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Biodiversity of Bear Seamount, New England Seamount Chain: Results of Exploratory Trawling

by

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Abstract

Bear Seamount (39° 55'N 67° 30'W) is an extinct undersea volcano located inside the U.S. Exclusive Economic Zone south of Georges Bank. The fauna associated with the seamount was little known until twenty trawl stations were made 2-7 December 2000, by the NOAA ship Delaware II. The objective of the cruise was to begin to document the biodiversity on and over the seamount, particularly of fishes, cephalopods, and crustaceans. Representatives of most species were preserved as vouchers and for subsequent definitive identification. Preliminary identifications indicate the capture of 115 fish species. Among these were a number of new fish records for the area or rare species, including *Acromycter pertubator* (Congridae), *Alepocephalus bairdii* (Alepocephalidae), *Mirognathus normani* (Alepocephalidae), *Bathygadus favosus* (Bathygadidae), *Nezumia longebarbata* (Macrouridae), *Gaidropsarus argentatus* (Phycidae), and *Dibranchius tremendus* (Ogcocephalidae). Only two fish species of potential commercial importance were encountered: *Coryphaenoides rupestris* and *Macrourus berglax*. Cephalopods comprised 26 species in 15 families, including one new distributional record and several rarely-collected species. The crustacean fauna was diverse with at least 46 species. Totals for other invertebrate species are pending laboratory identification, but number at least 113 species in 10 phyla. This includes a number of new distributional records and a new species of gorgonian.

Keywords: North Atlantic, seamount, deep-sea, fauna, fishes, invertebrates

Introduction

Seamounts represent biological islands in the deep sea and often feature characteristic faunas that are quite different from those found in the surrounding soft sediment and abyssal habitats. Large depth ranges, hard substrates, steep gradients, complex topography, impinging currents, topographically induced upwellings, clear oceanic water, and geographic isolation all combine to make seamounts specialized habitats for deep-sea organisms (Rogers 1994). The benthic faunas on seamounts include species that create structural habitat diversity and likely create essential habitat for some deep-sea fishes and crustaceans.

The New England Seamounts (NES) make up the longest seamount chain in the North Atlantic, encompassing more than 30 major volcanic peaks extending from Georges Bank southeast for about 1200 km to the eastern end of the Bermuda Rise, ending abruptly with Nashville Seamount to the ENE of Bermuda (Fig. 1). The major peaks of the NES rise as much as 4000 m above the Sohm Abyssal Plain. About 300 km east of Nashville Seamount, the Corner Rise Seamounts form a cluster of peaks midway between the eastern end of the NES and the

Mid Atlantic Ridge. The NES and Corner Rise Seamounts resulted from a mantle-plume hotspot, which moved towards the Mid Atlantic Ridge (Sleep 1990).

The NES chain lies roughly perpendicular to two major currents, the Gulf Stream, flowing to the northeast, and the Deep Western Boundary Current, which flows southwesterly along the continental slope (Hamilton et al 1996). In addition, the Antarctic Bottom Water flows around the bases of the seamounts at the eastern end of the chain. These seamounts alter the flow of the currents in their vicinity (Vastano and Warren 1976, Hogg et al. 1990), which may influence the recruitment of benthic and pelagic organisms.

While the geology of the New England Seamounts and the effects of the seamounts on the Gulf Stream have been extensively studied, the biota has been almost completely ignored (Zeigler 1955, Uchupi et al. 1970, Vastano and Warren 1976, Houghton et al. 1977, Heirtzler et al. 1977a and b, Hogg et al. 1990). A review of the biogeography of seamount faunas around the world (Wilson and Kaufman 1987) makes note of only one species known from the entire New England Seamount chain (the stony coral *Enallopsammia rostrata* from Gregg Seamount). Because of this dearth of biotic information, the NES were excluded from a recent discussion on the biology of seamounts around the world (Rogers 1994).

Examinations by one of us (JAM) of archived photos taken during the geological investigation of the NES has found that more than 50 species of invertebrates and at least eight species of fishes do in fact live on these seamounts. Exploratory commercial fishing in 1997 on Bear Seamount (the closest NES to the U.S.) captured another seven fish species, including two species previously known from the eastern Atlantic and one previously found only in the temperate southern hemisphere (Moore et al. ms.). Clearly, much can be done to investigate the NES fauna and integrate that information into the extensive knowledge gained from other seamounts in the Atlantic, Pacific, and elsewhere in the world.

With the rise of deep-sea fisheries, interest in commercially fishing seamounts has increased (Koslow 1997). Yet seamounts hold concentrations of sessile suspension-feeding invertebrates, such as scleractinians, gorgonians, and sponges, that add structural complexity, and there are concerns about the impact of fishing activities on these invertebrates (Dayton et al 1995, Auster et al 1996, Probert et al. 1997, Koslow and Gowlett-Holmes 1998, Moore and Mace 1999, Koslow et al. 2000). A recent haul of Darwin's roughy (*Gephyroberyx darwini*, also known as big roughy) from a canyon on the south side of Georges Bank generated renewed interest by some U.S. fishers in exploring the deepwater fishery resources of New England. One fishing company put forward a specific proposal to explore the fishery resources on Bear Seamount. This coincided with planning by the National Marine Fisheries Service (NMFS) to conduct an exploratory cruise to Bear Seamount in late 2000. One objective of our cruise was to begin to document the biodiversity on and over the seamount, particularly of fishes, cephalopods, and crustaceans before large-scale commercial fishing begins.

Bear Seamount (39° 55'N 67° 30'W) is an extinct undersea volcano located inside the U.S. Exclusive Economic Zone south of Lydonia Canyon on Georges Bank. Bear Seamount rises from the continental slope at depths of 2000-3000 m to a generally flat summit at a depth of 1100 m below the sea surface. Although the upper surface of Bear Seamount is draped in many places with thick sediment, there are also outcrops of basaltic volcanic rock and scattered glacial erratics varying in size from small pebbles to large boulders. These glacial erratics most likely fell to the seamount after dropping from icebergs calving off the glaciers that extended to Georges Bank during the Pleistocene.

Bear Seamount was first identified, named and sonar mapped during a series of cruises by Woods Hole Oceanographic Institution (WHOI) vessels in 1954 (Zeigler 1955). Subsequent investigations of Bear Seamount include more sonar mapping, one dredge haul and one camera lowering in 1962 (R/V Atlantis cruise A-281; Pratt and Thompson 1962), two Alvin dives in 1968 (Alvin dive 286 and 287), and a commercial exploratory trawl by the F/V Matthew Melissa out of Stonington, CT in 1997. A list of taxa identified from these previous studies is found in Table 1.

Materials and Methods

Twenty hauls were made on or over Bear Seamount using double-warp gear towed from the NMFS vessel R/V Delaware II from 2-7 Dec 2000 (cruise DE00-11). Six hauls were made with an IYGPT midwater trawl, five hauls with a NMFS standardized shrimp trawl, and nine tows with a Yankee 36 otter trawl. Catches were sorted and given preliminary identifications on shipboard. Tissue samples of many fish and cephalopod taxa were taken for DNA analysis (samples of fishes are deposited at the Museum of Natural History, University of Kansas). Representatives of most species were preserved as vouchers. The voucher specimens are deposited in the Museum of Comparative Zoology at Harvard University (most fish specimens), Peabody Museum of Natural History at Yale

University (some invertebrates), and the National Museum of Natural History, Smithsonian Institution (some fishes and most invertebrates). Many specimens were sent to taxonomic experts for subsequent definitive identification. A list of those experts can be found in the acknowledgments.

Results

Preliminary identifications indicate that 115 fish species were captured (Table 2). Several new fish records for the area or rare species were collected, including *Acromycter pertubator* (Congridae), *Alepocephalus bairdii* (Alepocephalidae), *Mirognathus normani* (Alepocephalidae), *Bathygadus favosus* (Bathygadidae), *Nezumia longebarbata* (Macrouridae), *Gaidropsarus argentatus* (Phycidae), and *Dibranchius tremendus* (Ogcocephalidae). The cephalopods comprised 26 species in 15 families, including one new distributional record and several rarely-collected species. The crustacean species numbered at least 46 species. Totals for other invertebrate species are pending laboratory identification, but number at least 113 species in 10 phyla. Notable captures of invertebrates include a solitary coral, *Vaughanella margaretata*, which represents the first record of this species since its original description over one hundred years ago (S. Cairns, pers. comm.). A redescription of an isopod species (*Syscenus atlanticus*, previously known only from off Iceland) has been submitted for publication based in part on specimens from Bear Seamount (Kensley ms). We have also been informed of a number of new distributional records and an undescribed species of gorgonian (F. Bayer, pers. comm.).

Only two fish species of potential commercial importance were encountered: *Coryphaenoides rupestris* and *Macrourus berglax*. *Coryphaenoides rupestris*, the roundnose grenadier, was caught at 4 stations at depths of 1100-1800 meters. They ranged from 47-103 cm TL, with an average length of 85 cm TL. A total of 88 individuals was caught, with the highest catch of 46 individuals at one station, weighing a total of 65.1 kg. *Macrourus berglax*, the roughhead grenadier, was captured at 5 stations, also at depths of 1100-1800 m. They ranged from 31-104 cm TL, with an average length of 50 cm. Twenty one individuals were caught, with the highest catch of 10 individuals.

No commercial cephalopods were captured and only a few commercial crustaceans were taken from Bear Seamount (a few isolated individuals of *Plesiopeneaus edwardsianus* and *Neolithodes grimaldii*).

Discussion

Our results have some bearing on statements made by Wilson and Kaufman (1987) in their review of seamount biotas. For instance, they state that although ophiuroid brittlestars are widespread and common in deep-sea sedimentary environments, they have been reported from very few seamounts. Our cruise collected a number of ophiuroid species and found the brittlestar *Ophiomusium lymani* to be common in all the benthic trawls. Archived photos of other seamounts in the NES chain also show numerous brittlestars on soft sediment, on rocks, and perched in the fronds of gorgonians (see fig 9 in Houghton et al. 1977).

Wilson and Kaufman (1987) also state that few of the reported seamount crustaceans are truly benthic. However, we collected a number of benthic crustacean species from Bear Seamount. A large spider crab, *Neolithodes grimaldii*, and numerous hermit crabs, *Parapagurus pilosimanus*, were taken, as were a variety of polychelid and galatheid crustaceans. Also, a gooseneck barnacle (*Scalpellum* sp.) was collected still attached to a small pebble. Archived photos from the two Alvin dives on Bear Seamount show a *Neolithodes* in a shallow dish-like depression, an unidentified small spider crab associated with an urchin, and large red shrimp, possibly *Plesiopeneaus edwardsianus*, just inside the mouths of small burrows in the soft sediment.

With regards to seamount fish faunas, Wilson and Kaufman (1987) state that fishes are associated with seamounts elsewhere, but have not been reported from the western North Atlantic seamounts. This was true at the time of that paper. Since then, Vinnichenko (1997) published a list of the fishes found on the Corner Rise Seamounts (about 300 km east to the eastern end of the NES). That faunal list compares well with our list of fishes from Bear Seamount. The main difference is that the Corner Rise features many species more typically found in the deep waters of the eastern North Atlantic, while our list has many more western North Atlantic deepwater species. However, a few eastern Atlantic species (e.g., *Hydrolagus pallida* and *Bathypterois dubius*) were found on Bear Seamount and may indicate that the NES chain provides a westward route of dispersal for at least some eastern Atlantic species.

Large pieces of live *Lophelia pertusa* were collected from two of the bottom hauls indicating that deepwater coral banks may exist on this seamount. Evidence of *Lophelia* has also been noted from other NES (Pratt and Thomson 1962, Heirtzler et al. 1977a). This species has been associated with very diverse communities elsewhere in the North Atlantic (Jensen and Frederiksen 1992, Mortensen 1995, Rogers 1999). Similarly diverse communities may also be present on Bear Seamount.

Even though Bear Seamount rises up out of the continental slope of Georges Bank, it apparently provides sufficiently unusual habitats or conditions that allow various species not generally reported from the nearby slope to live on the seamount. Three of us have been working for years on a checklist of deepwater fish species for all of New England and this is near completion (Moore et al. ms.). However, the trawls on Bear Seamount resulted in several new additions to that checklist. Similarly the cephalopods from this cruise add to the slope fauna recently compiled by Vecchione (2000) and Vecchione and Pohle (in press). Photographs of some of these unusual cephalopods have been added to the cephalopod section of the Tree of Life project on the World Wide Web (<http://tolweb.org/tree/eukaryotes/animals/mollusca/cephalopoda/cephalopoda.html>). This could indicate that there is some degree of separation of the seamount fauna from the nearby continental slope, or our ignorance of what lives in the deep sea may still be so great that a single cruise can add much new information, despite many deepwater investigations in the region over the last 130 years.

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Table 1. Taxa seen or sampled from Bear Seamount prior to 2000. The invertebrates and some fish were identified from archived photos from Atlantis cruise A-281 and Alvin dives 286 and 287. The archived photos are available at the Document Library of Woods Hole Oceanographic Institution. The fishes marked with * were captured in a commercial exploratory trawl in 1997 and identified back on shore by JAM. These are deposited at the Ichthyology Collection of Peabody Museum of Natural History, Yale University.

PROTOZOA	<i>Neomorphaster</i> sp. small 5-arm sea star
globose syringaminid? xenophyophore	<i>Ophiomusium lymani</i> brittle star
	unidentified light brittle stars
	<i>Echinus affinis</i> urchin
	Echinothuriid pancake urchin
	unidentified 5-arm bathyocrinid crinoid
	<i>Peniagone</i> sp. sea cucumber
PORIFERA	
unidentified sponges	
CNIDARIA	
cerianthid anemone	
unidentified large light-colored anemone	
<i>Desmophyllum cristagalli</i> scleractinian coral	
<i>Lepidoisis</i> sp. unbranched spiral whip coral	
<i>Primnoa</i> sp. gorgonian coral	
pinnate gorgonian corals	
<i>Anthophilum</i> sp. sea pen	
SIPUNCULIDA	
unidentified sipunculid worm	
ANNELIDA	
<i>Hyalinoecia</i> sp. polychaete worm	
ARTHROPODA	
<i>Neolithodes</i> sp. stone crab	
unidentified spider crab assoc.w/ urchin	
ECHINODERMATA	
<i>Solaster abyssicola</i> sunstar	
<i>Porania</i> sp. sea star	
	UROCHORDATA
	large transparent unstalked tunicate
	PISCES
	<i>Hydrolagus pallidus</i> chimaera*
	<i>Apristurus</i> sp. deepwater catshark*
	<i>Bathyraja</i> sp. skate
	unidentified notacanthid spiny eel
	unidentified halosaur
	<i>Serrivomer beanii</i> sawpalate eel*
	<i>Diastobranchus capensis</i> cuthroat eel*
	unidentified cuthroat eel
	unidentified smoothhead
	<i>Bathypterois dubius</i> spiderfish*
	<i>Coryphaenoides</i> sp. grenadier
	unidentified morid codling
	<i>Anoplogaster cornuta</i> fangtooth*
	<i>Antigonia capros</i> deepbody boarfish*
	<i>Sebastes</i> sp. redbfish
	<i>Zoarces atlanticus</i> eel-pout

Table 2. Taxa collected on or over Bear Seamount during NMFS cruise DE00-11 from 2-7 Dec 2000.

PROTOZOA	
agglutinated foraminiferans (3+ spp.)	
PORIFERA	
boring sponge	
demospongiae? Fragments	
hexactinellid fragments	
stoloniferous sponge	
white leathery sponge	
CNIDARIA	
Scyphozoans (5+ spp.)	
Poralia rufescens	
siphonophore pieces	
knobby pink anemone	
small white anemone	
Epizoanthus paguriphilus	
Caryophyllia ambrosia	
Flabellum alabastrum	
Vaughanella margareta	
Lophelia pertusa	
Acanthogorgia angustiflora	
Paragorgia sp.	
Lepidisis sp. spiral whip	
Anthoptilum grandiflorum	
Funiculina sp.	
Anthomastis agassizii	
CHAETOGNATHA	
chaetognaths	
NEMERTEANS	
Nectonemertes mirabilis	
Dinonemertes cf. investigatoris	
ANNELIDA	
polychaetes in wood	
polychaetes in Lophelia	
serpulid triangular tubes	
serpulid small tubes	
MOLLUSCA	
nudibranch	
Colus sp.	
Puncturella sp.	
Haminoea sp.	
Daphnella sp.	
Caliostoma sp.	
heteropods	
pteropods	
Clione sp.	
CEPHALOPODS	
Lampadioteuthis megaleia	
	Abralia veranyi
	Abraliopsis hoylei
	Pyroteuthis margaritifera
	Pterygioteuthis gemmata
	Pterygioteuthis giardi
	Taningia danae
	Octopoteuthis megaptera
	Gonatus fabricii
	Histioteuthis sp.
	Histioteuthis dofleini
	Histioteuthis reversa
	Bathyteuthis abyssicola
	Brachiooteuthis sp.
	Illex illecebrosus
	Chiroteuthis sp.
	Chiroteuthis spoeli
	Chiroteuthis veranii
	Mastigoteuthis sp.
	Mastigoteuthis agassizi
	Mastigoteuthis magna
	undetermined Cranchiidae
	Taonius pavo
	Teuthowenia megalops
	Stauroteuthis syrtensis
	Eledonella pygmaea
	Macrotritopus defilippi
	Graneledone verrucosa verrucosa
	Vampyroteuthis infernalis
	ARTHROPODA
	Sysenus atlanticus
	Bopyrid isopod (in Glyphocrangon)
	Hyperiid amphipods
	Phronima sp.
	Colossendeis colossea
	Scalpellum sp. gooseneck barnacle
	Plesiopeneaus edwardsianus
	Acanthephyra sp. (4 spp.)
	Glyphocrangon sp.
	Notostomus sp.
	Pasiphaea sp. (3 spp.)
	Gennadas sp. (3-4 spp.)
	Sergestes sp. (10 spp.)
	Homolids
	Oplophorus sp.
	Systellaspis sp.
	euphausids
	pandalid
	Stylopandalas sp.
	Polycheles granulatus
	Steromastis nana
	Polychelid spiny form
	Munidopsis sp.
	Munidopsis rostrata
	Munidopsis curvirostra

Table 2. (continued)

Mysids	
Gnathophausia zoea	
Parapagurus pilosimanus	
Neolithodes grimaldii	
Copepod parasite on Synbranchus eel	
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ECHINODERMATA	
<hr/>	
crinoid arm	
elasipodid holothurian	
Psychropotes depressa	
Plutonaster agassizi	
Psilaster andromeda florae	
Cheiraster sepius	
Persephonaster seastar	
Ceramaster granularis	
Mediaster bairdi	
Pseudarchaster parelii	
Neomorphaster forcipatus	
Chondraster grandis	
Henricia sp.	
Pteraster sp.	
Solaster benedicti	
Zoroaster sp.	
Brisingia costata	
Freyella microspina	
Freyella elegans	
Asteroschema sp.	
Ophiomusim lymani	
Ophiacanthidae sp.	
Ophiacantha sp.	
Amphiophiura saurura	
Homophiura tessellata	
Ophiocten gracilis	
Ophiura ljunghmani	
simple-armed basket star	
Echinus affinis	
Echinus sp.	
Zygothuria lacteal	
Phorosoma placenta	
Hygrosoma petersi	
<hr/>	
UROCHORDATA	
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Stalked tunicates	
thaliacean salps	
Pyrosoma sp.	
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PISCES	
<hr/>	
Hydrolagus affinis	
Apristurus manis	
Apristurus profundorum	
Etmopterus princeps	
Raja bigelowi	
Aldrovandia affinis	
Aldrovandia oleosa	
Aldrovandia phalacra	
Halosauropsis macrochir	
	Notacanthus chemnitzii
	Polyacanthonotus challengerii
	Ilyophis brunneus
	Diastobranchus capensis
	Synaphobranchus sp.
	Synaphobranchus kaupii
	Derichthys serpentinus
	Nessorhamphus ingolfianus
	Nemichthys scolopaceus
	Congridae larvae
	Acromycter perturbator
	Ariosoma sp. larvae
	Venefica procera
	Serrivomer beanii
	Eurypharynx pelacanoides
	Bathylagus berycoides
	Bathylagus euryops
	Dolichopteryx sp.
	Alepocephalus agassizi
	Alepocephalus australis
	Alepocephalus bairdii
	Bajacalifornia megalops
	Mirognathus normani
	Narcetes stomias
	Rouleina attrita
	Maulisia sp.
	Cyclothone pallida
	Cyclothone microdon
	Gonostoma bathyphilum
	Gonostoma elongatum
	Chauliodus sloani
	Argyropelecus aculeatus
	Argyropelecus hemigymnus
	Sternoptyx diaphana
	Sternoptyx pseudobscura
	Valenciennellus tripunctulatus
	Vinciguerra nimbaria
	Malacosteus niger
	Aristostomias tittmani
	Bathophilus pawneeii
	Borostomias antarcticus
	Leptostomias longibarba
	Melanostomias bartonbeani
	Photostomias gueneri
	Stomias boa ferox
	Stomias affinis
	Bathypterois phenax
	Bathypterois quadrifilis
	Scopelosaurus sp.
	Bathysaurus ferox
	Arctozenus rissoi
	Paralepis sp.
	Paralepis coregonoides
	Benthoosema glaciale
	Ceratoscopelus maderensis
	Ceratoscopelus warmingii
	Diaphus brachycephalus

Table 2. (continued).

Diaphus dumerili
 Diaphus rafinesqui
 Hygophum taaningi
 Lampadena speculigera
 Lampanyctus photonotus
 Lobianchia dofleini
 Lobianchia gemellari
 Myctophum affine
 Nannobranchium atrum
 Nannobranchium lineatum
 Nannobranchium mcdonaldi
 Notoscopelus resplendens
 Symbolophorus veranyi
 Dicrolene intronigra
 Penopus microcephalus
 Porogadus miles
 Bassogigas gilli
 Bathygadus favosus
 Coryphaenoides alateralis
 Coryphaenoides carapinus
 Coryphaenoides rupestris
 Macrourus berglax
 Nezumia longebarbata
 Nezumia sclerorhynchus

Sphagemacurus grenadae
 Trachonurus sulcatus
 Antimora rostrata
 Gaidropsarus ensis
 Gaidropsarus argenteus
 Halargyreus johnsoni
 Dibranthus tremendus
 Melanocetus murrayi
 Cryptopsarus couesii
 Melamphaes microps
 Melamphaes suborbitalis
 Poromitra megalops
 Scopelogadus beanii
 Scopeloberyx opisthopterus
 Anoplogaster cornuta
 Cottunculus thomsoni
 Howella brodei
 Anthias nicholsi larva
 Platyberyx opalescens
 Lycodes atlanticus
 Melanostigma atlanticum
 Chiasmodon niger
 Kali indica
 Glyptocephalus cynoglossus larvae
 Poecilopsetta beani larva

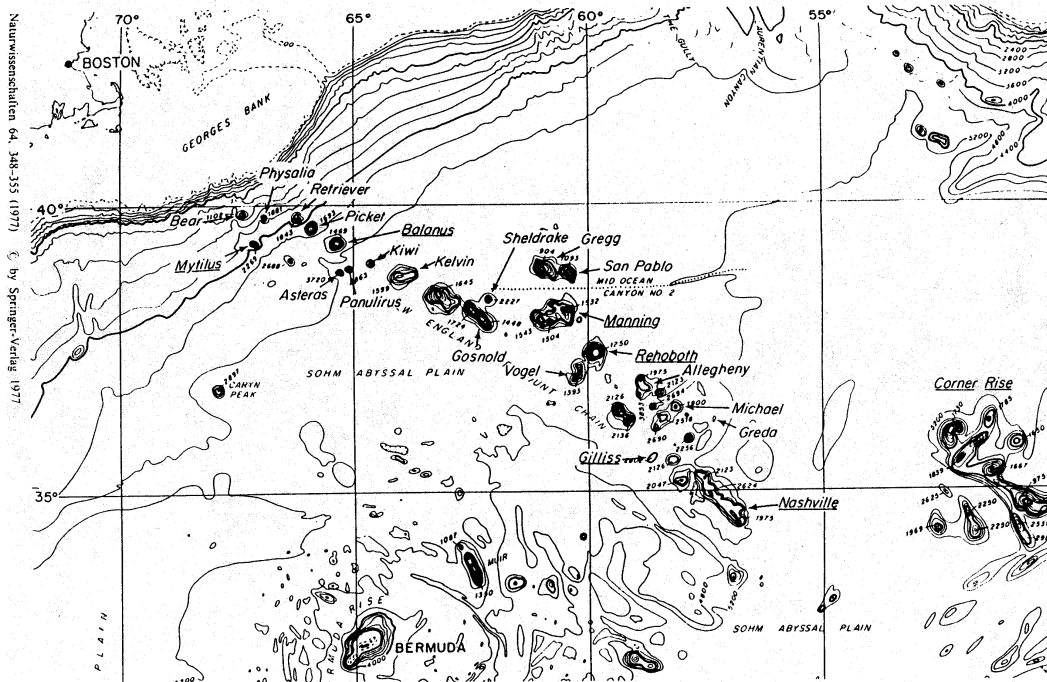


Fig. 1. Bathymetric chart of the New England Seamount chain in meters (from Houghton et al. 1977).