment of the requirements for the degree of Master of Science.

[2] The "level sea bottom" is the vast uniform area of the continental shelf characterized by a regular slope without abrupt changes in the bottom contour (see Thorson 1957, p. 466).

infauna comprises few genera having an extremely uniform distribution over broad geographical areas, and these animals have become widely used as index organisms in descriptive marine ecology.

The literature relating to benthic fauna has been extensively reviewed by various authors. Jones (1950) has an excellent review of the European literature. Kirsop (1922), Shelford, et al. (1935), and Hartman (1955), among others, have investigated the Pacific fauna. Parker (1956, 1959, 1960) made a detailed series of studies on both the recent and ancient faunal assemblages in the Gulf of Mexico. Atlantic faunistic studies date back to the qualitative surveys of Verrill (1873), followed by those of Kingsley (1901), Sumner, Osborn, and Cole (1913), Cowles (1930), and Allee (1934). Considering that the first truly quantitative benthic survey of any area of the Atlantic coast was not published until 1944 (Lee), advances in recent years are impressive. The New England region is represented in studies by Dexter (1944, 1947), Sanders (1956, 1958, 1960), Wigley (1956), Stickney and Stringer (1957), and Stickney (1959). Sanders' works, together with those of his associates (Wieser, 1960), in Buzzards Bay, Mass., have produced one of the most complete studies on the eastern coast to date. The present paper and that of Stickney (1959) provide a description of the fauna of the Sheepscot River estuary and part of Sheepscot Bay.

PHYSICAL FEATURES OF THE SHEEPSCOT ESTUARY

The Sheepscot River estuary cuts deeply into the Maine coast between Georgetown and Southport Islands (fig. 1). Its mouth, forming Sheepscot Bay, is located at approximately lat. 43°47′ N. and long. 69°42′ W. The lower portion of the estuary extends southward 13.6 miles from the town of Wiscasset to the open sea and varies in width from 2.9 miles to less than 0.1 of a mile. The banks are precipitous in parts of the upper portions of the estuary, and depths of the main river channel vary from about 60 feet at Wiscasset to 166 feet at the mouth. The shores of the lower estuary are exposed bedrock interspersed with mud flats. There are few sandy areas, and the bottom sediments, notably lacking in sand, are composed of a thick, soft, black mud. In places the strong currents have washed away sediments exposing a rocky bottom.

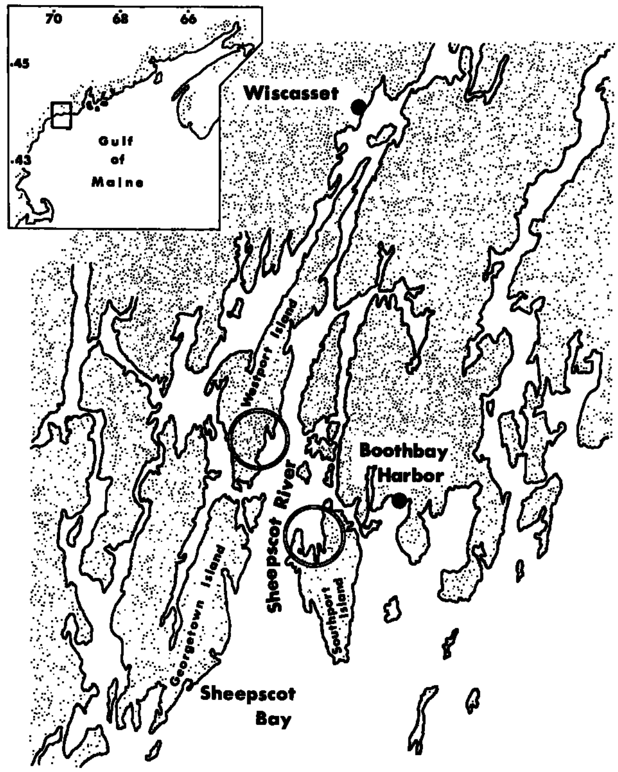

FIGURE 1.—The Sheepscot River and selected study areas. The upper circle encloses Jewett Cove; the lower circle encloses Ebenecook Harbor. (The small square in the upper left inset is not drawn to scale.)

DESCRIPTION OF EBENECOOK HARBOR

Ebenecook Harbor (fig. 2) is located on the northern end of Southport Island at lat. 43°50′ N. and long. 69°40′ W. There are three parallel coves—Love, Pierce, and Maddock—opening on a narrow, outer channel which forms a convenient northern boundary for the survey area. This channel conducts relatively swift currents into the estuary proper (see fig. 1), and the abrupt channel banks drop to depths of over 100 feet.

Love Cove, easternmost of the three-cove complex, is about 1,050 yards long and 150 yards wide with depths from 4 to 17 feet. Soft mud bottom material is typical with an occasional rocky outcrop. Mud flats cover the head of the cove but most of the shore is exposed bedrock. Pierce Cove is the longest (1,375 yards) of the three coves and has a uniform width of about 100 yards. The shore is rocky with remnants of old, stone wharfs

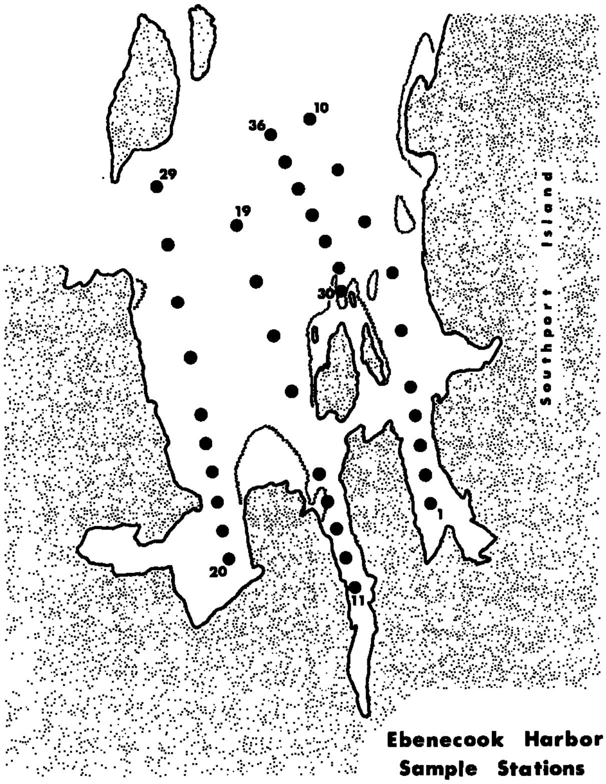

FIGURE 2.—Location of sample stations in Ebenecook Harbor.

in two places on the western side. This is a shallow cove, ranging in depth from 3 to 9 feet at mean low water. Past mussel (*Mytilus*) beds are indicated by an accumulation of shells on the soft bottom sediments. Maddock Cove is wider, about 250 yards, and deeper than the other coves with similar bottom sediments and shoreline.

The principal source of fresh water comes from the Sheepscot River, with headwaters located north of Wiscasset between the Penobscot and Kennebec valleys. Near Wiscasset salinities range from 22 ‰ to 30 ‰ at the surface, while bottom salinities are more constant ranging from 29 ‰ to 30 ‰. The basis for division of the estuary, upper and lower, and a more detailed description of the entire area including tidal exchange, salinity and temperature variations, currents, and biota were discussed by Stickney (1959). Bryant (1956) described the river proper. The two study areas, Ebenecook Harbor and Jewett Cove, are representative of the general environmental characteristics of the estuary. Salinities were in the range of bottom salinities cited, and bottom temperatures varied from 10.1° C. to 12.8° C. in Ebenecook Harbor, and from 10.6° C. to 14.7° C. in Jewett Cove.

DESCRIPTION OF JEWETT COVE

Jewett Cove, on the southeastern shore of Westport Island (fig. 3), is about 725 yards from north to south and about 350 yards from east to west. The shoreline in some sections is rocky and drops off sharply into deeper water, while in others it is composed of muddy flats gently sloping into the sea. Midway along the shore there are pilings of a fish weir built out for some distance into the cove. Sampling stations were not located in this area to avoid damage to the weir and possible loss of gear through fouling of lines on the weir stakes. The bottom slopes gradually to depths of 50 feet, beyond which it drops off sharply into the main channel where depths reach 147 feet.

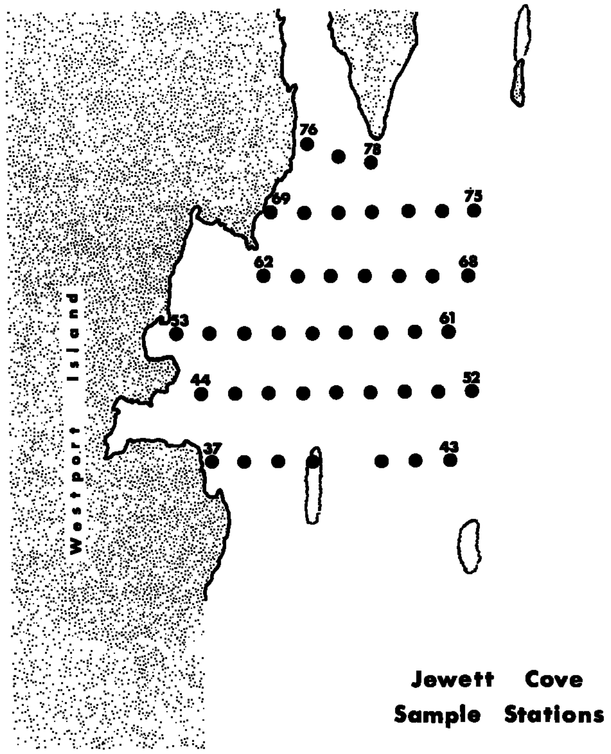

FIGURE 3.—Location of sample stations in Jewett Cove.

APPARATUS AND METHODS

FIELD PROCEDURE

Samples were collected throughout the period of late July to early November in 1955. Both areas were sampled essentially on a grid basis (figs. 2 and 3). Stations were spaced 300 feet apart in shallow water and 600 feet apart in the deeper portions with about 600-foot intervals between adjacent course lines. The stations were located by running the boat on compass courses at a predetermined speed and dropping marker buoys at selected time intervals. Ten different stations were occupied each week with one sample from each of the total 78 stations (table 1). A 28-foot cruiser, with a draft of 3 feet, and a speed of 15 knots, was equipped with winch and pump and used as a sampling platform. The small size was advantageous for shallow-water work, but limited working space and restricted operations to fair weather.

TABLE 1.—*Station data for Ebenecook Harbor and Jewett Cove, Maine, July to November 1955*

Station	Date	Depth, feet	Station	Date	Depth, feet
Ebenecook Harbor:			Jewett Cove—Con.		
1	July 29	3	40	Sept. 15	20
2	do	4	41	do	31
3	do	5	42	do	32
4	do	10	43	do	44
5	do	15	44	Sept. 22	13
6	do	15	45	do	13
7	do	20	46	do	15
8	do	23	47	do	19
9	do	23	48	do	18
10	do	29	49	do	
11	Aug. 2	4	50	do	25
12	do	7	51	do	30
13	do	10	52	do	41
14	do	10	53	Sept. 29	14
15	do	9	54	do	14
16	do	15	55	do	15
17	do	22	56	do	16
18	do	24	57	do	20
19	do	26	58	do	21
20	Aug. 8	12	59	do	23
21	do	16	60	Oct. 6	23
22	do	20	61	do	34
23	do	22	62	Oct. 20	20
24	do	27	63	Oct. 6	24
25	Aug. 10	32	64	do	24
26	do	35	65	do	22
27	Aug. 8	35	66	Oct. 20	26
28	do	45	67	do	26
29	Aug. 10	100	68	do	30
30	Aug. 17	14	69	do	20
31	do	23	70	do	26
32	do	27	71	do	25
33	do	27	72	Nov. 8	39
34	do	27	73	do	26
35	do	31	74	do	21
36	do	44	75	do	36
Jewett Cove:			76	do	13
37	Sept. 15	14	77	do	18
38	do	26	78	do	26
39	do	25			

A modified Petersen-type grab (Petersen and Boysen-Jensen, 1911) was used to obtain intact segments of the bottom sediments 0.1 meter square and about 20 cm. in depth (fig. 4). No sample was retained if the dredge was less than two-thirds full. The sample was placed in a screen box (fig. 5), which hung over the side of the vessel, and was washed with water from a pump. The box contained three trays with bottoms of plastic screen; the top screen of 8- by 8-mesh per inch, the next of 14- by 16-mesh, and the bottom tray of 20- by 20-mesh with openings of about 1.5 mm. Organisms were thus separated from sediments by a screen with 1.5 mm. openings; providing an arbitrary division between the macrofauna and microfauna. Each screen retained a portion of the material collected, and this reduced clogging. Clay, silt, and sand were washed through the screens with water, but quantities of broken shell, *Spartina* fragments, gravel, etc., were retained. Organisms collected in the top tray were large enough to remove and classify aboard the boat. The contents of the other two trays were emptied on a collecting board, washed into quart jars, and returned to the laboratory for identification.

Although routine sediment analyses were not made, several random samples were processed through a series of sieves. The finest screen used in this series was 250-mesh per inch (openings of 0.062 mm.). Silt is defined as being composed of particles from 0.05 to 0.002 mm. in diameter (Soil Survey Staff, 1951). Since all of the material in the samples passed through this finer screen, except shell fragments (less than 1 percent), the sediments in the survey areas were considered to be at least 90 percent silt and clay.

Measurements directly related to the sampler, screen size, and sample dimensions are given in the metric system because metric measurements were essential to the experimental design in relating it to other studies.

LABORATORY PROCEDURE

The contents of a quart jar from the field collections were placed in a large, white photographic tray and the organisms picked out by visual inspection. The animals were sorted into five major groups: mollusks, annelids, nemerteans, echinoderms, and miscellaneous. No dead organisms were counted with the single exception of *Volsella modiolus* shells, which were present in large numbers and were uniformly distributed. Epifaunal species were retained for study, but not considered as part of the infaunal association. The organisms were preserved in 10 percent neutralized formalin and later transferred to 70 percent alcohol to prevent deterioration of the calcified parts. Usually no narcotization was used, but when time permitted, or in the case of unusual or rare specimens, particularly polychaetes, coelenterates, and nemerteans, an 8-percent solution of magnesium chloride (isotonic with sea water) was used to relax and extend the animals before fixing. The material gathered each week was stored until the end of the collecting period, when all the organisms from each group were re-examined and identified to species, or to the lowest taxonomic category feasible.

Abundance (number of organisms) has been used as the basis of faunal evaluation for this study. Other factors, such as biomass or dry weight measurements, are recognized as being equally valuable, but were not within the scope of this work. A review of the literature on marine communities will show that the numerical basis of evaluation is not without precedent and one investigator (Sanders, 1960) has supported animal numbers as the most valid measurement.

RESULTS

DISTRIBUTION AND ABUNDANCE

Ebenecook Harbor and Jewett Cove faunas can be considered as one community (table 2) since they differ only in minor aspects. Two species were selected as dominants: the protobranchiate pelecypod *Nucula proxima* Say, the most abundant animal; and the polychaetous annelid *Nephtys incisa* Malmgren, the most uniformly distributed animal. Associated with these dominants are other species that were also evenly distributed in large numbers.

Cumaceans were second in abundance and were

TABLE 2.—*Species in the* Nephtys-Nucula *community found at 10 or more stations in Ebenecook Harbor and Jewett Cove, Maine, and listed in order of abundance*

Rank by number	Species	Number	Number stations	Percent by number	Cumulative percent by number	Percent stations	Average number per square meter	Area [1]	Depth range in survey
									Meters
1	*Nucula proxima*	2,358	59	18.3	18.3	75.6	399.6	E&J	4–30
2	Cumacea sp. (4+species)	1,973	55	15.3	33.6	70.5	358.7	E&J	4–14
3	*Stereobalanus canadensis*	768	34	6.0	39.6	43.6	225.8	E&J	3–31
4	*Thyasira gouldi*	717	46	5.6	45.2	59.0	155.8	E&J	4–31
5	*Phoxocephalus holbolli*	623	39	4.8	50.0	50.0	159.7	E&J	1–9
6	*Volsella modiolus*	573	68	4.4	54.4	87.2	84.2	E&J	1–31
7	*Corophium* sp.	557	22	4.3	58.7	28.2	253.1	E, mostly J	0–8
8	*Nucula tenuis*	515	46	4.0	62.7	59.0	111.9	E&J	4–31
9	*Dulichia* sp.	407	39	3.2	65.9	50.0	104.3	E&J	5–14
10	*Scoloplos armiger*	402	47	3.1	69.0	60.3	85.5	E&J	4–14
11	*Aricidea* sp.	395	43	3.1	72.1	55.1	91.8	E&J	1–14
12	*Nephtys incisa*	332	70	2.6	74.7	89.7	47.4	E&J	1–31
13	*Orchomenella pinquis*	292	28	2.3	79.3	35.9	104.2	E&J	4–14
14	*Ampelisca spinipes*	291	28	2.3	77.0	35.9	103.9	E&J	1–14
15	*Diplocirrus hirsutus*	253	19	2.0	81.3	24.4	133.1	E&J	6–13
16	*Retusa obtusa*	206	48	1.6	82.9	61.5	42.9	E&J	2–31
17	*Sternaspis scutata*	198	31	1.5	84.4	39.7	63.8	E&J	5–31
18	*Hartmania moorei*	155	39	1.2	85.6	50.0	39.7	E&J	5–31
19	*Ampharete acutifrons*	135	42	1.0	86.6	53.8	32.1	E&J	4–31
20	Nemertea sp.	134	49	1.0	87.6	62.8	27.3	E&J	----------
21	*Casco bigelowi*	134	16	1.0	88.6	20.5	83.7	E&J	5–8
22	*Nucula delphinodonta*	119	11	.9	89.5	14.1	108.1	E	3–8
23	*Pholoe minuta*	100	40	.8	90.3	51.3	25.0	E&J	4–13
24	*Cingula aculeus*	94	18	.7	91.0	23.1	52.2	E&J	4–14
25	*Crenella decussata*	76	24	.6	91.6	30.8	31.6	E&J	4–31
26	*Lacuna vincta*	75	31	.6	92.2	39.7	24.1	E&J	4–31
27	*Lumbrineris fragilis*	74	40	.6	92.8	51.3	18.5	E&J	4–31
28	*Pherusa plumosa*	66	28	.5	93.3	35.9	23.5	E&J	4–13
29	*Yoldia sapotilla*	66	20	.5	93.8	25.6	33.0	E&J	8–31
30	*Aeginina longicornis*	64	20	.5	94.3	25.6	32.0	E&J	6–14
31	*Ninoe nigripes*	48	27	.4	94.7	34.6	17.7	E&J	4–31
32	*Ammotrypane aulogaster*	34	12	.3	95.0	15.4	28.3	E&J	1–31
33	*Aricidea quadrilobata*	33	14	.3	95.3	17.9	23.5	E&J	1–14
34	*Cerastoderma pinnulatum*	32	17	.2	95.5	21.8	18.8	E&J	3–31
35	*Tellina agilis*	32	19	.2	95.7	24.4	16.8	E&J	1–31
36	*Lora scalaris*	31	20	.2	95.9	25.6	15.5	E&J	4–14
37	*Leptocheirus pinquis*	27	15	.2	96.1	19.2	18.0	J	4–13
38	*Trichobranchus roseus*	27	14	.2	96.3	17.9	19.2	E&J	8–31
39	*Rhodine loveni*	25	16	.2	96.5	20.5	15.6	E&J	4–13
40	*Yoldia limatula*	25	15	.2	96.7	19.2	16.6	E&J	5–10
41	*Nassarius trivittatus*	20	16	.2	96.9	20.5	12.5	E&J	5–31
42	*Phyllodoce groenlandica*	18	12	.1	97.0	15.4	15.0	J	4–13
43	*Terebellides stroemi*	17	14	.1	97.1	17.9	12.1	E&J	5–14
44	*Pitar morrhuana*	16	11	.1	97.2	14.1	14.5	E&J	5–31
45	*Astarte undata*	15	11	.1	97.3	14.1	13.6	E&J	4–31
46	*Priapulus caudatus*	15	11	.1	97.4	14.1	13.6	E&J	6–14
47	*Edotea triloba*	14	11	.1	97.5	14.1	12.7	mostly J	1–13
48	*Sarsiella americana*	11	10	.1	97.6	12.8	11.0	mostly J	1–13
49	Miscellaneous	----------	----------	2.4	100.0	----------	----------	----------	----------

[1] E=Ebenecook Harbor. J=Jewett Cove.

represented by several species tentatively identified as belonging to the genera *Eudorella* and *Diastylis*. Next in order was the hemichordate *Stereobalanus canadensis*; a selective deposit feeder living in fragile mucus-lined tubes that undoubtedly alter the texture of the sediments considerably. These tubes may also offer habitat for such potentially commensal animals as the amphipod *Corophium* sp. and the polychaete *Hartmania moorei*. *Thyasira gouldii*, a small bivalve, and *Phoxocephalus holbolli*, an amphipod, were fourth and fifth in abundance.

Sixth, in order of abundance, was the bivalve *Volsella modiolus* L. contributing 4.4 percent of all animals and uniformly distributed, occurring at 87.2 percent of the stations. This is a known epifaunal species and cannot be regarded as a member of the Sheepscot infaunal community. The fact that nearly all specimens were dead, zero year class juveniles indicates an adverse habitat for newly metamorphosed individuals of this species.

Nephtys incisa was twelfth in numerical order (2.6 percent) but was found at 89.7 percent of the stations. In this faunal association *Nephtys* is a nonselective deposit feeder burrowing through the upper layers of the sediment, ingesting the substratum from which food materials are obtained. *Nephtys* was selected as a dominant because a *Nephtys-Nucula* community had been described from a similar faunal association (Sanders, 1956) and because *Nephtys* was the most uniformly distributed animal in the Sheepscot survey. The comparatively low abundance may be ascribed to the great numerical fluctuations possible in some benthic communities as indicated by Thorson (1957).

The sampling period, July 29 to November 8, is assumed to have had no effect on the results of the survey, since no drastic environmental changes were observed, nor any important changes in faunal composition: Samples taken later in the year contained the same species typical of earlier samples. Possibly a slight increase in the abundance of some species may have occurred as small juveniles grew large enough to be retained by the screens. However, no change attributable to seasonal factors occurred in the order of species, ranked by abundance, during the survey period.

This, then, is a community of small animals including the bivalves *Nucula* and *Thyasira*, the polychaete *Nephtys*, and the acorn worm *Stereobalanus*. The latter two species provide tubes and tunnels for commensals, such as the scale worm *Hartmania moorei*. Cumaceans and amphipods, particularly *Phoxocephalus*, *Corophium*, and *Dulichia*, are common and may be found as commensals, building tubes, or crawling freely about in the upper layers of bottom material. Most of the organisms are deposit feeders, ingesting the organic materials from the fine ooze layer of the sediments. The numerical abundance of the fauna is concentrated in relatively few species. Fifteen of the 108 species contributed over 80 percent of the total number of organisms. Seven species supplied nearly 60 percent of the animals collected.

This community in the Sheepscot estuary, consisting of approximately 1,500 animals per square meter, is not heavily populated when compared with the 16,000 animals per square meter found by Sanders (1956) in the Long Island Sound community. Possibly the Sheepscot fauna could attain comparable densities. Sanders used a finer screen size (1.0 mm.) for his study which would increase estimates of population density by retaining smaller forms of the dominant species: *Nucula*, *Nephtys*, *Yoldia*, and *Cistenides*.

TABLE 3.—*Occurrence and abundance of selected* species, Ebenecook Harbor and Jewett Cove, Maine, July to November, 1955*

Species	Ebenecook Harbor			Jewett Cove		
	Specimens	Stations	Average number	Specimens	Stations	Average number
	Number	*Number*	*Per m.*²	*Number*	*Number*	*Per m.*²
Nucula proxima	619	19	325.7	1,739	40	434.7
Cumacea sp. (4+species)	828	17	487.0	1,145	38	301.3
Stereobalanus canadensis	158	13	121.5	610	21	290.4
Thyasira gouldi	98	13	75.3	619	33	187.5
Phoxocephalus holbolli	5	4	12.5	618	35	176.5
Volsella modiolus	129	27	47.7	444	41	108.2
Corophium sp	3	1	30.0	554	21	263.8
Nucula tenuis	73	11	66.3	442	35	126.1
Dulichia sp	188	12	156.6	219	27	81.1
Scoloplos armiger	173	17	101.7	229	30	76.3
Aricidea sp	272	19	143.1	123	24	51.2
Nephtys incisa	132	32	41.2	200	38	52.6
Orchomenella pinquis	4	4	10.0	288	24	120.0
Ampelisca spinipes	252	14	180.0	39	14	27.9
Diplocirrus hirsutus	4	4	10.0	249	15	166.0
Retusa obtusa	98	18	54.4	108	30	36.0
Sternaspis scutata	55	10	55.0	143	21	68.0
Hartmania moorei	48	13	36.9	107	26	41.1
Ampharete acutifrons	21	11	19.0	114	31	36.7
Nemertea sp	28	16	17.5	106	33	32.1
Casco bigelowi	3	2	15.0	131	14	93.5
Nucula delphinodonta	119	11	108.1	----	----	----
Pholoe minuta	18	10	18.0	82	30	27.3
Cingula aculeus	10	3	33.3	84	15	56.0
Crenella decussata	6	3	20.0	70	21	33.3

*First 25 from table 1.

COMMUNITY VARIATION

Although the two small areas studied produced nearly identical fauna, certain species were not found in both areas, and there were marked differences in occurrence and abundance (table 3). Greater average numbers of animals per sample were obtained in Jewett Cove than in Ebenecook Harbor (223.8 vs. 105.6) and more species per sample (24.9 vs. 14.8) were taken. The faunistic differences that exist between the two areas were found in fringe species that are incidental to the community (table 4). For example, 16 species were obtained in Jewett Cove that were not found in Ebenecook Harbor and Ebenecook Harbor provided 19 species not found in the other area. In Ebenecook Harbor, 15 of the 19 species were annelids, 2 species were mollusks, and 2 species were intertidal (epifaunal) gastropods. Only nine of the species in Jewett Cove were annelids, five were mollusks, and two were arthropods. Most of these animals were found in such small numbers that they appear to contribute little to community structure, but some species from each area were important to the bottom fauna. They were *Nucula delphinodonta* in Ebenecook Harbor and a three-species complex of the genus *Corophium* in Jewett Cove. *Corophium* was particularly important in the total abundance providing 4.3 percent of all fauna (table 2). Although *N. delphinodonta* contributed only about 1 percent to the combined fauna, the concentrated occurrence must be important in the bottom associations of the deeper regions of Ebenecook Harbor, possibly in competition with *Nucula proxima*.

TABLE 4.—*Species not found in both Ebenecook Harbor and Jewett Cove, Maine, July to November, 1955*

Ebenecook Harbor		Jewett Cove	
Species	Number	Species	Number
Annelida:		Annelida:	
Polycirrus medusa	2	*Eunoe nodosa*	7
Polycirrus eximus	5	*Goniada maculata*	1
Praxillura ornata	3	*Flabelligera affinis*	2
Heteromastus filiformis	3	*Scalibregma inflatum*	4
Capitella capitata	3	*Maldane sarsi*	13
Eteone longa	1	*Praxillella praetermissa*	6
Phyllodoce mucosa	1	*Phyllodoce groenlandica*	18
Nereis virens	12	*Euchone rubrocincta*	1
Nereis caudata	1	*Nereis pelagica*	1
Aricidea sp. 1	3		
Paraonis gracilis	2		
Polydora sp	1		
Streblospio benedicti	57		
Nephtys caeca	9		
Prionospio malmgreni	1		
Mollusca:		Mollusca:	
Nucula delphinodonta	119	*Clinocardium ciliata*	4
Yoldia myalis	2	*Mytilus edulis*	2
Littorina littorea	3	*Lyonsia arenosa*	1
Littorina saxatilis	5	*Lyonsia hyalina*	1
		Cylichna alba	8
		Arthropoda:	
		Leptocheirus pinquis	27
		Anonyx lilljeborgii	6

The faunal differences may be ascribed to physical and environmental conditions. Both Ebenecook Harbor and Jewett Cove were sampled essentially on the same grid plan. Ebenecook Harbor enclosed an area of 8,139 square meters, from which 36 one-tenth square meter samples were obtained, and Jewett Cove contained an area of 7,113 square meters, from which 42 one-tenth square meter samples were taken. Ebenecook Harbor is a more sheltered environment away from the main currents of the Sheepscot River and depends primarily on tidal exchange for circulation. Distinct environmental differences may be observed among the three coves in Ebenecook Harbor, probably as a result of their isolation from each other. Studies on the annual fluctuations in green crab, *Carcinus maenas*, populations have shown that winter mortalities—attributable to climatic factors—may be confined to one cove, but not necessarily the same cove, in successive years (W. R. Welch, oral communication). Jewett Cove, however, is hardly more than an indentation in the western bank of the Sheepscot River. The currents washing over the bottom are more pronounced than those in Ebenecook Harbor, water mass exchange may be more rapid, and probably more food material is available. These factors may also present an opportunity for a greater number of planktonic larvae to be brought into the area, and possibly provide for a more homogeneous distribution of the established animals. Differences in bottom slope, steeper in Jewett Cove and tending to compress the horizontal range of species with narrow depth requirements, may also be an important agent controlling faunal distribution.

DISCUSSION

Size composition

Apparently large animals are at a disadvantage in this community of small organisms and cannot establish themselves in this habitat. The marked small size of almost all animals in the *Nephtys-Nucula* community merits discussion, particularly with regard to some factors favoring small animals in this situation.

The possibility exists that the sampling equipment may not capture large animals either because

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the animals live beyond the depth of sediment to which the grab can dig, or because the animals are too widely scattered. Neither of these appear to be valid objections, since the equipment has obtained larger animals from other local communities in soft sediments and other types of samplers have been used on the *Nephtys-Nucula* community without obtaining significant numbers of large animals (Sanders, 1956, 1960; Stickney and Stringer, 1957).

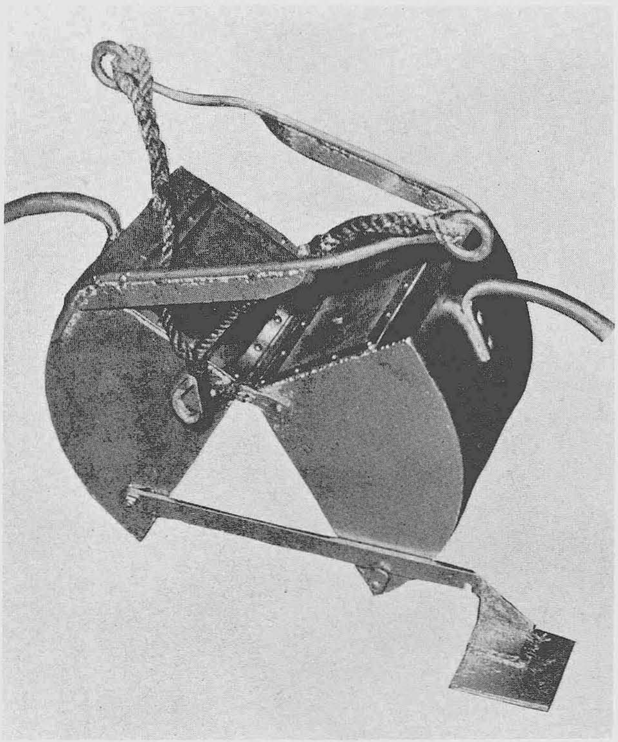

FIGURE 4.—Petersen-type dredge similar in construction to the grab used in this survey.

If the apparent size composition is not influenced by limitations of sampling then other selective factors must be operative. Juveniles of potentially large animals are occasionally taken in the sampler (for example, *Pitar morrhuana* at 11 stations), but these animals rarely reach mature size in this community. The advantage gained by superior numbers alone may be favorable to small animals in the competition for habitat and the ability to mature rapidly can be very advantageous in colonization. High natality, rapid growth, and early maturity enables the species within a population to fill the ecological niche rapidly tending to exclude species with the slow growth and late maturity characteristic of many large animals. If predation should become a dominant factor in controlling community size-composition, slow growth and late maturity expose prey to longer periods of predation and fewer individuals will reach adulthood. Recruitment of large animal species in the *Nephtys-Nucula* community tends to be at long intervals from sources outside the occupied area while recruitment is intensive and at shorter intervals from the endemic, smaller species.

Sediments conducive to the establishment of a population of small infaunal animals are probably not favorable to large organisms from the outset. Soil particle size may be an important selective factor in determining the size range of organisms in the community. The physical and chemical modifications (fecal deposition, tube construction, particle selection, etc.) of such sediments by a community of small animals would be expected to make the environment less attractive the longer the community successfully maintained itself.

Other environmental and ecological factors may regulate size composition within any animal community, and further research on this subject is needed.

Geographical distribution

The *Nephtys-Nucula* community was first described by Sanders (1956) from the benthos in Long Island Sound. Originally termed the *Nephtys incisa-Yoldia limatula* community, *Nucula* being rejected as a dominant because of small size, the name has been revised in recent papers on the basis of further study and now stands as *Nephtys incisa-Nucula proxima*. Sanders (1958, 1960) has also found the *Nephtys-Nucula* community in the soft mud bottoms of Buzzards Bay, Mass. He pointed out in these papers that although *Nephtys incisa* has often been classified as a carnivore, it is a nonselective deposit feeder in this association. This is particularly important if the animal is used to typify the community since predators are not considered to be stable members of an infaunal association (Thorson, 1957).

Stickney and Stringer (1957) have reported a faunal association from the soft mud bottoms of Greenwich Bay, R.I., which appears somewhat transitional between Sanders' *Ampelisca* community and the *Nephtys-Nucula* community. The *Ampelisca* community does exist in a large part of

TABLE 5.—*Comparison of four* "Nephtys-Nucula" *communities*

Rank	Sheepscot River	Buzzards Bay [1]	Long Island Sound [2]	Greenwich Bay [3]
1	*Nucula proxima*	*Nucula proxima*	*Nephtys incisa*	*Ampelisca spinipes.*
2	Cumacea sp	*Nephtys incisa*	*Nucula proxima*	*Corophium cylindricum.*
3	*Stereobalanus canadensis*	*Ninoe nigripes*	*Yoldia limatula*	*Podarke obscura.*
4	*Thyasira gouldi*	*Cylichna orzya*	*Cistenides gouldi*	*Tharyx acutus.*
5	*Phoxocephalus holbolli*	*Callocardia* [=*Pitar*] *morrhuana*		*Tornatina canaliculata.*
6	*Volsella modiolus*	*Hutchinsoniella macracantha*		*Spiochaetopterus oculatus.*
7	*Corophium* sp	*Lumbrinereis tenuis*		*Macoma tenta.*
8	*Nucula tenuis*	*Turbonilla* sp		*Nucula proxima.*
9	*Dulichia* sp	*Spio filicornis*		*Pitar morrhuana.*
10	*Scoloplos armiger*	*Retusa caniculata*		
11	*Aricidea* sp	*Dorvillea caeca*		
12	*Nephtys incisa*	*Tharyx* sp		
Sediment	Very high percent silt-clay	Very high percent silt-clay	Greater sand content than other surveys.	Highly modified by Ampelisca tubes.
Equipment	Petersen-type Grab	Foster Anchor Dredge (modified).	Foster Anchor Dredge (modified).	Hayworth clamshell.
Sample size	0.1 m.² x 10 cm. deep	7.6 cm. deep—calculated surface area from volume.	7.6 cm. deep—calculated surface area from volume.	0.5 m.² x 30 cm. deep.
Finest screen	1.5-mm. openings	0.2-mm. openings	1.0-mm. openings	2.0-mm. openings—subsample only (0.5 m.² x 8.0 cm.) remainder through 12-mm. openings.

[1] From Sanders (1960). [2] From Sanders (1956). [3] From Stickney and Stringer (1957).

Greenwich Bay, but there is a strong indication from sedimentary and faunal evidence, that at least a section of the center part of the Bay could support the *Nephtys-Nucula* community.

The *Nephtys-Nucula* community has been recorded therefore from three locations on the Atlantic coast: Long Island Sound, Buzzards Bay, and Sheepscot Bay, with the possibility of a fourth in Rhode Island. These communities are compared in table 5. Characteristically, they are composed of small deposit-feeding species which live in the top few centimeters of the bottom sediments where a supply of organic food materials provides nutritional support for relatively large numbers of short-lived, but early maturing animals. The community appears to be endemic to the northern coasts of the United States in relatively protected bodies of water and is confined to the soft mud bottoms which have a high silt-clay sediment composition. The animals which it comprises are generally boreal. Species composition of minor community organisms will vary depending on the geographical location of the population.

The *Syndosmya-Alba* community described by Petersen and Jensen from Danish waters (see review by Thorson 1957, p. 510) appears to be a close counterpart of the *Nephtys-Nucula* community. The original definition of the *Nephtys-Nucula* community and comparison with communities from other geographical areas can be found in Sanders (1956).

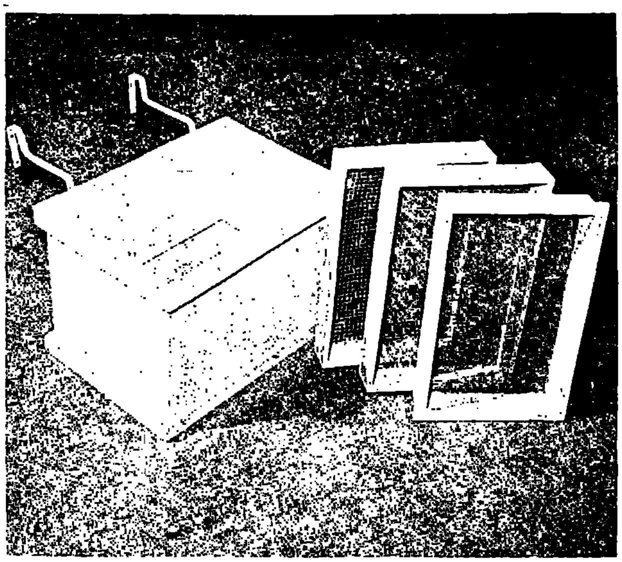

FIGURE 5.—Screen box and three nesting screens used to separate organisms from bottom sediments.

SUMMARY

A *Nephtys-Nucula* community is described from a series of bottom samples taken with a Petersen-type grab. The community was found in areas of the Sheepscot River estuary and has been previously described from similar soft mud sediments in Buzzards Bay, Mass., and Long Island

Sound. The faunal composition of the community is similar in all areas but incidental species composition varies with geographical location. *Nucula proxima*, a pelecypod, and *Nephtys incisa*, a polychaete, are the dominant organisms of the Sheepscot community with cumaceans, a hemichordate, a pelecypod (*Thyasira gouldi*), and an amphipod (*Phoxocephalus holbolli*) also numerous and widely distributed.

The community is composed of small animals that inhabit the surface layers of the bottom sediment. They are mostly deposit or filter feeders. Their small size may be of advantage in competition with larger animals, at least in this environmental situation.

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H. L. Sanders and R. L. Wigley reviewed the manuscript.

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