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Benthic Invertebrates of the New England Fishing Banks

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What does the sea bottom on the New England fishing banks look like? What kind of invertebrate animals dwell in these deep, cold waters?

Curiosity about this fauna undoubtedly stems from many sources. One aspect of interest, and perhaps a source of wonder, is the enormous productivity of the New England fishing grounds — they rank among the richest fish producing areas in the world. Long before this country was settled, fishermen from Europe found the stocks of fish sufficiently plentiful to undertake a long and somewhat hazardous voyage across the Atlantic to harvest them. During Colonial times these populations of fish provided the basis for both domestic and foreign trade. Fishing, in fact, was one of the key industries that made possible the development of this country. Other industries such as shipbuilding, salt manufacturing, iron works, and lumbering, developed, in part, to provide the fishermen's needs.

Allied with the subject of productivity is the fact that most fishing in this region is for bottom-dwelling species — the so called groundfish or demersal fish. This is in contrast to the kind of fishing practised in many other parts of the world where pelagic species (tunas, anchovies, etc.) are the principal types that are sought. In New England, cod was the preferred species during the early period because of its good keep-

ing qualities when salted and dried. Later on haddock, pollock, several species of hakes, and a number of different kinds of flounders made up the bulk of the commercial catch.

Each year about 1 million metric tons (2 billion pounds) of groundfish are harvested from the New England region. An adequate food supply for these fish is one of the vital necessities for their maintenance and growth. The food base for most of these groundfish is composed mainly of bottom-dwelling invertebrates, such as shrimps, crabs, worms, many kinds of mollusks, and echinoderms. Also, some of the less well-known invertebrate groups (brittlestars, holothurians, amphipods, mud shrimps) are important dietary items for certain species. Enormous quantities of these benthic organisms are necessary to support the large stocks of groundfish. The available food supplies are believed to affect some of the following: (a) observed differences in growth rate of fishes and their relative plumpness; (b) variations in the number of eggs produced and the survival of newly hatched young; (c) modifications in the normal migration routes and time of migration; (d) and, directly or indirectly, the survival of juvenile and adult stocks of fishes.

To provide information about the kinds and quantities of food organisms available to these vast stocks of groundfish, a study of the benthic invertebrate fauna was undertaken by the Bureau of Commercial Fisheries, with the close cooperation of the Woods Hole Oceanographic Institu-

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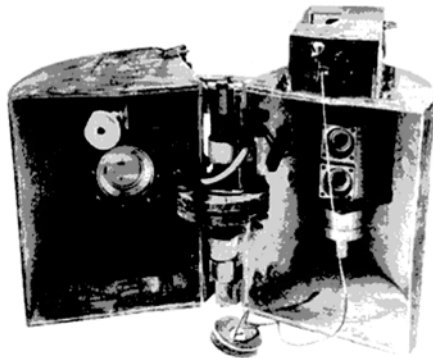


Chart of the Gulf of Maine region off the northwestern coast of the United States showing a few of the many fishing banks and topographic features.

tion and the U. S. Geological Survey. The work of the latter two organizations in this study primarily concerns the broad geological aspects (see the article describing the Atlantic Shelf geology).

Several different kinds of instruments were used for sampling the benthic invertebrates because the size of these organisms ranges from large tree-like corals that may be 6 to 8 feet tall, down to small crustaceans and worms only 1/8 of an inch long or smaller. The small and medium-size organisms were collected with clam-shell grab samplers (an example is the Campbell grab shown in the photograph). More than 1,000 samples, including sediment and the enclosed fauna, were collected with grab samplers from the area shown in the

chart. The contents from the sampler were washed over a fine-mesh screen and all animals were picked out, classified, counted and weighed. Medium-size and large specimens were collected with Naturalist's dredges, scallop dredges, and large trawl nets (width of mouth opening 80 feet or more) of a type used by the trawler fleet. Several thousand dredge and trawl samples were collected from the area and handled in the same way that grab samples were processed. Information based on the samples has been supplemented by several thousand photographs of the sea bottom, and by visual inspection of the benthic environment from a research submarine. We thus have assembled sufficient information to give a general description of the varied and exceedingly fascinating animal life that



Bottom view of a Campbell grab sampler used for collecting quantitative samples of the benthic invertebrate fauna. Camera is installed in the righthand bucket, strobe light is in the lefthand bucket, and attached to the cord is a lead camera-tripping weight.

inhabits the banks and adjacent basins on the New England Continental Shelf.

The fishing banks off New England range in size from a few square miles, such as The Banana, Henry Marshalls Ground, Bumbos, and Old Man's Pasture, to such large plateau-like areas as Browns Bank and Georges Bank. Georges Bank is by far the largest fishing bank in this region. It is 150 miles long and 75 miles wide encompassing an area of roughly 10,000 square miles (more than the combined area of Massachusetts and Rhode Island). From one location to another within a fishing bank, or from one bank to another, there may be totally different types of bottom sediments, wide ranges in water depth, and different physical and chemical properties of the overlying water. The many diverse habitats resulting from these varied environmental characteristics have made it possible for an even wider variety of organisms to inhabit these areas. In spite of the risks of oversimplification, a general understanding of the banks fauna can be gained by considering a few of the more common and widespread faunal associations. It should be kept in mind, however, that overlap

and intergradation of species is considerable between one faunal assemblage and another, and that exceptions occur to some of the broad statements concerning the geographic occurrence of particular faunas. Descriptions of the benthic invertebrate faunas that typically inhabit four common bottom types are given below in the following order: Sand Fauna, Silty Sand Fauna, Gravel Fauna, and Muddy Basin Fauna.

Sand Fauna

In large areas on the New England Banks the bottom is relatively free of silt and clay particles and is carpeted with sand. Water movements caused by wave action or by the strong tides typical of this region, and in some places by the nontidal water currents, have winnowed away the fine sediment particles leaving a rather "clean" sand. These areas are frequently in moderately shallow water atop the banks. In this type of habitat there live certain animals adapted to life in a loose and occasionally shifting sand substrate.

Some of the more common species in habitats of this type are: common sand-dollar, *Echinarachnius parma*, which is a thin, flat, circular echinoderm that rarely gets larger than 3 inches in diameter; sand shrimp, *Cragon septemspinosus*, a caridean decapod 2 to 3 inches long whose mottled coloration ranges from brown to nearly translucent white and blends in nicely with the sediment; two carnivorous gastropod mollusks — *Lunatia heros*, a large (2-1/2 inches) smooth-shelled species, and *Nassarius trivitatus*, a smaller (1 to 1-1/2 inches) rough-shelled form; surf clam, *Spisula solidissima*, a large (up to 7 inches) heavy-shelled bivalve mollusk that lives buried beneath the sediment surface; the chestnut astarte, *Astarte castanea*; small crustaceans such as *Leptocuma*, a cumacean, and *Chiridotea* an isopod; Acadian hermit crab, *Pagurus acadianus*, a relatively large spe-

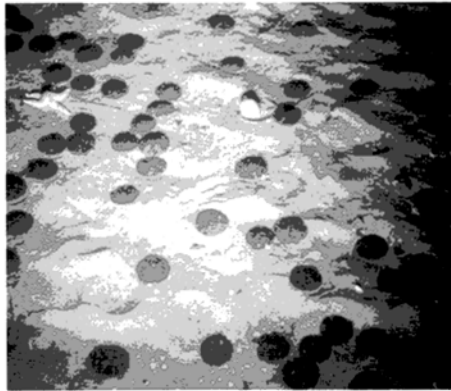
cies that utilizes gastropod shells for "houses"; various kinds of polychaete worms (*Ophelia*, *Goniadella*, *Clymenella* and others); tunicates *Heterostigma* and *Molgula* that camouflage their nest with sand grains; and a variety of haustoriid and phoxocephalid amphipods (beach fleas). Practically all of the above-named species are burrowing forms; some remain more or less permanently beneath the sediment surface and others burrow only occasionally as conditions demand. Also, a large proportion of these animals are translucent or light in color; often whitish.

Typical localities where this type of fauna occurs are as follows: Nantucket Shoals region, central part of Georges Bank, central and eastern parts of Browns Bank, Stellwagen Bank, parts of Lurcher Shoal, and other similar places.

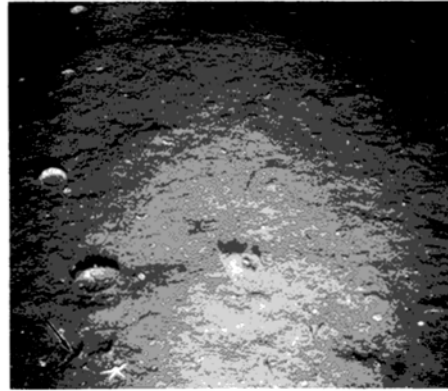
Silty Sand Fauna

Bottom deposits at moderately shal-

low depths around the periphery of some fishing banks are frequently composed of mixtures of sand, silt, and clay. This type of bottom, referred to as silty sand, has a loose, pliable surface. Weak to moderate water currents that flow over these deposits are rich in plankton and detritus. Substantial portions of this suspended matter settle out and serve as food for the deposit-feeding invertebrates. Other suspended components are removed directly from the water by filter-feeding species. The fauna inhabiting silty sand sediments is composed of a group of animals intermediate in form, structure, and habits between those living in silt-free sand and those from the muddy basins (see below), and some of the species from these other sediment types commonly occur in silty sand. Although the species composition of this fauna is not nearly as varied as that of the gravel fauna (see below) it is moderately rich in species and frequently contains



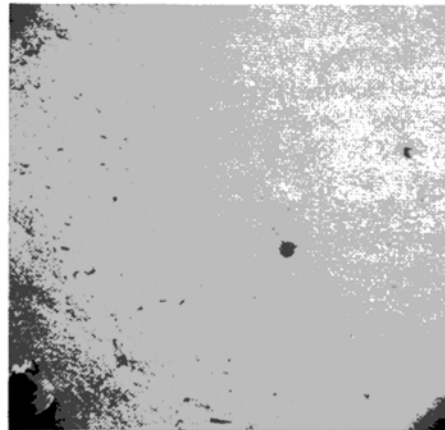
An oblique view of the sea bottom near the central part of Georges Bank shows sand ripples and some common invertebrate animals that inhabit sand sediments. The dark disk-shaped objects are sand-dollars; the light-colored rounded mollusks are moon shells; the small white elongate snail (near lower right) is a dog whelk; the starfish is a medium-size specimen of northern starfish; and on the righthand side of the picture just below the middle are several small specimens of Acadian hermit crabs.



An oblique view of the sea bottom on the southern side of Georges Bank showing a silty sand habitat and some of the animals that live there. The bivalve shells are from dead specimens of ocean quahogs; in the lower center is a shell from a long-dead ten-ridged neptune (snail); along lefthand side are four northern starfishes; and tubes of amphipods and polychaete worms are numerous. Also, at least a dozen pandalid shrimp are in this picture (see arrow); how many can you find?



A dense assemblage of animals on a gravel substrate is shown in this close-up vertical view of the sea bottom near Grand Manan Bank (northern Gulf of Maine). The numerous small white objects are brachiopods (lamp shells), the larger light-colored animals are sponges and an Iceland scallop, and the other common forms are bryozoans and polychaete worms.



No animals are visible in this close-up view of a mud-bottom area in the Gulf of Maine, but evidence of animal life is revealed by the tubes of amphipods (beach fleas) and polychaete worms, and by the tracks and burrows in the sediment. The object in the lower left-hand corner is the camera-tripping weight.

a large number of individuals of a few kinds — burrowing forms and tube-dwelling species are particularly abundant.

Some of the common inhabitants of the silty sand sediments are: ocean quahog, *Arctica islandica*, a rather heavy-shelled bivalve mollusk that is similar in size and habits to the shallow-water quahog or hard-shell clam from which it differs by having a thick, dark periostracum; rough-skinned thysone, *Thysone scabra*, a spindle-shaped burrowing sea cucumber 2 to 3 inches long with the body surface covered with short papillae; *Ampelisca vadorum* and *A. compressa*, small (1/4 to 1/2 inch) tube-dwelling amphipod crustaceans that are exceedingly numerous and an especially important food for groundfish; other common crustaceans — the decapod shrimp *Dichelopandalus*, the cumacean *Diastylis*, the isopod *Edotea*; polychaete worms such as *Scalibregma*, *Nephtys*, *Harmothoe*, and many others; a burrowing sea anemone *Cerianthus* that has long

slender tentacles gracefully arched toward the water current; brittlestars *Amphipolus* and *Amphylimna* that crawl on and through the sediments; pygmy distaff shell *Colus pygmaeus*, a small (1 inch) carnivorous gastropod; and many small to moderately small bivalve mollusks such as *Venericardia*, *Nucula*, and *Crenella*.

Localities where this fauna occurs are the deeper areas around Nantucket Shoals, the shelf area off southern New England, and along the southern side of Georges Bank. Somewhat similar faunas inhabit silty-sand sediments in the vicinity of many banks in the Gulf of Maine.

Gravel Fauna

A large number of banks in the Gulf of Maine region are floored with gravels that range in size from pebbles to boulders. Also, in a few areas, ledges of bedrock outcrop on the ocean bottom. The velocity of the waters flowing over these rocky areas is usually moderate to strong. With few exceptions, this combination of physical features forms

suitable habitats for colonization by sessile organisms that require a firm substrate for attachment and a food supply brought to them by the passing currents. This assemblage not infrequently develops into densely clustered masses of animals, including many colonial forms, that represent a wide diversity of taxonomic groups.

Some of the common components of the gravel fauna are: sponges, such as *Polymastia*, *Clionia*, and *Myxilla*; barnacles, *Balanus crenatus* and *B. hameri*; a great variety of beautifully shaped and delicately colored hydroids—*Tubularia*, *Eudendrium*, *Sertularia*, and *Bougainvillia*, to name a few; the lampshells (*Brachiopoda*) represented mainly by *Terebratulina*; soft corals only a few inches high (*Gersemia*) as well as others which attain a size comparable with that of small trees (*Paragorgia*); tunicates, represented by the solitary forms *Boltenia* and *Ascidia*, and colonial types like *Amaroucium*; filter-feeding bivalve mollusks, *Modiolus*, *Placopecten*, *Anomia* and *Musculus*; polychaete worms, *Serpula*, *Chone*, *Spiorbis*, and related kinds characterized by beautiful branchial plumes, plus numerous errant forms; rather large carnivorous motile forms such as the starfishes *Solaster* and *Crossaster*, the gastropod *Neptunea*, and the toad crab, *Hyas*; various kinds of nudibranchs (*Doris*, *Dendronotus*,) and brittlestars (*Ophiopholis*, *Ophiacantha*). This abundant and varied assemblage of benthic invertebrates form one of the richest and most complex — and highly interesting — faunal groups to be found on the New England banks.

Gravel faunas are abundantly represented on Cashes Ledge, parts of Great South Channel, the northeastern part of Georges Bank, western Browns Bank, Jefferys Ledge, and numerous other smaller banks in the Gulf of Maine region.

Muddy Basin Fauna

In the deepwater basins between the

fishing banks the sea bottom is blanketed with fine-grained sediments commonly referred to as mud. The major constituents of the mud are silts and clays, plus a smaller amount of fine sands. Water currents in these mud-bottomed basins are weak and the sediment surface is generally level and smooth. Some of the animals, especially crustaceans and polychaete worms, have long delicate legs, tentacles, or other appendages suitable for moving about or feeding in this soft-bottom environment. The number of different kinds of animals as well as the density or abundance of all species combined is low in comparison with that on the fishing banks.

Species of benthic invertebrates that are common inhabitants of the muddy basin areas are: *Briaster fragilis*, a heart urchin of moderate size (up to 3 or 4 inches) that burrows into the sediment and remains below the sediment surface; *Ophiura sarsi*, *O. robusta*, and *Amphiura otteri*, brittlestars that as adults range in diameter from about 3 to 12 inches; *Ctenodiscus crispatus*, mud star, a pentagonal-shaped starfish that derives its nourishment by engulfing the muddy sediment; *Modiolaria discors*, a small (1/2 inch) bivalve mollusk; *Scaphander*, a gastropod mollusk; *Cadulus* and *Dentalium*, scaphopod mollusks that are sometimes termed tusk shells; *Haploops tubicola*, a small (1/4 inch) tube-dwelling amphipod; *Munnopsis typica*, a delicate limbed isopod crustacean; decapod crustaceans—*Calocaris*, *Ger-yon*, and *Pandalus*; the solitary ascidian *Polycarpa fibrosa*; and a number of different kinds of polychaete worms, such as *Sternaspis*, *Amphitrite*, *Onuphis*, *Leanira*, and others. A rather large proportion of the animals mentioned above are deposit feeders; some feed indiscriminately on the sediments and others select particular portions of the sediment. Carnivores constitute the other main group of animals.