UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

THE BENTHIC FAUNA OF THE NORTHERN BERING SEA

By

Robert W. Rowland

Open-file report

1973

This report is preliminary
and has not been edited or
reviewed for conformity with
Geological Survey standards.

Abstract

The shelled benthic fauna of the northern Bering Sea has been extensively sampled and the taxonomy, distribution and functional role of 105 species of mollusks, two species of barnacles, two species of echinoids and one species of brachiopod have been examined. The major benthic communities were evaluated by cluster analysis. They are:

(1) the Balanus rostratus alaskensis community which inhabits cobble or gravel substrates;

(2) the Tellina lutea alternidentata community which is limited to areas of clean sand;

(3) the Clinocardium ciliatum community which is found on silty-sand substrates; and

(4) the Macoma balthica community which inhabits the brackish coastal lagoons.

These associations were compared with the classic boreal benthic communities of Peterson & Thorson. Although the Bering Sea fauna is compositionally similar to the Scandinavian, the species associations differ markedly. These differences are believed to be due to substrate differences. The Bering Sea sediments are more poorly sorted and patchily distributed than those of Scandinavian waters.

TABLE OF CONTENTS

List of Figures

Figure

List of Tables

Table

INTRODUCTION

The purpose of this report is threefold: first to describe the benthic species of the northern Bering Sea, secondly to delineate the communities they form, and thirdly to examine the ecological parameters which control the distribution of these species and communities.

The area studied (Figure 1) extends southward from the Bering Strait area to approximately 63° N latitude; the western boundary is the United States - Russia convention line of 1867 (American ships have been unable to obtain the permission of the Soviet government to sample the sea floor west of this line). Sampling covered the Chirikov Basin and Norton Sound areas of the northern Bering Sea; these areas encompass more than 100,000 km^2 (40,000 mi^2).

The impetus for what is essentially a large scale paleobiological study stems from an unusual source. It seems that much of Alaska's Seward Peninsula and Russia's Chukotka Peninsula are underlain by highly mineralized rocks and the heavy metals eroded from rocks are, in some instances, concentrated in placer deposits. For example, at Nome on the south coast of Seward Peninsula, gold has been mined commercially from the present beach in addition to beach deposits of Pliocene and Pleistocene age. The northern Bering Sea is shallow (fig. 2) and presumably it could be mined by suction dredges operating from surface vessels. To investigate the possibility of placer deposits on this section of sea floor, the Office of Marine Geology of the U.S. Geological Survey embarked on an extensive sea floor sampling project.

During the summers of 1968, 1969, and 1970, oceanographic research was conducted by the U.S. Geological Survey in cooperation with the National

Oceanographic and Atmospheric Agency, the University of Washington, the U.S. Coast and Geodetic Survey, the Alaska Department of Fish and Game, and the University of Alaska. In addition to the bottom samples, data was gathered on the bathymetry, hydrography (temperature, salinity and currents), gravity, magnetics and sub-bottom accoustic characteristics of the sediments. Some of the results of this work have been published; the remainder, to be published in the near future, has been made available to the author by the various investigators.

The principal function of the benthic samples was to determine the type and distribution of sediments and the concentration of particulate heavy metals, especially gold. Fortuitously, the sampling procedure was designed so that the larger benthic organisms could be preserved soon after dredging. The sampling procedure consisted of repeatedly lowering a one-tenth of a square meter Van-Veen grab sampler, until the equivalent of approximately 20 kilograms of dry sediment was obtained. After the removal of a small raw sample for size analysis the remaining sediment was washed through a 2 millimeter screen into a holding tank. The fine sediment in the tank was used for particulate gold analysis; the coarser sediment and biota on the screen were separately bagged. Initially the organisms were preserved in a formalin solution. On shore, in Nome, the biota were sorted into two categories, shelled and unshelled. The soft bodied, unshelled groups, primarily annelids and crustaceans, were retained by Mr. John Burns of the Alaska Department of Fish and Game.

The shelled organisms from 363 benthic samples form the basic data for this report. In addition, these groups comprise the major faunal component in the rich fossiliferous Quaternary strata which rim the northern Bering Sea. One of the eventual goals of the present study is to re-collect these deposits, then reconstruct the paleoecology of the area using the present study as a foundation.

The samples are at best semi-quantitative; roughly the same amount of material was obtained in areas of fine sediments, but in coarser environs often only a few cobbles covered with barnacles and brachiopods could be brought to the surface.

I have attempted to structure this report in a hierarchical fashion, where each unit is based on information provided by the units below. For example, the most elementary unit in this system is the individual shells obtained in each sample. The fauna on the cobbles mentioned above is a higher level of complexity for it approximates a community. The highest level of complexity with which this report will deal is the benthic communities of the northern Bering Sea and their ecosystems.

This report consists of four sections: a taxonomic synopsis of the species, the communities of organisms, the ecology of the communities, and conclusions.

Acknowledgements

At sea the sampling was carried out with the cooperation of the U.S. Coast and Geodetic Survey. Richard B. Perry, National Oceanographic and Atmospheric Administration, and C. Hans Nelson, U.S. Geological Survey, were valuable colleagues during this portion of the study.

In Alaska John Burns, Carl Yanagawa, and Robert Pegau of the Alaska Department of Fish and Game extended many courtesies.

Systematic collections at the U.S. National Museum, Stanford University, the California Academy of Sciences and the University of California at Davis were utilized to great benefit. My thanks to the curators and staffs of these institutions.

Specialists who provided valuable consultation include: Eugene V. Coan (Tellinidae), Clifford M. Nelson (neptunids), Louie Marinkovich (naticids), Carol Allison (Echinoidea), S.F. MacNeil (Myidae) and Oleg Petrov (some species of *Astarte*).

Dean McManus, University of Washington, and his co-authors made available a necessary manuscript on the sediments of the northern Bering Sea.

T.M. Haran was of great assistance in programming the cluster analysis. Computational time was funded through a National Science Foundation grant to the UCD computer center.

Throughout the study James W. Valentine and Richard Cowen, University of California, Davis, and David M. Hopkins and C. Hans Nelson, U.S. Geological Survey, provided valuable guidance and discussion: to them my express thanks. And lastly, my thanks and love to Linda, who saw me through it all.

TAXONOMIC SECTION

This study afforded the first opportunity to conduct a comprehensive study of the benthic fauna of the northern Bering Sea. The resident species were found in most cases to be adequately described. Many of the species are circum-arctic or circum-boreal in their distribution and as such they have been recently discussed by authors concerned with the fauna of other regions. Basic works of this type are the study of the East Greenland bivalves by Ockelmann (1958), the mollusks of Point Barrow by MacGinitie (1959), and Petrov's (1966) book on the Quaternary faunas of the Chukotsk Peninsula, which is especially valuable, for in addition to his own data he includes material from the unavailable text of Gorbunov (1952) on the bivalves of the Gulf of Anadyr and the Bering Sea.

Taxonomic work specifically on Bering Sea material started with specimens collected by Bering, Kotzebue and other Russian explorers. Much of this material was stored in Leningrad; its present disposition is unknown.

W.H. Dall worked in northwestern Alaska as a young man and after acquiring a position at the U.S. National Museum he continued to include Bering Sea specimens in his publications. Dall published over 1600 titles and retrieval of names and proper references would be a formidable task were it not for the alphabetical list of his taxa published by Boss, Rosewater and Ruhoff (1968).

F.S. MacNeil published several papers (1943, 1957, 1965, 1967) on the Cenozoic fossils of western Alaska; these proved to be of considerable use in identifying the Recent fauna. Specialists working on various groups have been consulted whenever possible. The results of these exchanges have been noted on the appropriate taxonomic data sheets. Additionally, four weeks were spent at the U.S. National Museum, and the collections housed at the California Academy of Sciences and at Stanford University have been utilized on several occasions.

Speciation is a process that operates over time in response to genetic isolation and environmental changes. At a given point in time some organisms will be clearly divided into discrete species, similar, yet without intermediate forms; while other groups are confusing, clearly separated in one area and transitional in another. The taxa encountered in the Bering Sea seem to fall mostly in the second category; commonly there are morphological intermediates between otherwise distinct species. For example, the tellinid bivalves: Coan (1971) conducted a thorough reexamination of this family, yet he noted that in the Bering Sea intermediates exist between *Macoma calcarea* and *M. brota* and between *M. brota* and *M. lipara*. The same is true for taxa of *Astarte*, *Yoldia*, *Buccinum* and several other genera. These problems arise from at least two sources: previously the collections of Bering Sea material have been inadequate to quantify variation, and secondly, speciation problems are not unexpected in light of the repeated transgressions-regressions and climatic changes which have occurred in the northern Bering Sea over the last five million years.

Each of the taxa discussed on the following pages has been treated independently as regards the data relevant to it and morphologic characteristics of the specimens at hand I have not endeavored to split or combine taxa as a matter of preference.

One hundred and two species are presented in the taxonomic synopsis. There are forty-seven species of bivalves, forty-nine species of gastropods, one species of chiton, one species of brachiopod, two species of echinoids and two species of barnacles.

The bivalves are clearly the dominant component of the fauna; they constitute more than 75% of the volume of material collected. Their taxonomy is presented in detail. The taxonomy of the other groups is referenced and described in a more summarized form. The identified taxa include nearly all the specimens collected, only a few microgastropods remain unidentified.

The taxonomic data sheets for each bivalve species are presented in the following form:

1. Name of the species, the original describer and the year of the description
2. Synonymy

   Original describer and reference

   Subsequent citations are those relevant to the taxon being treated, or to comprehensive works on boreal mollusks. Note that a comma separates the species name from the subsequent citation. The original describer's name is not repetitively reproduced.
3. Description

   A short description of the species mentioning the features used to separate it from nearby taxa.

   Measurements in millimeters of selected specimens, usually the largest live-collected individuals. This portion of the presentation follows Petrov (1966, p.182) who used the following measurements and ratios to quantify variation:

L - length - the greatest horizontal dimension

H - height - the greatest vertical dimension, measured at right angles to the length

W1V - width of one valve; used with equivalve species

W2V - width of two (both) valves; used with unequivalve species, or specimens which could not be disarticulated

UAM - the horizontal distance from the umbo to the anterior margin

KY - Coefficient of elongation - height divided by length, H/L

KB - Coefficient of inflation - width of one valve divided by the length, W1V/L

KH - equilateral coefficient - distance from the umbo to the anterior margin divided by the length, UAM/L

Other workers, notably Ockelmann (1958) and MacGinitie (1959), commonly gave measurements which can be converted to the above notation for comparative purposes.

This section concludes with the number of lots collected.

4. Discussion section

Comments on the variation, recent taxonomic studies and the criteria used to separate and recognize the species are presented here.

The taxonomic information for the gastropods, chiton, brachiopod, echinoids and barnacles includes a synonymy, a short description, and the number of lots collected.

This section concludes with Table 1, a listing of all the species and their occurrences at the 363 benthic samples in the northern Bering Sea. To conserve space only the last three digits of the 6000 series locality numbers are listed on these sheets. Complete locality descriptions are presented in Appendix A.

Nucula tenuis (Montagu, 1808)

Arca tenuis Montagu, 1808, suppl. p.56-57, pl.29, fig.1.

Nucula expansa Reeve, 1855, appendix, p.397, pl.33, fig.2.

Nucula inflata Hancock, 1846, p.333.

Nucula tenuis expansa, Oldroyd, 1924, p.14, pl.13, fig.6, 7.

Nucula tenuis expansa, Ockelmann, 1958, p.13-15.

Nucula tenuis expansa, MacGinitie, 1959, p.149-150, pl.18, fig.4.

Nucula tenuis, Petrov, 1966, p.182-183, pl.10, fig.1-8.

Bering Sea specimens of this species are covered with a shiny, mottled deep olive periostracum, while juveniles are lighter colored. The shell surface is ornamented with microscopic growth lines. Adults have up to 10 anterior teeth and up to 17 posterior teeth. The five largest specimens are (length, height, width of both valves):

Sta. No.	L	H	W2V
M-6081	13.3	11.0	8.4
M-6012	13.5	10.5	6.8
M-6011	12.8	10.5	7.6
M-6078	12.5	10.0	6.3
M-6241	12.1	9.8	7.5

63 lots

Discussion:

This species is widespread throughout the Arctic, the north Pacific, and north Atlantic oceans and inflated varieties have been recognized throughout its range. In the Atlantic and Arctic tumid forms are designated N. tenuis inflata Hancock, 1846; in the north Pacific obese individuals are referred to N. tenuis expansa Reeve, 1855. The amount of inflation (KB) has been quantified by Petrov (see Introduction); he obtained values of KB = .25 to .27 for the typical form and KB = .30 to .34 for the variety N. t. inflata. Inflation values (KB) for the specimens noted above are respectively .32, .25, .28, .25, .31; these values suggest continuous variation in inflation. Additionally I have noted that both typical and obese individuals can be found in a single grab sample. This leads me to conclude that the variation is a population characteristic and is probably not related to a specific ecologic parameter.

Concerning the nomenclature, Nucula tenuis is an adequate name, should the tumidness warrant designation, the term "expansa" is available for Bering Sea specimens.

Leda buccata Steenstrup, 1842

Leda buccata, Steenstrup, 1842, p.17.

Leda buccata, Oldroyd, 1924, p.25

Nuculana buccata, Richards, 1962, p.51, pl.1, fig.21, 22.

Leda buccata, Petrov, 1966, p.184, pl.10, fig.9, 10.

Nuculana buccata, Morris, 1966, p.3, pl.9, fig.11.

This species is quite rare. It is represented by single valves at M-6013 and M-6079 and by a pair of valves and a single valve at M-6269. Dimensions are (length, height, width of one valve, BK):

Sta. No.	L	H	W1V	KB	
M-6269	14.2	8.0	2.9	.20	
M-6013	16.9	9.7	3.5	.21	3 lots

Discussion:

Leda minuta is very similar to *Leda buccata*, however *L. buccata* has less prominent concentric ribs and is somewhat more inflated. Petrov (1966, p. 184) noted that KB for *L. buccata* is .20 to .22 and *L. minuta* is .19.

Leda pernula (Muller, 1779)

Arca pernula Muller, 1779, p.55.

Leda pernula, Oldroyd, 1924, p.19, pl.19, fig.7, 7a.

Leda pernula, Grant and Gale, 1931, p.119.

Leda pernula costigera, Ockelmann, 1958, p.15-18, pl.1, fig.9.

Nuculana pernula, Richards, 1962, p.51, pl.1, fig.14-15.

Leda pernula, Petrov, 1966, p.185-186, pl.10, fig.12-15.

One valve of this species was collected. The surface of the valve has closely spaced growth striae which are covered with a dull olive periostracum. The interior of the valve is white and has a small (1 mm) faint longitudinal rib in the middle of the siphonal gap. Measurements are (length, height, width of one valve, distance from umbo to anterior margin, anterior teeth, posterior teeth):

Sta. No.	L	H	W1V	UAM	AT	PT
M-6095	18.4	11.5	3.0	6.2	16	18

1 lot

Discussion:

The posterior dorsal margin is straight not upturned as the variety "costigera".

Portlandia arctica (Gray, 1824)

Nucula arctica Gray, 1824, p.214.

Leda arctica, Oldroyd, 1924, p.26, pl.19, fig.6, 6a.

Portlandia arctica, Ockelmann, 1958, p. 23-26.

Yoldia arctica, MacGinitie, 1959, p.151-152, pl.18, fig.8.

Portlandia arctica, Petrov, 1966, p.190-191.

Valves of this species were collected at only two localities; fragments of a single valve were found at M-6132 and a pair of valves filled with sediment was obtained at M-6233. The shells are elliptical with obliquely truncated posteriors. The dimensions of the complete pair are (length, height, width of both valves, distance umbo to anterior margin):

Sta. No.	L	H	W	UAM	
M-6233	11.6	6.9	3.9	4.8	2 lots

Discussion:

As noted by MacGinitie (1959, p.151-152) this species is quite variable in obesity and truncateness. The complete specimen compares well to examples obtained by MacGinitie at Point Barrow.

The distribution of the species is anomalous; some authors list it as occurring south of the Bering Straits, however, Petrov (1966, p.191) concludes that these occurrences are reworked fossils and that presently members of this genus do not live south of the Bering Straits. The present collections suggest that small populations of *P. arctica* inhabit the sea floor approximately 50 miles east of Nome and in the vicinity of Stuart Island.

Yoldia scissurata Dall, 1897

Yoldia scissurata Dall, 1897, art.1, p.8.

Yoldia scissurata, Dall, 1898, vol.3, pt.4, p.595.

Yoldia scissurata, Oldroyd, 1924, p.31, pl.5, fig.2.

Yoldia scissurata, Grant & Gale, 1931, p.131, pl.1, fig.1.

Yoldia scissurata, MacGinitie, 1959, p.154-155.

This species is large, reaching 44.3 mm (M-6302) in length. The valves are covered with a shiny green periostracum; surface ornamentation consists of very fine lines which do not parallel the growth edge of the valve. The three largest live collected specimens measure (length, height, width of both valves):

Sta. No.	L	H	W2V	
M-6302	44.3	23.6	12.4	
M-6292	43.8	22.9	12.8	
M-6060	37.7	19.4	10.1	28 lots

Discussion:

The distinctive surface ornamentation serves to clearly separate this species from other members of the genus. Grant and Gale synonymized *Yoldia ensifera* Dall, 1897 with *Yoldia scissurata*. MacGinitie, on the other hand, noted the following consistent differences between the two species: (1) the posterior dorsal blades are longer and much higher in *Y. ensifera*, (2) the rostrum is more upturned in *Y. scissurata*. All of the specimens collected are clearly *Y. scissurata*.

Yoldia amygdalea Valenciennes, 1846

Yoldia amygdalea Valenciennes, 1846, pl.23, fig.6.

Yoldia hyperborea limatuloides, Ockelmann, 1954, p.11-13, pl.1, fig.2, pl.2, fig.1,2.

Yoldia amygdalea, Valenciennes, Cowan, 1968, p.58, pl.5, fig.1-5.

A very low umbo and distinct sinuations in both the posteroventral and anteroventral margins are characteristic of this species. Each sinuation produces a slight indentation on the shell margin. Often the umbonal areas are eroded on adults, the rest of the shell covered with a highly reflective periostracum. The three largest individuals measure (length, height, width of both valves, distance from anterior end to umbo, anterior teeth, posterior teeth):

Sta. No.	L	H	W2V	UAM	AT	PT
M-6323	43.5	21.1	10.2	24.1	33	24
M-6252	38.1	18.9	8.7	20.9	33	23
M-6315	38.0	19.0	9.6	20.4	27	22

62 lots

Discussion:

Ockelmann (1954) established two subspecies of Yoldia hyperborea, Yoldia hyperborea hyperborea and Yoldia hyperborea limulatoides. The subspecies "limulatoides" is differentiated primarily by its sharply pointed posterior and by having an overall length exceeding twice the height. Cowan (1968) published the results of an extensive quantitative investigation of Yoldia of the northern seas; he concluded that Y. h. limulatoides "differs as profoundly from Y. hyperborea as any of the other stocks compared. The weight of evidence now suggests that this stock be regarded as conspecific with _Y. amygdalea_" (p.56). He also recognized _Y. hyperborea_ as a distinct stock restricted to the Arctic seas.

Only 13 specimens of Bering Sea material were available to Cowan (from Saint Matthew, Nunivak, Unimak and the Pribilof Islands). He noted that these forms were "intermediate" between _Y. hyperborea_ and _Y. amygdalea_ and suggested that the Bering Sea may represent a zone of introgression between the otherwise distinct species. The specimens collected are shiny and elongate with distinct posterior and anterior sinuations; they are best referred to _Y. amygdalea_ as used by Cowan and are clearly best placed in that species and not in any intermediate category.

Yoldia myalis (Couthouy, 1838)

Nucula myalis Couthouy, 1838, p.62, pl.3, fig.7.

Yoldia myalis, Oldroyd, 1924, p.30, pl.5, fig.8.

Yoldia myalis, Ockelmann, 1958, p.18-20, pl.1, fig.5, pl.2, fig.5,10.

Yoldia myalis, MacGinitie, 1959, p.152, pl.18, fig.1.

Yoldia myalis, Petrov, 1966, p.189, pl.10, fig.21.

This species is medium sized with dark olive, silky periostracum. A faint sinuation extends from the low, slightly posteriorly-located beaks to the anterior ventral area, where the foot of the animal exists; this feature is very faint, generally it does not indent the shell surface or shell margin. The anterior portion of the shell is distinctly inflated; the greatest height of the valves is measured slightly anterior of the umbos. Dimensions of three large and two average-sized individuals are (length, height, width both valves, distance umbo to anterior margin, anterior teeth, posterior teeth in the right valve):

Sta. No.	L	H	W2V	UAM	AT	PT
M-6292	42.1	20.8	12.3	24.2	23	16
M-6085	37.2	20.7	11.2	22.0	25	17
M-6069	35.1	19.0	11.1	19.3	25	18
M-6324	30.9	17.7	10.0	18.5	23	17
M-6350	22.7	11.7	6.2	11.6	18	14

152 lots

Discussion:

The umbo is slightly posterior in most specimens and distinctly posterior in a few individuals (for example, M-6324 above), which seem to have shortened posteriors. The lack of a posterior sinuation, a less prominent anterior sinuation, more inflated valves and a duller periostracum separate this species from Y. amygdalea. These features clearly separate the two species even when they occur at the same locality.

Determining the valid name for this species is more difficult than objectively separating it from the other yoldids. Most individuals are similar to the specimen figured by MacGinitie though her specimen is approximately 21 mm in length. All but one of the specimens Ockelmann studied were less than 20 mm long and Petrov lists a maximum size of 17 mm. In the original description, reprinted in Oldroyd, the length of the type is given as 22/20 of an inch (28 mm). The average size of the adult specimens that I collected is a perturbing 35 mm.

Hinge teeth are also a problem. The number of teeth increase as the shell grows and as a result the total number of teeth is of little taxonomic value. Ockelmann concluded that the ratio of anterior to posterior teeth was more significant. Unfortunately the teeth near the resilifer are minute and exposing them for quantification without destruction is very difficult. Counting errors of $\pm$ 1 or $\pm$ 2 produce large errors in the anterior-posterior ratio (for example, a ratio of 24/16 = .15, an error of $\pm$ 2 produces ratios varying from .122 (22/18) to .185 (26/14). Ockelmann calculated ratios of 1.2 to 1.3; the specimens described above have ratios of 1.28 to 1.46.

To summarize, the northern Bering Sea houses populations of Y. myalis which are both large in size and large in numbers.

Mytilus edulis Linne, 1758

Mytilus edulis Linne, 1758, p.705.

Mytilus edulis, Oldroyd, 1924, p.66, pl.27, fig.4.

Mytilus edulis, Soot-Ryen, 1955, p.19-22, pl.1, fig.1 & 2, text-fig.1,2,10,11.

Mytilus edulis, Ockelmann, 1958, p.61-63, pl.3, fig.11.

Mytilus edulis, MacGinitie, 1959, p.157.

Mytilus edulis, Petrov, 1966, p.199-200, pl.12, fig.2-7.

Dark blue-black in color; the surface sculpture consists of concentric growth lines. The largest specimens collected on the beach at Stuart Island, M-6232, is 65.4 mm long, 28.8 mm high and 24.6 mm width of both valves. Only one live specimen was collected, M-6225, and unfortunately it was crushed by the jaws of the sampler; its original length was approximately 22 mm.

10 lots

Discussion:

Mytilus edulis is generally thought of an an intertidal species; however, both Soot-Ryen and Ockelmann have recorded its occurrence in deeper waters. In the northern Bering Sea the single live specimen was attached to a large Balanus; occasional single valves were found in other benthic samples. Clumps of specimens are encountered in beach collections and in lagoon dredges. Unfortunately, living material from these localities has not been obtained.

Musculus niger (Gray, 1824)

Modiola nigra Gray, 1824, p.244.

Musculus niger obesus, Dall, 1916, p.406.

Musculus nigra, Oldroyd, 1924, p.74, pl.13, fig.21, pl.39, fig.9.

Modiolaria nigra, Ockelmann, 1958, p.58-61.

Musculus niger, MacGinitie, 1959, p.155-156, pl.18, fig.6, pl.21, fig.6.

Musculus nigra, Richards, 1962, p.57, pl.5, fig.12.

Musculus niger, Petrov, 1966, p.203-204, pl.12, fig.14-18.

Musculus niger, Morris, 1966, p.10, pl.10, fig.4.

Juveniles are dark-yellow brown, adults are shiny black. The surface of the shell is covered with minute growth lines which are intersected on the posterior half and anterior third of the shell by radial striations. Many of the specimens collected are incomplete and crushed; the two largest complete live-collected individuals measure (length, height, distance from umbo to anterior margin, width of both valves):

Sta. No.	L	H	UAM	W2V	
M-6202	70.2	36.5	3.4	22.4	
M-6320	42.6	22.1	2.8	9.9	18 lots

Discussion:

This species is quite variable in form. Dall designated those specimens of greater inflation as *M. niger* variety *obesus*. MacGinitie examined numerous lots from northern and boreal seas; she noted continuous intergradation from thin to obese. Whether the degree of obesity is a population variation or environmentally controlled is not clear. Unfortunately, the Bering Sea collections are inadequate to resolve this problem; only 6 of the 18 lots contain whole valves.

Musculus discors var. laevigatus forma substriatus (Gray, 1824)

Modiola laevigata var. substriata Gray, 1824, p.245.

Modiolaria substriata, Oldroyd, 1924, p.76-77.

Musculus discors laevigata, Ockelmann, 1958, p.52-58.

Musculus discors var. laevigatus forma substriatus, MacGinitie, 1959, p.159-162, pl.18, fig.10, pl.21, fig.5.

Musculus discors, Petrov, 1966, p.202-203, pl.12, fig.10.

Surface sculpture is fine growth lines, below the beaks are nine subtle radial striations, no posterior striations are visible. The periostracum is dark brown, the interior has a pearly lustre. Only one specimen of this species was obtained; it measures (length, height, width of both valves):

Sta. No.	L	H	W2V	
M-6210	16.6	11.2	6 mm	1 lot

Discussion:

MacGinitie, Petrov and Ockelmann have commented extensively on the variation in this group: to MacGinitie and Ockelmann M. discors and M. laevigatus are variants of the same species; to Petrov they are separate species. Obviously comprehensive revision is needed. The form "substriatus" is characterized by the lack of posterior striations. For the present the specimen collected is best referred to MacGinitie's figures and description.

Chlamys pseudislandica MacNeil, 1967

Pecten islandicus, Grant and Gale, 1931, p.161, pl.11, fig.1a, 1b (in part)

Chlamys islandica, MacGinitie, 1959, p.155, pl.19, fig.14.

Chlamys islandica, Grau, 1959, p.69, pl.22 (in part).

Chlamys islandica, Morris, 1966, p.15, pl.14, fig.4.

Chlamys pseudislandica MacNeil, 1967, p.31-32, pl.19, fig.7, pl.20, fig.8, pl.23, fig.1, 2.

Right valves are light colored, nearly white, posterior ear short and slightly convex, anterior ear with a distinct byssal notch, primary ribs bifurcate, secondary ribs develop between the primary ribs on adult specimens. Left valves are mottled dark reddish-brown, the ribs are narrow, a frilled secondary inter-rib develops on adults, posterior ear as right valve, anterior ear relatively short. Faint concentric growth lines cover the valves. Dimensions of the largest specimen collected alive (length, height, width of both valves, number of ribs):

Sta. No.	L	H	WIV	NR	
M-6275	49.0	52.6	21.8	67	22 lots

Discussion:

MacNeil's paper contains an extensive description and discussion of this species. He separated this species from *C. islandica* and *C. rubida hindsii* after a careful examination of rib form and the manner in which the ribs bifurcate.

Chlamys beringiana (Middendorff, 1849)

Chlamys islandica behringiana, Grau, 1959, p.73-75, pl.23, fig.2 (in part).

Chlamys beringiana, MacNeil, 1967, p.24-25, pl.20, fig.2, pl.23, fig.6, 9, pl.24, fig.2, 3.

Three left valves of this species were collected. They are dark reddish brown, concentric growth lines are visible in the interrib areas, the crown of the larger ribs is covered with a reticulate microsculpture, occasionally patches of this microsculpture occur on the inter-rib areas. Three or four prominent trifurcate ribs occur on each valve, the rest of the ribs are variable in amplitude, narrow and steepsided. Dimensions of the largest complete valve (length, height, width of valve, number of ribs):

Sta. No.	L	H	WIV	NR	
M-6007	58.3	62.5	12.8	29	3 lots

Discussion:

Formerly this species was recognized as _Pecten islandicus_ var. _behringiana_. MacNeil raised it to species status and went on to recognize several subspecies within the group, for example, _C. beringiana unalaskae_. Rib pattern and microsculpture were the characters used by MacNeil to differentiate this group. The specimens at hand are too few to add any information in terms of population or geographic variation.

Pododesmus macroschisma (Deshayes, 1839)

Anomia macrochisma Deshayes, 1839, p.359.

Pododesmus macroschisma, Grant and Gale, 1931, p.241-242, pl.12, fig.3, 4.

Pododesmus macroschisma, MacNeil 1943, p.87, pl.13, fig.6, 7.

Pododesmus macroschisma, Chase, 1972, p.1-10, fig.1-6.

Pododesmus macroschisma, Hertlein and Grant, 1972, p.225-226, pl.40, fig.3, pl.41, fig.9, 12, 13.

This species is notably irregular in form as the valves conform to the hard substrate on which the animal lives. The attached valve is crudely plicate on the exterior and glossy white on the interior. The upper, left, valve is more convex than the lower valve; it is generally irregularly ribbed. Dimensions for the only paired valves obtained are (length, height, width of both valves, length of foramen):

Sta. No.	L	H	WIV	LF	
M-6201	35.6	40.9	15.2	15.4	5 lots

Discussion:

Chase's (1972) article documents the effect of substrate on the ribbing and shape of the animal. He concludes that all members of this genus in the north and northwestern Pacific should be placed in P. macroschisma. The northern limit of this species is given as the Pribilof Islands (MacNeil, 1943, p.87), however the occurrence of fresh looking specimens at three stations of the north coast of St. Lawrence Island and at two stations of the south coast of the Seward Peninsula indicates that populations may exist 600 miles northward.

Astarte borealis (Schumacher, 1817)

Tridontia borealis Schumacher 1817, p.147, pl.17, fig.1.

Astarte arctica Gray 1824, p.243.

Astarte placenta Morch, 1853.

Astarte borealis, Dall, 1903, p.944.

Astarte borealis, Oldroyd, 1924, p.106.

Astarte borealis, Ockelmann, 1958, p.74-79.

Astarte borealis, MacGinitie, 1959, p.165-166, pl.22, fig.1-6.

Astarte borealis arctica, Petrov, 1966, p.207-208, pl.14, fig.1-4.

Astarte borealis borealis, Petrov, 1966, p.208-209, pl.14, fig.5-10.

Astarte borealis placenta, Petrov, 1966, p.209, pl.14, fig.11-14.

Astarte borealis pseudoactis, Petrov, 1966, p.209-210, pl.13, fig.1-2.

Members of this species complex are notably variable in shape, valve thickness and surface sculpture. Shape ranges from nearly circular to ovate-elongate; adult valves of some forms are only 3 mm thick while others exceed 7 mm; the concentric ribbing is clearly defined on the beaks of some forms and absent on others, in all cases the ribbing fades toward the ventral margin. The color of the periostracum ranges from black to rusty brown, the shells are chalky white. Measurements of selected valves are (length, height, width of one valve, distance from umbo to anterior margin, KY, KB, KH as per introduction):

Sta. No.	L	H	W1V	UAM	KY	KB	KH
M-6070	47.2	41.9	10.1	17.4	.89	.21	.37
M-6282	48.6	42.3	16.6	17.3	.87	.34	.36
M-6006	40.0	33.7	6.7	15.8	.84	.17	.39

M-6310	33.8	27.8	6.0	12.6	.82	.18	.37	
M-6001	31.1	23.0	4.8	10.9	.77	.16	.36	
M-6354	34.2	26.0	4.6	10.8	.76	.14	.32	
M-6306	33.3	29.0	7.8	14.3	.84	.23	.43	97 lots

Discussion:

The variation in this species has given rise to numerous species and subspecies. Dall (1903, p.941 and 944) lists more than ten synonyms, MacGinitie and Ockelmann have also commented on the taxonomy and variation. The most recent taxonomic revision of the group has been attempted by Petrov (1966, p.206-210) who used numerical ratios to define four subspecies:

	KY	KB	KH
Astarte borealis arctica	.87 - .95	.18 - .25	.45 - .50
Astarte borealis borealis	.84 - .88	.16 - .19	.38 - .44
Astarte borealis placenta	.77 - .84	.15 - .20	.36 - .44
Astarte borealis pseudoactis	.85 - .91	.19 - .23	.39 - .45

Only two problems were encountered in separating the material collected along Petrov's guidelines: firstly, perfectly preserved specimens are necessary for the calculations, however it is very common for the umbos on live-collected adult specimens to be spalled off or eroded. Secondly, the KH ratio for A. b. arctica is given in the text as .45 to .50 though the ratios which can be calculated from the photos of the subspecies (Petrov, 1966, pl. 14, fig. 1, 2, 3) are respectively .39, .38 and .42; this suggests that values lower than .45 are acceptable for this subspecies. If this is the case, the numerical ratios for A. b. pseudoactis and A. b. arctica overlap. Generally however, A. b. pseudoactis can be separated by its less prominent umbo and heavier hinge from A. b. arctica.

The measurements listed above are examples of Petrov's subspecies; M-6070 and M-6282 are *A. b. arctica*--note that the latter example is relatively obese; M-6006 and M-6310 are *A. b. borealis*; and M-6001 and M-6354 are *A. b. placenta*. *Astarte borealis pseudoactis* is represented by the last set of measurements; this is the only valve in the dredge collections which can be placed in this subspecies.

In conclusion, with the exception of badly broken valves, the *Astarte borealis* collected can be placed in Petrov's subspecies. Though there are minor numerical variances, transitional forms are rare and generally different subspecies are not found at the same locality. Petrov (1966, p.210) questioned whether *Astarte rollandi*, Bernardi, 1858 and *Astarte actis* Dall, 1903 might be members of the "pseudoactis" subgroup. At present I do not have sufficient information to resolve this question, however, I do note that no Recent valves yet examined are as thick and heavy-hinged as *Astarte actis*. *Astarte rollandi* was not obtained in the dredged material, however, valves tentatively referred to this species are found in U.S.G.S. beach collections from Saint Lawrence Island.

Astarte bennettii Dall, 1903

Astarte bennettii Dall, 1903, p.946-947, pl.53, fig.6.

Astarte bennettii, Meek, 1923, p.418.

Astarte bennettii, Oldroyd, 1924, p.107.

Juveniles of this species are covered with a shiny light green periostracum; in adults the periostracum is often worn off the beaks and the rest of the shell is a dull brownish-grey. The beaks are clearly elevated and the height of the valves nearly equals the length. Fine concentric striations cover the exterior of the valves, generally these are better developed on the umbonal areas. Measurements are (length, height, width of one valve, distance umbo to anterior margin):

Sta. No.	L	H	W1V	UAM	
M-6336	12.2	11.3	.31	5.4	
M-6347	13.7	12.8	3.10	6.0	12 lots

Discussion:

There is a major problem with this species and it is not presently resolvable. Dall (1903) established this species on the basis of specimens from Bennett Island (north of the New Siberian Islands) and the Bering Sea. The specimens at hand are comparable to his type description and figures; however, there is also the possibility that this taxon represents the typical form of *A. montagui* as defined by Jensen (1912) and discussed in MacGinitie (1959, p.167). Further complications arise from Petrov's studies. Under *A. montagui* he figures individuals which could be placed in *A. bennettii*. MacGinitie and Ockelmann, on the other hand, did not include *A. bennettii* in their extensive lists of species synonymous with *A. montagui*.

Astarte montagui (Dillwyn, 1817)

Venus montagui Dillwyn, 1817, p.167.

Astarte fabula, Oldroyd, 1924, p.107, pl.19, fig.4, 4a.

Astarte montagui, Ockelmann, 1954, p.83-85.

Astarte montagui, MacGinitie, 1959, p.167-169, pl.22, fig.11-16.

Astarte fabula, Morris, 1966, p.19, pl.11, fig.16.

The exterior of the shell has concentric growth ridges on the dorsal portion; these fade to irregular growth striae towards the ventral edge. Colour ranges from yellow rusty brown to black. The interior is glossy white except for the muscle scars and pallial line which are grey. The beaks are nearly central and point towards the anterior; on larger individuals they may be eroded. As the following measurements show, the breadth and configuration of the valves is quite variable (length, height, width of one valve, distance umbo to anterior margin, KY, KB, KH as per introduction):

Sta. No.	L	H	W1V	UAM	KY	KB	KH	
6033	14.3	11.4	3.2	6.8	.80	.22	.48	
6268	20.0	15.3	4.6	8.7	.76	.23	.44	
6282	18.1	15.4	4.3	7.9	.85	.24	.44	
6265	25.4	20.4	5.9	13.4	.80	.23	.53	
6064	17.4	13.9	4.2	8.7	.80	.24	.50	
6187	16.4	13.3	3.5	6.3	.84	.21	.38	
6188	17.5	14.7	4.4	7.8	.84	.25	.44	64 lots

Discussion:

Both MacGinitie (1943, p.167) and Ockelmann (1954, p.180) present long synonymies of names which have been proposed for taxa that are now considered to be only variants of this species. Among the taxa synonymized are Astarte bansksii, A. striata, A. puchella, A. warhami and A. fabula. Their synonymies are derived from the work of Jensen (1912) who calculated numerical ratios of height divided by length (equivalent to KY) and breadth divided by length (equivalent to two times KB); he concluded that the above taxa are either synonyms or at best only vague varieties of A. montagui. The varieties are defined by specific values:

	KY	2xKB
typical form	92.9	53.6
"striata"	86.7	53.3
"warhami"	76.1	43.2
"globosa"	----	60 - 70

However both Jensen and subsequent authors have noted that the varieties are transitional, representing only artificial subdivisions of a continuum of variation. MacGinitie (1959, p.167-168) further remarked that some shells could as easily be assigned to one variety as another and that often several varieties and transitional forms could be found in a single dredge haul. The specimens collected in the northern Bering Sea have not been assigned to varieties or intermediate categories.

A valuable study would be to examine the relationship of A. vernicosa Dall, 1903 and A. bennetti to the A. montagui complex. Presumably this question will be answered when Petrov monographs the Astartidae.

Cardita _crassidens_ (Broderip & Sowerby, 1829)

Astarte _crassidens_ Broderip & Sowerby, 1829, p.365.

Cardita _borealis_ var. _paucicostata_ Krause, 1885, p.30, pl.3, fig.5.

Venericardia _crassidens_, Dall, 1903, p.949, pl.63, fig.9.

Venericardia _paucicostata_, Oldroyd, 1924, p.112, pl.13, fig.13.

Venericardia _crassidens_, Oldroyd, 1924, p.113.

Cardita _crassidens_, MacNeil, 1957, p.117, pl.14, fig.15, 16.

Cardita _crassidens_, MacGinitie, 1959, p.170, pl.22, fig.7-10.

Cyclocardia _paucicostata_, Kira, p.147, pl.53, fig.21.

Venericardia _crassidens_, Petrov, 1966, p.214-215, pl.16, fig.1-2.

Venericardia _paucicostata_, Petrov, 1966, p.215-216, pl.16, fig.3,4,5.

The young of this species are dark yellow or reddish brown in color. They have 10 to 14 low ribs. With age the ribs tend to flatten and coarse, irregular, concentric undulations develop. Adult specimens are exceedingly variable in shape, as the measurements show (length, height, width of one valve, distance umbo to anterior margin):

Sta. No.	L	H	W1V	UAM	
M-6032	32.2	34.8	11.1	4.9	
M-6032	25.1	24.0	5.9	5.8	
M-6038	34.9	32.8	10.1	6.2	
M-6324	34.0	30.6	5.7	9.9	
M-6264	26.4	22.0	6.0	8.1	
M-6265	25.0	23.7	7.2	8.0	21 lots

Discussion:

The variation in this species has given rise to two taxa, C. crassidens and C paucicostata. Petrov (1966, p.214) discussed these as separate species with C. crassidens having a height equal to or slightly greater than the length of the shell and C. paucicostata having the height less than the length and an external sculpture of 12 to 13 flat ribs which broaden toward the edge of the shell. MacGinitie synomized C. paucicostata under C. crassidens. She writes (1959, p.171):

> Cardita paucicostata is the young of a C. crassidens or a C. crassidens that has been favored by fate. When the latter species does not grow in cramped quarters and does not become eroded and covered with other animals, it shows the same color and texture of periostracum attributed to C. paucicostata and the length tends to remain equal to the height.

Though specimens can be classified according to Petrov's criteria, I do not believe in the light of MacGinitie's statements that the taxa would represent separate species.

MacNeil (1943, p.90-91, pl.15, fig.1, 3) described C. subcrassidens with 7 to 10 rounded ribs. No specimens referrable to this species are in the Recent collections.

Cardita crebricostata (Krause, 1885)

Cardita borealis var. crebricostata Krause, 1885, p.30, pl.3, fig.4.

Venericardia alaskana Dall, 1903a, pl.63, fig.7.

Venericardia crebricostata, Oldroyd, 1924, p.114, pl.13, fig.12.

Cardita crebricostata, MacNeil, 1943, p.90, pl.14, fig.16, 17.

Cardita crebricostata, MacGinitie, 1959, p.169.

Venericardia crebricostata, Petrov, 1966, p.215-216, pl.16, fig.3.

Fresh specimens are covered with a furry brown periostracum. There are 20 to 25 broad low radial ribs on the surface of each valve; paralleling these ribs are very fine striations. Concentric growth lines are absent on the umboral areas and increase in intensity across the valve, producing irregular corrugations on the ventral portions of adults. The three largest specimens measure (length, height, width of one valve, distance umbo to the anterior margin):

Sta. No.	L	H	WIV	UAM	
M-6337	33.1	30.6	15.3	11.6	
M-6292	31.9	27.7	14.4	11.1	
M-6067	29.1	25.0	12.6	10.2	59 lots

Discussion:

This species is easily recognized by its numerous low ribs. MacNeil obtained several specimens from the Pleistocene deposits near Nome which have 27 or 28 closely set ribs; he designated these Cardita crebricostata var. nomensis. Specimens with this many ribs have not been found in the Recent fauna of the northern Bering Sea.

Thyasira gouldi (Philippi, 1845)

Lucina gouldii Philippi, 1845, p.75, pl.2, fig.7.

Axinus gouldii Sars, 1878, p.59, pl.19, fig.6a-6b.

Thyasira gouldii, Oldroyd, 1924, p.120-121, pl.34, fig.5.

Thyasira gouldi, Ockelmann, 1954, p.100-104, pl.2, fig.4-5.

Thyasira flexuosa var. sarsi, MacGinitie, 1959, p.171-172, pl.4, fig.12.

Thyasira gouldi, Richards, 1962, p.60, pl.7, fig.6-7.

Thyasira gouldi, Petrov, 1966, p.217-218, pl.16, fig.6-7.

This small rounded species has a thin white shell marked with irregular concentric growth striations. Two radial postero-dorsal folds are visible on adult shells; they are very faint on juvenile specimens. Dimensions of the three largest live collected specimens are (length, height, width of both valves):

Sta. No.	L	H	W2V
M-6028	7.8	8.1	5.1
M-6012	8.1	8.3	5.0
M-6060	7.2	7.0	4.6

57 lots

Discussion:

Though MacGinitie (1959, p.171) called this form T. flexuosa var. sarsi, her personal communication indicates that she thinks the form is "perhaps T. gouldi". Ockelmann who examined many Arctic and boreal faunas concluded that T. gouldi and T. flexuosa should not be synonomized (1954, p.100). The reason is primarily that T. flexuosa has a boreal-lusitanian distribution and is absent from Arctic seas, while T. gouldi is panArctic.

Petrov (1966, p.217) in his description notes adult _T. gouldi_ has two radial folds; this feature is clearly demonstrated on the larger specimens.

Diplodonta aleutica Dall, 1901

Diplodonta aleutica Dall, 1901, p.795, 820-821, pl.42, fig.3.

Diplodonta aleutica, MacGinitie, 1959, p.172-173.

The exterior of the chalky valves is covered with a silky, shiny periostracum; closely spaced growth lines underlie the periostracum. In outline the valves are oval shaped, the posterior end is more rotund than the anterior. The low beaks are eroded even on the smallest live-collected specimens. Dimensions of the largest specimen and the two largest live-collected specimens are (length, height, width of both valves, distance umbo to anterior margin):

Sta. No.	L	H	W2V	UAM	
M-6255	30.2	26.8	17.7	9.6	
M-6283	26.4	22.0	13.4	7.8	
M-6280	22.6	19.0	11.4	8.0	12 lots

Discussion:

Dall (1901, p.820) described this taxon as a separate species with the query that it might be synonymous with or a variety of the North Atlantic species D. torelli Jefferys. I have not seen this question resolved in the literature and unfortunately I do not have comparative material from the North Atlantic on which to base an opinion. Grant & Gale (1931, p.294) inferred that D. aleutica is a form of the Eastern Pacific species D. orbellus. I strongly question this opinion for the specimen I have seen show consistent morphological differences between the two taxa.

Clinocardium californiense (Deshayes, 1839)

Cardium californiense Deshayes, 1839, p.360.

Cardium californiense, Oldroyd, 1924, p.143, pl.2, fig.3.

Laevicardium californiense, Grant and Gale, 1931, p.309, pl.A, fig.13, 16.

Cardium ciliatum brooksi, MacNeil, Mertie & Pilsbry, 1943, p.91, pl.15, fig.14.

Clinocardium californiense, Habe & Ito, 1965, p.132, pl.44, fig.2.

Clinocardium californiense, Kira, 1965, p.156, pl.56, fig.4.

Clinocardium californiensis, Petrov, 1966, p.219-220, pl.16, fig.14-15.

Rounded radial ribs with narrow interspaces are characteristic of this species. The maximum number of ribs is 47, they are commonly eroded on the beaks and noticeably reduced in height where the darker concentric annual growth increments traverse the valve. On the posterior dorsal portion of the shell the ribs are very closely packed; also in this area the general ovate outline of the valves is distinctly indented. Dimensions of the two largest live collected specimens are (length, height, width of both valves, distance umbo to anterior margin):

Sta. No.	L	H	W2V	UAM	
M-6025	48.0	43.2	27.7	15.2	
M-6131	52.3	44.4	27.8	19.4	92 lots

Discussion:

The rib shape and indentation of the posterior-dorsal area clearly identify this species. Recent specimens of this species and C. ciliatum are thin shelled (for example, specimen 6131 has an average thickness of 0.9 mm) and after being stored in open trays, the valves develop long radial dessication cracks. Pleistocene specimens from the same area have thicker shells and do not tend to fracture.

Clinocardium ciliatum (Fabricus, 1780)

Cardium ciliatum Fabricus, 1780, p.410.

Cardium ciliatum, Oldroyd, 1924, p.142, pl.19, fig.8.

Laevicardium ciliatum, Grant & Gale, 1931, p.310, pl.19, fig.11.

Clinocardium ciliatum, Oldroyd, 1924, p.176, pl.26, fig.4.

Clinocardium ciliatum, Habe & Ito, 1965, p.132, pl.44, fig.3, 4.

Clinocardium ciliatum, Petrov, 1966, p.221-220, pl.17, fig.1-3.

This large ovate bivalve has up to 35 vee-shaped radial ribs. The shell is covered with a light brown periostracum which extends in a fringe-like fashion above the crest of the ribs. On valves which have the periostracum worn away a faint line or scar is visible on the rib crest. Dimensions of the two largest live-collected specimens are:

Sta. No.	L	H	W2V	UAM	
M-6007	66.2	64.6	43.9	26.4	
M-6225	64.9	56.1	41.1	21.7	103 lots

Discussion:

On first appearances this species is similar to Clinocardium californiense, however the vee-shaped ribs and the ovate outline clearly identify adults of C. ciliatum. Juvenile specimens can be recognized by the rib-crest scar should the periostracum be worn away.

MacNeil (1943, p.91, pl.15, fig.14) named a new subspecies C. ciliatum brooksi from the Pleistocene deposits of the Nome area. Petrov (1966, p.220) considers the figured specimen to be a C. californiense. I concur with him.

Serripes groenlandicus (Bruguiere, 1789)

Cardium groenlandicum Bruguiere, 1789, p.222.

Serripes groenlandicus, Oldroyd, 1924, p.145, pl.8, fig.3.

Serripes gronlandicus, Grant & Gale, 1931, p.314.

Serripes groenlandicus, Ockelmann, 1954, p.113-118.

Serripes gronlandicus, MacGinitie, 1959, p.176-177, pl.26, fig.5.

Serripes groenlandicus, Richards, 1962, p.63, pl.8, fig.12, 13.

Serripes groenlandica, Habe & Ito, 1965, p.133, pl.44, fig.11, 12.

Serripes groenlandicus, Petrov, 1966, p.222-223, pl.17, fig.4-9, pl.18, fig.1-3.

Juvenile specimens are tan colored with zig-zag lines underneath the periostracum, on adults the brown lines are obscure or faint and the valves are dark grey or brown. The surface sculpture is unevenly spaced concentric growth lines. There is a slight posterior gap in the area of the siphons and the shell adjacent to this region is marked by 15 to 20 faint radial grooves; similar grooves are found on the anterior portion of some specimens. Variation in shape is shown by the following measurements (length, height, width of one valve, distance umbo to anterior margin, KY, KB, KH, as per introduction):

Sta. No.	L	H	W1V	UAM	KY	KB	KH	
M-6034	74.6	62.1	19.6	30.8	.83	.26	.41	
M-6266	76.4	65.0	20.8	29.5	.85	.27	.39	
M-6173	59.2	47.2	15.0	18.9	.80	.25	.32	
M-6110	47.0	40.3	11.9	17.9	.84	.25	.37	
M-6192	38.7	31.8	11.1	16.6	.82	.29	.43	
M-6172	19.4	16.3	4.7	7.3	.84	.24	.38	220 lots

Discussion:

The few figures above and the comments by other authors (Ockelmann, 1954, p.117; Petrov, 1966, p.222) attest to the variation of *Serripes groenlandicus* wherever it is found. Petrov's values, KY = .81-89, KB = .24-.28 and KH = .27-.38 are only slightly different than those calculated above and indicate that some individuals (e.g., M-6192) tend to have their beaks nearly centrally located. For all its variation in shape, the cardiid hinge and smooth exterior make this species one of the easiest to identify. A taxonomic problem arises only when we consider whether *Serripes laperousi* is a separate species or a variant of *S. groenlandicus*.

Serripes laperousi (Deshayes, 1839)

Cardium laperousi Deshayes, 1839, p.360.

Serripes laperousi, Oldroyd, 1924, p.145-146.

Serripes laperousi, Grant & Gale, 1931, p.314.

Serripes laperousi Keen, 1939, p.480.

Serripes laperousi, Richards, 1962, p.87.

Serripes laperousi, Habe & Ita, 1965, p.33, pl.44, fig.9, 10.

Serripes greenlandicus laperousi, Petrov, 1966, p.222.

Fragments collected indicate that the maximum size of this species may be 10 to 20 mm longer than the valves listed below. The outline of the valves is ovate-elongate; the cardinal teeth are weak and the lateral portions of the hinge are nearly edentulate. Measurements of the largest valve, a medium-sized valve, and the largest live collected specimen are (length, height, width of one valve, distance umbo to anterior margin, KY, KB, KH as per introduction):

Sta. No.	L	H	W1V	UAM	KY	KB	KH	
M-6023	130.0	97.5	33.1	59.4	.75	.25	.45	
M-6026	81.5	61.4	19.2	36.1	.75	.24	.44	
M-6026?*	104.5	84.8	28.6	43.7	.81	.27	.42	9 lots

Discussion:

This taxon is distinguished from Serripes groenlandicus by its elongate shape, larger maximum size and nearly edentulate hinge. Keen (1939, p.480)

*Collected between M-6026 and M-6032.

and Habe & Ito (1965, p.133) regard *S. laperousi* as a separate species, while Petrov (1966, p.222) considers it to be only a variety of *S. groenlandicus*, which lives on cobble and gravel substrate. At present, the data are equivocal, the values listed above and those listed previously for *S. groenlandicus* indicate that there is no clear dividing line between the two taxa. If "laperousi" is an ecotype of *S. groenlandicus*, we could expect it to occur throughout the range of *S. groenlandicus*, wherever the substrate is appropriate. This seems not to be the case. The Recent distribution of *S. groenlandicus* is circumarctic, extending into north Pacific and north Atlantic waters, yet *S. laperousi* is recognized only in the north Pacific and Bering Sea. For the present I have treated *S. laperousi* as a separate species.

Gomphina fluctuosa (Gould, 1841)

Venus fluctuosa Gould, 1841, p.87, fig.50.

Liocyma fluctuosa, Grant & Gale, 1931, p.336.

Gomphina fluctuosa, Ockelmann, 1958, p.123-125, pl.2, fig.9.

Liocyma fluctuosa, MacGinitie, 1959, p.177-179, pl.23, fig.1-8.

Liocyma fluctuosa, Habe & Ito, 1965, p.135, pl.45, fig.5, 6.

Gomphina fluctuosa, Petrov, 1966, p.255-256, pl.18, fig.6-16.

The exterior of the species is ornamented with irregularly spaced concentric growth lines and growth ridges. Colour is white, pink or yellowish brown and the overlying periostracum is shiny. The interior of the shell is glossy and the angular pallial sinus is clearly visible. Variation in the shape of the shell and the growth lines has led to a complex taxonomy; some specimens are oval in outline and tumid, while others are more elongate and less inflated. The measurements of six live collected specimens covering the range of variation encountered in the northern Bering Sea is (length, height, width of paired valves, distance umbo to anterior margin, KY, KB, KH as per introduction):

Sta. No.	L	H	W2V	UAM	KY	KB	KH	
M-6275	23.9	19.5	11.6	9.0	.82	.24	.38	
M-6280	25.4	22.2	13.9	9.6	.87	.27	.38	
M-6320A	23.0	19.2	11.1	8.2	.83	.24	.36	
M-6320B	23.1	17.3	10.0	7.4	.75	.22	.32	
M-6063	25.0	19.1	10.3	8.8	.76	.21	.34	
M-6284	23.9	18.3	10.1	8.3	.76	.21	.35	78 lots

Discussion:

MacGinitie (1959, p.177-179) conducted a systematic examination of this species. In addition to her own material from Point Barrow, she examined and measured many G. fluctuosa in the U.S. National Museum collection and the type material of several other northern species of Gomphina. She concluded that G. fluctuosa is highly variable and that the "species" G. scammoni (Dall, 1971), G. schefferi (Bartch & Rehder, 1939), G. aniwana (Dall, 1907), G. viridis (Dall, 1871), and probably G. becki (Dall, 1870) are all variants of G. fluctuosa.

As mentioned in the preceeding description, Bering Sea specimens are of two general types: an oval shaped, tumid species, clearly G. fluctuosa (M-6275, M-6280, and M-6320A); the more elongated, less inflated specimens (M-6320B, M-6063, M-6284) are closer to the "viridis" form. Nonetheless, the variation appears to be continuous and sample M-6320 shows that both forms can occur at the same locality. At present the designation G. fluctuosa is adequate to name this variable species.

Spisula polynyma (Stimpson, 1860)

Mactra polynyma Stimpson, 1860, p.3 (new name for Mactra ovalis Gould, 1840).

Spisula voyi Gabb, 1866, vol.2, p.24, pl.5, fig.41.

Spisula polynyma alaskana Dall, 1894, vol.8, no.4, p.40.

Spisula alaskana, Dall, 1921, p.51.

Spisula voyi, Oldroyd, 1924, p.193, pl.23, fig.1, 2.

Spisula polynyma voyi, Grant & Gale, 1931, p.395.

Mactra polynyma, Richards, 1962, p.69, pl.12, fig.1.

Spisula polynyma, Chamberlain & Stearns, 1963, p.1-12.

Spisula alaskana, Morris, 1966, p.31, pl.20, fig.6.

Fresh shells of this species are covered with a glossy periostracum; colour ranges from tan on juveniles to dark brown on adults. The fine concentric growth lines which form the external sculpture on juvenile valves become coarser as the animal grows. The posterior dorsal portion of the valve is rugose. Shell form is variable: shorter valves tend to have the posterior portion inflated, the beaks twisted and a distinct lunular area; elongate specimens are narrower, less prosogyrate and do not have distinct lunules. Beaks are slightly anterior on the larger valves (see M-6299 below) and slightly posterior on the smaller specimens (see M-6029 below). The collected material is of two types: large "dead" valves, and smaller live-collected specimens. This grouping is probably an artifact of the van-veen grab sampler which did not penetrate the bottom sufficiently to obtain the deeper burrowing adult animals. Dimensions of one large valve and one live collected animal are (length, height, width of one valve, distance umbo to anterior margin, KY, KB, KH):

Sta. No.	L	H	WIV	UAM	KY	KB	KY	
M-6299	84.3	61.8	17.0	30.5	.73	.20	.46	
M-6029	32.4	23.7	5.8	15.8	.71	.18	.51	20 lots

Discussion:

The name Spisula polynyma voyi has been used for California Tertiary specimens and S. p. alaskana for Recent northern Pacific specimens. Grant & Gale (1931, p.395) synonymized S. p. alaskana under S. p. voyi and suggested that S. p. voyi is at most a variety of S. polynyma, an Atlantic species.

Chamberlain and Stearns (1963) examined a large number of specimens from both the Atlantic and Pacific Oceans in the course of their geographic and ecologic study of S. polynyma; they used the name S. polynyma for both Atlantic and Pacific populations. Presently the species is not known to occur in arctic Alaska or northern Canada.

After examining the variation in the Bering Sea populations and the Atlantic specimens of S. polynyma in the U.S. National Museum collections, I agree with Chamberlain and Stearns that the two presently disjunct populations can not and should not be taxonomically separated.

Siliqua alta (Broderip & Sowerby, 1829)

Solen altus Broderip & Sowerby, 1829, p.362.

Siliqua media, Dall, 1921, p.51.

Siliqua patula alta, Dall, 1921, p.51.

Siliqua patula alta, Oldroyd, 1924, p.190, pl.47, fig.1,2.

Siliqua alta, Grant & Gale, 1931, p.388-389, pl.21, fig.1.

Siliqua aff. *S. media*, MacNeil, Mertie & Pilsbry, 1943, p.92, pl.15, fig.15,18.

Most shells of this species have purple rays or streaks. The periostracum is shiny and yellowish-brown. It overlays closely spaced growth lines. The shape is oblong with rounded ends. On the interior, descending vertically from the low anteriorly placed beaks, is a prominent rib.

Fragments of shells indicate a maximum length of 70 mm is attained in the Bering Sea. Dimensions of the largest live-collected specimen and the largest valve obtained are (length, height, width one valve, distance umbo to anterior margin, KY, KB, KH as per introduction):

Sta. No.	L	H	W1V	UAM	KY	KB	KH	
M-6349	16.8	8.6	1.5	3.6	.51	.09	.21	
M-6121	39.4	19.6	4.1	10.2	.50	.10	.26	8 lots

Discussion:

The strong vertical internal rib is characteristic of this species and serves to separate it from *Siliqua patula*, which has an anteriorly inclined rib.

The pre-1931 entries in the synonymy were justified by Grant and Gale. The specimen described and figured by MacNeil, Mertie & Pilsbry appears to be best placed with Grant & Gale's taxon. Petrov's specimens (1966, p.232, pl.20, fig.11-12), labeled *Siliqua media* have inclined interior ribs suggestive of *S. patula*.

Tellina lutea alternidentata Broderip & Sowerby, 1829.

Tellina alternidentata Broderip & Sowerby, 1829, p.363.

Tellina lutea, Oldroyd, 1924, p.169, pl.1, fig.9.

Tellina lutea, Grant & Gale, 1931, p.363.

Tellina lutea, MacGinitie, 1959, p.180.

Tellina lutea alternidentata, Coan, 1971, p.8-10, pl.1, fig.1-3, text fig.1.

Living specimens are covered with a shiny yellowish green periostracum; the interior of the shell is rose coloured. The large size and elongate shape serve to easily identify this species. The dimensions of the two largest living specimens and the two largest valves dredged are (length, height, width of one valve, KY, KB as per introduction):

Sta. No.	L	H	W1V	KY	KB	
M-6297	45.2	26.8	4.5	.59	.09	
M-6074	43.8	26.1	4.5	.60	.10	
M-6299	70.3	41.7	7.6	.59	.11	
M-6360	71.1	44.8	7.7	.63	.11	27 lots

Discussion:

The morphology of this species is distinct and relatively consistent in the northern Bering Sea. Coan (1971, p.9) discussed the nomenclatural status of the species and provisionally recognized the pink north Pacific specimens as a separate subspecies _Tellina lutea alternidentata_.

Macoma calcarea (Gmelin, 1791)

Macoma calcarea Gmelin, 1791, p.3236.

Macoma calcarea, Oldroyd, 1924, p.173-174.

Macoma calcaria, Ockelmann, 1958, p.125-128, pl.2, fig.10.

Macoma calcarea, MacGinitie, 1959, p.181-182, pl.24, fig.5-7; pl.26, fig.6-9.

Macoma calcarea, Petrov, 1966, p.228-229, pl.19, fig.3-11.

Macoma calcarea, Coan, 1971, p.20-22, pl.3, fig.20; pl.4, fig.21-24; pl.5, fig.25; text fig. 9.

Dull, chalky white shells are characteristic of this species; on fresh valves an irregular band of thin, reddish or tan periostracum adheres to the growing margins. The anterior is rounded, the ventral margin is upturned, the posterior is angulate and deflected to the right. This deflection produces a shallow sinus on the right valve which extends from the umbo to the posterior ventral margin. The ligament is relatively long, extending more than half way down the posterior dorsal margin. The ligamental support is tapered at the posterior end. Pallial sinuses are elongate; the left is larger than the right. Dimensions of the five largest live-collected specimens are (length, height, width of both valves, KY, KB as per introduction):

Sta. No.	L	H	W2V	KY	KB
M-6131	42.5	30.6	14.9	.72	.18
M-6054	47.4	33.0	14.0	.70	.15
M-6259	46.1	32.4	16.1	.70	.17
M-6309	44.2	31.6	18.2	.72	.15
M-6301	45.0	31.5	15.8	.70	.18

164 lots

Discussion:

Although Coan (1971) treated *Macoma calcarea*, *M. brota* and *M. lipara* as separate species, he recognized that intermediate forms between these taxa live in the Bering Sea. The intermediate forms are between *M. calcarea* and *M. brota* and between *M. brota* and *M. lipara*. The problems of *M. lipara* and *M. brota* will be discussed under *M. lipara*.

The large majority of *M. calcarea* and *M. brota* can be easily separated by differences in size, shape and internal features. Intermediate specimens were generally of intermediate size and shape. I was able to place these specimens in one of the taxa using primarily the conformity of the pallial sinuses (more elongate in *M. calcarea*) and secondarily the shape of the ligamental support (truncate at the posterior end in *M. brota*).

Macoma brota Dall, 1916

Macoma brota Dall, 1916, p.413 (New name for Tellina edentula Broderip & Sowerby)

Macoma brota, Oldroyd, 1924, p.170-171, pl.9, fig.2.

Macoma brota, Grant & Gale, 1931, p.368.

Macoma brota, Petrov, 1966, p.230-231, pl.20, fig.1-4.

Macoma brota, Coan, 1971, p.23-24, pl.5, fig.27, 28, text fig.11.

This species is large and thick shelled; in outline the valves have smoothly rounded anterior sections and truncate posteriors. The right valve has a shallow sulcus extending vertically across its posterior half. The ligament is short; generally it extends less than half the way along the posterior dorsal margin. The underlying ligament support is abruptly truncate at the posterior end. The depth and height of the right pallial sinus are nearly equal; the left pallial sinus is larger. Dimensions of the five largest live collected specimens are (length, height, width of both valves, KY, KB as per introduction):

Sta. No.	L	H	W2V	KY	KB
M-6101	51.8	41.2	19.7	.81	.19
M-6080	57.8	41.9	19.3	.73	.17
M-6095	51.3	37.5	17.8	.73	.17
M-6332	49.1	36.7	16.4	.75	.17
M-6176	50.7	37.6	17.8	.74	.17

111 lots

Discussion:

The ratios calculated above fall within the range of values obtained by Petrov (1966, p.230) for this species, KY = .72-.82, KB = .12-.19.

Juveniles of this species are very difficult to separate from those of *M. calcarea*. Adult specimens can be separated with ease from *M. calcarea* and with difficulty from *M. lipara*.

Prior to Petrov's study Russian workers considered this species to be *M. calcarea* var. *soot-ryeni*.

Macoma lipara Dall, 1916

Macoma brota var. *lipara* Dall, 1916, p.414.

Macoma brota lipara, Oldroyd, 1924, p.171, pl.42, fig.6.

Macoma brota var. *lipara*, Grant & Gale, 1931, p.368-369.

Macoma lipara, Coan, 1971, p.24-25, pl.6, fig.29, text fig.12.

An ovate shape characterizes this species; the anterior is smoothly rounded and the posterior is tapered. The exterior of the valves is covered by closely spaced growth lines. Except for thin patches along the ventral margin, the reddish-tan periostracum is worn away. The interior of the shell is glossy; the left pallial sinus is larger than the right. Dimensions of the three largest live-collected valves are (length, height, width of both valves, KY, KB as per introduction):

Sta. No.	L	H	W2V	KY	KB	
M-6012	61.7	47.7	18.9	.78	.16	
M-6034	59.8	44.7	19.0	.75	.16	
M-6253	66.1	51.2	22.4	.77	.17	12 lots

Discussion:

Prior to Coan's review, this taxon was treated as *Macoma brota* variety *lipara*. Coan (1971, p.24-26) observed only one sample that appeared to have intermediate characteristics between *M. brota* and *M. lipara*. It was from the Bering Sea.

The specimens referred to *M. lipara* in this study have a larger maximum size and a more rounded, tapering posterior end than *M. brota*.

Macoma middendorfi Dall, 1894

Macoma (edentula var?) middendorfi Dall, 1884, p.347.

Macoma edentula var. middendorfi Dall, 1886, p.308-398, pl.4, fig.11.

Macoma middendorfii, Oldroyd, 1924, p.170, pl.53, fig.1.

Macoma middendorfi, Grant & Gale, 1931, p.372-373.

Macoma middendorfi, MacNeil, Mertie & Pilsbry, 1943, p.91-92, pl.15, fig.2, 5.

Macoma middendorfi, Coan, 1971, p.25-26, pl.6, fig.30, text fig. 13.

The shell of this species is large, thick and trigonal shaped. Beaks are prominent and slightly posterior. Growth lines spaced at irregular intervals cover the exterior surface of the valves. Large muscle scars and a thick pallial line indent the interior surface of the valves. No living specimens were collected. The dimensions of the largest incomplete valve and the two complete valves are (length, height, width of one valve, distance umbo to anterior margin, KY, KB, KH as per introduction):

Sta. No.	L	H	W1V	UAM	KY	KB	KH	
M-6026	58.2	55.2	15.4	32.3	.95	.26	.56	rt. valve (inc)
M-6026	47.2	44.4	18.2	26.3	.94	.24	.56	rt. valve
M-6037	52.2	47.3	9.7	29.4	.91	.19	.56	left valve

3 lots

Discussion:

Though similar in shape to Macoma obliqua, M. middendorfi is larger, has thicker valves and has a plane of commisure which is not deflected. This taxon is now recognized as a separate species, though it was originally described by Dall (1884, 1886) as a variety of M. edentula (now synonymized to M. brota).

Macoma obliqua (Sowerby, 1817)

Tellina obliqua J. Sowerby, 1817, p.137-138, pl.161, fig.1.

Macoma incongrua, Oldroyd, 1924, p.179, pl.42, fig.10.

Macoma incongrua, Grant & Gale, 1931, p.373.

Macoma incongrua, MacGinitie, 1959, p.180.

Macoma incongrua, Petrov, 1966, p.229-230, pl.19, fig.12-16.

Macoma obliqua, Coan, 1971, p.26-27, pl.6, fig.31, pl.7, fig.33, text fig.14.

This species is ovate shaped: the anterior is distinctly rounded and the posterior is tapered. The posterior portion of the plane of commisure is deflected to the right. As a consequence the right valve is indented along the posterior dorsal surface. Muscle scars and a pallial sinus which is deeper on the left valve than the right are clearly visible on the interior of the valve. Irregularly spaced concentric growth lines cover the shell surface which lacks periostracum except for patches along the growing edges. The dimensions of the largest pair of valves collected and the three largest live-collected individuals are (length, height, width of one valve, distance umbo to anterior margin, KY, KB, KH as per introduction):

Sta. No.	L	H	WIV	UAM	KY	KB	KH	
M-6174	39.8	35.6	8.9	21.1	.89	.22	.53	
M-6101	33.3	28.6	7.5	18.1	.86	.23	.54	
M-6115	35.8	31.1	7.8	19.0	.87	.21	.53	
M-6334	33.6	28.1	7.1	17.7	.84	.21	.53	34 lots

Discussion:

Previously in the eastern Pacific and Bering Sea this species has been named *M. incongrua*; however, Coan (1971, p.26) in his taxonomic study of the Tellinidae discovered that the Japanese species, *M. incongrua*, is quite distinct from the eastern Pacific boreal species. He recognized this "new" species as identical with *M. obliqua* from the Pleistocene of England.

Macoma moesta moesta (Deshayes, 1855)

Tellina moesta Deshayes, 1855, p.361.

Macoma krausei Dall, 1900, p.306, pl.4, fig.8.

Macoma oneilli Dall, 1919, p.20, pl.2, fig.1.

Macoma moesta, Oldroyd, 1924, p.173.

Macoma moesta, Grant & Gale, 1931, p.370.

Macoma moesta, MacGinitie, 1959, p.182-184, pl.21, fig.1-3; pl.23, fig.10, pl.24, fig.1-3.

Macoma moesta, Ockelmann, 1959, p.129-131, pl.2, fig.13.

Macoma moesta moesta, Coan, 1971, p.28-29, pl.7, fig.35-37, text fig.16.

The exterior of this species has very fine concentric growth lines which are covered by a shiny thin, white or pink periostracum. The growth lines become coarser on the posterior portion of adult valves. Valves are oval shaped in outline; the left is more inflated and has a larger pallial sinus than the right. Dimensions of the two largest live collected specimens are (length, height, width of both valves, distance umbo to anterior margin, KY, B, KH as per introduction):

Sta. No.	L	H	W2V	UAM	KY	KB	KH	
M-6309	25.1	17.5	7.7	15.6	.70	.15	.62	
M-6239	27.7	19.2	8.4	17.8	.69	.15	.64	4 lots

Discussion:

MacGinitie (1959, p.182-183) synonymized Dall's *Macoma krausei* and *M. oneilli* after a re-examination of his type material. The name *M. moesta moesta* was designated by Coan (1971, p.28) to separate the northern, ovate specimens, *M. m. moesta*, from the more southerly elongate specimens which he designated *Macoma moesta alaskana*. No specimens of this latter subspecies were found in the northern Bering Sea.

Macoma crassula (Deshayes, 1855)

Tellina crassula Deshayes, 1855, p.354.

Tellina torelli, Ockelmann, 1959, p.134-135, pl.2, fig.12.

Macoma crassula, Coan, 1971, p.30-31, pl.7, fig.39, 40; pl.8, fig.41, text fig.18.

The shell of this species is ovate-elongate with a truncate posterior. The posterior portion of the plane of commissure is deflected to the right and the right valves have a sinuation which extends from the umbo to the posterior ventral margin. The left pallial sinus is considerably larger than the right; both are arcuate shaped. Fine growth lines comprise the external sculpture and the thin brown periostracum is always eroded from the umbonal regions. Dimensions of the two largest specimens and two living specimens are (length, height, width of two valves, distance umbo to anterior margin, KY, KB, KH as per introduction):

Sta. No.	L	H	W2V	UAM	KY	KB	KH	
M-6337	23.6	19.1	9.4	13.1	.81	.20	.55	
M-6106	21.5	17.7	8.7	11.8	.83	.22	.55	
M-6006	17.4	14.5	6.7	9.4	.83	.19	.54	
M-6031	14.0	11.1	5.4	7.8	.79	.19	.56	12 lots

Discussion:

Coan (1971, p.30) gives an extensive nomenclatural commentary on this species. After examining the type material of Tellina crassula, Macoma inflata and Tellina torelli he synonymized all three under the name Macoma crassula. For the present I follow Coan--however, I do have some reservations. Macoma torelli as it appears in Coan's and Ockelmann's plates has an abruptly truncate posterior, while the holotype of Tellina crassula (Coan, 1971, pl.7, fig.39) has a rounded posterior. Additionally, according to Coan the pallial sinuses of T. crassula are equal sized and shorter than those of T. torelli, which extend nearly to the anterior adductor scar. It is not clear whether these features signify two species or variation in one species, for comparative material is very rare. Coan uncovered only two lots of material, though he visited all the major U.S. museums. In addition to the rarity, this is a classic case of taxonomic intrigue involving senior synonyms, preoccupation, and nomina nuda.

Macoma lama Bartsch, 1929

Macoma lama Bartsch, 1929, p.133, pl.2, fig.8-14.

Macoma planiuscula, Grant & Gale, 1931, p.372, pl.14, fig.11A, 11B; pl.20, fig.8A, 8B.

Macoma lama, Coan, 1971, p.32-33, pl.8, fig.44, 45, text fig.20.

This species has a very shiny periostracum which covers a smooth shell surface, only slightly indented by concentric growth striae. The valves are thin, translucent and not inflated. In outline the anterior is round, the posterior acuminate and the posterior dorsal margin nearly straight. The posterior is deflected slightly to the right and on the interior the left pallial sinus is larger than the right. Dimensions of the largest valve and the largest live-collected specimen are (length, height, width of one valve, distance umbo to anterior margin):

Sta. No.	L	H	WIV	UAM	
M-6072	24.8	18.4	4.0	13.7	
M-6301	21.4	15.8	3.0	11.2	4 lots

Discussion:

Recognition of this species is not easy for it closely resembles juveniles of the more abundant species M. calcarea. The best criteria of separation seems to be the shiny periostracum and uneven pallial sinuses of M. lama.

Macoma balthica (Linnaeus, 1758)

Tellina balthica Linnaeus, 1758, p.677.

Macoma balthica, Oldroyd, 1924, p.172, pl.44, fig.1, 2, 9.

Macoma balthica, Grant & Gale, p.371-372, pl.14, fig.6A, 6B.

Macoma balthica, Petrov, 1966, p.227, 228, pl.19, fig.1, 2.

Macoma balthica, Coan, 1971, p.44-46, pl.11, fig.65, pl.12, fig.66-69, text fig.30.

The thin shells are coloured pale yellow or pink; the surface is ornamented with closely set growth lines which are covered by a pink periostracum. Beaks are centrally situated, the anterior is smoothly rounded and the posterior is pointed. Pallial sinuses are large and nearly equal in size. Specimens dredged from Safety Sound, east of Nome, measure (length, height, width of both valves, KY, KB as per introduction):

Sta. No.	L	H	W2V	KY	KB	
Safety Sound	16.3	13.4	5.6	.82	.17	
Safety Sound	16.7	13.5	6.6	.81	.20	
Safety Sound	16.7	12.9	6.5	.78	.19	1 lot

Discussion:

An extensive synonymy of eastern Pacific, Arctic and north Atlantic species and references was compiled by Coan (1971, p.44-45).

This species is rarely found on the floor of the northern Bering Sea: only one lot (M-6248) of one valve was obtained in the offshore dredges. In contrast, makeshift dredging in the coastal lagoons (Shishmaref Inlet, Safety Sound) of Seward Peninsula yielded large numbers of *Macoma balthica* shells. Thick beds of eel grass and the light weight of the dredge prevented the substrate penetration necessary to obtain living specimens.

Mya elegans (Eichwald, 1871)

Anatina elegans Eichwald, 1871, p.119, new name for _M. arenaria_ Grewingk)

Mya intermedia, Dall, 1898, p.857.

Mya arenaria var. _profundior_ Grant & Gale, 1931, p.414 (new name for _M. crassa_ Grewingk)

Mya elegans, MacNeil, 1965, p.G29-30, p.2, fig.3,4 6-8, 13, p.3, fig.1,4.

In addition to the large thick shell, several other features serve to separate this species from the other members of the genus: they are a very thick, protuberant spoon, and a deep narrow pallial sinus. The upper margin of the pallial sinus traverses the valve in a nearly straight line from the posterior adductor muscle scar to the anterior ventral area. No live specimens were collected. The dimensions of the two largest valves, both right valves, are (length, height, width of one valve):

Sta. No.	L	H	WIV
M-6033	116.1	73.2	25.8
M-6026	117.2	76.7	26.2

7 lots

Discussion:

The genus _Mya_ has been thoroughly restudied by MacNeil (1965); he provides a description, a synonomy and a discussion of the phylogenetic relationships for each species. The _Mya_ comments in this study are based on MacNeil's work.

The collected specimens of _Mya elegans_ are typical for the species; they have massive shells and thick concave spoons.

<u>Mya japonica</u> Jay, 1856

<u>Mya japonica</u> Jay, 1856, p.292, pl.1, fig.7, 10.

<u>Mya japonica</u>, MacGinitie, 1959, p.187, pl.19, fig.8.

<u>Mya japonica</u>, MacNeil, 1965, p.G31-G33, pl.3, fig.7, 8, 10; pl.4, fig.1-11; pl.6, fig.16.

One incomplete valve of this species was collected in the dredge samples; only the spoon and the posterior end are intact. Identification is based on the characteristics of the spoon. The spoon has a straight anterior edge which is nearly perpendicular to the hinge line, an anterior ridge is lacking; the outer edge of the spoon is smoothly rounded except for the posterior ridge which extends approximately 1 millimeter beyond the edge of the spoon.

1 lot

Discussion:

The lack of complete specimens hinders the identification of this species, but the single spoon obtained compares favorably to MacNeil's (1965) description and plates of this species.

Mya arenaria Linne, 1758

Mya arenaria Linne, 1758, p.670.

Mya arenaria, Oldroyd, 1924, p.198, pl.32, fig.1.

Mya arenaria, MacNeil, 1965, p.G35-38, pl.5, fig.2-12, pl.6, fig.1-15, 17, 18

Mya arenaria, Petrov, 1966, p.236, pl.21, fig.1, 2.

A single incomplete specimen of this species was obtained; only the spoon and the posterior end are intact. The anterior ridge of the spoon curls over the anterior portion of the fibrum receptacle. There is a thick ligamental callus on the surface of the spoon and a large subumbonal solution pit on the valve. The outer edge of the spoon is slightly indented near the posterior ridge.

1 lot

Discussion:

This identification is tenuous. The specimen is incomplete and the species to which it has been assigned has not been previously recorded from the northern Bering Sea. Yet the morphologic characteristics of the specimen can not be referred to another species.

The specimen is cracked and worn, but appears not to be a fossil, for remnants of tissue remain in the subumbonal solution pit.

Mya truncata Linne, 1758

Mya truncata Linne, 1758, p.670.

Mya truncata, Oldroyd, 1924, p.197-198, pl.10, fig.4.

Mya truncata, Grant & Gale, 1931, p.414.

Mya truncata, Ockelmann, 1958, p.144-149.

Mya truncata, MacGinitie, 1959, p.184-186, pl.25, fig.1-3.

Mya truncata, MacNeil, 1963, p.G38-G40, pl.8, fig.1-12, pl.9, fig.1-3, 5-20.

Mya truncata truncata, Petrov, 1966, p.238-239, pl.23, fig.1-3.

The shape of this species is exceedingly variable; it ranges from elongate to quadrate to abruptly truncate. This last form is sometimes recognized as *M. truncata* var. *uddevalensis*.

The spoon is also subject to variation, but to a lesser extent than the valves. Its general features are: an anterior ridge which is upturned and wider at the inner end, the fibrum receptacle portion of the spoon is distinctly concave, its outer margin is slightly convex, the laminum attachment portion of the spoon is nearly horizontal with a straight outer margin. Behind the posterior ridge is a slight indentation. The pallial sinus is short; it descends abruptly from the posterior muscle scar to the pallial line. It does not extend into the anterior portion of the valve.

No large specimens were collected alive. The dimensions of five left valves are (length, height, width of one valve not including spoon, distance umbo to anterior margin, KH as per introduction):

Sta. No.	L	H	WIV	UAM	KH
M-6037	67.5	47.1	15.6	34.6	.51
M-6016	74.2	55.9	17.0	43.7	.59

Sta. No.	L	H	WIV	UAM	KH
M-6275	39.0	33.7	9.6	23.1	.59
M-6065	52.1	39.0	12.0	28.7	.56
M-6034	65.0	49.6	17.7	34.4	.53

102 lots

Discussion:

Most specimens of this species can be recognized with ease, though problems did arise concerning Mya pseudoarenaria Schlesch. At the initial sorting I segregated some individuals I thought might be referrable to M. pseudoarenaria. Concerning this taxon, Ockelmann (1958, p.148) did not consider it a distinct species or even a reasonably defined subspecies of M. truncata. MacNeil (1965, p.G37), on the other hand, treats M. pseudoarenaria as a distinct species. I sent representative specimens of this enigmatic group to Dr. MacNeil. He responded (letter of 25 August 1972) that all the specimens I sent him except one were definitely M. truncata; one juvenile from M-6284 is questionably M. truncata or possibly M. pseudoarenaria.

Mya priapus Tilesius, 1822

Mya priapus Tilesius, 1822, p.295, pl.9, fig.1.

Mya priapus, MacNeil, 1965, p.G40-42, pl.10, fig.1-7, pl.11, fig.1-8, 10, 13-15.

This species has a thick shell and a large thick spoon. The spoon is concave with a rounded outer edge. At the anterior edge of the spoon the anterior ridge is recurved over the fibrum receptacle. Only one complete valve was obtained. It measures (length, height, width of one valve):

Sta. No.	L	H	W1V	
M-6306	86.8	64.6	21.5	2 lots

Discussion:

MacNeil (1965) appears to be the first worker since the original describer to treat this taxon as a separate species. In the years between, it had been recognized as M. japonica, M. truncata, and M. arenaria. MacNeil's description and plates make the species readily identifiable.

Panomya ampla Dall, 1898

Panomya ampla Dall, 1898, p.833.

Panomya ampla, MacNeil, Mertie & Pilsbry, 1943, p.93, pl.16, fig.7, 10.

Panomya ampla, MacGinitie, 1959, p.189-190, pl.25, fig.7.

The exterior of this species is irregularly corrugated and covered with a thin brownish periostracum which extends beyond the shell margin. In outline the valves are subtrigonal, the anterior-ventral and posterior-ventral margins intersect, and a distinct ventral margin is absent. Deep muscle scar pits occur along the posterior-ventral and anterior-ventral margins. No live specimens were collected. The dimensions of the largest complete valve obtained are (length, height, width of one valve):

Sta. No.	L	H	W1V	
M-6007	61.6	49.2	11.8	14 lots

Discussion:

Specimen M-6007 was compared to Dall's type at the U.S. National Museum.

A thorough treatment of this species and *Panomya arctica* is found in MacGinitie (1959, p.189-190). The roughly tapered anterior section is characteristic of *P. ampla*. *P. arctica* has a rounded anterior margin. Most of the specimens collected are incomplete, but enough of the valves remain intact to be referred to *P. ampla*; only one lot (M-6305) may be *P. arctica*.

Hiatella arctica (Linne, 1767)

Mya arctica Linne, 1767, p.1113.

Saxicava arctica, Oldroyd, 1924, p.208, pl.9, fig.6, pl.51, fig.4.

Saxicava arctica, Grant & Gale, 1931, p.427-428.

Saxicava arctica, MacNeil, Mertie & Pilsbry, 1943, p.93, pl.15, fig.16.

Saxicava arctica, MacNeil, 1957, p.119, pl.14, fig.6, 8,; pl.15, fig.12.

Hiatella arctica, MacGinitie, 1959, p.190-191, pl.26, fig.1-3.

Hiatella arctica, Ockelmann, 1958, p.135-142.

Hiatella arctica, Richards, 1962, p.71, pl.12, fig.17-20.

Hiatella arctica, Petrov, 1966, p.233-234, pl.20, fig.5, 6.

Hiatella arctica, Keen, 1971, p.271, fig.687.

The shells of this species are chalky with irregular growth lines; the shape is variable, ranging from quadrate to elongate. Specimens less than 10 millimeters in length have a radial rib which extends from the umbo to the posterior-ventral margin; this rib diminishes as the animal grows. The dimensions of the two largest live-collected specimens and the two largest single valves are (length, height, width of one valve, KY as per introduction):

Sta. No.	L	H	W1V	KY
M-6267	40.7	19.4	7.2	.48
M-6022	26.1	13.2	5.8	.51
M-6005	48.1	24.1	4.6	.50
M-6018	49.6	23.4	4.5	.47

88 lots

Discussion:

Two taxa of *Hiatella* are recognized in the north and eastern Pacific:

they are *H. arctica* and *H. pholadis*. It has never been resolved whether two species are represented or only a single species which is polymorphic. The mode of life followed by the animal has a strong influence on the size and shape of the valves. Hiatellas are known to bore in soft rocks or firm sediments, to nestle and to attach by byssal threads. Generally the elongate burrowers are referred to *H. pholadis* and the attached or nestling forms are named *H. arctica*. I have identified all the *Hiatella* specimens collected in the northern Bering Sea as *H. arctica*. In shell form they range continuously from quadrate to elongate; most specimens are intermediate (KY equals approximately .5) and no specimens are as elongate as *H. pholadis* (KY less than .4).

Zirfaea pilsbryi Lowe, 1931

Zirfaea pilsbryi Lowe, 1931, p.52-53, pl.3, fig.1-2.

Pholas gabbi, Grant & Gale, 1931, p.432-433, pl.24, fig.2.

No living or complete specimens of this species were obtained. Fragments are readily identified by the beaked anterior, the large spoon-shaped apophyses on the interior, and the imbricate, concentric ridges on the anterior portion of the exterior of the valve.

5 lots

Discussion:

No other members of the family Pholadidae were obtained in the northern Bering Sea. The specimens were identified by G.L. Kennedy, University of California, Davis; a complete synonymy can be found in Kennedy (MS).

Pandora glacialis Leach, 1819

Pandora glacialis Leach, 1819, p.465.

Pandora glacialis, Oldroyd, 1924, p.89, pl.15, fig.11.

Pandora glacialis, Ockelmann, 1958, p.152-153.

Pandora glacialis, Richards, 1962, p.58, pl.6, fig.1, 2.

Pandora glacialis, Petrov, 1966, p.240-241, pl.23, fig.12-13.

This species is strongly inequivalve: the right valve is concave and fits inside the left valve. The shells of some specimens are shiny and translucent. Other specimens are thicker and chalky. The external sculpture is unevenly spaced growth lines; very faint radial striations occur on some right valves. The posterior and anterior dorsal margins slope in a low chevron fashion from the low anterior beaks. The ventral margin is ovate in outline with a slight indentation near the anterior end. Measurements of the three largest live-collected individuals are (length, height, width of both valves):

Sta. No.	L	H	W2V
M-6067	25.0	17.1	6.6
M-6067	22.6	14.0	5.2
M-6238	20.6	15.1	4.8

3 lots

Discussion:

Only four specimens of this species were obtained. They were identified after comparison with specimens labeled Pandora glacialis in the U.S. National Museum and the California Academy of Sciences. The specimens also compare to Ockelmann's (1958, p.153) statements and to the figures of Petrov (1966, pl.23, fig.10-11) and Richards (1962, pl.6, fig.19); however, they do not have the dorsal radial grooves shown on Oldroyd's (1924) plate 42, fig.3, 4 and mentioned in the description she reprinted from Sowerby (p.89).

Lyonsia arenosa ventricosa Gould, 1861

Lyonsia ventricosa Gould, 1861, p.23.

Pandorina arenosa, Moller, 1842, p.20.

Lyonsia arenosa, Dall, 1916, p.453.

Lyonsia arenosa, Ockelmann, 1958, p.149-151.

Lyonsia ventricosa, Habe & Ito, 1965, p.158, pl.55, fig.1.

The interior of this species is very shiny; the pallial line is only slightly indented at the posterior end; no hinge or hinge teeth are visible. Fine sand adheres to the periostracum. The exterior sculpture consists of microscopic growth lines crossed by very fine radial lines. In outline the anterior dorsal margin is steeply inclined; the posterior section is horizontal. Some specimens have elongate posteriors; others are truncate. The dimensions of the three largest live-collected specimens are (length, height, width of both valves, distance umbo to anterior margin, KH as per introduction):

Sta. No.	L	H	W2V	UAM	KH	
M-6008	16.5	10.4	7.6	5.7	.35	
M-6064	18.4	12.0	7.9	5.2	.27	
M-6080	17.4	11.8	7.9	6.0	.35	22 lots

Discussion:

Several of the collected lots were compared to the Lyonsia in the collections of the U.S. National Museum. The most similar specimens were labeled L. arenosa ventricosa from the Sea of Japan. The figure in Habe & Ito (1965, pl.55, fig.1) is very similar to some of the specimens I have; they accord L.

ventricosa species status. Ockelmann (1958, p.151) noted variation in the shell proportions of *L. arenosa* and I suspect *L. ventricosa* could fall within this variation.

I am not certain of the taxonomic status of *Lyonsia arenosa ventricosa*; a thorough study of the biogeography and variation is needed.

Thracia devexa Sars, 1878

Thracia myopsis var. devexa Sars, 1878, pl.6, fig.11a-11b.

Thracia devexa, Ockelmann, 1958, p.157-159, pl.3, fig.5.

Thracia myopsis, MacGinitie, 1959, p.162-163, pl.23, fig.9, pl.24, fig.4.

Live specimens have a worn and eroded appearance because the thin, dull yellow or tan periostracum is irregularly flaked off the anterior portion of the shell. The exterior growth lines are rounded and irregularly spaced. The left valve is smaller and less inflated than the right. In outline the valves are widely truncate at the posterior; the ventral margin shows continuous variation from slightly rounded to deeply rounded. The anterior is rounded and the low beaks are centrally located. Dimensions of the three largest live-collected specimens and the largest set of valves are (length, height, width of both valves, distance umbo to anterior margin, KY, KB, KH as per introduction):

Sta. No.	L	H	W2V	UAM	KY	KB	KH	
M-6034	30.0	23.4	11.8	13.5	.78	.20	.45	
M-6283	29.2	22.3	11.2	12.8	.77	.19	.44	
M-6314	27.4	22.2	11.1	12.3	.81	.20	.45	
M-6271	33.4	26.1	14.2	13.8	.78	.21	.41	13 lots

Discussion:

This species appears to be identical to Thracia myopsis as described and figured by MacGinitie (1959). The specimens are also very similar to T. devexa as it appears in Ockelmann's (1958) report. Figures and measurements of both T. myopsis and T. devexa are given by Ockelmann and the specimens at hand appear to be closer to _T._ _devexa_. Formerly _T._ _devexa_ was recognized as _T._ _myopsis_ variety _devexa_, but Soot-Ryen (1941) in an obscure and presently unavailable Norvegean Museum publication separated the two taxa. The proper literature and comparative material will have to be thoroughly examined to resolve the taxonomy of this species.

Asthenothaerus adamsi (MacGinitie, 1959)

Thracia adamsi MacGinitie, 1959, p.163-164, pl.18, fig.9, pl.21, fig.7, pl.24, fig.8.

The following is a description of the largest live-collected specimen. Exterior sculpture of concentric growth lines is overlain by a thick, brittle brown periostracum. The left valve is smaller and less inflated than the right. The anterior is smoothly rounded, the ventral margin is slightly convex, and the posterior is broadly truncate. Beaks are low set and slightly posterior. Under the beaks on the inside of the shell is a calcified ligament, which rests in a buttressed resilifer. Dimensions are (length, height, width of both valves, distance from anterior margin to umbo):

Sta. No.	L	H	W2V	UAM	
M-6076	25.8	21.1	11.1	15.0	5 lots

Discussion:

MacGinitie (1959, p.163-164) originally described this species from a single pair of valves. I compared her holotype to my largest live-collected specimen and they are the same. The specimens at hand have an internal calcified ligament; there is no external ligament. I have followed Keen's (1971, p.295) treatment of the Thraciidae in which the genus *Asthenothaerus* is characterized by an internal ligament, whereas in *Thracia* the ligament is mainly or entirely external.

The type species of *Asthenothaerus* is *A. villosior*. Described by Carpenter in 1864, this species lives along the western coast of North America from Cape San Lucas, Baja California to San Pedro, California. The genus is quite rare; in addition to the one western North American species, Keen (1971, p.295) notes that there are two Caribbean species. The only other reference to the genus that I can find is in Habe & Ito (1963, p. 150, pl.51, fig.22). Their figure of <u>Asthenothaerus pusillus</u> (Gould, 1861) does not resemble the Bering Sea specimens. A preliminary search of the boreal mollusk literature (Grant & Gale, 1931; La Rocque, 1953; MacGinitie, 1959; Ockelmann, 1958; Petrov, 1966; Richards, 1962) provided no references to the genus.

GASTROPODA

FISSURELLIDAE

Puncturella noachina (Linnaeus, 1771)

Patella noachina Linnaeus, 1771, p.551.

Puncturella noachina, MacGinitie, 1959, p.74-75, pl.2, fig.5, pl.4, fig.2.

Puncturella noachina, MacPherson, 1971, p.10-12, pl.1, fig.4, 5.

The apex of this species is turned forward and a narrow slit is positioned behind it. The exterior sculpture consists of radial ribs and concentric growth lines.

8 lots

ACMAEIDAE

Acmaea testudinalis (Muller, 1776)

Patella testudinalis Muller, 1776, p.237.

Acmaea testudinalis, Richards, 1962, p.72, pl.14, fig.1, 2.

Acmaea testudinalis, MacPherson, 1971, p.13-15, pl.1, fig.6.

Though only one lot of two small dead shells was collected, the reddish brown colour pattern and the fine radial lines serve to identify this species.

1 lot

LEPETIDAE

<u>Lepeta caeca</u> (Muller, 1776)

<u>Patella caeca</u> Muller, 1776, p.237.

<u>Lepeta caeca</u>, Sars, 1878, p.123, pl.20, fig.7a-7b.

<u>Lepeta caeca</u>, MacGinitie, 1959, p.73-74, pl.4, fig.1, 1A.

<u>Lepeta caeca</u>, Richards, 1962, p.72, pl.14, fig.3, 4.

<u>Lepeta caeca</u>, MacPherson, 1971, p.15-16, pl.1, fig.7.

Very fine radial ribs crossed by microscopic growth lines produce a cancellate sculpture. The apex is eroded; the rest of the shell is covered with a yellowish-brown periostracum.

TROCHIDAE

<u>Margarites costalis</u> (Gould, 1841)

<u>Margarita striata</u> Broderip & Sowerby, 1829, p.371.

<u>Turbo cinereus</u> Couthouy, 1838, p.99, pl.3, fig.9.

<u>Trochus costalis</u> Gould ex Loven MS, 1841, p.252.

<u>Margarites costalis</u>, MacGinitie, 1959, p.75-77, pl.1, fig.1-7.

<u>Margarites cinereus</u>, Petrov, 1966, p.142-143, pl.1, fig.11.

<u>Margarites costalis</u>, MacPherson, 1971, p.16-18, pl.1, fig.9.

On the upper surface of the whorls there are four spiral ribs with developing secondary lirae; the base of the body whorl has up to 12 low ribs, those near the umbilicus are larger. The variation within this species has been discussed by both MacGinitie (1959) and MacPherson (1971).

14 lots.

<u>Margarites frigidus</u> Dall, 1919

<u>Margarites frigidus</u> Dall, 1919, p.367.

<u>Margarites frigidus</u>, MacGinitie, 1959, p.78-79, pl.2, fig.7, pl.3, fig.7.

The identification of this small, conical species was confirmed by comparison with specimens in the Stanford University collection which were identified by MacGinitie.

2 lots.

<u>Solariella obscura</u> (Couthouy, 1838)

<u>Turbo obscurus</u> Couthouy, 1838, p.100, pl.3, fig.12.

<u>Solariella obscura</u>, MacGinitie, 1959, p.80-81, pl.1, fig.9, pl.2, fig.11.

<u>Solariella obscura</u>, MacPherson, 1971, p.25, 27, pl.1, fig.17.

Live-collected specimens are worn and abraded. Spiral threads of varying amplitude occasionally intersect with growth lines forming small nodes.

18 lots.

Solariella varicosa (Mighels & Adams, 1842)

Margarita varicosa Mighels & Adams, 1842, p.46, pl.4, fig.4.

Solariella varicosa, MacPherson, 1971, p.28, pl.2, fig.4a, 4b.

This species is distinguished from S. obscura by proportionately greater height, stronger longitudinal ribs and threaded base.

4 lots.

LITTORINIDAE

Littorina squalida Broderip & Sowerby, 1829

Littorina squalida Broderip & Sowerby, 1829, p.370.

Littorina squalida, Oldroyd, 1927, p.661.

This species is much like the typical littorine in shape; its numerous spiral lines and the slight sulcation below the suture are distinctive. The identification of this species was confirmed by Dr. J. Rosewater of the U.S. National Museum.

This species is absent from the sea-floor dredge samples; however, it is found in great numbers in the brackish lagoons bordering the Seward Peninsula. In Safety Lagoon, for example, this species was taken alive in dredge samples and formed the dominant component of the shelly beach drift.

EPITONIIDAE

Epitonium greenlandicum (Perry, 1811)

Scalaria greenlandica Perry, 1811, pl.28, fig.8.

Epitonium greenlandicum, MacGinitie, 1959, p.83, pl.5, fig.2, 3.

Epitonium greenlandicum, Richards, 1962, p.74, pl.14, fig.28.

The spiral striae of this species are overlain by large longitudinal ribs. The number of these large ribs varies from 9 to 14 on the body whorl of comparable sized individuals. No live specimens of this species were collected.

7 lots.

TURRITELLIDAE

Tachyrhynchus erosus (Couthouy, 1838)

Turritella erosa Couthouy, 1838, p.103, pl.3, fig.1.

Tachyrhynchus erosus, Petrov, 1966, p.147-148, pl.1, fig.16-19.

Tachyrhynchus erosus, MacPherson, 1971, p.38-39, pl.1, fig.20.

The turreted slightly convex whorls are indented by a spiral sculpture of 5 channeled grooves. Four or more undulatory spiral grooves occur on the base of the ultimate whorl.

Dall's (1919, p.346) variety major was distinguished from T. erosus on the basis of its size; his type specimen (decollate) measured 35 mm in height and the diameter of the last whorl is 14 mm. No specimens this large were obtained in the northern Bering Sea. 92 lots.

Tachyrhynchus reticulatus (Mighels & Adams, 1842)

Turritella reticulata Michels & Adams, 1842, p.50, pl.4, fig.19.

Tachyrhynchus reticulatum, MacGinitie, 1959, p.86, pl.5, fig.9.

Tachyrhynchus reticulatus, MacPherson, 1971, p.40, pl.1, fig.21.

The exterior of this shell has as many as a dozen low, irregular plications on each whorl and up to five radial striations. The resulting sculpture is a poor example of the reticulate pattern suggested by the name.

30 lots.

CREPIDULIDAE

Crepidula grandis Middendorf, 1849

Crepidula grandis Middendorf, 1849, p.101-103, pl.11, fig.8-10.

Crepidula grandis, Oldroyd, 1927, p.718.

Crepidula grandis, MacGinitie, 1959, p.87-88, pl.1, fig.11, pl.5, fig.7.

Crepidula grandis, Kira, 1965, p.32, pl.15, fig.3.

Crepidula grandis, Petrov, 1965, p.151-152, pl.2, fig.7-10.

The specimens of this species are typical. The largest specimen collected alive measures 43.1 mm in length.

13 lots.

TRICHOTROPIDAE

Trichotropis bicarinata (Sowerby, 1825)

Turbo bicarinatus Sowerby, 1825, p.12-13.

Trichotropis bicarinata, MacGinitie, 1959, p.88.

Trichotropis bicarinata, Kira, 1965, p.29, pl.14, fig.3.

Trichotropis bicarinata, Petrov, 1965, p.149-150, pl.2, fig.1-3.

Trichotropis bicarinata, MacPherson, 1971, p.41, 43, pl.3, fig.3.

This species is readily identifiable by the two spiral cords which encircle the body whorl.

3 lots.

Trichotropis kroyeri Philippi, 1849

Trichotropis kroyeri Philippi, 1849, p.175-176.

Trichotropis kroyeri Dall, 1921, p.149, pl.11, fig.1.

Trichotropis kroyeri, MacGinitie, 1959, p.89.

Trichotropis kroyeri, Petrov, 1965, p.150-151, pl.2, fig.5, 6.

The upper whorls of this species are eroded and the rest of the shell is covered with a pale yellow periostracum; the shell beneath has up to 17 low spiral cords. The aperature is tapered at both ends; the umbilicus is open.

3 lots.

Trichotropis borealis Broderip & Sowerby, 1829

Trichotropis borealis Broderip & Sowerby, 1829, p.375.

Trichotropis borealis, MacGinitie, 1959, p.88-89.

Trichotropis borealis, MacPherson, 1971, p.43-45, pl.3, fig.2.

The variation in external shape and sculpture of this species has been commented on by MacGinitie (1959) and MacPherson (1971). Less variable is the aperture: it is wide and it extends vertically more than half the height of the shell.

6 lots.

Trichotropis insignis Middendorf, 1849

Trichotropis insignis Middendorf, 1849, p.107, pl.10, fig.7-9.

Trichotropis insignis, Oldroyd, 1927, p.643, pl.31, fig.9, 9a.

Ariadnaria insignis, Habe & Ito, 1965, p.22, pl.14, fig.33.

The undulating spiral cords on the exterior of this shell are generally covered with bryozoan colonies and other growths. The aperture is large and nearly circular with a white interior.

6 lots

NATICIDAE

The taxonomy of this family is currently being revised by L. Marincovich of the University of Southern California. In the course of his study of the "Cenozoic and Recent Naticidae of the eastern Pacific" he examined and identified the naticids in the northern Bering Sea collections. The synonymies below were compiled by the present writer.

Amauropsis purpurea Dall, 1871

Amauropsis purpurea Dall, 1871, p.124, pl.15, fig.16

Amauropsis purpurea, MacPherson, 1971, p.55-56, pl.3, fig.10.

3 lots.

Bulbus fragilis (Leach, 1819)

Natica fragilis Leach 1819, p.464.

Bulbus fragilis apertus, Oldroyd, 1927, p.735-736.

4 lots.

<u>Natica clausa</u> Broderip & Sowerby, 1829

<u>Natica clausa</u> Broderip & Sowerby, 1829, p.372.

<u>Natica affinis</u> Gmelin, 1791, p.3675.

<u>Natica russa</u> Gould, 1859, p.43.

<u>Natica aleutica</u> Dall, 1919, p.352.

<u>Natica clausa</u>, MacGinitie, 1959, p.90-91, pl.1, fig.10, pl.12, fig.8.

<u>Natica clausa</u>, Petrov, 1966, p.153-154, pl.2, fig.11-16.

<u>Natica russa</u>, Petrov, 1966, p.154, pl.2, fig.17-19.

<u>Natica clausa</u>, MacPherson, 1971, p.56-58, pl.3, fig.9.

55 lots.

<u>Polinices pallidus</u> (Broderip & Sowerby, 1829)

<u>Natica pallida</u> Broderip & Sowerby, 1829, p.372.

<u>Polinices pallida</u>, Oldroyd, 1927, p.728, pl.97, fig.9.

<u>Polinices pallidus</u>, MacGinitie, 1959, p.91, pl.12, fig.10.

<u>Polinices pallidus</u>, Petrov, 1966, p.155-156, pl.2, fig.20-25.

<u>Lunatia pallida</u>, MacPherson, 1971, p.58-59, pl.3, fig.8.

18 lots.

Polinices nanus (Moller, 1842)

Natica nana Moller, 1842, p.7.

Polinices nanus, Oldroyd, 1927, p.732.

Polinices nanus, LaRocque, 1953, p.155.

4 lots.

Polinices monteronus (Dall, 1919)

Euspira monterona Dall, 1919, p.352.

Polinices monteronus, MacGinitie, 1959, p.91-92, pl.12, fig.9.

6 lots.

LAMELLARIIDAE

Velutina plicatilis (Muller, 1776)

Bulla plicatilis Muller, 1776, p.242.

Velutina plicatilis, MacGinitie, 1959, p.96-97, pl.6, fig.6, 8-10.

Velutina plicatilis, MacPherson, 1971, p.49, pl.2, fig.13.

A single small calcareous whorl is visible on the exterior of this species; the rest of the "shell", the rapidly expanding body whorl, is composed of flexible leathery material.

2 lots.

Velutina undata Brown, 1839

Velutina undata Brown, 1839, p.102, pl.1, fig.15.

Velutina undata, MacGinitie, 1959, p.94-95, pl.5, fig.1-3.

Velutina undata, MacPherson, 1971, p.49-50, pl.3, fig.5.

7 lots

The rapidly expanding whorls of this species are covered with fine spiral growth lines. The inner lip of the aperature is wide and flat.

MURICIDAE

Boreotrophon clathratus (Linne, 1767)

Murex clathratus Linne, 1767, p.1223.

Boretrophon clathratus, MacGinitie, 1959, p.98-99, pl.7, fig.1-3.

Boretrophon clathratus, MacPherson, 1971, p.60, pl.2, fig.15.

This species has prominent axial lamellae and a relatively long siphonal canal.

5 lots.

Boreotrophon clathratus variety *gunneri* (Loven, 1846)

Tritonium gunneri Loven, 1846, p.144.

Boreotrophon clathratus var. *gunneri*, MacGinitie, 1959, p.98, pl.7, fig.4-7.

Prominent varices atop the axial lamellae distinguish this variety.

2 lots.

Boreotrophon beringi (Dall, 1902)

Trophon beringi Dall, 1902, p.544.

Neptunea beringi, Dall, 1921, p.109, pl.20, fig.6.

Boreotrophon beringi, MacGinitie, 1959, p.99-100, pl.7, fig.11, 12.

The axial ribs are of constant height over their length; no high varices are formed at the shoulder of whorls. The siphonal canal is relatively long.

4 lots.

Boreotrophon pacificus (Dall, 1902)

Trophon pacificus, Dall, 1902, p.544.

Neptunea pacifica Dall, 1921, p.110, pl.11, fig.5.

Boreotrophon pacificus, MacGinitie, 1959, p.100, pl.7, fig.13,14.

Boreotrophon pacificus, Petrov, 1966, p.157, pl.3, fig.22-23.

Boreotrophon pacificus, MacPherson, 1971, p.62, pl.3, fig.12.

The outer lip of this species is distinctly indented where body whorl joins the siphonal notch.

5 lots.

Boreotrophon truncatus (Strom, 1768)

Buccinum truncatum Strom, 1768, p.369, pl.16, fig.26.

Boreotrophon truncatus, MacGinitie, 1959, p.101-102, pl.3, fig.8-10, pl.8, fig.3, 4, 7, 9.

Boreotrophon truncatus, MacPherson, 1971, p.62-63, pl.3, fig.12.

The siphonal canal of this species is relatively short when compared to the other species of Boreotrophon.

3 lots.

BUCCINIDAE

Volutopsius deformis (Reeve, 1847)

Fusus deformis Reeve, 1847, pl.12, fig.45a-b.

Pyrulofusus deformis, MacGinitie, 1959, p.114-115, pl.13, fig.3-5.

Volutopsius deformis, Petrov, 1966, p.172-173, pl.8, fig.3.

Volutopsius deformis, MacPherson, 1971, p.68-69, pl.4, fig.6.

This species is sinistrally coiled.

2 lots.

Colus spitzbergensis (Reeve, 1855)

Fusus spitzbergensis Reeve, 1855, p.395, pl.32, fig.6.

Colus spitzbergensis, MacGinitie, 1959, p.119-120.

Sipho spitzbergensis, Petrov, 1966, p.175, pl.8, fig.8-10.

Colus spitzbergensis, MacPherson, 1971, p.75-76, pl.5, fig.9.

The exterior sculpture of low closely-spaced spiral ribs readily identifies this species.

10 lots.

Colus hypolispus (Dall, 1891)

Chrysodomus hypolispus Dall, 1891, p.188.

Colus hypolispus, Oldroyd, 1927, p.224, pl.15, fig.1.

The periostracum of this species is reddish-brown; smaller specimens are dark olive in colour. The aperture is white with a recured siphonal canal. Faint spiral threads are visible on the body whorl; the only other ornamentation on the rounded whorls is closely spaced growth lines.

5 lots.

Plicifusus kroyeri (Moller, 1842)

Fusus kroyeri Moller, 1842, p.18.

Plicifusus kroyeri, MacGinitie, 1959, p.126-128, pl.10, fig.10-13.

Plicifusus kroeyeri, MacPherson, 1971, p.80-81, pl.5, fig.7.

MacGinitie (1959) examined the variation in the external sculpture of this species. She concluded that the smooth sided specimens formerly recognized as P. verkruzeni should be synonymized under P. kroyeri.

5 lots.

Neptunea

Mr. C.M. Nelson of the Department of Paleontology at the University of California, Berkeley is currently completing a revision of this genus. He examined the neptunids of the northern Bering Sea; there are three species:

N. heros (Gray, 1850)	19 lots
N. beringiana (Middendorf, 1849)	10 lots
N. borealis (Philippi, 1850)	2 lots.

A preliminary examination of Nelson's work indicates that the nomenclature concerning these species is very complex. I will not attempt to construct synonymies.

Buccinum glaciale Linne, 1761

Buccinum glaciale Linne, 1761, p.523.

Buccinum glaciale, MacGinitie, 1959, p.102-104, pl.9, fig.1-7,10,13.

Buccinum glaciale, Petrov, 1965, p.160-161, pl.3, fig.16-21.

Buccinum glaciale, MacPherson, 1971, p.92-93, pl.6, fig.2.

The variation in this species is attested to by the long synonymies compiled by MacGinitie (1959) and MacPherson (1971). The exterior sculpture of this species is a complex interplay of oblique folds and spiral cords on whorls of varying shape. One of the specimens collected is straight sided, the other has more inflated whorls; both have strong oblique folds on the whorls and are encircled by spiral cords.

2 lots.

Buccinum plectrum Stimpson, 1865

Buccinum plectrum Stimpson, 1865, p.374.

Buccinum plectrum, MacGinitie, 1959, p.105-107, pl.9, fig.11, 12.

Buccinum plectrum, MacPherson, 1971, p.100.

Sigmoidal axial folds, crossed by numerous spiral lines, are characteristic of this species.

1 lot.

Buccinum tenue Gray, 1839

Buccinum tenue Gray, 1839, p.128, pl.36, fig.19.

Buccinum tenue, MacGinitie, 1959, p.107, pl.9, fig.8, 9.

Buccinum tenue, MacPherson, 1971, p.102-104, pl.6, fig.8.

This species is identified by its discontinuous axial folds. Most of the folds start near the suture and fade out part way along the whorl. Other folds originate, then in turn fade out; this pattern is clearly visible on the body whorl.

3 lots.

CANCELLARIIDAE

Admete couthouyi (Jay, 1839)

Cancellaria couthouyi Jay, 1839, p.77.

Admete couthouyi, MacGinitie, 1959, p.129-131, pl.2, fig.1-3.

Admete couthouyi, Petrov, 1966, p.177-178, pl.9, fig.1.

Admete couthouyi, MacPherson, 1971, p.107-109, pl.3, fig.14.

This species has considerable variation in the number and strength of the spiral ribs and axial folds. MacGinitie (1959) discussed this variation and synonymized A. middendorffiana (Dall, 1885).

3 lots.

THAIDIDAE

Thais lima (Martyn, 1788)

Buccinum lima Martyn, 1788, pl.46.

Thais lima, Dall, 1916, p.566, pl.75, fig.4-6.

Thais lima, Grant & Gale, 1931, p.717-718, pl.32, fig.15.

The specimens at hand are low spired with spiral cords covering the whorls; they appear to be well within the variation attributed to this species (see Dall, 1916, pl.75, fig.4-6).

4 lots.

TURRIDAE

Arctic and boreal members of this family are in need of thorough revision. Species were originally described on the basis of the shell morphology of one or two specimens. Later collections have shown that the morphology is quite variable and the morphologic overlap between the taxa is not uncommon. Hopefully a comprehensive study using the radular characteristics and the biogeographic distribution of Recent species as well as the fossil taxa will resolve the taxonomy of this species.

The specimens listed below are the more common turrids found in the northern Bering Sea. They were identified primarily by comparison with material identified by MacGinitie in the collection of the Geology Department, Stanford University.

Obesotoma tenuilirata (Dall, 1871)

Bela tenuilirata Dall, 1871, p.98.

Lora tenuilirata, Dall, 1919a, p.42, pl.15, fig.4.

Obesotoma tenuilirata, MacGinitie, 1959, p.132, pl.15, fig.1.

2 lots.

Obesotoma simplex (Middendorf, 1849)

Pleurotoma simplex Middendorf, 1849, p.19.

Bela laevigata, Dall, 1886, p.300, pl.3, fig.7.

Obesotoma simplex, MacGinitie, 1959, p.133, pl.16, fig.2.

2 lots.

Oenopota turricula (Montagu, 1803)

Murex turricula Montagu, 1803, p.262-263, pl.9, fig.1.

Oneopota turricula, MacPherson, 1971, p.123, pl.7, fig.11.

5 lots.

Oenopota elegans (Moller, 1842)

Defrancia elegans Moller, 1842, p.13.

"Oenopota" elegans, MacGinitie, 1959, p.135, pl.16, fig.7, 8.

Oenopota elegans, MacPherson, 1971, p.117, pl.7, fig.7.

5 lots.

Nodotoma impressa (Morch, 1869)

Pleurotoma impressa Morch, 1869, p.21.

Nodotoma impressa, MacGinitie, 1959, p.137, pl.16, fig.14, 15.

Lora impressa, Petrov, 1966, p.179, pl.9, fig.4-6.

1 lot.

PYRAMIDELLIDAE

Odostomia arctica Dall & Bartsch, 1909

Odostomia arctica Dall & Bartsch, 1909, p.224, pl.28, fig.5.

Odostomia arctica, Oldroyd, 1927, p.510, pl.64, fig.5.

Oldroyd (1927) reproduced Dall & Bartsch's (1909) original description and type figure; the two specimens collected are typical.

2 lots.

SCAPHANDRIDAE

Cylichna alba (Brown, 1827)

Volvaria alba Brown, 1827, p.3, pl.19, fig.43, 44.

Cylichnella alba, Oldroyd, 1927, p.39, pl.2, fig.5.

Cylichna alba, Morris, 1966, p.109, pl.40, fig.28.

This species is recognized by its shiny brown periostracum, cylindrical shape and the slight fold at the base of the short columella.

33 lots.

Cylichna occulta (Mighels, 1841)

Bulla occulta Mighels, 1841, p.50.

Cylichnella occulta, Oldroyd, 1927, p.39-40.

Cylichna occulta, MacGinitie, 1959, p.140-141, pl.4, fig.3.

Cylichna occulta, Richards, 1962, p.87, pl.16, fig.7.

Cylichna occulta, Petrov, 1966, p.181-182, pl.9, fig.11-14.

A thin, white, ovate-cylindrical shell with a smoothly tapering inner lip identifies this shell.

61 lots.

AMPHINEURA

ISCHNOCHITONIDAE

Lepidochitona albus (Linnaeus, 1767)

Chiton albus Linnaeus, 1767, p.1107.

Trachdermon albus, MacGinitie, 1959, p.145-146, pl.17, fig.3, 4.

Lophyrochiton albus, MacPherson, 1971, p.7-8, pl.1, fig.3.

This species is the only chiton collected in the northern Bering Sea. The identification was confirmed by A.G. Smith of the California Academy of Sciences, San Francisco.

10 lots.

BRACHIOPODA

Hemithyris psittacea (Gmelin, 1792)

Anomia psittacea Gmelin, 1792, p.3348.

Hemithyris psittacea, Oldroyd, 1924, p.223, pl.16, fig.8-12.

Hemithyris psittacea, Cooper, 1959, p.47, pl.3, fig.12-21.

The exterior of this species is ornamented with closely spaced radial striations; these are traversed infrequently by concentric ridges which presumably represent intervals of reduced growth. The shape varies; adults are relatively more elongate than juveniles. Dimensions of five live collected valves are (length, height, width of both valves):

Sta. No.	L	H	W2V
M-6007	24.5	20.1	15.2
M-6044	26.1	24.1	13.2
M-6048	19.1	18.4	10.7
M-6294	22.0	20.0	11.1
M-6295	22.3	20.2	12.1

53 lots

Discussion:

Dall (1920, p.34, pl.5, fig.4, 5) described Hemithyris psittacea variety alaskana from the Pleistocene of Nome, MacNeil, Mertie & Pilsbry (1943, p.94, pl.16, fig.9, 15, 18, 19) recollected this variety. Dorsal valves of the variety have 24 to 28 ribs. The number of ribs on the typical form, as collected in the northern Bering Sea, is approximately 50. It seems reasonable to conclude that the variety alaskana is extinct.

ECHINOIDEA

Large numbers of sea urchins and sand dollars were dredged in the northern Bering Sea. Dr. C.W. Allison of the University Museum, University of Alaska, College, Alaska, kindly identified this material. Only one species of sand dollar and one species of sea urchin were obtained; they are, respectively:

<u>Echinarachnius parma</u> (Lamark)	40 lots
<u>Stronglyocentrotus drobachiensis</u> (Muller)	21 lots

CIRRIPEDIA

Balanus rostratus alaskensis Pilsbry, 1916

Balanus rostratus alaskensis Pilsbry, 1916, p.141-142, pl.38, fig.4, 4a, 5.

Balanus rostratus alaskensis, MacNeil, Mertie & Pilsbry, 1943, p.94-95, pl.15, fig.10, pl.16, fig.16.

Balanus rostratus alaskensis, MacNeil, 1957, p.120, pl.14, fig.19, pl.17, fig.4.

This species is easily identified by its large size and thick, commonly pinkish plates. The largest live collected specimen measures (carinorostral diameter and height):

Sta. No.	CRD	H
M-6198	54	48

65 lots.

Balanus crenatus Bruguiere, 1789

Balanus crenatus Bruguiere, 1789, p.168.

Balanus crenatus, Pilsbry, 1916, p.165-175, pl.39, 40.

Balanus crenatus, MacNeil, Mertie & Pilsbry, 1943, p.95.

There is considerable variation in the morphology of this species. Some individuals are conical with smooth exteriors, while others are taller with plicate exteriors. Pilsbry (1916) provides an extensive discussion of this variation. Most of the material collected consists of disarticulated valves.

19 lots.

RECURRENT GROUPS OF SPECIES

Classic concepts in marine ecology are based on data from northern boreal seas. Studies by Danish biologists have characterized the distribution and species composition of northern boreal benthic communities. The major purpose of this section is to define and examine the recurrent groups of organisms which occur in the northern Bering Sea and compare these results to the traditional communities.

Historical Perspective

The pioneering work of Peterson (1911, 1914, 1915A, 1915B, 1918) and the later advances have been presented by Thorson (1957). There has been much progress in the field of ecology since 1957, but Thorson's review stands, nearly 20 years after it was written, as the definitive text on shallow water bottom communities.

As related by Thorson (1957, p.465-473), Peterson's original goal was to conduct a census of the benthic organisms so that he could calculate the available quantity of flounder food. To accomplish this he designed a benthic grab which would obtain a standardized portion of the sea floor, usually an area of one tenth of a square meter. From his samples Peterson observed that different associations of organisms inhabit different areas of the sea floor and that within each association there are characteristic patterns of membership and abundance. Peterson first described these associations or communities as statistical units. Other biologists quickly expanded this concept to include the corollary that the associations of animals also represented ecological units. This corollary has been challenged in other areas of ecology, particularly terrestrial plant ecology, but it was and is presently, generally accepted by marine ecologists. Minor disagreements developed between marine ecologists as to whether the community associations are the result of the surrounding hydrographic conditions or due to properties of the bottom sediment.

Communities have become accepted units of science as evidenced by the fact that workers now use the term without providing a definition (see for example, Lie & Kelley, 1970, and Walker, 1972). A recent definition is given by Valentine (1968, p.256): "collections of populations that are associated in time and space". This is purely descriptive, as are Peterson's original statistical units; there is no implication as to the mechanisms by which the membership is bonded. Valentine characterized the environmental interactions of the community as an ecosystem "involving energy flow and nutrient cycling through the trophic structure" (Valentine, 1968, p.256). This definition doesn't specify whether biotic interactions or external physical properties of the environment give rise to the community. Quite probably abiotic and biotic factors combine in different proportions in different communities to unite the component species populations. We will return to this topic after examining the species distributions in the northern Bering Sea.

Community Recognition

The greatest value of Peterson's communities is that they can be recognized in boreal and arctic seas far distant from the Danish waters where they were originally described. These remote communities contain either the same species as Peterson described or species of the same genera which have a very similar morphology to the originally prescribed species. They have been found on a worldwide scale wherever the sea floor is shallow and level and covered with a compatible sediment type.

Thorson (1957) compiled a geographical summary listing the level bottom communities of the world. From the Arctic part of the Pacific he listed

the *Macoma calcarea* community,

the *Gomphina fluctuosa* community,

the *Yoldia hyperborea* community,

the *Amphiodia cratoderma* community,

the *Amphioplus* community

the *Maldane sarsi* - *Ophiura sarsi* community, and

the *Asabelloides siberica* community.

The area studied in the Bering Sea is clearly suitable for these communities to inhabit; it is shallow--the depths do not exceed 60 meters--and extremely flat (note that fig. 2 is 1:1,000,000 scale horizontally and contoured at 2 meter intervals). The sediment ranges from cobbles to sands to silts (figures 3 & 4). Table 2 below lists the component species of each community as specified by Thorson (1957, p.505-520) and the species or analogous species found in the northern Bering Sea.

TABLE 2

The left hand column is a list of the communities and their characteristic species as specified by Thorson. The right hand column is a list of species obtained from the northern Bering Sea. No data is available on soft-shelled or unshelled organisms in the Bering Sea samples.

from Thorson, 1957	Northern Bering Sea
Macoma calcarea community. Open sea or slightly reduced salinity, depths less than 60 meters, mixed substrates, with increasing sand more C. ciliatum & S. groenlandicus, with increasing silt more M. calcarea.	
Macoma calcarea	Macoma calcarea
Cardium ciliatum	Cardium ciliatum
Serripes groenlandicus	Serripes groenlandicus
Ophiocten sericcum	No data
Pectinaria granulata	No data
Astarte borealis	Astarte borealis
Astarte elliptica	Absent
Astarte montagui	Astarte montagui
Gomphina fluctuosa community. Open sea, depths 3 to 80 meters, sand substrate, increasing amounts of silt will lead to an intermingling with C. ciliatum and S. groenlandicus and finally to a pure M. calcarea community.	
Gomphina fluctuosa	Gomphina fluctuosa
Thracia truncata	Thracia devexa
Pandora glacialis	Pandora glacialis
Euchone analis	No data
Scoloplos armiger	No data
Astarte borealis	Astarte borealis
Astarte elliptica	Absent
Astarte montagui	Astarte montagui

from Thorson (1957	, Northern Bering Sea
Yoldia hyperborea community. Sub-arctic waters, 10 to 70 meters, muddy substrate.	
Yoldia hyperborea	*Yoldia amydgalea*, *Yoldia myalis*
Pectinaria hyperborea	No data
Sternapis fossor	No data
Leda pernula	*Leda pernula*
Leda minuta	*Leda buccata*
Nucula species	*Nucula tenuis*
Polychaete worms	No data
Amphiodia cratoderma community. Depth 25 to 45 meters, further details lacking.	
Amphiodia cratoderma	No data
Turritella fenestrata	Absent
Axinopsis orbiculata	Absent
Magelona longicornis	No data
Yoldia johanni	Absent, perhaps *Y. scissurata* is equivalent
Amphioplus macrapsis community. Depths greater than 100 meters, soft substrate.	
Amphioplus macrapsis	No data
Ophiospenia tetracantha	No data
Ophiura sarsi	No data
Verticordia nadina	Absent
Maldane sarsi community. Shallow estuaries to 300 m in open seas, soft fine mud substrates.	
Maldane sarsi	No data
Ophiura sarsi	No data
Terebellides strogmi	No data
Mellina cristata	No data
Clymenella gracilis	No data
Pectinaria hyperborea	No data
Nucula tenuis	*Nucula tenuis*
Syndosmya nitidea	Absent
Cylichna species	*Cylichna alba*, *Cylichna occulta*

from Thorson, 1957	Northern Bering Sea
Asabelloides siberica community. Depth 22 meters, substrate unknown.	
Asabelloides siberica	No data
Nucula tenuis	Nucula tenuis
Yoldia johanni	Absent, perhaps Yoldia scissurata is equivalent
Axinopsis orbiculata	Absent

The last four of these communities were treated by Thorson even though they were known only from the Peter the Great Bay, near Vladivostok in the Sea of Japan (latitude 43°). They are dominated by soft-shelled or unshelled organisms. The mollusks listed for these communities are either absent from the northern Bering Sea collections or are significant members of one of the other communities. These four communities are not included in the following discussion because they are not recognizable with the data at hand.

To summarize the preceding table, in the northern Bering Sea we find species which are characteristic components of the following communities:

the Macoma calcarea community

the Gomphina fluctuosa community

the Yoldia hyperborea community

Methodology

There are several ways to examine the raw data for the presence of recurrent groups of species, that is, communities. The Danish biologists quantified the relative abundance of each species in each sample, then determined recurrent groups of species via inspection. This approach has some weaknesses. A Peterson grab does not always obtain a quantitative sample; its penetration ability is reduced in coarse sands and when sampling very coarse substrates, pebbles often prevent the jaws from closing completely and portions of the sample are washed away. The Van-Veen sampler used in the Bering Sea is slightly more efficient for its long lever arms apply increased force to the jaws; this results in deeper penetration in sand substrates and less washout in coarser substrates. Unfortunately, neither device has adequate penetration to obtain deeply burrowing bivalves, such as Mya or Panope.

Because of these negative features I have not attempted a quantitative analysis of each sample. I regard the samples as semi-quantitative and have recorded only qualitative presence-absence data (as the species occurrence lists at the conclusion of the taxonomic section).

Several recent community studies have achieved similar results using either quantitative or qualitative data. For example, Mello and Buzas (1968 and references) used a qualitative clustering technique and obtained species patterns which were in good agreement with those previously published by an investigator who used quantitative data. Additional impetus to use presence-absence data stems from the fact that a method for obtaining a sample from a fossil outcrop that is comparable to a sample of a living association has never been developed.

Quantification of the differences between samples is a separate problem. The Danish workers did not quantitatively measure the differences between samples, though they clearly understood that members of different communities could intermix in response to changing conditions. The changes in the Gomphina fluctuosa community with increasing percentages of silt in the substrate (p.114) serves as an example. Techniques are presently available which can quantify the similarity between large numbers of samples and then group the samples on the basis of their relative similarity. Cluster analysis is one of these techniques. Previous studies (Valentine & Peddicord, 1967; Mello & Buzas, 1968; and Hazel, 1970) have demonstrated the ability of cluster analysis to provide meaningful results. The method is suitable for the present study by virtue of its ability to: (1) accept large volume presence-absence data; (2) rapidly calculate the similarity between large numbers of items, then (3) objectively group the data.

OPERATIONAL PROCEDURE

Bonham-Carter (1967) published a cluster program which was quite versatile: up to 130 objects (samples) containing up to 100 characters (species) can be clustered, the user can select either Jaccard's or Sokal and Michener's similarity coefficient, either the weighted or unweighted pair-group method of clustering, and several printout options, including one which compiles a data deck, can be used to plot the resultant dendrograms. This program was modified and expanded.

The original raw data input format required that each character (species) be defined (2 = present, 1 = absent, 0 = uncertain or no information) for every sample under consideration. To make the program more compatible with binary similarity coefficients, the program was modified to accept only presence-absence data.

Often, especially with paleontologic data, many species are relatively rare and symbolizing each non-occurrence leads to increased costs; as a consequence we have installed an alternative data format. Species occurring in the study area are listed numerically from 001 to a maximum of 110 and in a like manner samples are listed from 001 to a maximum of 400. For example, the data cards denoting a species, the seventh, occurring in the third, eighty-second and one hundred twenty-third samples is constructed as follows:

007bb1*

003b082b123

The input routine stores a 2 for presence and a 1 for absence (as Tables 3 and 4).

---

*a continuation number specifying the number of cards following.

Cheetham and Hazel (1969) and Sokal and Sneath (1963) have discussed the properties of the common binary presence-absence similarity coefficients. Each coefficient is somewhat unique so the user's selection depends on the nature of the data and the purposes of the analysis. Bonham-Carter supplied two coefficients, Jaccard's and Sokal and Michener's; five more were added to the program. The name, formula and mean expected value for all the coefficients presently installed in the program are listed on Table 3.

The original program performs Q-mode cluster analysis, that is, the samples are grouped by the characters (species) they have in common. Q-mode analysis is very valuable for the recognition of faunal areas or bio-facies. R-mode analysis groups the characters by the samples in which they occur. By means of a matrix transformation routine the input matrix is converted to R-mode; as many as 110 species from up to 400 localities can be compared.

CLUST 3 is constructed so that all the available options can be exercised from a single control card placed in front of the users' data. The modifications have been installed as additional options on this card. All changes are written in Fortran IV, the cards are coded in EBCDIC, and the entire program runs on a Burroughs 6700. Bonham-Carter's (1967, p.24-25) dendrogram plotting program (DNPLOT) has been adapted to run on the U.C. Davis Cal Comp #750 plotting system.

Analysis of the Cluster Data

The original goal was to cluster all of the raw data--105 species from 362 localities. This analysis was not possible as the matrix which resulted

TABLE 3. The similarity coefficients, their names, formulas and mean expected values.

Sokal & Michener's $= \dfrac{C + A}{(N_T + A)}$, M.E.V. $= \dfrac{(N_1N_2) + (N_2 - C)(N_1 - C)}{(N_T + A)^2}$

Jaccard's $= \dfrac{C}{(N_1 + N_2 - C)}$, M.E.V. $= \dfrac{N_1N_2}{(N_T + A(N_1 + N_2) - N_1N_2)}$

Dice's $= \dfrac{2C}{(N_1 + N_2)}$, M.E.V. $= \dfrac{2}{(N_T/N_2 + N_T/N_1)}$

Fager's* $= \dfrac{C}{\sqrt{N_1N_2}} - \dfrac{1}{2\sqrt{N_2}}$, M.E.V. $= \dfrac{\sqrt{N_1N_2}}{N_T} - \dfrac{1}{2}\sqrt{N_2}$

Phi $= \dfrac{CA - E_1E_2}{\sqrt{N_1N_2(E_1 + A)(E_2 + A)}}$, M.E.V. $= 0$

Otsuka's $= \dfrac{C}{\sqrt{N_1N_2}}$, M.E.V. $= \dfrac{\sqrt{N_1N_2}}{N_T}$

Simpson's $= \dfrac{C}{N_1}$, M.E.V. $= \dfrac{N_2}{N_T}$

N_2 = number present in second

E_1 = number present in first but not in second

E_2 = number present in second but not in first

A = number absent in both but present in others

$N_T = N_1 + N_2 - C$

$N_2 > N_1$

*negative values of coefficients set = 0 before clustering far exceeded the core storage capacity of the computer. The first step in reducing the data was to select 15 stations from the 123 stations which were occupied on a closely spaced grid along the south coast of the Seward Peninsula (see figure 1, inset A). A matrix of 254 stations and 105 species resulted. This matrix also proved to be too large; one run which calculated a single coefficient (Simpson's), and which completed only a portion of the first clustering cycle, cost $75. It was clear that the number of stations had to be further reduced. Three factors were taken into consideration in the selecting process. I retained stations that provided a good areal distribution and excluded stations that contained only one or two rare species or stations that contained only ubiquitous species. These last two criteria are in keeping with Thorson's ideas (1957, p.476) for he stressed that rare or ubiquitous species are to be avoided in characterizing communities.

The basic data for the cluster analysis is 94 species from 103 stations. Figure 5 shows the location of these stations. The species which were dropped from the analysis because they did not occur at the 94 selected stations are _Musculus discors_, _Macoma balthica_, _Bulbus fragilis_, _Amauropsis purpureus_, _Astarte borealis pseudoactis_, _Margarites frigidis_, _Trichotropsis kroyeri_, _Boreotrophon clathuratus gunneri_, _Buccinum tenue_, and _Admete couthouyi_. The maximum number of occurrences among these species was 4 (_B. fragilis_); the average number of occurrences was 2.3 per species. It should be noted _Macoma balthica_ only occurred once in the offshore samples, M-6232, and that this station was a shore collection at Stuart Island. This species is the dominant bivalve in the brackish lagoons along the coast of the Seward Peninsula; its importance will be discussed later.

When compiling the species data sheets, it was recorded whether the species was live-collected or dead. Stations at which the species was collected alive were recorded first on the data cards. The brackets on the species data sheets (Table 1) separate the living and dead occurrences. Stations to the right and below the bracket are localities at which only dead shells were obtained. For example, for species 1, Nucula tenuis, the bracket occurs between 250 and 178, the 36 localities above and to the left of the bracket are localities at which the species was collected alive, the 17 localities listed to the right and below the bracket are the localities at which only dead valves were obtained. It should be remembered that when clustering the data, only the occurrences at the 103 specified localities were utilized; for Nucula tenuis this included 18 live-collected occurrences and 17 stations at which only dead shells were collected. Table 4 is a reproduction of the total fauna data matrix and Table 5 is a reproduction of the living fauna data matrix.

The floor of the northern Bering Sea has had a complex Quaternary history. It has been transgressed by shallow seas several times and overrun by glaciers (Hopkins, 1967). It is not implausible that the grab samples could contain fossil and subfossil shells which do not represent the present hydrographic regime. Therefore, our most reliable insight into the recurrent groups of species which presently inhabit the floor of northern Bering Sea should be gained by examination of the live-collected data.

The live-collected data matrix when extracted from the total cluster data matrix of 103 stations and 94 species, was found to consist of 65 species which occurred live at 97 stations (Table 5). The data were clustered using the weighted pair-group method; this technique, which gives increased weight to the late joining members, appears to give more actualistic clusters when the units under consideration have not been equally sampled (Hazel, 1970, p.3238-3239). The data were analyzed by both Q and R modes.

The patterns of similarity within the raw data matrix were calculated using first Jaccard's coefficient, then Fager's coefficient. The dendrograms which resulted are very similar. On the Q mode dendrograms clusters containing identical groups of stations were formed. The clusters have been designated by the letters A - J on the Jaccard's-Q mode (figure 6A) and A' - J' on the Fager's-Q mode (figure 6B). These samples were clustered on the basis of the species in common. It is possible to reexamine the original data matrix (Table 5) and determine which species contributed to the formation of the clusters. For example, Cluster I - I' consists of samples 6082, 6291, 6077, 6296, 6074, and 6295; each of these samples contain Echinarachnius parma, four of the samples contain Tellina lutea alternidentata. In this manner a list of the most common species in each cluster was determined (see Table 6).

The R-mode dendrograms also produced recurrent groups of species; these were labeled P - T on Jaccard's-R mode (figure 6C) and P' - T' on the Fager's-R mode (figure 6D). Table 6 is a comparison of the Q-mode clusters and their component species and the R-mode clusters and their component species.

TABLE 6. An examination of recurrent groups of species from figures 6A, 6B, 6C, and 6D. The left column is the cluster formed under Q mode. The number of samples in the cluster is followed by a list of the species which contributed to the cluster and the number of occurrences of the species within the cluster. The right column is the clusters formed under R mode. The component species of each cluster are listed.

B - B' 8 samples		P - P' 7 species
Cardita crassidens	7	*Cardita crassidens*
Balanus rostratus alaskensis	4	*Balanus rostratus alaskensis*
Serripes gronlandicus	4	
Crepidula grandis	3	*Crepidula grandis*
Puncturella noachina	3	*Puncturella noachina*
3 species	2	
9 species	1	Plus 3 species
I - I' 6 samples		R - R' 7 species
Echinarachnius parma	6	*Echinarachnius parma*
Tellina lutea alternidentata	4	*Tellina lutea alternidentata*
Cardita crebricostata	3	*Cardita crebricostata*
Thracia devexa	3	*Thracia devexa*
Polinices nanus	3	*Polinices nanus*
7 species	1	Plus 2 species
H - H' 10 samples		
Echinarachnius parma	5	
Nucula tenuis	5	
Cardita crebricostata	5	
2 species	2	
9 species	1	
J - J' 5 samples		S - S' 6 species
Stronglyocentrotus drobachiensis	5	*Stronglyocentrotus drobachiensis*
Chlamys pseudislandica	2	*Chlamys pseudislandica*
Crepidula grandis	2	
Serripes gronlandicus	2	
Lepidochitona albus	2	*Lepidochitona albus*
5 species	1	Plus 3 species

D - D' 6 samples

Yoldia amygdalea	6
Maloma brota	4
5 species	1

C - C' 7 samples

Thyasira gouldi	7
Macoma calcarea	5
Nucula tenuis	5
Gomphina fluctuosa	5
Yoldia scissurata	4
Serripes gronlandicus	4
3 species	3
1 species	2
5 species	1

E - E' 4 stations

Yoldia myalis	4
4 species	2
1 species	1

F - F' 4 samples

Yoldia myalis	4
Astarte montagui	4
1 species	1

G - G' 3 samples

Nucula tenuis	3
Yoldia myalis	3
Astarte borealis arctica	3
Thyasira gouldi	2
4 species	1

A - A' 5 samples

Serripes gronlandicus	5
4 species	1

T - T' 4 species

Yoldia amygdalea
Maloma brota
Plus 2 species

Q - Q' 6 species

Thyasira gouldi
Macoma calcarea
Nucula tenuis

Yoldia scissurata

Plus 2 other species

U - U' 3 species

Yoldia myalis
Astarte montagui
Plus 1 species

Recurrent Groups of Species

Table 6 indicates the presence of five recurrent groups of species in the northern Bering Sea. These groups are characterized by the following species:

Group 1 (B-B', P-P')	*Cardita crassidens*
	Balanus nostratus alaskensis
	Crepidula grandis
	Puncturella noachina
Group 2 (I-I' & H-H'; R-R')	*Echinarachnius parma*
	Tellina lutea alternidentata
	Cardita crebricostata
	Thracia devexa
	Polinices nanus
Group 3 (J-J', S-S')	*Strongylocentrotus drobachiensis*
	Chlamys pseudislandica
	Ledidochitona albus
Group 4 (C-C', Q-Q')	*Thyasira gouldi*
	Macoma calcarea
	Nucula tenuis
	Yoldia scissurata
Group 5 (?E-E', F-F', G-G' D-D' and U-U')	*Yoldia myalis*
	Nucula tenuis
	Astarte montagui
	Yoldia amygdalea
	Macoma brota

There is in addition one other group of recurrent species. It consists of:

Macoma balthica

Littorina squalida

Mytilus edulis

This group was repeatedly collected in the lagoons which border the Seward Peninsula. The samples were obtained by various means: digging, dredging, and shore collections. Because of the erratic data collection methods, samples containing these species were not included in the data to be clustered. Nonetheless, this group appears to be of a characteristic, recurring composition and to be clearly distinct from the other groups.

The recurrent groups of species listed above do not compare very well with the communities proposed for the Arctic-Pacific by Thorson (reference Table 2). Thorson's communities are both statistical and ecological units. The above groups are purely statistical units; they appear to be well founded, for they are the consistent result of Q and R mode cluster analyses using two different coefficients. Let us now examine the above groups to determine if they have an ecological basis or if they are only statistical artifacts.

THE BENTHIC ECOLOGY OF THE NORTHERN BERING SEA

Two types of ecologic data have been compiled for the northern Bering Sea and its fauna. The first type relates to the overall ecologic parameters of the area. Under this heading, data on the water temperature, salinity, currents, dissolved nutrients, depth and substrates of the region have been assembled. The second type is the physical or functional ecology of the individual species.

OCEANOGRAPHIC DATA

Water Masses and Currents

The primary source of hydrographic data was the U.S. Coast Guard Oceanographic Reports authored by Gladfelter et al. (1964), Husby (1969), Husby (1971), and Husby & Hufford (1971). Their reports are the results of four summer cruises to the northern Bering Sea. To best approximate the conditions at the sediment-water interface, the data plotted and summarized are the deepest measurement obtained at each station. These values were obtained, on the average, at 5 to 10 meters above the bottom. This follows from the conventional practice of not allowing the delicate and costly hydrographic equipment to contact the substrate. Figures 7, 8 and 9 summarize, respectively, the salinity, temperature and current data.

On figures 7, and 8 the isopleths of temperature and salinity are approximately parallel and the generalized current pattern (Fig. 9) is compatible with their distribution.

A band of relatively warm (>4°C), low salinity (<32°/₀₀) water is found off the Yukon delta, in Norton Sound and along the southwest coast of the

Seward Peninsula. A large portion of this water mass originates as runoff from the Yukon River (Husby & Hufford, 1971, p.2). Unfortunately, there is no current data from Norton Sound, but from theoretical considerations, much of this water should enter Norton Sound, then exit along the southwest coast of the Seward Peninsula. This appears to be the case, for warm, low salinity water is found moving rapidly along the coast of Seward Peninsula toward the Bering Straits.

Another water mass of relatively low temperature (averaging less than 1°C) with a salinity of approximately 33°/₀₀ is found in the deeper areas. It is reflected in the temperature distribution east of Saint Lawrence Island and in the temperature and salinity distribution west of Saint Lawrence Island and northward to the Bering Straits. This is the Modified Shelf Water mass referred to by Husby & Hufford (1971, p.2). A general northward flow is associated with this water mass.

The central portion of the area of study, the Chirikov Basin, is occupied by a water mass with properties which are intermediate between the Modified Shelf Water and the Yukon derived water. Currents in this area are moderate and often erratic. Husby & Hufford (1971, p.3) found the water column in large portions of this area to be nearly homogeneous.

Special note should be made of the coastal lagoons. Last September I measured a bottom temperature of 12°C and a salinity of 18°/₀₀ at the mouth of Safety Lagoon.

Dissolved Nutrients

Very few data exists concerning the distribution of inorganic nutrients in the northern Bering Sea. Husby & Hufford (1971, p.3) found nitrate and inorganic phosphate concentrations to be very low in the waters along the Seward Peninsula and then increasing toward Chukotka. Nutrient values are calculated in micrograms per liter. Perhaps these low volumetric concentrations are immaterial to a benthic fauna if the area is swept by strong currents.

Bathymetry

The floor of the northern Bering Sea is very flat, perhaps the flattest shelf area on earth; only on the margins of the study area do depths exceed 50 meters. The entire region could be classified as an inner sublittoral marine environment. The bathymetry contoured on two meter intervals is shown on figure 2. Some areas of micro-relief exist: off north-central Saint Lawrence Island, between the Bering Straits and King Island, and south of Cape Rodney. These areas will be discussed in the following section.

Sediments as Substrates

The purpose of this section is to examine the areal distribution of the sediment types which floor the northern Bering Sea. Several workers are actively pursuing research on the sediments and sedimentation processes involved in the Bering Sea (C.H. Nelson, D.A. McManus and D.M. Hopkins). These investigators have been most cooperative by providing unpublished sediment distribution maps. The dynamic processes involved in sedimentation will not be discussed in detail.

The sediment base map (figure 3) was provided by Nelson; it incorporates summary data from more than 700 sediment samples. Though simple in appearance, with only four categories of sediment, the map actually presents a complex array of sediment types.

Yukon silt is the most distinctive sediment type; this fine silt and clay blankets a large area adjacent to the Yukon delta--other small patches occur east of Safety Sound and in inner Norton Bay. The Yukon River has an estimated suspended load of 88 million tons per year (Inman & Nordstrom, 1971, p.8), but Yukon derived sediments are scarcely found beyond the confines of the delta. McManus (1972, MS) proposed that the fine particles remain in suspension as the Yukon derived water mass (previously discussed) proceeds northwestward along the coast of the Seward Peninsula. This suggestion was prompted by the discovery of large volumes of Yukon sediment on the sea floor north of the Bering Straits (McManus et al., 1969).

The Chirikov Basin is floored with sand and silty sand. The heavy mineral suites from these sands indicate that they were derived from Chuckotka. They are relict, having been deposited before the Yukon River discharged northward (McManus, 1972, MS).

Patches of relict coarse gravel occur in many areas of the northern Bering Sea. In a few areas the gravels have been swept free of fine material, but in most areas the gravel is intermixed with a continuum of finer particles. Nelson arbitrarily divided the gravel beds into two categories (>50% gravel, <50% gravel) for mapping purposes. In actuality, the sediments which are less than 50% gravel are so variable in the percentages of fine components that they almost require individual descriptions. Figure 4, a map of the sediment modes prepared by McManus (1972, MS), demonstrates the complexity of the sediment composition.

Summary of the Oceanographic Data

It is unfortunate that ecological data could not have been gathered when the samples were collected. Instead I have had to use other sources. From the data at hand, the overall pattern of temperature and salinity does not appear to be too complex. This is somewhat deceptive, for the region is very shallow and presumably storm activity and seasonal effects disrupt the normal regime.

I interpret the data available to indicate that temperature, salinity, depth and dissolved nutrients are relatively uncomplicated ecologic parameters. This leaves currents and substrate type as the principal factors to be considered in evaluating the recurrent groups of species.

TAXA ECOLOGY

In the course of this study I attempted to compile ecological information on each species that was collected. The data are very inconsistent; some species are well documented, others are unstudied. In some cases the generic name or higher taxonomic unit stipulates certain ecological limitations. For example, no specific information is available on the mode of life of the barnacle _Balanus rostratus alaskensis_, but all members of the cirripedia are known to be epifaunal suspension feeders.

This section is concentrated on the ecological parameters (particularly substrate and current preference) of the species which characterize the recurrent groups.

Group 1

Cardita crassidens:

MacGinitie, 1959, rocks & gravel, 80 to 477 feet

Petrov, 1966, hard sand & cobbles, 24 to 140 meters, temperature -1.2° to 3.2°C, salinity 32-34°/₀₀ (data from Okhotsk Sea).

Stanley, 1971, _C. crassidens_ appears to be similar in dimensions and shape to _Venericardia borealis_. _V. borealis_ inhabits coarse sands which are swept by moderately strong currents.

This study, primarily in gravel or sandy gravel substrates, a live specimen from M-6051 is notable in that the shell is covered with barnacles and bryozoans indicating that the animal lived on top of the substrate.

Summary: An infaunal (rarely epifaunal) suspension feeder, which prefers sandy or coarser substrates.

Balanus rostratus alaskensis:

Pilsbry, 1916, sessile, attached to firm substrate.

This study, attached to large rocks or cobbles.

Summary: An epifaunal suspension feeder, needs a firm substrate for attachment.

Crepidula grandis:

MacGinitie, 1959, commonly found attached to rocks, 120 to 435 feet.

Kira, 1965, usually attached to the shells of other mollusks.

Petrov, 1966, common on the shells of other mollusks in regions of sand, pebbles or cobble substrates. Depth 24-65 meters, salinity 30.4 to 33.5°/₀₀, temperatures of -1.6 to 0.4°C, in the Okhotsk Sea.

This study, occurs in gravel rich samples.

Summary: An epifaunal suspension feeder attached to rocks or other mollusks.

Puncturella noachina:

MacGinitie, 1959, one specimen from 184 feet.

MacPherson, 1971, on mud and rocks at depths from 18 to 90 meters.

This study, collected on rocky substrates.

Summary: An epifaunal feeder.

Summary of Group 1:

The members of this group are epifaunal suspension feeders; they live attached to rocks or other hard substrates. The only exception is C. crassidens which commonly lives infaunally in patches of sand among cobble beds. Currents of moderate velocities may be required by this group.

Group 2

Echinarachnius parma:

This study, lives on clean sand or sand and gravel substrates. The occurrence of this species at station M-6348, in eastern Norton Sound, is unexpected. Individuals from this location are small (maximum diameter 6 millimeters) with fine sand adhering to the tests.

Summary: A sediment-water interface deposit feeder, on sandy bottoms.

Tellina lutea alternidentata:

Coan, 1971, lives in sand on exposed coasts from intertidal depth to 84 meters.

This study, occurs in patches of clean sand.

Summary: An infaunal suspension feeder which prefers sand substrates.

Cardita crebricostata:

Petrov, 1966, lives on silty sand substrate at depths of 40-45 meters, temperatures of 0.26 to 1.36°C and salinities of 32 to 34 °/₀₀, data from Okhotsk Sea.

Summary: An infaunal suspension feeder, in silty sand substrates.

Thracia devexa:

As stated in the taxonomic section, the relationship of this taxon to T. myopsis is not presently resolved.

Ockelmann, 1958, T. devexa was found on clay substrates in the inner portions of fjords, while T. myopsis inhabits sandy bottoms on the open sea floor.

This study, obtained at cobble-sand or cobble-silt locations.

Polinices nanus:

The Naticidae are carnivores. Species of Polinices inhabit sandy areas along the west coast of North America.

This study, lives on clean sand substrates.

Summary: A predator in sandy environments.

Summary of Group 2:

The species of this group appear to have strong ties to sand substrates.

Group 3

Stronglyocentratus drobachiensis:

Ricketts & Calvin, 1968, an omnivore, but feeds mainly on algae.

Carl, 1971, in crevasses and chambers of rocks in the surf zone.

This study, commonly on rocks or sands, occasionally in muddy areas.

Summary: An epifaunal browser generally on coarse grained substrates.

<u>Chlamys pseudislandica</u>:

Grau, 1959, <u>C. islandica</u>, a closely related species, is usually found on rocky bottoms.

This study, on gravel dominated substrates.

Summary: An epifaunal suspension feeder.

<u>Lepidochitona albus</u>:

MacPherson, 1971, on rocks and mud from 19 to 128 meters.

This study, inhabits rocky substrates.

Summary: An epifaunal browser, on rocks.

Summary of Group 3:

This group is composed of epifaunal browsers and suspension feeders which prefer rocky substrates.

Group 4

<u>Thyasira gouldii</u>:

Ockelmann, 1958, lives on different substrates, primarily clay or mud; associated with the <u>Macoma calcarea</u> community.

Petrov, 1966, silty sand substrate, at depths of 22 to 47 meters with a temperature range -1.3 to 4.8°C, salinity 32.1°/₀₀ to 33.5°/₀₀ (data from Okhotsk Sea).

This study, inhabits silty sand substrates.

Summary: An infaunal suspension feeder in areas where the substrate is silty or muddy sand.

Macoma calcarea:

Ockelmann, 1958, on clay or mud substrate, may be mixed with sand or gravel or stones.

MacGinitie, 1959, found at all stations having a mud bottom; additionally, a few small specimens were obtained from mixed gravel substrates.

Petrov, 1966, on silty and silty sand substrates, rarely on sand, in sublittoral depths, often the dominant form in communities.

Dunnill & Ellis, 1969, in sediment ranging from sands to silty sands to clayey sands.

Reid & Reid, 1969, an infaunal siphonate deposit feeder, particles larger than 20 microns generally rejected.

Coan, 1971, from 2 to 320 meters in silty sand and sands, most common over 50 meters.

This study, very common in mixed sand-silt substrates.

Summary: An infaunal siphonate deposit feeder, common in silty and silty sand substrates, rarely found on clean sand areas.

Nucula tenuis:

Ockelmann, 1958, on clay, clay with sand, and mixed mud and gravel substrates, only a few animals taken on sand.

MacGinitie, 1959, taken on mud bottoms.

Petrov, 1966, lives predominantly on silty sand where there is good aeration and significant amounts of organic debris.

Stanley, 1968, a labial palp deposit feeder living near the surface.

This study, obtained at muddy, silty, and silty sand localities.

Summary: A labial palp deposit feeder living predominantly, but not exclusively, in silty sand environments.

<u>Yoldia</u> <u>scissurata</u>:

Stanley, 1968, Yoldias are labial palp deposit feeders.

Stanley, 1970, <u>Yoldia</u> <u>limulata</u>, a similar shaped species, was obtained from muddy and clay-silt substrates.

This study, common on silty sand substrates, rarely found on clean sands.

Summary: A labial pulp deposit feeder, substrate preference for fine sand and smaller sized material.

Summary of Group 4:

The species of this group are infaunal, on silty-sand substrates. Three feeding types are present: the Yoldias feed within the sediment, <u>Macoma</u> <u>calcarea</u> obtains its food at the sediment surface, and <u>Thyasira</u> is a suspension feeder.

Group 5

Yoldia myalis:

MacGinitie, 1959, at Pt. Barrow depth range from 72 to 453 feet.

Petrov, 1966, depths 8-84 meters, temperatures -1.8° to +1.8°C, salinity from 30.2°/oo to 36.6°/oo (data from Okhotsk Sea).

Stanley, 1968, a labial palp deposit feeder.

This study, on sand, silt and mud substrates.

Summary: An infaunal deposit feeder on fine sand, silt or mud substrates.

Nucula tenuis:

Ockelmann, 1958, on clay, clay with sand, and mixed mud and gravel substrates, only a few animals taken on sand.

MacGinitie, 1959, taken on mud bottoms.

Petrov, 1966, lives predominantly on silty sand where there is good aeration and significant amounts of organic debris.

Stanley, 1968, a labial palp deposit feeder living near the surface.

This study, obtained at muddy, silty, and silty sand localities.

Summary: A labial palp deposit feeder living predominantly, but not exclusively, in silty sand environments.

Astarte montagui:

Ockelmann, 1958, various types of bottoms from rocks to mud, more common on clay, sandy clay and sand.

MacGinitie, 1959, 80 to 120 feet, gravel and mud substrates, large hauls usually have several varieties of the species with intergrades.

Stanley, 1968, an infaunal suspension feeder.

This study, found on silty sand, sand and mud.

Summary: An infaunal suspension feeder on mixed medium and fine grained substrates. A careful analysis of substrate grain size would be necessary to determine if morphology and substrate are interrelated. MacGinitie's statement implies that shape may be independent of substrate.

Macoma brota:

Petrov, 1966, silty substrate, 20 to 130 meters.

Dunnill & Ellis, 1969, 30 to 80 meters, clayey sand, silty sand and mud.

Reid & Reid, 1969, feeds on particles smaller than 20 microns, observed to deposit feed, but appears to be primarily a suspension feeder.

This study, lives in silty sand or mud substrates.

Summary: Occurs on mixed fine grained substrates, infaunally, primarily a suspension feeder.

Summary of Group 5:

This group of infaunal bivalves lives primarily on silty sand and finer grained substrates; both deposit feeders and suspension feeders comprise this group.

Group 6

Macoma balthica:

Stanley, 1970, intertidal and subtidal on muddy sands, in aquaria animals were never observed to be deposit feeders.

Wagner, 1970, suggested that *M. balthica* could tolerate salinities as low as 3.5°/oo.

Levinton, 1971, referred to studies which indicated that intertidal specimens deposit feed when the tide is out and suspension feed when the tide is in.

Coan, 1971, found in bays and brackish areas, also offshore to depths of 37 m, in silt substrates.

This study, absent in the offshore samples, obtained in the brackish lagoons.

Summary: In northwestern Alaska this species appears to be limited to the brackish water lagoons; presumably it is a suspension feeder.

Littorina squalida:

U.S. National Museum collections contain *L. squalida* from the coast of the Seward Peninsula. The specimens appear to have been collected near the mouths of lagoons and large rivers.

This study, absent in offshore samples; abundant at Safety Sound.

Summary: an epifaunal browser inhabiting brackish lagoons.

Mytilis edulis:

Soot-Ryen, 1955, intertidal zone to 20 fathoms, attached to rocks or pilings.

Ockelmann, 1958, epifaunal at depths less than 10 meters in areas of rocks or gravel.

Petrov, 1966, eurythermal and eurykaline, attached to various substrates, can tolerate salinities as low as 5°/₀₀.

Wagner, 1970, suggested that M. edulis can tolerate salinities as low as 3.5°/₀₀.

This study, one live specimen obtained at M-6225 attached to a large barnacle. Large numbers of fresh unoccupied shells were obtained in the brackish lagoons.

Summary of Group 6:

In the study area this group appears to be confined mostly to the brackish lagoons, but Mytilus edulis appears occasionally in other habitats. McRoy (1969) studied Safety Sound; under winter ice he found anoxic conditions, a temperature of -1.8°C and an average salinity of 31°/₀₀. In bottom cores he obtained a live gastropod and a bivalve; presumably these were Littorina squalida and either Macoma balthica or Mytilis edulis. The duration of the anoxic condition and the strategies the mollusks use to survive the condition is not known.

one lives in silts. We could chart the similarity between the groups in the general form of a dendrogram (figure 10). The main value of this figure is that it leads us to the next chapter, a discussion of the benthic communities of the northern Bering Sea.

COMMUNITIES

The previous sections of this study have been largely descriptive and objective, and now this information can be assessed in terms of ecological constructs. Data must be synthesized and conclusions must be formed regarding the groups of organisms which inhabit the northern Bering Sea.

Some of the recurrent groups have common members and common ecological requirements. By combining these groups we are uniting animals which have similar habitat requirements. We are in a conservative sense forming biofacies--groups of organisms which inhabit similar areas. In a more liberal sense we are erecting communities.

The Benthic Communities

This study has nearly run its course, the shelled fauna of the northern Bering Sea has been documented. Some of its species are recognizable as important members of traditional communities. These species constitute the raw material out of which the traditional benthic communities were constructed. The fauna of the northern Bering Sea is not unique for a boreal sea and its resident species could reasonably be placed in the traditional communities. I chose to group the species on the basis of their joint occurrences, then examine the resulting groups. Groups of species were formed by cluster analysis and in the preceding section these groups were shown to have common ecological requirements. Yet each of these recurrent groups is not necessarily a community.

Recurrent groups 1 and 3 are a case in point. Both are composed of species that primarily attach to cobble substrates and secondarily occur on sediment patches within rocky areas. I regard this collective unit as Community I.

Most of the species in Group 2 are restricted to clean sand environs though some can tolerate sandy-silt substrates. Group 2 appears to be distinctive; it represents a community--Community II.

Groups 4 and 5 have many species and many habitat requirements in common. As shown in the previous chapter, group 4 members are found on silty sand and finer substrates, while group 5 species occur about equally on sand silt and mud substrates. Possibly these groups represent different community associations, but in the northern Bering Sea they do not appear to be readily separable. These groups are combined as Community III. The members are suspension and detritus feeders inhabiting substrates ranging from fine sand through silty-sands and muds to clays.

The low salinity tolerance of group 6 labels this association as Commmunity IV.

Table 7 lists the species which comprise the benthic communities of the northern Bering Sea. The communities are polythetic. No rigid order of appearance is implied by the listing.

Table 7. Benthic communities of the northern Bering Sea.

Community I

Cardita crassidens

Strongtyocentrotus drobachiensis

Crepidula grandis

Balanus nostratus alaskensis

Puncturella noachina

Chlamys pseudislandica

Lepidochitona albus

Serripes gronlandicus

Community II

Echinarachnius parma

Cardita crebricostata

Tellina lutea alternidentata

Thracia devexa

Polinices nanus

Nucula tenuis

Community III

Yoldia myalis

Nucula tenuis

Thyasira gouldi

Yoldia amygdalea

Macoma calcarea

Table 7 (continued)

Yoldia scissurata

Macoma brota

Gomphina fluctuosa

Serripes gronlandicus

Astarte borealis arctica

Community IV

Macoma balthica

Littorina squalida

Mytilus edulis

Unprecedented Communities

The communities of Table 7 do not compare to the communities of Peterson & Thorson (Table 2).

Community I is composed of many epifaunal animals. Thorson (1957, p.461-467) discussed epifaunal animals, but did not recognize any epifaunal communities. He reasoned that boreal seas were impoverished in epifaunal forms because the intertidal zone where epifaunal communities thrive is essentially devoid of life in boreal seas. Granted, that each winter sea ice is forced by currents and winds against the shoreline and that this ice scours and obliterates any fauna inhabiting the coastal zone. But this report has shown that a sublittoral benthic epifauna is common and that the fauna is composed of distinctive animals.

Thorson listed two communities frequently found on sandy substrates. One is a Tellina community found on hard sand in shallow waters. He suggested that this community was not found in arctic seas. The other community, termed the Gomphina fluctuosa community, lives on sandy bottoms and is observed to intermix with the Macoma calcarea community as the proportion of silt in the substrate increases. Community II is found in the northern Bering Sea to inhabit sandy substrates; it is reminiscent of Thorson's Tellina community by the presence of Tellina lutea alternidentata. The strong adherence of the association to sandy substrates is enhanced by the membership of the sand dollar Echinarachnius parma.

Community III is very complex. It includes a large number of species which inhabit mixed sand-silt-clay substrates. It appears to be a combination of Thorson's Macoma calcarea, Gomphina fluctuosa and Yoldia hyperborea communities. Some members of Community III may be separable into the

Yoldia hyperborea community which includes Yoldias and nuculids, but in general most of these species appear to be closely associated with many other members of Community III.

Thorson recognized a *Macoma balthica* community which inhabited silty and mixed substrates in areas of brackish water. Community IV may be an impoverished version of this community.

Of these four communities, community three is the most thought-provoking for it appears to be a mixture of several of Thorson's communities. Perhaps a refined methodology could subdivide this unit into overlapping transitional elements, but in this study it is a discrete entity quite distinct from the other communities. There is good reason to presume that the non-discrimination of sub-groups in community three is more than a methodological artifact.

The distribution of benthic animals in the northern Bering Sea is primarily controlled by the nature of the substrate and over large areas of the sea floor the substrate is very heterogeneous. The sediment maps previously presented (figures 3 and 4) attest to these complexities, and figure 11, a map of the relative sorting of the surface sediments, compiled by McManus (1972, MS), shows that only a few small areas of well sorted sediment exist. Over most of the area the sediment is very poorly sorted or at best only moderately sorted. In terms of areal distribution this poorly sorted sediment, particularly in the sand-silt ranges, houses a benthic community which is composed of species that have sufficient morphological plasticity to inhabit varying substrates.

The work of Stanley (1970) clearly relates the external morphology of burrowing bivalves to life habits in differing substrates. These effects of substrate on morphology can be quantified somewhat if we recall the morphological variation discussed in chapter 1. For example, among the Macoma is considerable variation and intermediate specimens seem to exist between Macoma brota and M. calcarea and between M. brota and M. lipara (Coan, 1971, p.21, 24-25); among the genus Astarte, A. montagui has a highly variant morphology as does A. borealis. In the latter case perhaps some of the subspecies proposed by Petrov (1966, p.206-210) will prove to be reliably recognizable as ecotypic forms. Other members of community three, Gomphina fluctuosa, the yoldids, are also notably variable.

In general, the species discussed above are deposit and suspension feeders and the food resources they utilize are derived from the overlying water column independently of the substrate. Although there is not much data, the work of Reid & Reid (1969) on Macomas suggests that siphon behaviour, diet and ciliary mechanisms within the mantle cavity may combine to differentiate the size and kind of food particles acceptable to each species. This would allow some of the species to function in different niches within the same general habitat.

Much more work of this type is needed, for some species appear to be following a different strategy. For example, Serripes gronlandicus is morphologically relatively conservative, yet it is found in virtually all the habitats of boreal seas causing one to suspect that it might be rather unspecialized in terms of food requirements and substrate preference.

Total Fauna Clusters

The communities which have been discussed are the result of the clustering and ecological evaluation of the live-collected specimens. The total fauna, the live-collected specimens plus the dead shells, was also clustered. This portion of the study was undertaken with considerable caution, for the floor of the northern Bering Sea could be a prime locale for the preservation of relict faunas. As discussed in the section "Sediments as Substrates", Recent sedimentation appears to be confined to the Yukon delta and inner Norton Sound; the substrate in the other areas is believed to be relict, having been deposited during a series of Pleistocene glacial and glacial-marine events which preceeded the Holocene rise of sea level to its present position.

In spite of these reservations, the total fauna clusters are quite compatible with the living communities. The 103 stations selected for clustering contained 94 species. The dendrogram produced by Jaccard's coefficient clustering under R mode is presented as figure 12. As with the live-collected derived clusters, it is the bivalves and non-molluscan species which reflect the benthic environmental conditions. Gastropod species appear to be sparsely distributed throughout several habitats.

The members of Community I (cluster 1 on figure 12) are joined by other species which are associated with cobble and gravel substrates. For example, the brachiopod Hemithyris psittacea and the bivalves Hiatella arctica and Panomya ampla all of which are associated with coarse substrates join this community.

Community II (cluster 2 on figure 12) is joined by the sand dwelling bivalve Spisula polynyma. The barnacle Balanus crenatus also joins this community; it is commonly found attached to shell debris in areas swept by moderate currents. Several gastropods also join this cluster but unfortunately not much is known of their life habits.

The members of Community III (cluster 3 on figure 12) are joined by many bivalves that are known to inhabit silty-sand substrates. Notable examples are Clinocardium ciliatum, Siliqua alta and Mya truncata.

Community Names

The communities of the northern Bering Sea were derived mathematically by cluster analysis, then examined ecologically; now they have been expanded to include both biocoenoses and dead shell material. They appear to be large, significant, coherent biological units. It is thus appropriate to name them. Naturally in a polythetic classification the name-bearer need not be present everywhere that the community occurs.

Community I is composed of animals inhabiting cobbles and gravel or patches of finer sediment among these coarser modes. The large barnacle Balanus rostratus alaskensis occurs quite frequently in this community and is a suitable standard bearer for this community.

Community II is best recognized as the Tellina lutea alternidentata community. The species appears to be limited to areas of clean sand; also by recognizing this genus I am indicating an appropriate similarity to the Tellina communities of Thorson (1950, p.507-508).

Community III is more difficult to name. The most common species, Serripes gronlandicus, is clearly not limited to this community, for it occurs in the Balanus community and the Tellina community. The next alternative is Macoma calcarea. This name would imply a high degree of similarity with Thorson's M. calcarea community that is not desirable by virtue of the differences previously discussed. Clinocardium ciliatum is commonly found on silty-sand substrates. The species was noted by Thorson (1950) as a characterizing speies in his Macoma calcarea community and as a marginal member of the sand dwelling Gomphina fluctuosa community when the percentage of silt increased. Clinocardium ciliatum is a suitable identifier for this community.

Community IV appears to be limited to the brackish water lagoons. As previously stated, it is probably a depauperate equivalent of Thorson's *Macoma balthica* community. The *Macoma balthica* community is a fitting name for this group of organisms.

A Short Comment on Boreal Marine Ecosystems

Classic concepts in benthic ecology are based on boreal data. The work of Peterson, Thorson and their Scandinavian colleagues has provided extensive treatises on the distribution, physiology and reproductive strategies of boreal marine animals. Because of the quantity and high quality of their work, boreal ecosystems have tended to be regarded as rather simple and well-understood entities. By virtue of their end member position on a diversity gradient which increases equatorward, boreal ecosystems have come to be regarded as early phases of a biosystem which will eventually become more complex and mature. There are geologic and biologic data which cast doubt on this hypothesis.

Firstly, the geologic data: it is clearly established that the western boundary of the North American plate is located in northeastern Siberia, not in North America or the region of the Bering Straits (Churkin, 1972). The presently available evidence indicates that these two plates have been sutured since a collision in Early Cretaceous times.

Unfortunately the geologic history of the Arctic Ocean is not clearly understood but there are indications that a basin has existed northward of the North American plate since at least Paleozoic times (Churkin, 1971, p.12).

In terms of biogeography, these events set the stage for the Cenozoic migrations which took place through the Bering Strait. The patterns of migration of the shelled benthic animals through this biogeographic gateway have been discussed by Durham and MacNeil (1967) and the paleoenvironmental and geological history of the area has been compiled by Hopkins (1967).

The first recognizable seaway between the Pacific and Arctic-Atlantic appears to have opened in late Miocene or Early Pliocene times. Several species migrated through the region in both directions before the sealevel dropped and the region stood as a barrier to migration throughout most of the Pliocene. In late Pliocene and Pleistocene times the region was again submerged and extensive migrations occurred. In all, Durham and MacNeil recognized over 125 species which have migrated from the Pacific Ocean to the Arctic-Atlantic waters. Only 16 species or species groups are recognized as having migrated from the Atlantic to the Pacific. There are 33 species whose phylogenies and direction of migration are uncertain.

The purpose of the preceding is to point out that the resident fauna of the northern Bering Sea and other boreal seas have a long and interblended phylogenetic history. They are not a young, junvenile conglomeration of species hastily assembled during the latest Pleistocene to occupy the recently flooded portions of the northern continental shelves. In terms of diversity (number of species) productivity and trophic structure boreal ecosystems do not attain the magnitudes reached by more equatorward biosystems. Nevertheless they appear to be well defined, biologically and ecologically founded systems.

LITERATURE

Bartsch, P., 1929, Report upon the collec ion of marine mollusks made by Prof. Dr. K. Derjugin in the Gulf of Peter the Great: Inst. Hydrol. Russ. Explor. des Mers d'U.R.S.S., v. 10, p. 129-140, pls. 1-4.

Bonham-Carter, G. F., 1967, Fortran IV program for Q-mode cluster analysis of nonquantitative data using IBM 7090/7094 computers: Kansas Geol. Survey Computer Contribution 17, 28 p.

Boss, K. J., Rosewater, J., and Ruhoff, F., 1969, Zoological taxa of William Healy Dall: U.S. Natl. Mus. Bull., v. 287, 427 p.

Broderip, W. J., and Sowerby, G. B., 1829, Observations on new and interesting Mollusca contained for the most part in the Museum of the Zoological Society: Zool. Jour., v. 4, no. 15, art. 48, p. 359-379, pl. 9.

Brown, T., 1827, Illustrations of the recent conchology of Great Britain and Ireland: Ed. 1, 144 p., 20 pls.

__________, 1839, in Smith, J., On the last changes in the relative levels of the land and sea in the British Islands: Mem. Wernerian Nat. Hist. Soc. Edinburgh, v. 8, pt. 1, p. 49-113, pls. 1-2.

Bruguiere, J. G., 1789, Encyclopedie methodique, histoire naturelle des vers, des mollesques, des cocquilloages et zoophytes: Histoire naturelle des vers, v. 1, 757 p. not seen

Buzas, M. A., 1972, Biofacies analysis of presence or absence data through canonical variate analysis: Jour. Paleontology, v. 46, no. 1, p. 55-57.

Carl, G. C., 1971, Guide to the marine life of British Columbia: Victoria, British Columbia Provincial Museum, handbook 21, 135 p.

Chace, E. P., 1972, Pododesmus complex on the West Coast: Tabulata, v. 5, no. 2, p. 3-10, 1 pl.

Chamberlain, J. L., and Stearns, F., 1963, A geographic study of the Clam, Spisula polynyma: New York, American Geog. Soc., Serial Atlas of the Marine Environment, no. 3, 12 p., 6 pls.

Cheetham, A. H., and Hazel, J. E., 1969, Binary (presence-absence) similarity coefficients: Jour. Paleontology, v. 43, no. 5, p. 1130-1136.

Churkin, M. Jr., 1971, Geologic concepts of Arctic Ocean basin, in 2nd International Symp. Arctic Geology, San Francisco, 1971: Amer. Assoc. Petroleum Geologists, Program, p. 12.

__________, 1972, Western boundary of the North American continental plate in Asia: Geol. Soc. America Bull., v. 83, p. 1027-1036.

Coan, E. V., 1971, Northwest American Tellinidae: Veliger, v. 14, supplement, 63 p., 12 pls.

Cooper, G. A., 1959, Genera of Recent and Tertiary Rhynchonelloid Brachiopods: Smithsonian Misc. Coll., v. 139, no. 5, 90 p., 22 pls.

Cowan, I. McT., 1968, Interrelationships of certain boreal and arctic species of Yoldia Muller, 1842: Veliger, v. 11, no. 1, p. 51-58, pl. 5.

Couthouy, J. P., 1838, Descriptions of new species of Mollusca and shells, and remarks on several polypi found in Massachusetts Bay: Boston Jour. Natl. History, v. 2, no. 1, p. 53-111, 3 pls.

Dall, W. H., 1871, Descriptions of sixty new forms of Mollusks from the West Coast of North America, the North Pacific Ocean, with notes on others already described: Am. Jour. Conch., v. 7, pt. 2, p. 93-106, pls. 13-16.

__________, 1884, Contributions to the history of the Commander Islands, no. 3, Report on the Mollusca of the Commander Islands, Bering Sea, collected by Leonhard Stejneger in 1882 and 1883: U.S. Natl. Mus. Proc., v. 7, no. 442, p. 340-349, pl. 2.

__________, 1886, Contributions to the natural history of the Commander Islands, no. 6, Report on Bering Island Mollusca collected by Mr. Nicholas Grebnitzkii: U.S. Natl. Mus. Proc., v. 9, no. 571, p. 297-309, pls. 3-4.

__________, 1891, Scientific results of explorations by the U.S. Fish Commission steamer "Albatross"; On some new or interesting west American shells obtained from the dredgings of the U.S. Fish Commission steamer "Albatross" in 1888 and from other sources: U.S. Natl. Mus. Proc., v. 14, no. 849, p. 173-191, pls. 5-7.

__________, 1894, Synopsis of the Mactridae of northwest America, south to Panama: Nautilus, v. 8, no. 4, p. 39-43.

__________, 1897, Notice of some new and interesting species of shells from British Columbia and the adjacent region: Natl. Hist. Soc. British Columbia, Bull. 2, art. 1, 18 p., 2 pls.

__________, 1898, Contributions to the Tertiary fauna of Florida: Wagner Free Inst. Sci. Philadelphia Trans., v. 3, pt. 4, p. 571-947, pls. 23-25.

__________, 1900, Synopsis of the family Tellinidae and of the North American species: U.S. Natl. Mus. Proc., v. 23, no. 1210, p. 285-326, pls. 2-4.

__________, 1901, Synopsis of the Lucinacea and of the American species: U.S. Natl. Mus., Proc., v. 23, no. 1237, p. 779-833, pls. 39-42.

__________, 1902, Illustrations and descriptions of new, unfigured or imperfectly known shells, chiefly American, in the U.S. National Museum: U.S. Natl. Mus. Proc., v. 24, no. 1264, p. 499-566, pls. 27-40.

__________, 1903, Synopsis of the family Astartidae, with a review of the American species: U.S. Natl. Mus. Proc., v. 26, no. 1342, p. 933-951, pls. 62-63.

__________, 1916, Diagnoses of new species of marine bivalves from the northwest coast of America in the U.S. National Museum: U.S. Natl. Mus. Proc., v. 52, no. 2183, p. 393-417.

__________, 1919, Descriptions of new species of mollusks of the family Turritidae from the west coast of America and adjacent regions: U.S. Natl. Mus. Proc., v. 56, no. 2288, p. 1-86, pls. 1-24.

__________, 1919, Descriptions of new species of Mollusca from the north Pacific Ocean in the collection of the United States National Museum: U.S. Natl. Mus. Proc., v. 56, no. 2295, p. 293-371.

__________, 1919, The Mollusca of the Arctic coast of America collected by the Canadian Arctic Expedition west from Bathurst Inlet with an appended report on a collection of Pleistocene fossil Mollusca: Canad. Arctic Exped. 1913-1918, Reports, v. 8, pt. A, p. 1A-29A, pls. 1-3.

__________, 1921, Summary of the marine shellbearing mollusks of the northwest coast of America, from San Diego, California, to the Polar Sea, mostly contained in the collection of the United States National Museum, with illustrations of hitherto unfigured species: U.S. Natl. Mus. Bull., v. 112, p. 1-217, pls. 1-22.

Dall, W. H., and Bartsch, P., 1909, A monograph of West American pyramidellid mollusks: U.S. Natl. Mus. Bull. 68, 258 p. 30 pls.

Deshayes, G. P., 1839, Nouvelles especes de mollusques, provenant des cotes de la Californie, du Mexique, du Kantschatka et de la Nouvelle-Zelande: Rev. Zool. par la Soc. Cuvierienne, v. 2, p. 356-361.

__________, 1855, Descriptions of new shells from the collection of Hugh Cuming, Esq.: Zool. Soc. London, Proc., pt. 22, p. 317-371.

Dillwyn, L. W., 1817, A descriptive catalogue of Recent shells, arranged according to synonymy: London, v. 1, 580 p.

Dunnill, R. V., and Ellis, D. V., 1969, Recent species of the genus Macoma (Pelecypoda) in British Columbia: Natl. Mus. Canada, Natural History Papers, no. 45, p. 1-34.

Durham, J. W., and MacNeil, F. S., 1967, Cenozoic migrations of marine invertebrates through the Bering Strait region, in Hopkins, D. M. (ed.), The Bering land bridge: Stanford, Stanford University Press, p. 326-349.

Eichwald, E. I. von, 1871, Geognostisch-palaeontologische Bemerkungen über die Halbinsel Mangischalk und die Aleutischen Inseln: not seen.

Fabricus, O., 1780, Fauna Groenlandica: Lipsiae, 452 p., 1 pl.

Gabb, W., 1866, Tertiary invertebrate fossils: California Geological Survey, Paleontology, v. 2, sect. 1, pt. 1, p. 1-38, pls. 1-13.

Gladfelter, W. H., ed., 1964, Oceanographic cruise, U.S.C.G.C. Northwind, Bering and Chukchi Seas, July - September 1962: U.S. Coast Guard Oceanographic Report, no. 1, 104 p.

Gmelin, J. F., 1788-1793, Caroli Linnaei systema naturae per regna tria naturae, Ed. 13, aucta, reformata, Yermes Testacea: Lipsiae, v. 1-3.

Gorbunov, G. P., 1952, Bivalve mollusks of the Chukotsk Sea and Bering Straits in far north-east S.S.S.R.: S.S.S.R. Acad. Sci., v. 2, pt. M. not seen.

Gould, A. A., 1841, A report on the invertebrata of Massachusetts: Cambridge, 373 p.

__________, 1859, Descriptions of new shells collected by the North Pacific exploring expedition: Boston, Soc. Nat. History Proc., v. 7, p. 43. not seen.

__________, 1861, Descriptions of new shells collected by the North Pacific exploring expedition: Boston, Soc. Natl. Hist. Proc., v. 8, p. 14-40.

Grant, U. S. IV, and Gale, H. R., 1931, Catalogue of the marine Pliocene and Pleistocene Mollusca of California and adjacent regions: San Diego Soc. Natl. History Mem., v. 1, 1036 p., 32 pls.

Grau, G., 1959, Pectinidae of the eastern Pacific (Allan Hancock Pacific Expeditions, v. 23): Los Angeles, Calif., University of Southern California, 308 p., 57 pls.

Gray, J. E., 1824, Shells, in A supplement to the appendix to Parry's first voyage: Natural History, no. 10, Zool., p. 240-246. not seen

__________, 1839, Molluscous animals and their shells, in Beechey, F. W., The zoology of Captain Beechey's voyage: p. 101-155, pls. 33-34.

__________, 1850, Description of a new species of Chrysodomus from the mouth of the Mackenzie River: Zool. Soc. London Proc., v. 18, p. 14-15.

Habe, T. and Ito, K., 1965, Shells of the world in colour, 1, the northern Pacific: Hoikusha, Osaka, 176 p., 56 pls.

Hancock, A., 1846, A list of shells dredged on the west coast of Davis Strait; with notes and descriptions of eight new species: Ann. Mag. Natl. Hist., v. 18, p. 323-338, 5 pls. not seen

Hazel, J. E., 1970, Binary coefficients and clustering in biostratigraphy: Geol. Soc. America Bull., v. 81, p. 3237-3252.

Hertlein, L. G., and Grant, U. S. IV, 1972, Geology and paleontology of the marine Pliocene of San Diego, California (Paleontology: Pelecypoda): San Diego Soc. Natl. History Mem., v. 2, pt. 2B, p. 143-409, pls. 27-57.

Hopkins, D. M., 1967, Quaternary marine transgressions in Alaska, in Hopkins, D. M. (ed.), The Bering land bridge: Stanford, Stanford University Press, p. 47-90.

Husby, D. M., 1969, Report of oceanographic cruise U.S.C.G.C. Northwind, northern Bering Sea - Bering Strait - Chuckchi Sea, July 1967: U.S. Coast Guard Oceanographic Report, no. 24, 75 p.

__________, 1971, Oceanographic investigations in the northern Bering Sea and Bering Strait, June - July 1968: U.S. Coast Guard Oceanographic Report, no. 40, 50 p.

Husby, D. M., and Hufford, G. L., 1971, Oceanographic investigation of the northern Bering Sea and Bering Strait, 8 - 21 June 1969: U.S. Coast Guard Oceanographic Report, no. 42, 55 p.

Inman, D. L., and Nordstrom, C. E., 1971, On the tectonic and morphologic classification of coasts: Jour. Geology, v. 79, no. 1, p. 1-21.

Jay, J. C., 1839, A catalogue of shells in the collections of John C. Jay, M.D., with descriptions: Ed. 3, 125 p., 10 pls.

__________, 1856, Report on the shells collected ... together with a list of Japan shells, in Perry, M. C., Narrative of the expedition of an American squadron to the China seas and Japan ... in ... 1852-1854, under the command of M. C. Perry, U.S.N.: v. 2, p. 291-297, pls. 1-5. not seen.

Keen, A. M., 1939, Molluscan species common western North America and Japan: Proceedings Sixth Pacific Science Congress, v. 3, p. 479-483.

__________, 1971, Sea shells of tropical west America, marine mollusks from Baja California to Peru: Stanford, Stanford University Press, 1064 p., illus.

Kennedy, G. L., 1972, West American Cenozoic Pholadidae (Mollusca: Bivalvia): Davis, University of California, Masters Thesis, 288 p.

Kira, T., 1965, Shells of the western Pacific in colour: Hoikusha, Osaka, 224 p., 72 pls.

Krause, A., 1885, Ein Beitrag zur Kenntniss der Mollusken-Fauna des Beringsmeeres: Arch. Naturg., v. 51, heft 1, p. 14-40, pl. 3.not seen.

Lamark, J. B. P. A. de Monet de, 1815-1822, Histoire naturelle des animaux sans vertebres ...: Ed. 1, v. 1-7.

La Rocque, A., 1953, Catalogue of the Recent Mollusca of Canada: Natl. Mus. Canada, Bull. 129, 406 p.

Leach, W. E., 1819, Descriptions des nouvelles especes d'animaux decouvertes par le vaisseau Isabelle dans un voyage au pole boreal ...: Jour. Phys., Chim., Hist. Nat., et Arts, v. 88, pt. 6, p. 462-467. not seen

Levinton, J. S., 1971, Control of Tellinacean (Mollusca: Bivalvia) feeding behavior by predation: Limnology & Oceanography, v. 16, no. 4, p. 660-662.

Lie, U., and Kelley, J. C., 1970, Benthic infunal communities of the coast of Washington and in Puget Sound; identification and distribution of the communities: Jour. Fish. Res. Bd. Canada, v. 27, p. 621-651.

Linnaeus, C., 1758, Systema naturae per regna tria naturae: Stockholm, Ed. 10, v. 1, 824 p. not seen

__________, 1761, Fauna Svecica: Ed. 2, 578 p. not seen

__________, 1767, Systema naturae per regna tria naturae: Stockholm, Ed. 12, pt. 2, p. 533-1327. not seen

__________, 1771, Mantissa plantarum altera, generum editionis 6, et specierum editionis 2: Appendix, p. 544-552.

Loven, S., 1846, Index Molluscorum litora Scandinaviae occidentalia habitantium Holmiae: Ofv. Kongl. Vetensk. - Akad. Forhandl., v. 3, no. 5, p. 135-161.

Lowe, H. N., 1931, Note on West Coast _Zirfaea_: Nautilus, v. 45, no. 2, p. 52-53, pl. 3.

MacGinitie, N., 1959, Marine Mollusca of Point Barrow, Alaska: U.S. Natl. Mus. Proc., v. 109, no. 3412, p. 59-208, 27 pls.

MacNeil, F. S., 1957, Cenozoic megafossils of northern Alaska: U.S. Geol. Survey Prof. Paper 294-C, p. 99-126, pls. 11-17.

__________, 1965, Evolution and distribution of the genus _Mya_ with a discussion of Tertiary faunal migrations: U.S. Geol. Survey Prof. Paper 483-G, p. G1- G51, 11 pls.

__________, 1967, Cenozoic pectinids of Alaska, Iceland and other northern regions: U.S. Geol. Survey Prof. Paper 553, 57 p., 25 pls.

MacNeil, F. S., Mertie, J. B. Jr., and Pilsbry, H. A., 1943, Marine invertebrate faunas of the buried beaches near Nome, Alaska: Jour. Paleontology, v. 17, no. 1, p. 69-96, pls. 10-16.

MacPherson, E., 1971, Marine mollusks of Arctic Canada: Natl. Mus. Canada, Pub. in Biol. Oceanography, no. 3, 149 p., 7 pls.

Martyn, T., 1784, The universal conchologist: v. 2.

McManus, D. A., Kelley, J. C., and Creager, J. S., 1969, Continental shelf sedimentation in an Arctic environment: Geol. Soc. America Bull., v. 80, p. 1961-1984.

McManus, D. A., Venkatarathnam, K., Hopkins, D. M., and Nelson, C. H., 1972, Distribution of bottom sediments on the continental shelf, northern Bering Sea: manuscript, 36 p., 15 figs.

McRoy, C. P., 1969, Eelgrass under Arctic winter ice: Nature, v. 224, no. 5221, p. 818-819.

Meek, C. E., 1923, Notes on the stratigraphy and Pleistocene fauna from Peard Bay, Arctic Alaska: Univ. of California, Dept. Geology Bull., v. 14, no. 13, p. 409-422, pls. 75-79.

Mello, J. F., and Buzas, M. A., 1968, An application of cluster analysis as a method of determining biofacies: Jour. Paleontology, v. 42, no. 3, p. 747-758.

Middendorf, A. Th. von, 1849, Beitrage zu einer malacozoologia Rossica: St. Petersborg, Imp. Acad. Sci. Mem., ser. 6, v. 6, p. 329-610, 21 pls.

Mighels, J. W., 1841, in Mighels, J. W., and Adams, C. B., 1842, Descriptions of twenty-four species of the shells of New England: Boston, Jour. Nat. Hist., v. 4, pt. 1, p. 37-54.

Montagu, G., 1803, Testacea Britannica, or the natural history of British shells, marine, land and fresh-water, including the most minute, systematically arranged and embellished with figures: Romsey, 606 p., 16 pls.

Moller, H. P. C., 1842, Index Molluscorum Groenlandiae: Naturhist. Tidsskrift, v. 4, no. 1, p. 76-97 (also separately bound, 24 p.)

Morch, O. A. L., 1852-1853, Catalogus conchyliorum quae reliquit D. Alphonso D'Aguirra et Gadea Comes de Yoldi: Copenhagen, Fasc. 1, 170 p., Fasc. 2, 74 p.not seen.

__________, 1869, Catalogue des molluscorum du Spitzberg recueillis par le Dr. H. Kroyer pendant le voyage de la corvette la Recherche en Juin 1838: Mem. Soc. Malac. Belgique, v. 4, p. 9-32.

Morris, P. A., 1966, A field guide to the shells of the Pacific coast and Hawaii: Boston, Houghton Mifflin Co., 297 p., 72 pls.

Muller, O. F., 1776, Prodromus zoologiae Danicae: Havniae, p. 282.

__________, 1779, Beschaft Naturf. Freunde zu Berlin: v. 4, p. 55.
not seen

Nelson, C. H., and Hopkins, D. M., 1972, Sedimentary processes and distribution of particulate gold in the northern Bering Sea: U.S. Geol. Survey Prof. Paper 689, 27 p.

***
Oldroyd, I. S., 1924, Marine shells of the west coast of North America: Stanford University Pubs. Geol. Sci., v. 1, 247 p., 57 pls.

__________, 1927, Marine shells of the west coast of North America: Stanford University Pubs. Geol. Sci., v. 2, 3 pts., 941 p., 108 pls.

***
Peterson, C. G. J., 1911, Valuation of the sea, I, Animal life of the sea bottom, its food and quantity: Danish Biol. Sta. Reports, v. 20, 81 p., 6 pls.

__________, 1914, Valuation of the sea, II, The animal communities of the sea-bottom and their importance for marine zoogeography: Danish Biol. Sta. Reports, v. 21, p. 3-44, 6 pls.

__________, 1915a, Notes on Charts I and II: Danish Biol. Sta. Appendix to Report 21, v. 22, p. 3-7.

__________, 1915b, On the animal communities of the sea bottom in the Skagerak, the Christiania Fjord and Danish waters: Danish Biol. Sta. Reports, v. 23, p. 3-28.

__________, 1915c, A preliminary result of the investigations on the valuation of the sea: Danish Biol. Sta. Reports, v. 23, p. 29-32.

__________, 1918, The sea-bottom and its production of fish-food, a survey of the work done in connection with the valuation of Danish waters from 1883-1917: Danish Biol. Sta. Reports, v. 24, p. 1-62.

Petrov, O. M., 1966, Stratigraphy and fauna of the marine mollusks in the Quaternary deposits of the Chukotsk Peninsula: Akad. Nauk SSSR, Geol. Inst., Trudy Moscow, v. 155, 290 p., 23 pls.

Philippi, R. A., 1845, Bemerkungen über die Mollusken Fauna von Massachusetts: Zeitschr. Malakozool., Jahrgang 2, pp. 68-79. not seen

__________, 1849, Centuria tertia testaceorum novorum: Zeit. Malak., v. 5, p. 161-176.

__________, 1850, Abbildungen und beschreibungen never oder wenig gekannter conchylien: v. 3, p. 115-120.

Pilsbry, H. A., 1916, The sessile barnacles (Cirripedia) contained in the collections of the U.S. National Museum; including a monograph of the American species: U.S. Natl. Mus. Bull. 93, 366 p., 76 pls.

Reeve, L. A., 1847, Monograph of the genus Buccinum: Conch. Iconica, v. 3, 141 pls.

__________, 1855, Account of the shells collected by Captain Sir Edward Belcher, C.B. north of Beechey Island, in Belcher, E., Last of the Arctic voyages: v. 2, Appendix, p. 392-399.

Reid, R. G. B., and Reid, A., 1969, Feeding processes of members of the genus Macoma (Mollusca: Bivalvia): Canadian Jour. Zoology, v. 47, p. 649-657.

Richards, H. G., 1962, Studies on the marine Pleistocene: Am. Philos. Soc. Trans., v. 52, pt. 3, 141 p., 21 pls.

Ricketts, E. F., and Calvin, J., 1968, Between Pacific tides, revised by J. W. Hedgpeth: Stanford, Stanford University Press, 614 p.

Sars, G. O., 1878, Bidrag til Kundskaben om Norges Arktiske Fauna. I. Mollusca regionis arcticae Norvegiae: Christiana, 466 p., 34 pls.

Schumacher, C. F., 1817, Essai d'un noveau systeme des habitations des vers testaces: Copenhagen, 287 p., 22 pls.

Sokal, R. R. and Sneath, P. H. A., 1963, Principles of numerical taxonomy: San Francisco, Freeman, 359 p.

Soot-Ryen, T., 1955, Report on the family Mytilidae (Allan Hancock Pacific Expeditions, v. 2): Los Angeles, Calif., University of Southern California, 175 p., 10 pls.

Sowerby, J., 1817, The mineral conchology of Great Britain; or coloured figures and descriptions of those remains of testaceous animals or shells, which have been preserved at various times and depths in the earth: London, Sowerby, 251 p., pls. 103-203.

Sowerby, G. B., 1825, A catalogue of the shells contained in the collection of the late Earl of Tankerville, with an appendix describing new species: London, 92 p., Appendix 34 p., 9 pls.

Stanley, S. M., 1968, Post-Paleozoic adaptive radiation of infaunal bivalve mollusca--a consequence of mantle fusion and siphon formentation: Jour. Paleontology, v. 42, no. 1, p. 214-229.

__________, 1970, Relation of shell form to life habits of the Bivalvia (Mollusca): Geol. Soc. America, Mem. 125, 296 p., 40 pls.

Stimpson, W., 1860, Checklist of east coast shells: Smithsonian Misc. Coll., v. 2, art. 6, no. 3,

__________, 1865, Review of northern Buccinums: Can. Nat. n.s. v. 2, p. 364-387.

Strom, H., 1768, Beskrivelse over noiske insecter. Pt. 2, Buccinum: Kongl. Norske Vidensk. Selsk. Skrift., v. 4, p. 369-370, pl. 16.

Thorson, G., 1957, Bottom communities (sublittoral or shallow shelf): Geol. Soc. America, Mem. 67, v. 1, p. 461-534.

Tilesius, W. G., 1822, Additamenta conchyliologica and Zoographiam Rosso-Asiaticam: St. Petersbourg Acad. Sci. Mem. 8, p. 293-302.

Valenciennes, A., 1846, Mollesques, in du Petit-Thouars, A., Voyage autour du monde de la Fregate Venus: Paris, Atlas de Zoologie, 24 pls.

Valentine, J. W., 1968, Evolution of ecological units above the population level: Jour. Paleontology, v. 42, no. 2, p. 233-267.

Valentine, J. W., and Peddicord, R. G., 1967, Evaluation of fossil assemblages by cluster analysis: Jour. Paleontology, v. 41, no. 2, p. 502-507.

Wagner, F. J. E., 1970, Faunas of the Pleistocene Champlain Sea: Geol. Survey Canada Bull. 181, p. 1-104, 7 pls.

Walker, K. R., 1972, Trophic analysis: a method for studying the function of ancient communities: Jour. Paleontology, v. 46, no. 1, p. 82-93.

***

Ockelmann, W. K., 1954, On the interrelationship of northern species of Yoldia Moller, s. str. (Mollusca, Fam. Ledidae) with a new subspecies: Meddelelser om Gronland, v. 107, no. 7, 32 p., 2 pls.

Ockelmann, W. K., 1958, Marine Lamellibranchiata (part of) Zoology of East Greenland: Meddelelser om Gronland, v. 122, 256 p., 3 pls.

Perry, G., 1811, Conchology, or the natural history of shell ; containing a new arrangement of the species and genera : Conchology, folio, 61 pls.

APPENDIX A

LOCALITY DATA

M-6001 Alaska, Bering Sea, Recent, Van Veen Grab sample
U.S. Coast & Geodetic Ship "Oceanographer"
Collected by Robert W. Rowland, Summer 1968.

Latitude: 65°13.5'N | Longitude: 166°40.0'W
Depth: 11 m | Date: 7-25-68
Field No.: 68 ANC 50 | Sediment Type: Mud and shell

M-6002 as 6001
Latitude: 65°21.0'N | Longitude: 167°08.0'W
Depth: 19 m | Date: 7-26-68
Field No.: 68 ANC 55 | Sediment Type: Sandy gravel

M-6003 as 6001
Latitude: 65°22.0'N | Longitude: 167°12.0'W
Depth: 22 m | Date: 7-26-68
Field No.: 68 ANC 56 | Sediment Type: Gravel

M-6004 as 6001
Latitude: 65°32.1'N | Longitude: 168°02.1'W
Depth: 26.5 m | Date: 7-26-68
Field No.: 68 ANC 70 | Sediment Type: Gravel and mud

M-6005 as 6001
Latitude: 65°37.7'N | Longitude: 168°20.9'W
Depth: 51 m | Date: 7-27-68
Field No.: 68 ANC 73 | Sediment Type: Gravel

M-6006 as 6001
Latitude: 65°27.0'N | Longitude: 168°56.0'W
Depth: 56 m | Date: 7-27-68
Field No.: 68 ANC 76 | Sediment Type: Mixed

M-6007 as 6001
Latitude: 65°19.5'N | Longitude: 169°32.0'W
Depth: 41.5 m | Date: 7-27-68
Field No.: 68 ANC 77 | Sediment Type: Gravel sand

M-6008 as 6001
Latitude: 65°04.3'N | Longitude: 169°34.39'W
Depth: 51 m | Date: 7-27-68
Field No.: 68 ANC 78 | Sediment Type: Silty sand

M-6009 as 6001
Latitude: 64°51.0'N | Longitude: 169°50'W
Depth: 49.5 m | Date: 7-27-68
Field No.: 68 ANC 79 | Sediment Type: Silty sand

M-6010 as 6001
Latitude: 64°47.2'N Longitude: 169°42.5'W
Depth: 49.5 m Date: 7-27-68
Field No.: 68 ANC 80 Sediment Type: Silty sand

M-6011 as 6001
Latitude: 64°40.0'N Longitude: 169°33.4'W
Depth: 47 m Date: 7-27-68
Field No.: 68 ANC 81 Sediment Type: Silty sand

M-6012 as 6001
Latitude: 64°32.9'N Longitude: 170°06.4'W
Depth: 47 m Date: 7-27-68
Field No.: 68 ANC 82 Sediment Type: Mud

M-6013 as 6001
Latitude: 64°27.0'N Longitude: 170°21.0'W
Depth: 46 m Date: 7-27-68
Field No.: 68 ANC 83 Sediment Type: Gravel

M-6014 as 6001
Latitude: 64°23.5'N Longitude: 170°12.0'W
Depth: 43 m Date: 7-27-68
Field No.: 68 ANC 84 Sediment Type: Mixed

M-6015 as 6001
Latitude: 64°20.14'N Longitude: 170°01.78'W
Depth: 42 m Date: 7-27-68
Field No.: 68 ANC 85 Sediment Type: Silty sand

M-6016 as 6001
Latitude: 64°16.0'N Longitude: 170°18.5'W
Depth: 38.5 m Date: 7-27-68
Field No.: 68 ANC 86 Sediment Type: Gravel

M-6017 as 6001
Latitude: 64°01.4'N Longitude: 170°27.0'W
Depth: 38.5 m Date: 7-27-68
Field No.: 68 ANC 87 Sediment Type: Muddy gravel

M-6018 as 6001
Latitude: 64°03.9'N Longitude: 170°30.8'W
Depth: 39 m Date: 7-27-68
Field No.: 68 ANC 88 Sediment Type: Mixed

M-6019 as 6001
Latitude: 64°08.0'N
Longitude: 170°36.0'W
Depth: 39 m
Date: 7-27-68
Field No.: 68 ANC 89
Sediment Type: Pebbles and fine sand

M-6020 as 6001
Latitude: 64°02.8'N
Longitude: 171°02.8'W
Depth: 25.5 m
Date: 7-27-68
Field No.: 68 ANC 90
Sediment Type: Very clean sand

M-6021 as 6001
Latitude: 64°02.3'N
Longitude: 172°00.0'W
Depth: 51.5 m
Date: 7-28-68
Field No.: 68 ANC 93
Sediment Type: Gravel

M-6022 as 6001
Latitude: 63°54.0'N
Longitude: 171°42.0'W
Depth: 37 m
Date: 7-28-68
Field No.: 68 ANC 94
Sediment Type: Gravel

M-6023 as 6001
Latitude: 63°49.0'N
Longitude: 171°40.0'W
Depth: 37 m
Date: 7-28-68
Field No.: 68 ANC 95
Sediment Type:

M-6024 as 6001
Latitude: 63°47.3'N
Longitude: 171°38.0'W
Depth: 24.5 m
Date: 7-28-68
Field No.: 68 ANC 96
Sediment Type: Sand and gravel

M-6025 as 6001
Latitude: 63°41.5'N
Longitude: 171°34.0'W
Depth: 18.5 m
Date: 7-28-68
Field No.: 68 ANC 99
Sediment Type: Gravel

M-6026 as 6001
Latitude: 63°40.2'N
Longitude: 171°27.7'W
Depth: 19.5 m
Date: 7-28-68
Field No.: 68 ANC 101
Sediment Type: Sand and gravel

M-6027 as 6001
Latitude: 63°39.2'N
Longitude: 171°24.4'W
Depth: 16 m
Date: 7-28-68
Field No.: 68 ANC 102
Sediment Type: Sand and silt

M-6028 as 6001
Latitude: 63°37.8'N   Longitude: 171°15.2'W
Depth: 16 m   Date: 7-28-68
Field No.: 68 ANC 104   Sediment Type: Silty sand

M-6029 as 6001
Latitude: 63°37.0'N   Longitude: 171°10.8'W
Depth: 15 m   Date: 7-28-68
Field No.: 68 ANC 105   Sediment Type: Sand

M-6030 as 6001
Latitude: 63°36.1'N   Longitude: 171°06.8'W
Depth: 12 m   Date: 7-28-68
Field No.: 68 ANC 106   Sediment Type: Clean sand

M-6031 as 6001
Latitude: 63°37.2'N   Longitude: 170°50.0'W
Depth: 23.5 m   Date: 7-28-68
Field No.: 68 ANC 109   Sediment Type:

M-6032 as 6001
Latitude: 63°42.8'N   Longitude: 170°33.0'W
Depth: 28.5 m   Date: 7-28-68
Field No.: 68 ANC 113   Sediment Type: Rock

M-6033 as 6001
Latitude: 63°43.0'N   Longitude: 170°29.6'W
Depth: 26 m   Date: 7-28-68
Field No.: 68 ANC 114   Sediment Type: Cobbles with sand and shells

M-6034 as 6001
Latitude: 63°44.0'N   Longitude: 170°25.2'W
Depth: 43.5 m   Date: 7-28-68
Field No.: 68 ANC 115   Sediment Type:

M-6035 as 6001
Latitude: 63°43.0'N   Longitude: 170°19.0'W
Depth: 31 m   Date: 7-28-68
Field No.: 68 ANC 116   Sediment Type: Sand

M-6036 as 6001
Latitude: 63°42.0'N   Longitude: 170°15.0'W
Depth: 53 m   Date: 7-28-68
Field No.: 68 ANC 117   Sediment Type: Sand and shells

M-6037 as 6001
Latitude: 63°41.0'N | Longitude: 170°11.0'W
Depth: 43 m | Date: 7-28-68
Field No.: 68 ANC 118 | Sediment Type: Silt and sand

M-6038 as 6001
Latitude: 63°41.3'N | Longitude: 170°03.5'W
Depth: 37.5 m | Date: 7-28-68
Field No.: 68 ANC 119 | Sediment Type: All shells

M-6039 as 6001
Latitude: 63°39.8'N | Longitude: 170°01.5'W
Depth: 43.5 m | Date: 7-28-68
Field No.: 68 ANC 120 | Sediment Type: Silty sand

M-6040 as 6001
Latitude: 63°39.6'N | Longitude: 169°58.0'W
Depth: 42.5 m | Date: 7-28-68
Field No.: 68 ANC 121 | Sediment Type: Silt and clay

M-6041 as 6001
Latitude: 63°35.4'N | Longitude: 169°58.4'W
Depth: 38 m | Date: 7-28-68
Field No.: 68 ANC 123 | Sediment Type: Mud

M-6042 as 6001
Latitude: 63°33.6'N | Longitude: 169°49.0'W
Depth: 39.5 m | Date: 7-28-68
Field No.: 68 ANC 125 | Sediment Type: Silt and clay

M-6043 as 6001
Latitude: 63°32.0'N | Longitude: 169°44.6'W
Depth: 37 m | Date: 7-28-68
Field No.: 68 ANC 126 | Sediment Type: Mud

M-6044 as 6001
Latitude: 63°31.8'N | Longitude: 169°40.0'W
Depth: 36 m | Date: 7-28-68
Field No.: 68 ANC 127 | Sediment Type: Gravel and rock

M-6045 as 6001
Latitude: 63°30.8'N | Longitude: 169°37.0'W
Depth: 33 m | Date: 7-29-68
Field No.: 68 ANC 128 | Sediment Type: Muddy sand and gravel

M-6046 as 6001
Latitude: 63°22.5'N Longitude: 169°13.0'W
Depth: 25 m Date: 7-29-68
Field No.: 68 ANC 136 Sediment Type: Rock

M-6047 as 6001
Latitude: 63°22.7'N Longitude: 169°08.7'W
Depth: 24.5 m Date: 7-29-68
Field No.: 68 ANC 137 Sediment Type:

M-6048 as 6001
Latitude: 63°23.0'N Longitude: 169°05.1'W
Depth: 26 m Date: 7-29-68
Field No.: 68 ANC 138 Sediment Type: Gravel

M-6049 as 6001
Latitude: 63°22.5'N Longitude: 169°51.4'W
Depth: 25 m Date: 7-29-68
Field No.: 68 ANC 141 Sediment Type: Gravel

M-6050 as 6001
Latitude: 63°20.4'N Longitude: 168°43.4'W
Depth: 25 m Date: 7-29-68
Field No.: 68 ANC 143 Sediment Type: Mud and gravel

M-6051 as 6001
Latitude: 63°19.5'N Longitude: 168°38.9'W
Depth: 31 m Date: 7-29-68
Field No.: 68 ANC 144 Sediment Type: Gravel with sand and mud

M-6052 as 6001
Latitude: 63°20.5'N Longitude: 168°40.0'W
Depth: 33 m Date: 7-29-68
Field No.: 68 ANC 145 Sediment Type: Sand

M-6053 as 6001
Latitude: 63°35.8'N Longitude: 168°26.5'W
Depth: 31 m Date: 7-29-68
Field No.: 68 ANC 148 Sediment Type: Silty sand

M-6054 as 6001
Latitude: 63°37.0'N Longitude: 169°10.0'W
Depth: 38 m Date: 7-29-68
Field No.: 68 ANC 150 Sediment Type: Silty sand

M-6055 as 6001
Latitude: 63°41.0'N Longitude: 169°28.0'W
Depth: 33 m Date: 7-29-68
Field No.: 68 ANC 151 Sediment Type: Silty sand

M-6056 as 6001
Latitude: 63°45.4'N Longitude: 169°35.2'W
Depth: 33 m Date: 7-29-68
Field No.: 68 ANC 152 Sediment Type:

M-6057 as 6001
Latitude: 63°49.0'N Longitude: 169°40.0'W
Depth: 45 m Date: 7-29-68
Field No.: 68 ANC 153 Sediment Type: Silt

M-6058 as 6001
Latitude: 63°50.0'N Longitude: 169°47.0'W
Depth: 31 m Date: 7-29-68
Field No.: 68 ANC 154 Sediment Type: Silty sand

M-6059 as 6001
Latitude: 63°52.8'N Longitude: 169°54.4'W
Depth: 31 m Date: 7-29-68
Field No.: 68 ANC 155 Sediment Type: Silty sand

M-6060 as 6001
Latitude: 64°02.0'N Longitude: 169°02.7'W
Depth: 36 m Date: 7-29-68
Field No.: 68 ANC 156 Sediment Type: Silty sand

M-6061 as 6001
Latitude: 64°12.5'N Longitude: 169°47.3'W
Depth: 38 m Date: 7-30-68
Field No.: 68 ANC 158 Sediment Type: Silty sand

M-6062 as 6001
Latitude: 64°33.9'N Longitude: 169°02.9'W
Depth: 43 m Date: 7-30-68
Field No.: 68 ANC 161 Sediment Type: Silty sand

M-6063 as 6001
Latitude: 64°41.5'N Longitude: 169°12.2'W
Depth: 44 m Date: 7-30-68
Field No.: 68 ANC 162 Sediment Type: Silt

M-6064 as 6001
Latitude: 64°43.8'N Longitude: 168°59.5'W
Depth: 47 m Date: 7-30-68
Field No.: 68 ANC 163 Sediment Type: Silt and shell

M-6065 as 6001
Latitude: 64°49.0'N Longitude: 168°28.5'W
Depth: 44 m Date: 7-30-68
Field No.: 68 ANC 164 Sediment Type: Silt and gravel

M-6066 as 6001
Latitude: 64°54.6'N Longitude: 168°03.5'W
Depth: 38 m Date: 7-30-68
Field No.: 68 ANC 165 Sediment Type: Silt and shell

M-6067 as 6001
Latitude: 64°57.0'N Longitude: 167°49.0'W
Depth: 41 m Date: 7-30-68
Field No.: 68 ANC 166 Sediment Type:

M-6068 as 6001
Latitude: 65°04.0'N Longitude: 168°00.0'W
Depth: 46 m Date: 7-30-68
Field No.: 68 ANC 167 Sediment Type: Silty sand; pebbles

M-6069 as 6001
Latitude: 65°10.0'N Longitude: 168°13.0'W
Depth: 47 m Date: 7-30-68
Field No.: 68 ANC 168 Sediment Type: Silty sand

M-6070 as 6001
Latitude: 65°23.0'N Longitude: 168°39.0'W
Depth: 57 m Date: 7-30-68
Field No.: 68 ANC 170 Sediment Type: Silty sand

M-6071 as 6001
Latitude: 65°27.5'N Longitude: 168°26.0'W
Depth: 58 m Date: 7-30-68
Field No.: 68 ANC 171 Sediment Type: Sand and gravel

M-6072 as 6001
Latitude: 65°16.2'N Longitude: 166°57.2'W
Depth: 21 m Date: 7-30-68
Field No.: 68 ANC 180 Sediment Type: Clean sand with pebbles

M-6073 as 6001
Latitude: 65°09.5'N Longitude: 167°20.0'W
Depth: 19 m Date: 7-30-68
Field No.: 68 ANC 183 Sediment Type: Sandy gravel cobbles

M-6074 as 6001
Latitude: 64°45.0'N Longitude: 166°50.5'W
Depth: 21 m Date: 7-30-68
Field No.: 68 ANC 196 Sediment Type: Well-sorted sand

M-6075 as 6001
Latitude: 64°29.5'N Longitude: 166°18.0'W
Depth: 21 m Date: 7-31-68
Field No.: 68 ANC 207 Sediment Type: Sand and gravel

M-6076 as 6001
Latitude: 64°27.7'N Longitude: 166°14.6'W
Depth: 22 m Date: 7-31-68
Field No.: 68 ANC 208 Sediment Type: Gravel

M-6077 as 6001
Latitude: 64°40.3'N Longitude: 167°31.2'W
Depth: 30 m Date: 7-31-68
Field No.: 68 ANC 213 Sediment Type: Sand and shell

M-6078 as 6001
Latitude: 64°34.6'N Longitude: 167°44.0'W
Depth: 34 m Date: 7-31-68
Field No.: 68 ANC 214 Sediment Type:

M-6079 as 6001
Latitude: 64°26.0'N Longitude: 168°04.6'W
Depth: 36 m Date: 7-31-68
Field No.: 68 ANC 215 Sediment Type: Sand and pebbles

M-6080 as 6001
Latitude: 64°18.5'N Longitude: 168°20.8'W
Depth: 39 m Date: 7-31-68
Field No.: 68 ANC 216 Sediment Type: Sand with pebbles

M-6081 as 6001
Latitude: 63°47.9'N Longitude: 168°21.8'W
Depth: 34 m Date: 7-31-68
Field No.: 68 ANC 219 Sediment Type: Silty sand

M-6082 as 6001
Latitude: 64°17.3'N Longitude: 167°39.5'W
Depth: 32 m Date: 8-1-68
Field No.: 68 ANC 223 Sediment Type: Well-sorted sand

M-6083 as 6001
Latitude: 64°18.3'N Longitude: 167°22.0'W
Depth: 30 m Date: 8-1-68
Field No.: 68 ANC 224 Sediment Type: Sand with pebbles

M-6084 as 6001
Latitude: 64°22.7'N Longitude: 166°37.4'W
Depth: 28 m Date: 8-1-68
Field No.: 68 ANC 227 Sediment Type: Silty sand with pebbles

M-6085 as 6001
Latitude: 64°23.8'N Longitude: 166°25.8'W
Depth: 30 m Date: 8-1-68
Field No.: 68 ANC 228 Sediment Type: Silty sand and gravel

M-6086 as 6001
Latitude: 64°18.4'N Longitude: 166°21.6'W
Depth: 27 m Date: 8-1-68
Field No.: 68 ANC 229 Sediment Type: Silty, sand and clay

M-6087 as 6001
Latitude: 64°13.9'N Longitude: 166°14.9'W
Depth: 25 m Date: 8-1-68
Field No.: 68 ANC 230 Sediment Type: Silty, muddy sand

M-6088 as 6001
Latitude: 64°20.8'N Longitude: 166°08.4'W
Depth: 41 m Date: 8-1-68
Field No.: 68 ANC 231 Sediment Type: Dark olive gray to dark gray compact mud

M-6089 as 6001
Latitude: 61°15.4'N Longitude: 165°54.6'W
Depth: 26 m Date: 8-1-68
Field No.: 68 ANC 238 Sediment Type: Mud with pebbles

M-6090 as 6001
Latitude: 64°11.0'N Longitude: 165°45.0'W
Depth: 21 m Date: 8-1-68
Field No.: 68 ANC 239 Sediment Type: Silt and pebbles

M-6091 as 6001
Latitude: 64°18.2'N Longitude: 165°40.2'W
Depth: 21 m Date: 8-1-68
Field No.: 68 ANC 240 Sediment Type: Silt

M-6092 as 6001
Latitude: 64°24.0'N Longitude: 165°35.0'W
Depth: 31 m Date: 8-1-68
Field No.: 68 ANC 241 Sediment Type: Clay with pebbles

M-6093 as 6001
Latitude: 64°27.0'N Longitude: 165°35.9'W
Depth: 23 m Date: 8-1-68
Field No.: 68 ANC 242 Sediment Type: Silty gravel

M-6094 as 6001
Latitude: 64°27.4'N Longitude: 165°24.7'W
Depth: 21 m Date: 8-1-68
Field No.: 68 ANC 244 Sediment Type: Mixed gravel, sand and mud

M-6095 as 6001
Latitude: 64°19.6'N Longitude: 165°29.3'W
Depth: 23 m Date: 8-1-68
Field No.: 68 ANC 246 Sediment Type: Mud

M-6096 as 6001
Latitude: 64°10.2'N Longitude: 165°24.0'W
Depth: 20 m Date: 8-2-68
Field No.: 68 ANC 248 Sediment Type: Sandy mud

M-6097 Alaska, Bering Sea, Recent, Van Veen Grab Sample
"Tomcod" cruise
Collector: Robert W. Rowland, Summer 1968

Latitude: 64°12'17"N Longitude: 164°44'43"W
Depth: 18 m Date: 8-11-68
Field No.: 68 AWF 302 Sediment Type:

M-6098 as 6097
Latitude: 64°26'17"N Longitude: 164°44'43"W
Depth: 15 m Date: 8-11-68
Field No.: 68 AWF 305 Sediment Type: Cobbles with sand

M-6099 as 6097
Latitude: 64°27'15"N Longitude: 164°40'56"W
Depth: 18 m Date: 8-11-68
Field No.: 68 AWF 307 Sediment Type: Pebbles and sandy mud

M-6100 as 6097
Latitude: 64°30'40"N Longitude: 164°27'03"W
Depth: 12 m Date: 8-12-68
Field No.: 68 AWF 316 Sediment Type: Black mud with few pebbles at surface

M-6101 as 6097
Latitude: 64°31'00"N Longitude: 164°30'W
Depth: 13 m Date: 8-12-68
Field No.: 68 AWF 317 Sediment Type: Sand

M-6102 as 6097
Latitude: 64°32'50"N Longitude: 164°21'34"W
Depth: 10 m Date: 8-12-68
Field No.: 68 AWF 321 Sediment Type: Gravel with sand

M-6103 as 6097
Latitude: 64°33'17"N Longitude: 164°16'05"W
Depth: 10 m Date: 8-12-68
Field No.: 68 AWF 324 Sediment Type: Silty mud

M-6104 as 6097
Latitude: 64°32'20"W Longitude: 164°13'50"W
Depth: 17 m Date: 8-12-68
Field No.: 68 AWF 326 Sediment Type: Silty mud

M-6105 as 6097
Latitude: 64°33'15"N Longitude: 164°13'45"W
Depth: 14 m Date: 8-12-68
Field No.: 68 AWF 325 Sediment Type: Silty mud

M-6106 as 6097
Latitude: 64°31'50"N Longitude: 164°20'33"W
Depth: 16 m Date: 8-12-68
Field No.: 68 AWF 329 Sediment Type: Black silty mud

M-6107 as 6097
Latitude: 64°32'10"N Longitude: 164°18'50"W
Depth: 17 m Date: 8-12-68
Field No.: 68 AWF 330 Sediment Type: Clayey mud; pebbles

M-6108 as 6097
Latitude: 64°32'15"N Longitude: 164°17'35"W
Depth: 17 m Date: 8-12-68
Field No.: 68 AWF 331 Sediment Type: Clayey mud

M-6109 as 6097
Latitude: 64°32'18"N | Longitude: 164°16'08"W
Depth: 17 m | Date: 8-12-68
Field No.: 68 AWF 332 | Sediment Type: Mud

M-6110 as 6097
Latitude: 64°33'15"N | Longitude: 164°11'30"W
Depth: 13.7 m | Date: 8-12-68
Field No.: 68 AWF 333 | Sediment Type: Sandy mud

M-6111 as 6097
Latitude: 64°33'08"N | Longitude: 164°09'02"W
Depth: 14 m | Date: 8-12-68
Field No.: 68 AWF 334 | Sediment Type: Mud

M-6112 as 6097
Latitude: 64°33'N | Longitude: 164°06'50"W
Depth: 13.7 m | Date: 8-12-68
Field No.: 68 AWF 335 | Sediment Type: Sandy mud

M-6113 as 6097
Latitude: 64°33'N | Longitude: 164°04'31"W
Depth: 14 m | Date: 8-12-68
Field No.: 68 AWF 336 | Sediment Type: Sandy mud

M-6114 as 6097
Latitude: 64°32'50"N | Longitude: 164°02'18"W
Depth: 13 m | Date: 8-12-68
Field No.: 68 AWF 337 | Sediment Type: Sandy mud with gravel

M-6115 as 6097
Latitude: 64°32'41"N | Longitude: 163°59'50"W
Depth: 14 m | Date: 8-12-68
Field No.: 68 AWF 338 | Sediment Type: Sand with silt and mud

M-6116 as 6097
Latitude: 64°32'30"N | Longitude: 163°58'W
Depth: 13.7 m | Date: 8-12-68
Field No.: 68 AWF 339 | Sediment Type: Sand with mud

M-6117 as 6097
Latitude: 64°32'30"N | Longitude: 163°55'W
Depth: 13 m | Date: 8-12-68
Field No.: 68 AWF 340 | Sediment Type: Sand with mud

M-6118 as 6097
Latitude: 64°32'30"N   Longitude: 163°55'W
Depth: 14 m   Date: 8-12-68
Field No.: 68 AWF 340   Sediment Type: Sand with mud

M-6119 as 6097
Latitude: 64°33'30"N   Longitude: 163°56'W
Depth: 4 m   Date: 8-12-68
Field No.: 68 AWF 343   Sediment Type: Clean sand

M-6120 as 6097
Latitude: 64°34'N   Longitude: 163°51'W
Depth: 6 m   Date: 8-13-68
Field No.: 68 AWF 344   Sediment Type: Medium sand

M-6121 as 6097
Latitude: 64°34'N   Longitude: 163°46'W
Depth: 5 m   Date: 8-13-68
Field No.: 68 AWF 346   Sediment Type: Medium sand

M-6122 as 6097
Latitude: 64°33'30"N   Longitude: 163°51'W
Depth: 10 m   Date: 8-13-68
Field No.: 68 AWF 349   Sediment Type: Rocky bottom

M-6123 as 6097
Latitude: 64°32'30"N   Longitude: 163°51'W
Depth: 14 m   Date: 8-13-68
Field No.: 68 AWF 350   Sediment Type: Mud

M-6124 as 6097
Latitude: 64°32'30"N   Longitude: 163°49'W
Depth: 14 m   Date: 8-13-68
Field No.: 68 AWF 351   Sediment Type: Mud

M-6125 as 6097
Latitude: 64°32'30"N   Longitude: 163°47'W
Depth: 14 m   Date: 8-13-68
Field No.: 68 AWF 352   Sediment Type: Mud

M-6126 as 6097
Latitude: 64°32'30"N   Longitude: 163°44'W
Depth: 15 m   Date: 8-13-68
Field No.: 68 AWF 353   Sediment Type: Sandy, silty mud

M-6127 as 6097
Latitude: 64°33'30"N — Longitude: 163°44'W
Depth: 7 m — Date: 8-13-68
Field No.: 68 AWF 354 — Sediment Type:

M-6128 as 6097
Latitude: 64°33'30"N — Longitude: 163°41'W
Depth: 6 m — Date: 8-13-68
Field No.: 68 AWF 355 — Sediment Type: Sand

M-6129 as 6097
Latitude: 64°32'30"N — Longitude: 163°41'W
Depth: 14 m — Date: 8-13-68
Field No.: 68 AWF 356 — Sediment Type: Mud

M-6130 as 6097
Latitude: 64°31'30"N — Longitude: 163°41'W
Depth: 15 m — Date:8-13-68
Field No.: 68 AWF 357 — Sediment Type: Sandy silt

M-6131 as 6097
Latitude: 64°31'30"N — Longitude: 163°44'W
Depth: — Date: 8-13-68
Field No.: 68 AWF 358 — Sediment Type: Silty mud

M-6132 as 6097
Latitude: 64°31'30"N — Longitude: 163°47'W
Depth: 15 m — Date: 8-13-68
Field No.: 68 AWF 359 — Sediment Type: Silty mud

M-6133 as 6097
Latitude: 64°31'30"N — Longitude: 163°49'W
Depth: 14 m — Date: 8-13-68
Field No.: 68 AWF 360 — Sediment Type: Silty mud

M-6134 as 6097
Latitude: 64°31'30"N — Longitude: 163°51'W
Depth: 14 m — Date: 8-13-68
Field No.: 68 AWF 361 — Sediment Type: Silty mud

M-6135 as 6097
Latitude: 64°31'30"N — Longitude: 163°53'W
Depth: 15 m — Date: 8-13-68
Field No.: 68 AWF 362 — Sediment Type: Silty mud

M-6136 as 6097
Latitude: 64°31'30"N Longitude: 163°56'W
Depth: 16 m Date: 8-13-68
Field No.: 68 AWF 363 Sediment Type: Silty mud

M-6137 as 6097
Latitude: 64°31'30"N Longitude: 163°58'W
Depth: 17 m Date: 8-13-68
Field No.: 68 AWF 364 Sediment Type: Silty mud

M-6138 as 6097
Latitude: 64°31'48"N Longitude: 163°59'45"W
Depth: 17 m Date: 8-13-68
Field No.: 68 AWF 365 Sediment Type: Silty mud with cobbles

M-6139 as 6097
Latitude: 64°31'55"N Longitude: 164°02'25"W
Depth: 17 m Date: 8-13-68
Field No.: 68 AWF 366 Sediment Type: Silty mud with pebbles

M-6140 as 6097
Latitude: 64°32'02"N Longitude: 164°04'38"W
Depth: 17 m Date: 8-13-68
Field No.: 68 AWF 367 Sediment Type: Silty mud with pebbles

M-6141 as 6097
Latitude: 64°32'05"N Longitude: 164°06'55"W
Depth: 17 m Date: 8-13-68
Field No.: 68 AWF 368 Sediment Type: Silty mud with sand

M-6142 as 6097
Latitude: 64°32'15"N Longitude: 164°09'15"W
Depth: 17 m Date: 8-13-68
Field No.: 68 AWF 369 Sediment Type: Silty mud with cobble

M-6143 as 6097
Latitude: 64°32'20"N Longitude: 164°11'35"W
Depth: 17 m Date: 8-13-68
Field No.: 68 AWF 370 Sediment Type: Silty mud

M-6144 as 6097
Latitude: 64°31'15"N Longitude: 164°14'00"W
Depth: 20 m Date: 8-13-68
Field No.: 68 AWF 371 Sediment Type: Silty mud

M-6145 as 6097
Latitude: 64°31'17"N | Longitude: 164°16'12"W
Depth: 19 m | Date: 8-13-68
Field No.: 68 AWF 372 | Sediment Type: Silty mud

M-6146 as 6097
Latitude: 64°31'15"N | Longitude: 164°17'59"W
Depth: 19 m | Date: 8-13-68
Field No.: 68 AWF 373 | Sediment Type: Silty mud with sand and pebbles

M-6147 as 6001
Latitude: 65°33.1'N | Longitude: 168°02.1'W
Depth: 25 m | Date: 7-26-68
Field No.: 68 ANC 71 | Sediment Type: Silt and gravel

M-6148 as 6097
Latitude: 64°30'40"N | Longitude: 164°21'28"W
Depth: 18 m | Date: 8-13-68
Field No.: 68 AWF 375 | Sediment Type: Silty mud with sand and pebbles

M-6149 as 6097
Latitude: 64°31'02"N | Longitude: 164°24'35"W
Depth: 15 m | Date: 8-13-68
Field No.: 68 AWF 377 | Sediment Type: Gravel and mud

M-6150 as 6097
Latitude: 64°29'20"N | Longitude: 164°22'35"W
Depth: 20 m | Date: 8-14-68
Field No.: 68 AWF 378 | Sediment Type: Gravelly sandy mud

M-6151 as 6097
Latitude: 64°29'48"N | Longitude: 164°20'33"W
Depth: 20 m | Date: 8-14-68
Field No.: 68 AWF 379 | Sediment Type: Gravelly mud

M-6152 as 6097
Latitude: 64°30'15"N | Longitude: 164°18'30"W
Depth: 21 m | Date: 8-14-68
Field No.: 68 AWF 380 | Sediment Type: Sandy mud

M-6153 as 6097
Latitude: 64°30'17"N | Longitude: 164°16'09"W
Depth: 20 m | Date: 8-14-68
Field No.: 68 AWF 381 | Sediment Type: Mud with pebbles

M-6154 as 6097
Latitude: 64°30'13"N
Longitude: 164°14'05"W
Depth: 20 m
Date: 8-14-68
Field No.: 68 AWF 382
Sediment Type: Sandy silty mud

M-6155 as 6097
Latitude: 64°31'15"N
Longitude: 164°11'40"W
Depth: 20 m
Date: 8-14-68
Field No.: 68 AWF 383
Sediment Type: Silty mud

M-6156 as 6097
Latitude: 64°31'08"N
Longitude: 164°09'20"W
Depth: 20 m
Date: 8-14-68
Field No.: 68 AWF 384
Sediment Type: Mud

M-6157 as 6097
Latitude: 64°31'02"N
Longitude: 164°06'59"W
Depth: 19 m
Date: 8-14-68
Field No.: 68 AWF 385
Sediment Type: Mud

M-6158 as 6097
Latitude: 64°30'59"N
Longitude: 164°04'45"W
Depth: 18 m
Date: 8-14-68
Field No.: 68 AWF 386
Sediment Type: Black mud with shells

M-6159 as 6097
Latitude: 64°30'50"N
Longitude: 164°02'29"W
Depth: 18 m
Date: 8-14-68
Field No.: 68 AWF 387
Sediment Type: Silty mud

M-6160 as 6097
Latitude: 64°29.6'N
Longitude: 163°57.0'W
Depth: 17 m
Date: 8-14-68
Field No.: 68 AWF 389
Sediment Type: Mud

M-6161 as 6097
Latitude: 64°29.7'N
Longitude: 163°54.7'W
Depth: 17 m
Date: 8-14-68
Field No.: 68 AWF 390
Sediment Type: Silty mud

M-6162 as 6097
Latitude: 64°29.7'N
Longitude: 163°52.5'W
Depth: 16 m
Date: 8-14-68
Field No.: 68 AWF 391
Sediment Type: Silty mud

M-6163 as 6097
Latitude: 64°29.7'N | Longitude: 163°50.3'W
Depth: 16 m | Date: 8-14-68
Field No.: 68 AWF 392 | Sediment Type: Silty mud

M-6164 as 6097
Latitude: 64°29.7'N | Longitude: 163°16.0'W
Depth: 16 m | Date: 8-14-68
Field No.: 68 AWF 394 | Sediment Type: Silty mud

M-6165 as 6097
Latitude: 64°29.5'N | Longitude: 163°41.0'W
Depth: 16 m | Date: 8-14-68
Field No.: 68 AWF 396 | Sediment Type: Silty mud

M-6166 as 6097
Latitude: 64°28.6'N | Longitude: 163°41.0'W
Depth: 16 m | Date: 8-14-68
Field No.: 68 AWF 397 | Sediment Type: Silty mud

M-6167 as 6097
Latitude: 64°28.6'N | Longitude: 163°43.4'W
Depth: 16 m | Date: 8-14-68
Field No.: 68 AWF 398 | Sediment Type: Silty mud

M-6168 as 6097
Latitude: 64°28.7'N | Longitude: 163°16.0'W
Depth: 16 m | Date: 8-14-68
Field No.: 68 AWF 399 | Sediment Type: Silty mud

M-6169 as 6097
Latitude: 64°28.7'N | Longitude: 163°50.3'W
Depth: 15 m | Date: 8-14-68
Field No.: 68 AWF 401 | Sediment Type: Silty mud

M-6170 as 6097
Latitude: 64°28.6'N | Longitude: 163°52.5'W
Depth: 16 m | Date: 8-14-68
Field No.: 68 AWF 402 | Sediment Type:

M-6171 as 6097
Latitude: 64°28.6'N | Longitude: 163°54.7'W
Depth: 16 m | Date: 8-14-68
Field No.: 68 AWF 403 | Sediment Type: Silty mud

M-6172 as 6097
Latitude: 64°28.7'N Longitude: 163°57.0'W
Depth: 17 m Date: 8-14-68
Field No.: 68 AWF 404 Sediment Type: Mud

M-6173 as 6097
Latitude: 64°29'48"N Longitude: 164°59'55"W
Depth: 17 m Date: 8-14-68
Field No.: 68 AWF 405 Sediment Type: Mud

M-6174 as 6097
Latitude: 64°29'50"N Longitude: 164°02'25"W
Depth: 17 m Date: 8-14-68
Field No.: 68 AWF 406 Sediment Type: Silty mud

M-6175 as 6097
Latitude: 64°30'00"N Longitude: 164°07'15"W
Depth: 18 m Date: 8-14-68
Field No.: 68 AWF 408 Sediment Type: Silty mud

M-6176 as 6097
Latitude: 64°30'05"N Longitude: 164°09'30"W
Depth: 18 m Date: 8-14-68
Field No.: 68 AWF 409 Sediment Type: Silty mud with pebbles

M-6177 as 6097
Latitude: 64°30'10"N Longitude: 164°11'50"W
Depth: 19 m Date: 8-14-68
Field No.: 68 AWF 410 Sediment Type: Silty mud

M-6178 as 6097
Latitude: 64°19'20"N Longitude: 164°16'25"W
Depth: 21 m Date: 8-14-68
Field No.: 68 AWF 412 Sediment Type: Silty mud

M-6179 as 6097
Latitude: 64°29'25"N Longitude: 164°17'40"W
Depth: 21 m Date: 8-14-68
Field No.: 68 AWF 413 Sediment Type: Sandy mud and gravel

M-6180 as 6097
Latitude: 64°28'55"N Longitude: 164°19'32"W
Depth: 22 m Date: 8-14-68
Field No.: 68 AWF 414 Sediment Type: Silty mud

M-6181 as 6097
Latitude: 64°28'30"N — Longitude: 164°21'35"W
Depth: 23 m — Date: 8-14-68
Field No.: 68 AWF 415 — Sediment Type: Till-like

M-6182 as 6097
Latitude: 64°28'05"N — Longitude: 164°23'28"W
Depth: 21 m — Date: 8-14-68
Field No.: 68 AWF 416 — Sediment Type: Gravelly mud

M-6183 as 6097
Latitude: 64°29'42"N — Longitude: 164°25'43"W
Depth: 17 m — Date: 8-14-68
Field No.: 68 AWF 421 — Sediment Type: Gravelly, sandy mud

M-6184 as 6097
Latitude: 64°29'12"N — Longitude: 164°27'45"W
Depth: 17 m — Date: 8-15-68
Field No.: 68 AWF 422 — Sediment Type: Sand and mud

M-6185 as 6097
Latitude: 64°28'45"N — Longitude: 164°29'43"W
Depth: 18 m — Date: 8-15-68
Field No.: 68 AWF 423 — Sediment Type: Sand and mud

M-6186 as 6097
Latitude: 64°27'17"N — Longitude: 164°35'38"W
Depth: 23 m — Date: 8-15-68
Field No.: 68 AWF 425 — Sediment Type: Mud and pebbles

M-6187 as 6097
Latitude: 64°27'54"N — Longitude: 164°28'38"W
Depth: 22 m — Date: 8-15-68
Field No.: 68 AWF 426 — Sediment Type: Sandy mud and pebbles

M-6188 as 6097
Latitude: 64°28'24"N — Longitude: 164°26'40"W
Depth: 20 m — Date: 8-15-68
Field No.: 68 AWF 427 — Sediment Type: Sandy mud and pebbles

M-6189 as 6097
Latitude: 64°28'50"N — Longitude: 164°29'36"W
Depth: 20 m — Date: 8-15-68
Field No.: 68 AWF 428 — Sediment Type: Pebbly mud

M-6190 as 6097
Latitude: 64°27'37"N Longitude: 164°29'18"W
Depth: 19 m Date: 8-15-68
Field No.: 68 AWF 429 Sediment Type: Pebbly mud

M-6191 as 6097
Latitude: 64°28'26"N Longitude: 164°26'30"W
Depth: 21 m Date: 8-15-68
Field No.: 68 AWF 430 Sediment Type: Pebbly mud

M-6192 as 6097
Latitude: 64°27'29"N Longitude: 164°25'22"W
Depth: 23 m Date: 8-15-68
Field No.: 68 AWF 432 Sediment Type: Pebbly mud

M-6193 as 6097
Latitude: 64°27'05"N Longitude: 164°27'33"W
Depth: Date: 8-15-68
Field No.: 68 AWF 433 Sediment Type: Pebbly mud

M-6194 as 6097
Latitude: 64°26'35"N Longitude: 164°29'38"W
Depth: 24 m Date: 8-15-68
Field No.: 68 AWF 434 Sediment Type: Pebbly mud

M-6195 as 6097
Latitude: 64°25'10"N Longitude: 164°40'30"W
Depth: 26 m Date: 8-15-68
Field No.: 68 AWF 437 Sediment Type: Pebbly mud

M-6196 as 6097
Latitude: 64°23'40"N Longitude: 164°46'31"W
Depth: 25 m Date: 8-15-68
Field No.: 68 AWF 440 Sediment Type: Mud with sand and gravel

M-6197 as 6097
Latitude: 64°23'15"N Longitude: 164°49'28"W
Depth: 25 m Date: 8-15-68
Field No.: 68 AWF 442 Sediment Type: Gravel with mud

M-6198 as 6097
Latitude: 64°24'18"N Longitude: 164°49'44"W
Depth: 19 m Date: 8-15-68
Field No.: 68 AWF 443 Sediment Type: Gravel with mud

M-6199 as 6097
Latitude: 64°24'21"N | Longitude: 164°48'32"W
Depth: 21 m | Date: 8-15-68
Field No.: 68 AWF 444 | Sediment Type: Gravel with mud

M-6200 as 6097
Latitude: 64°24'29"N | Longitude: 164°47'40"W
Depth: 20 m | Date: 8-15-68
Field No.: 68 AWF 445 | Sediment Type: Gravel with mud

M-6201 as 6097
Latitude: 64°25'00"N | Longitude: 164°45'38"W
Depth: 17 m | Date: 8-15-68
Field No.: 68 AWF 446 | Sediment Type: Gravel and mud

M-6202 as 6097
Latitude: 64°25'58"N | Longitude: 164°41'36"W
Depth: 19 m | Date: 8-15-68
Field No.: 68 AWF 448 | Sediment Type: Gravelly mud

M-6203 as 6097
Latitude: 64°26'25"N | Longitude: 164°39'39"W
Depth: 22 m | Date: 8-15-68
Field No.: 68 AWF 449 | Sediment Type: Mud

M-6204 as 6097
Latitude: 64°26'55"N | Longitude: 164°37'43"W
Depth: 23 m | Date: 8-15-68
Field No.: 68 AWF 450 | Sediment Type: Gravel and mud

M-6205 as 6097
Latitude: 64°27'38"N | Longitude: 164°25'28"W
Depth: 23 m | Date: 8-15-68
Field No.: 68 AWF 451 | Sediment Type: Sandy mud

M-6206 as 6097
Latitude: 64°26'15"N | Longitude: 164°26'23"W
Depth: 24 m | Date: 8-16-68
Field No.: 68 AWF 454 | Sediment Type: Muddy sand

M-6207 as 6097
Latitude: 64°24'20"N | Longitude: 164°39'15"W
Depth: 28 m | Date: 8-16-68
Field No.: 68 AWF 458 | Sediment Type: Pebbly sand

M-6208 as 6097
Latitude: 64°23'47"N | Longitude: 164°41'28"W
Depth: 28 m | Date: 8-16-68
Field No.: 68 AWF 459 | Sediment Type: Pebbly sand

M-6209 as 6097
Latitude: 64°23'20"N | Longitude: 164°43'30"W
Depth: 32 m | Date: 8-16-68
Field No.: 68 AWF 460 | Sediment Type: Pebbly sand

M-6210 as 6097
Latitude: 64°22'48"N | Longitude: 164°45'25"W
Depth: 32 m | Date: 8-16-68
Field No.: 68 AWF 461 | Sediment Type: Pebbly sand

M-6211 as 6097
Latitude: 64°22'12"N | Longitude: 164°51'31"W
Depth: 32 m | Date: 8-16-68
Field No.: 68 AWF 464 | Sediment Type: Pebbly sand

M-6212 as 6097
Latitude: 64°21'57"N | Longitude: 164°56'05"W
Depth: 32 m | Date: 8-16-68
Field No.: 68 AWF 466 | Sediment Type: Pebbly sand

M-6213 as 6097
Latitude: 64°21'48"N | Longitude: 164°58'15"W
Depth: 31 m | Date: 8-16-68
Field No.: 68 AWF 467 | Sediment Type: Silty sand with pebbles

M-6214 as 6097
Latitude: 64°22'45"N | Longitude: 164°58'30"W
Depth: 28 m | Date: 8-16-68
Field No.: 68 AWF 468 | Sediment Type: Sandy mud

M-6215 as 6097
Latitude: 64°22'50"N | Longitude: 164°56'13"W
Depth: 29 m | Date: 8-16-68
Field No.: 68 AWF 469 | Sediment Type: Sandy mud with gravel

M-6216 as 6097
Latitude: 64°23'00"N | Longitude: 164°54'00"W
Depth: 29 m | Date: 8-16-68
Field No.: 68 AWF 470 | Sediment Type: Sandy mud with gravel

M-6217 as 6097
Latitude: 64°23'47"N Longitude: 164°56'32"W
Depth: 21 m Date: 8-16-68
Field No.: 68 AWF 474 Sediment Type: Sandy mud with gravel

M-6218 as 6097
Latitude: 64°24'45"N Longitude: 164°59'00"W
Depth: 18 m Date: 8-16-68
Field No.: 68 AWF 476 Sediment Type: Gravel

M-6219 as 6097
Latitude: 64°27'15"N Longitude: 164°45'56"W
Depth: 17 m Date: 8-16-68
Field No.: 68 AWF 478 Sediment Type: Sand

M-6220 as 6097
Latitude: 64°25'45"N Longitude: 164°59'15"W
Depth: 13 m Date: 8-16-68
Field No.: 68 AWF 484 Sediment Type: Muddy sand

M-6221 as 6097
Latitude: 64°29'N Longitude: 166°11'W
Depth: 14 m Date: 8-17-68
Field No.: 68 AWF 485 Sediment Type: Gravel with sand

M-6222 as 6097
Latitude: 64°30'30"N Longitude: 166°11'W
Depth: 12 m Date: 8-17-68
Field No.: 68 AWF 488 Sediment Type: Muddy sand and gravel

M-6223 as 6097
Latitude: 64°31'N Longitude: 166°13'W
Depth: 13 m Date: 8-17-68
Field No.: 68 AWF 489 Sediment Type: Muddy sand and gravel

M-6224 as 6097
Latitude: 64°32'N Longitude: 166°12'W
Depth: 14 m Date: 8-18-68
Field No.: 68 AWF 496 Sediment Type: Gravel with sand

M-6225 as 6097
Latitude: 64°32'N Longitude: 166°16'W
Depth: 14 m Date: 8-18-68
Field No.: 68 AWF 497 Sediment Type: Gravel

M-6226 as 6097
Latitude: 64°34'N | Longitude: 166°20'W
Depth: 13 m | Date: 8-18-68
Field No.: 68 AWF 502 | Sediment Type: Gravel with sand

M-6227 as 6097
Latitude: 64°33'30"N | Longitude: 166°18'30"W
Depth: 12 m | Date: 8-18-68
Field No.: 68 AWF 503 | Sediment Type: Cobbles with sand

M-6228 as 6097
Latitude: 64°33'N | Longitude: 166°17'W
Depth: 13 m | Date: 8-18-68
Field No.: 68 AWF 504 | Sediment Type: Gravel with sand

M-6229 as 6097
Latitude: 64°33'N | Longitude: 166°11'W
Depth: 12 m | Date: 8-18-68
Field No.: 68 AWF 506 | Sediment Type: Gravel with sand

M-6230 as 6097
Latitude: 64°36'N | Longitude: 166°22'W
Depth: 11 m | Date: 8-18-68
Field No.: 68 AWF 517 | Sediment Type: Pebbles with sand

M-6231 as 6097
Latitude: 64°35'N | Longitude: 166°16'W
Depth: 6 m | Date: 8-18-68
Field No.: 68 AWF 524 | Sediment Type: Pebbles

M-6232 as 6097
Latitude: ______ | Longitude: ______
Depth: Beach collection | Date: 9-1-69
Field No.: ______ | Sediment Type:
Onshore beach collection North Bay, Stuart Island

M-6233 Alaska, Bering Sea, Recent, Van Veen grab sample
U.S. Coast and Geodetic Survey Ship "Surveyor"
Collector: Robert W. Rowland, Summer 1969

Latitude: 63°39.2'N | **Longitude:** 162°29.1'W
Depth: 16 m | **Date:** 9-2-69
Field No. 69 ANC 100 | **Sediment Type:** Silt

M-6234 as 6233
Latitude: 64°09.7'N | **Longitude:** 164°07.6'W
Depth: 22 m | **Date:** 9-2-69
Field No.: 69 ANC 101 | **Sediment Type:** Silt with gravel

M-6235 as 6233
Latitude: 64°05.5'N | **Longitude:** 164°52.2'W
Depth: 18 m | **Date:** 9-3-69
Field No.: 69 ANC 102 | **Sediment Type:** Sandy mud

M-6236 as 6233
Latitude: 63°58.4'N | **Longitude:** 165°25.3'W
Depth: 19 m | **Date:** 9-3-69
Field No.: 69 ANC 103 | **Sediment Type:** Silt

M-6237 as 6233
Latitude: 64°06.2'N | **Longitude:** 166°01.0'W
Depth: 17 m | **Date:** 9-3-69
Field No.: 69 ANC 104 | **Sediment Type:** Silt

M-6238 as 6233
Latitude: 64°10.6'N | **Longitude:** 166°33.7'W
Depth: 28 m | **Date:** 9-3-69
Field No.: 69 ANC 105 | **Sediment Type:** Silty mud

M-6239 as 6233
Latitude: 63°50.8'N | **Longitude:** 166°35.9'W
Depth: 32 m | **Date:** 9-3-69
Field No.: 69 ANC 106 | **Sediment Type:** Sandy, silty mud

M-6240 as 6233
Latitude: 63°52'N | **Longitude:** 167°18.8'W
Depth: 33 m | **Date:** 9-3-69
Field No.: 69 ANC 107 | **Sediment Type:** Sandy silt

M-6241 as 6233
Latitude: 63°40.7'N | **Longitude:** 167°52.5'W
Depth: 31 m | **Date:** 9-3-69
Field No.: 69 ANC 108 | **Sediment Type:** Sandy silt

M-6242 as 6233
Latitude: 63°21.8'N | Longitude: 167°31.4'W
Depth: 33 m | Date: 9-3-69
Field No. 69 ANC 109 | Sediment Type: Sand

M-6243 as 6233
Latitude: 63°35.4'N | Longitude: 166°39.2'W
Depth: 23 m | Date: 9-4-69
Field No.: 69 ANC 110 | Sediment Type: Sandy silt

M-6244 as 6233
Latitude: 63°15.5'N | Longitude: 166°25'W
Depth: 24 m | Date: 9-4-69
Field No.: 69 ANC 111 | Sediment Type: Sandy silt

M-6245 as 6233
Latitude: 63°03.7'N | Longitude: 167°03.9'W
Depth: 11 m | Date: 9-4-69
Field No.: 69 ANC 112 | Sediment Type: Sand

M-6246 as 6233
Latitude: 62°48.7'N | Longitude: 166°31'W
Depth: 22 m | Date: 9-4-69
Field No.: 69 ANC 113 | Sediment Type: Sand

M-6247 as 6233
Latitude: 62°31.4'N | Longitude: 165°57.5'W
Depth: 8 m | Date: 9-4-69
Field No.: 69 ANC 114 | Sediment Type: Silt

M-6248 as 6233
Latitude: 62°57.5'N | Longitude: 165°50.1'W
Depth: | Date: 9-4-69
Field No.: 69 ANC 115 | Sediment Type: Silt and clay

M-6249 as 6233
Latitude: 63°24.8'N | Longitude: 165°31.5'W
Depth: | Date: 9-4-69
Field No.: 69 ANC 117 | Sediment Type: Silt with rock fragments

M-6250 as 6233
Latitude: 63°37'N | Longitude: 165°00'W
Depth: 15 m | Date: 9-5-69
Field No.: 69 ANC 119 | Sediment Type: Silt

M-6251 as 6233

Latitude: 63°39.5'N	Longitude: 164°37'W
Depth:	Date: 9-5-69
Field No.: 69 ANC 120	Sediment Type: Silt

M-6252 as 6233

Latitude: 63°55.5'N	Longitude: 163°59'W
Depth: 12 m	Date: 9-5-69
Field No.: 69 ANC 121	Sediment Type:

M-6253 as 6233

Latitude: 64°22.5'N	Longitude: 165°44.8'W
Depth:	Date: 9-5-69
Field No.: 69 ANC 122	Sediment Type: Gravel and heavy sand

M-6254 Alaska, Bering Sea, Recent, Van Veen Grab Sample
"T. Thompson" Cruise
Collector: Robert W. Rowland, Summer 1969

Latitude: 63°52.1'N	Longitude: 170°09.9'W
Depth: 43 m	Date: 9-16-69
Field No.: 69 ANC 201	Sediment Type: Sandy mud

M-6255 as 6254

Latitude: 63°47.3'N	Longitude: 170°16.0'W
Depth: 44 m	Date: 9-16-69
Field No.: 69 ANC 202	Sediment Type: Gravel and mud

M-6256 as 6254

Latitude: 63°46.6'N	Longitude: 170°0.15'W
Depth: 43 m	Date: 9-16-69
Field No.: 69 ANC 204	Sediment Type: Silt

M-6257 as 6254

Latitude: 63°41.0'N	Longitude: 170°00.0'W
Depth: 44 m	Date: 9-16-69
Field No.: 69 ANC 206	Sediment Type: Sand and mud

M-6258 as 6254

Latitude: 63°43.7'N	Longitude: 169°54.2'W
Depth: 42 m	Date: 9-16-69
Field No.: 69 ANC 207	Sediment Type: Sand and silt

M-6259 as 6254

Latitude: 63°42.6'N	Longitude: 169°36.6'W
Depth: 38 m	Date: 9-16-69
Field No.: 69 ANC 208	Sediment Type: Sand and mud

M-6260 as 6254
Latitude: 64°03'N Longitude: 169°26.0'W
Depth: 38 m Date: 9-16-69
Field No.: 69 ANC 210 Sediment Type: Sand and mud

M-6261 as 6254
Latitude: 63°52.0'N Longitude: 170°02.0'W
Depth: 31 m Date: 9-17-69
Field No.: 69 ANC 211 Sediment Type: Sand

M-6262 as 6254
Latitude: 63°51.2'N Longitude: 170°22.1'W
Depth: 34 m Date: 9-17-69
Field No.: 69 ANC 212 Sediment Type: Gravel and sand

M-6263 as 6254
Latitude: 63°53.6'N Longitude: 170°35.5'W
Depth: 30 m Date: 9-17-69
Field No.: 69 ANC 213 Sediment Type: Gravel and sand

M-6264 as 6254
Latitude: 64°00.7'N Longitude: 170°33.3'W
Depth: 29 m Date: 9-17-69
Field No.: 69 ANC 214 Sediment Type: Rock and gravel

M-6265 as 6254
Latitude: 63°54.0'N Longitude: 170°48.5'W
Depth: 32 m Date: 9-17-69
Field No.: 69 ANC 215 Sediment Type: Gravel and sand

M-6266 as 6254
Latitude: 63°53.0'N Longitude: 171°26.0'W
Depth: 26 m Date: 9-17-69
Field No.: 69 ANC 217 Sediment Type: Silt and sand

M-6267 as 6254
Latitude: 63°57.4'N Longitude: 171°57.0'W
Depth: 49 m Date: 9-17-69
Field No.: 69 ANC 219 Sediment Type: Gravel and sand

M-6268 as 6254
Latitude: 63°51.3'N Longitude: 171°59.4'W
Depth: 38 m Date: 9-17-69
Field No.: 69 ANC 220 Sediment Type: Gravel

M-6269 as 6254
Latitude: 63°52.3'N Longitude: 172°18.0'W
Depth: 54 m Date: 9-17-69
Field No.: 69 ANC 221 Sediment Type: Gravel

M-6270 as 6254
Latitude: 63°56.8'N Longitude: 172°31.0'W
Depth: 55 m Date: 9-17-69
Field No.: 69 ANC 222 Sediment Type: Gravel

M-6271 as 6254
Latitude: 64°00.9'N Longitude: 172°52.1'W
Depth: 56 m Date: 9-17-69
Field No.: 69 ANC 223 Sediment Type: Gravel

M-6272 as 6254
Latitude: 63°58.3'N Longitude: 172°12.8'W
Depth: 54 m Date: 9-17-69
Field No.: 69 ANC 224 Sediment Type: Gravel

M-6273 as 6254
Latitude: 64°05.4'N Longitude: 172°10.1'W
Depth: 47 m Date: 9-17-69
Field No.: 69 ANC 225 Sediment Type: Rock and sand

M-6274 as 6254
Latitude: 64°06.3'N Longitude: 171°57.1'W
Depth: 48 m Date: 9-17-69
Field No.: 69 ANC 226 Sediment Type: Gravel and sand

M-6275 as 6254
Latitude: 64°08.2'N Longitude: 171°47.3'W
Depth: 52 m Date: 9-17-69
Field No.: 69 ANC 227 Sediment Type: Gravel

M-6276 as 6254
Latitude: 64°09.0'N Longitude: 171°32.0'W
Depth: 45 m Date: 9-17-69
Field No.: 69 ANC 228 Sediment Type: Gravel and mud

M-6277 as 6254
Latitude: 64°08.6'N Longitude: 171°13.7'W
Depth: 36 m Date: 9-18-69
Field No.: 69 ANC 229 Sediment Type: Sand

M-6278 as 6254
Latitude: 64°13.0'N
Longitude: 170°52.7'W
Depth: 36 m
Date: 9-18-69
Field No.: 69 ANC 230
Sediment Type: Sand with gravel

M-6279 as 6254
Latitude: 64°08.5'N
Longitude: 170°18.0'W
Depth: 32 m
Date: 9-18-69
Field No.: 69 ANC 231
Sediment Type: Gravel

M-6280 as 6254
Latitude: 64°15.5'N
Longitude: 170°18.0'W
Depth: 38 m
Date: 9-18-69
Field No.: 69 ANC 232
Sediment Type: Mud and gravel

M-6281 as 6254
Latitude: 64°19.0'N
Longitude: 170°04.0'W
Depth: 41 m
Date: 9-18-69
Field No.: 69 ANC 233
Sediment Type: Silt and clay

M-6282 as 6254
Latitude: 64°22.0'N
Longitude: 170°13.0'W
Depth: 41 m
Date: 9-18-69
Field No.: 69 ANC 234
Sediment Type: Mud and gravel

M-6283 as 6254
Latitude: 64°53.4'N
Longitude: 169°21.7'W
Depth:
Date: 9-18-69
Field No.: 69 ANC 236
Sediment Type: Silt and sand

M-6284 as 6254
Latitude: 65°04.5'N
Longitude: 168°50.5'W
Depth: 50 m
Date: 9-18-69
Field No.: 69 ANC 238
Sediment Type: Sand and mud

M-6285 as 6254
Latitude: 64°57.0'N
Longitude: 168°41.0'W
Depth: 47 m
Date: 9-18-69
Field No.: 69 ANC 239
Sediment Type: Sand and mud

M-6286 as 6254
Latitude: 65°05.2'N
Longitude: 168°30.0'W
Depth: 47 m
Date: 9-18-69
Field No.: 69 ANC 240
Sediment Type: Sand and mud

M-6287 as 6254
Latitude: 65°23.5'N | Longitude: 167°55.6'W
Depth: 34 m | Date: 9-19-69
Field No.: 69 ANC 241 | Sediment Type: Gravel and silt

M-6288 as 6254
Latitude: 65°18.5'N | Longitude: 167°56.4'W
Depth: 37 m | Date: 9-19-69
Field No.: 69 ANC 242 | Sediment Type: Heavy sand

M-6289 as 6254
Latitude: 65°13.6'N | Longitude: 168°06.6'W
Depth: 47 m | Date: 9-19-69
Field No.: 69 ANC 243 | Sediment Type: Sand and mud with gravel

M-6290 as 6254
Latitude: 65°08.4'N | Longitude: 168°04.5'W
Depth: 49 m | Date: 9-19-69
Field No.: 69 ANC 244 | Sediment Type: Sand and mud with gravel

M-6291 as 6254
Latitude: 65°11.2'N | Longitude: 167°53.2'W
Depth: 31 m | Date: 9-19-69
Field No.: 69 ANC 245 | Sediment Type: Sand

M-6292 as 6254
Latitude: 65°12.4'N | Longitude: 167°45.1'W
Depth: 27 m | Date: 9-19-69
Field No.: 69 ANC 246 | Sediment Type: Silty sand

M-6293 as 6254
Latitude: 65°13.9'N | Longitude: 167°39.5'W
Depth: 36 m | Date: 9-19-69
Field No.: 69 ANC 247 | Sediment Type: Muddy sand with gravel

M-6294 as 6254
Latitude: 65°14.8'N | Longitude: 167°27.0'W
Depth: 18 m | Date: 9-19-69
Field No.: 69 ANC 248 | Sediment Type: Clean sand

M-6295 as 6254
Latitude: 65°15.0'N | Longitude: 167°9.5'W
Depth: 11 m | Date: 9-19-69
Field No.: 69 ANC 249 | Sediment Type: Sand

M-6296 as 6254

Latitude: 65°07.4'N
Longitude: 167°30.0'W
Depth: 17 m
Date: 9-19-69
Field No.: 69 ANC 250
Sediment Type: Sand

M-6297 as 6254

Latitude: 65°06.3'N
Longitude: 167°37.2'W
Depth: 21 m
Date: 9-19-69
Field No.: 69 ANC 251
Sediment Type: Sand

M-6298 as 6254

Latitude: 65°05.1'N
Longitude: 167°47.0'W
Depth: 36.5 m
Date: 9-19-69
Field No.: 69 ANC 252
Sediment Type: Gravel, sand and silt

M-6299 as 6254

Latitude: 65°05.4'N
Longitude: 167°47.0'W
Depth: 31 m
Date: 9-19-69
Field No.: 69 ANC 253
Sediment Type: Sand and mud

M-6300 as 6254

Latitude: 65°01.6'N
Longitude: 168°05.5'W
Depth: 34 m
Date: 9-19-69
Field No.: 69 ANC 254
Sediment Type: Sand and silt

M-6301 as 6254

Latitude: 64°57'N
Longitude: 160°15'W
Depth: 41 m
Date: 9-19-69
Field No.: 69 ANC 255
Sediment Type: Muddy sand

M-6302 as 6254

Latitude: 64°51.5'N
Longitude: 168°00.5'W
Depth: 42 m
Date: 9-19-69
Field No.: 69 ANC 256
Sediment Type: Sand and silt

M-6203 as 6254

Latitude: 64°37.5'N
Longitude: 167°54.2'W
Depth: 44 m
Date: 9-20-69
Field No.: 69 ANC 257
Sediment Type: Sand and mud

M-6304 Alaska, Bering Sea, Recent, Van Veen Grab Sample
U.S. Coast and Geodetic Survey Ship "Rainier"
Collector: Robert W. Rowland, Summer 1970

Latitude: 63°50.1'N — Longitude: 172°33.2'W
Depth: 53 m — Date: 8-18-70
Field No.: 70 ANC 1 — Sediment Type: Pebbly mud

M-6305 as 6304
Latitude: 63°38.0'N — Longitude: 173°01.0'W
Depth: 61.7 m — Date: 8-18-70
Field No.: 70 ANC 2 — Sediment Type: Sand and gravel

M-6306 as 6304
Latitude: 63°43.3'N — Longitude: 171°53.6'W
Depth: 27 m — Date: 8-18-70
Field No.: 70 ANC 4 — Sediment Type: Sand and gravel

M-6307 as 6304
Latitude: 63.63°N — Longitude: 171.93°N
Depth: 33.8 m — Date: 8-18-70
Field No.: 70 ANC 5 — Sediment Type: Sand

M-6308 as 6304
Latitude: 63.559°N — Longitude: 171.95°W
Depth: — Date: 8-18-70
Field No.: 70 ANC 6 — Sediment Type: Sand

M-6309 as 6304
Latitude: 63°17.5'N — Longitude: 172°18.0'W
Depth: 125 m — Date: 8-18-70
Field No.: 70 ANC 7 — Sediment Type: Pebbly and sandy mud

M-6310 as 6233
Latitude: 65°04.5'N — Longitude: 169°14.7'W
Depth: 50 m — Date: 8-18-70
Field No.: 70 ANC 237 — Sediment Type: Sand and silt

M-6311 as 6304
Latitude: 63°16.8'N — Longitude: 171°36.8'W
Depth: 51.2 m — Date: 8-19-70
Field No.: 70 ANC 9 — Sediment Type: Sandy gravel

M-6312 as 6304
Latitude: 63°17.7'N — Longitude: 171°19.6'W
Depth: 36.1 m — Date: 8-19-70
Field No.: 70 ANC 10 — Sediment Type: Silty gravel

M-6313 as 6304
Latitude: 63°18.5'N | Longitude: 170°55.9'W
Depth: 26.9 m | Date: 8-19-70
Field No.: 70 ANC 11 | Sediment Type: Sand and silt with gravel

M-6314 as 6304
Latitude: 63°14.1'N | Longitude: 170°36.0'W
Depth: 29.2 m | Date: 8-19-70
Field No.: 70 ANC 12 | Sediment Type: Gravel and silt

M-6315 as 6304
Latitude: 63°08.2'N | Longitude: 170°28.0'W
Depth: 37.6 m | Date: 8-19-70
Field No.: 70 ANC 13 | Sediment Type: Sandy silt

M-6316 as 6304
Latitude: 62°54.8'N | Longitude: 170°36.8'W
Depth: 42.2 m | Date: 8-19-70
Field No.: 70 ANC 14 | Sediment Type: Sand and silt

M-6317 as 6304
Latitude: 62°54.0'N | Longitude: 169°58.0'W
Depth: 41.8 m | Date: 8-19-70
Field No.: 70 ANC 16 | Sediment Type: Gravel and sand

M-6318 as 6304
Latitude: 62°45.8'N | Longitude: 170°03.3'W
Depth: 43.8 m | Date: 8-19-70
Field No.: 70 ANC 17 | Sediment Type: Sand and silt

M-6319 as 6304
Latitude: 62°50.7'N | Longitude: 159°38.1'W
Depth: 47.1 m | Date: 8-19-70
Field No.: 70 ANC 18 | Sediment Type: Sand and silt

M-6320 as 6304
Latitude: 62°45'N | Longitude: 169°14'W
Depth: 37.6 m | Date: 8-19-70
Field No.: 70 ANC 19 | Sediment Type: Sand and silt

M-6321 as 6304
Latitude: 62°57.3'N | Longitude: 169°24.0'W
Depth: 34.8 m | Date: 8-19-70
Field No.: 70 ANC 20 | Sediment Type: Sand and gravel

M-6322 as 6304
Latitude: 62°54.9'N Longitude: 168°48.9'W
Depth: 33.2 m Date: 8-20-70
Field No.: 70 ANC 22 Sediment Type: Silt

M-6323 as 6304
Latitude: 63°05.1'N Longitude: 168°32.0'W
Depth: 42.4 m Date: 8-20-70
Field No.: 70 ANC 23 Sediment Type:

M-6324 as 6304
Latitude: 63°10.0'N Longitude: 168°38.0'W
Depth: 26.9 m Date: 8-20-70
Field No.: 70 ANC 24 Sediment Type: Sand

M-6325 as 6304
Latitude: 63°10.0'N Longitude: 168°22.0'W
Depth: Date: 8-20-70
Field No.: 70 ANC 25 Sediment Type: Gravel and silt

M-6326 as 6304
Latitude: 63°10.3'N Longitude: 168°09.9'W
Depth: 21.2 m Date: 8-20-70
Field No.: 70 ANC 26 Sediment Type: Fine sand

M-6327 as 6304
Latitude: 63°09.6'N Longitude: 167°56.9'W
Depth: 23.6 m Date: 8-20-70
Field No.: 70 ANC 27 Sediment Type:

M-6328 as 6304
Latitude: 62°56.1'N Longitude: 167°38.8'W
Depth: 24.2 m Date: 8-20-70
Field No.: 70 ANC 28 Sediment Type: Sand

M-6329 as 6304
Latitude: 62°52.0'N Longitude: 167°04.0'W
Depth: 22.7 m Date: 8-20-70
Field No.: 70 ANC 29 Sediment Type: Sand

M-6330 as 6304
Latitude: 62°44.6'N Longitude: 166°19.7'W
Depth: Date: 8-20-70
Field No.: 70 ANC 30 Sediment Type: Sand and silt

M-6331 as 6304
Latitude: 64°26.7'N | Longitude: 163°51.3'W
Depth: 17.7 m | Date: 8-21-70
Field No.: 70 ANC 32 | Sediment Type: Silt

M-6332 as 6304
Latitude: 64°27.5'N | Longitude: 163°41.8'W
Depth: 17 m | Date: 8-21-70
Field No.: 70 ANC 33 | Sediment Type:

M-6333 as 6304
Latitude: 64°30.0'N | Longitude: 163°33.0'W
Depth: 17 m | Date: 8-22-70
Field No.: 70 ANC 34 | Sediment Type:

M-6334 as 6304
Latitude: 64°28.6'N | Longitude: 163°25.5'W
Depth: 16.3 m | Date: 8-22-70
Field No.: 70 ANC 35 | Sediment Type:

M-6335 as 6304
Latitude: 64°26.7'N | Longitude: 163°20.2'W
Depth: 13.7 m | Date: 8-22-70
Field No.: 70 ANC 36 | Sediment Type:

M-6336 as 6304
Latitude: 64°23.0'N | Longitude: 163°18.8'W
Depth: 16.8 m | Date: 8-22-70
Field No.: 70 ANC 37 | Sediment Type: Sand and silt

M-6337 as 6304
Latitude: 64°18.6'N | Longitude: 163°17.0'W
Depth: 20.8 m | Date: 8-22-70
Field No.: 70 ANC 38 | Sediment Type: Sand and silt

M-6338 as 6304
Latitude: 64°15.3'N | Longitude: 163°04.0'W
Depth: 20.7 m | Date: 8-22-70
Field No.: 70 ANC 39 | Sediment Type: Sand and silt

M-6339 as 6304
Latitude: 64°23.3'N | Longitude: 163°02.5'W
Depth: 11.8 m | Date: 8-22-70
Field No.: 70 ANC 40 | Sediment Type: Clean sand

M-6340 as 6304
Latitude: 64°19.1'N Longitude: 162°53.1'W
Depth: 19.3 m Date: 8-22-70
Field No.: 70 ANC 41 Sediment Type: Gravel and silt

M-6341 as 6304
Latitude: 64°11.1'N Longitude: 162°49.4'W
Depth: 24.6 m Date: 8-22-70
Field No.: 70 ANC 42 Sediment Type: Muddy sand

M-6342 as 6304
Latitude: 64.25°N Longitude: 162.5°W
Depth: 19.6 m Date: 8-22-70
Field No.: 70 ANC 43 Sediment Type: Clayey silt

M-6343 as 6304
Latitude: 64°19.1'N Longitude: 162°37.6'W
Depth: 22.0 m Date: 8-22-70
Field No.: 70 ANC 44 Sediment Type:

M-6344 as 6304
Latitude: 64°23.8'N Longitude: 162°32.8'W
Depth: 18.7 m Date: 8-22-70
Field No.: 70 ANC 45 Sediment Type:

M-6345 as 6304
Latitude: 64°25.8'N Longitude: 162°26.5'W
Depth: 15.4 m Date: 8-22-70
Field No.: 70 ANC 46 Sediment Type:

M-6346 as 6304
Latitude: 64°31.7'N Longitude: 162°14.0'W
Depth: 12.8 m Date: 8-22-70
Field No.: 70 ANC 47 Sediment Type: Sand and silt

M-6347 as 6304
Latitude: 64°30.3'N Longitude: 161°56.6'W
Depth: 13.2 m Date: 8-22-70
Field No.: 70 ANC 48 Sediment Type: Sand and silt

M-6348 as 6304
Latitude: 64°31.8'N Longitude: 161°37.8'W
Depth: 10.1 m Date: 8-23-70
Field No.: 70 ANC 49 Sediment Type: Silt and clay

M-6349 as 6304
Latitude: 63°23.0'N Longitude: 161°38.1'W
Depth: 13.2 m Date: 8-23-70
Field No.: 70 ANC 50 Sediment Type: Clayey silt

M-6350 as 6304
Latitude: 64°15.9'N Longitude: 161°20.0'W
Depth: 13.4 m Date: 8-23-70
Field No.: 70 ANC 51 Sediment Type: Gravel, sand and mud

M-6351 as 6304
Latitude: 64°14.9'N Longitude: 161°59.6'W
Depth: 19.8 m Date: 8-23-70
Field No.: 70 ANC 52 Sediment Type:

M-6352 as 6304
Latitude: 64°00.0'N Longitude: 162°01.5'W
Depth: 18.3 m Date: 8-23-70
Field No.: 70 ANC 53 Sediment Type: Gravel, sand and mud

M-6353 as 6304
Latitude: 64°01.5'N Longitude: 161°16.6'W
Depth: 15.6 m Date: 8-23-70
Field No.: 70 ANC 54 Sediment Type: Gravel and silt

M-6354 as 6304
Latitude: 63.85°N Longitude: 161.09°W
Depth: Date: 8-23-70
Field No.: 70 ANC 55 Sediment Type: Gravel, sand and mud

M-6355 as 6304
Latitude: 63.69°N Longitude: 161.19°W
Depth: Date: 8-23-70
Field No.: 70 ANC 56 Sediment Type: Silty clay

M-6356 as 6304
Latitude: 63.63°N Longitude: 161.67°W
Depth: Date: 8-23-70
Field No.: 70 ANC 57 Sediment Type: Silty clay

M-6357 as 6304
Latitude: 63°31.8'N Longitude: 163°2.8'W
Depth: 11.8 m Date: 8-23-70
Field No.: 70 ANC 60 Sediment Type: Mud

M-6358 as 6304

Latitude: 63.44°N	Longitude: 163.45°W
Depth:	Date: 8-23-70
Field No.: 70 ANC 61	Sediment Type:

M-6359 as 6001

Latitude: 64°24'N	Longitude: 165°26.2'W
Depth: 28 m	Date: 8-1-68
Field No.: 68 ANC 245	Sediment Type:

M-6360 as 6001

Latitude: 63°40.3'N	Longitude: 170°43.1'W
Depth: 24 m	Date: 7-28-68
Field No.: 68 ANC 111	Sediment Type: Gravel and sand

M-6361 as 6254

Latitude: 63°43.1'N	Longitude: 170°08.0'W
Depth: 51 m	Date: 9-16-69
Field No.: 69 ANC 205	Sediment Type: Muddy gravel

M-6362 as 6001

Latitude: 64°22.2'N	Longitude: 165°51.0'W
Depth: 27 m	Date: 8-1-68
Field No.: 68 ANC 237	Sediment Type: Gravel and mud

ROWLAND FIGURE 6.
DENDROGRAMS OF THE LIVING BENTHIC FAUNA OF THE NORTHERN BERING SEA. FOR COMPLETE EXPLANATION, SEE TEXT PAGES 119-128.

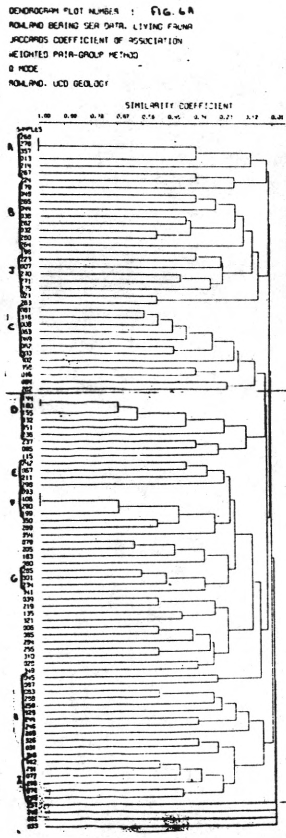


FIGURE 6A.
Q-MODE (SAMPLE) CLUSTER ANALYSIS USING JACCARDS COEFFICIENT OF ASSOCIATION.

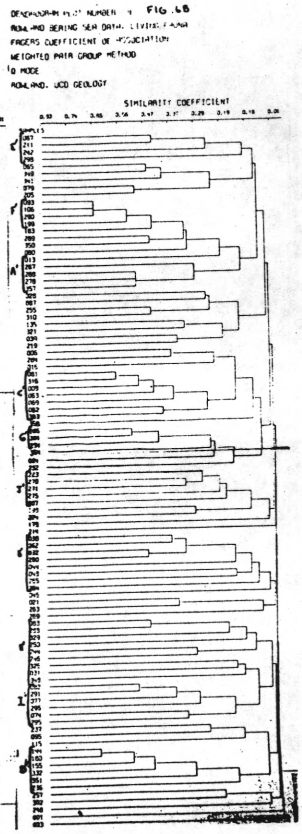


FIGURE 6B.
Q-MODE (SAMPLE) CLUSTER ANALYSIS USING FAGERS COEFFICIENT OF ASSOCIATION.

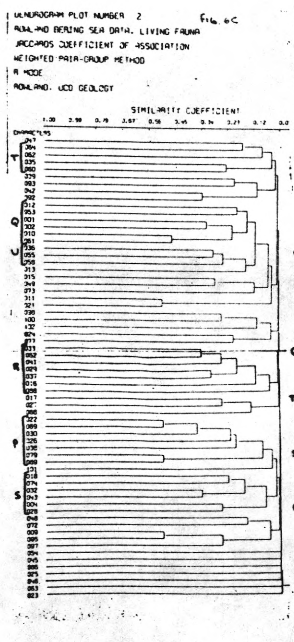


FIGURE 6C.
R-MODE (SPECIES) CLUSTER ANALYSIS USING JACCARDS COEFFICIENT OF ASSOCIATION.

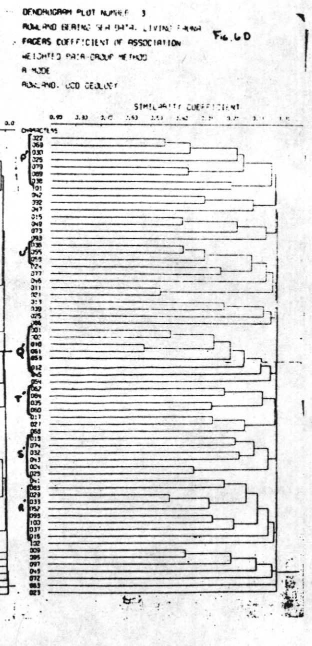


FIGURE 6D.
R-MODE (SPECIES) CLUSTER ANALYSIS USING FAGERS COEFFICIENT OF ASSOCIATION.

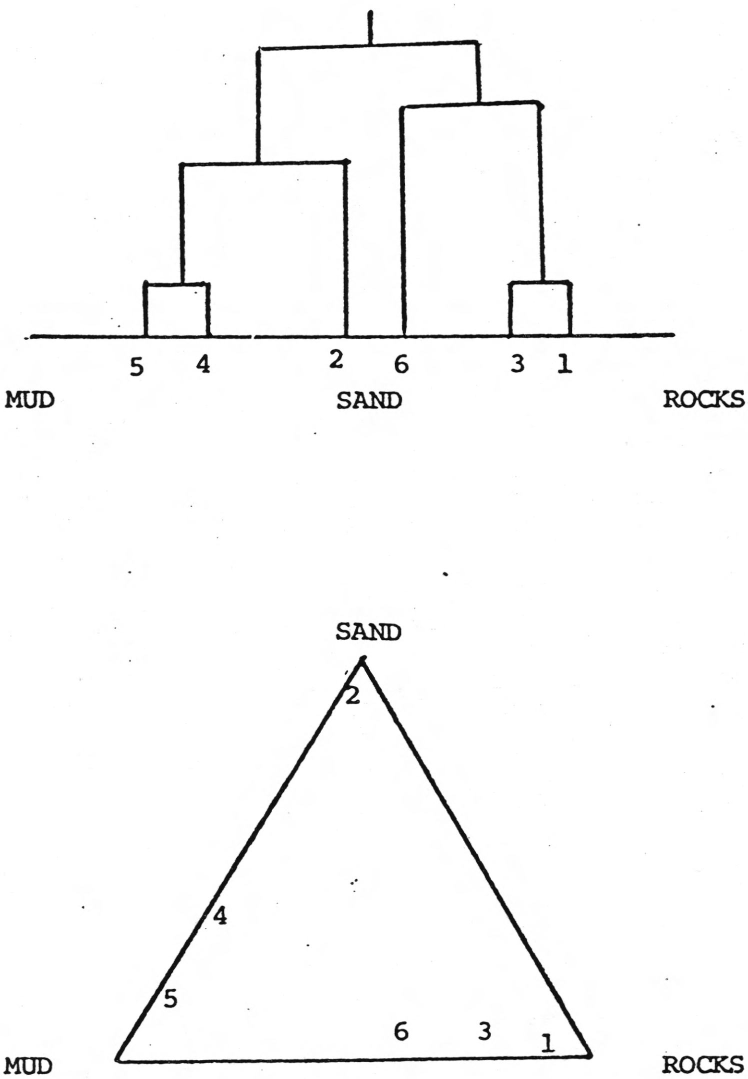
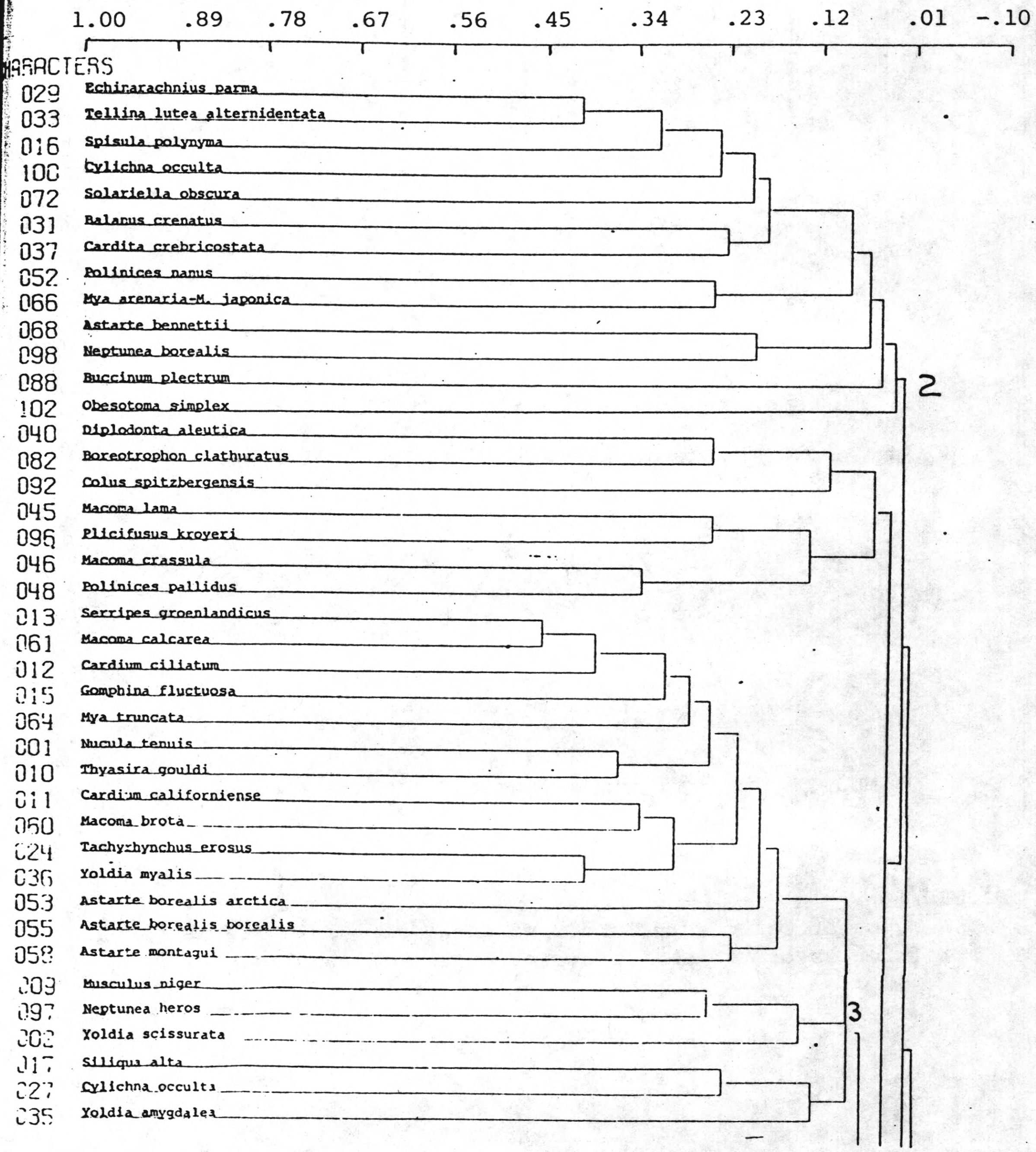


FIGURE 10
A hypothetical diagram and dendrogram expressing the substrate preferences of the six recurrent groups of species.

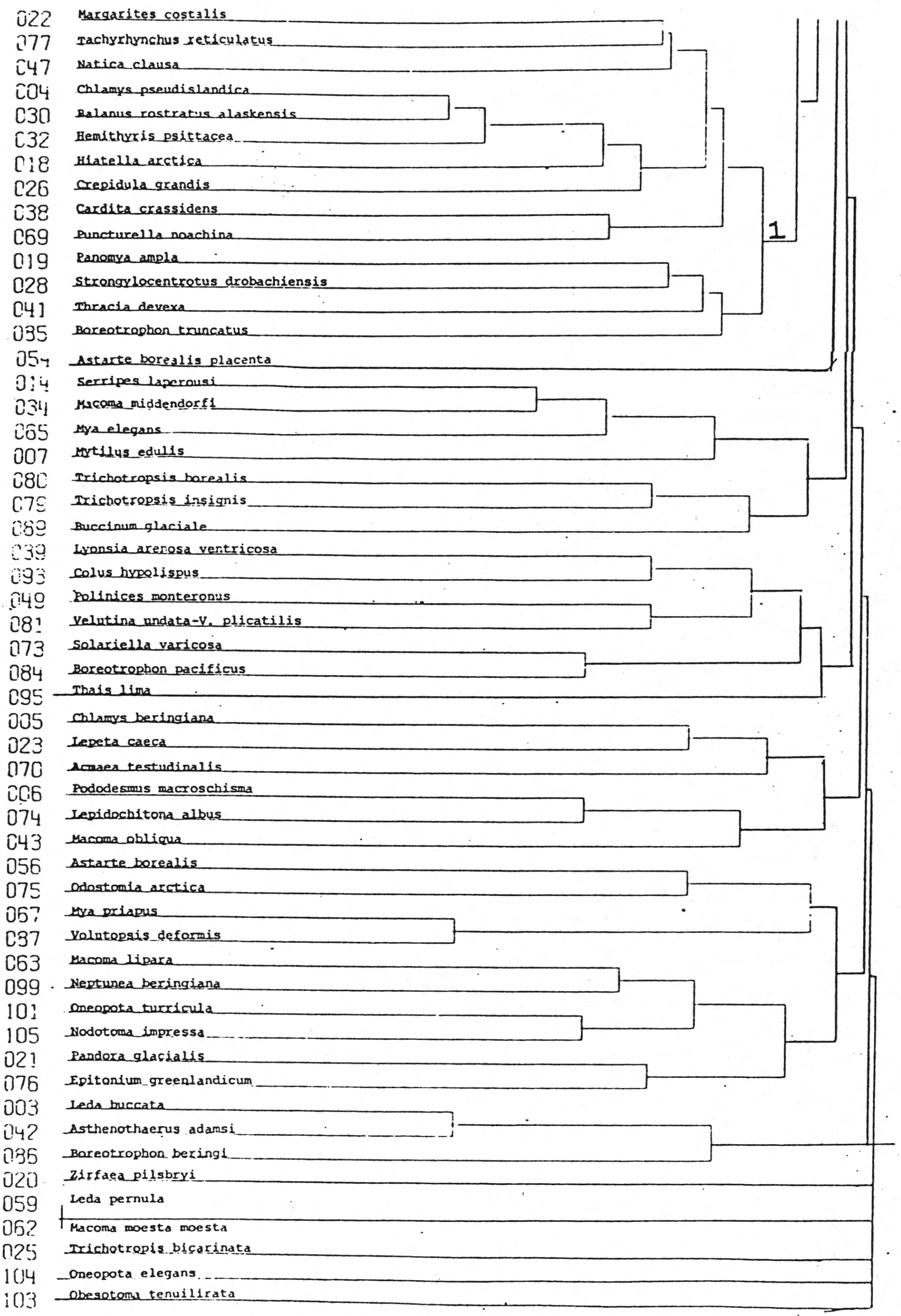
ROWLAND FIGURE 12.

DENDRUGRAM OF THE TOTAL BENTHIC FAUNA OF THE NORTHERN BERING SEA. R-MODE (SPECIES) CLUSTER ANALYSIS USING JACCARDS COEFFICIENT OF ASSOCIATION. FOR COMPLETE EXPLANATION SEE TEXT PAGES 119-124 AND 153-155.



CONTINUED ON PAGE 221A

CONTINUED FROM.PAGE 221.



ROWLAND TABLE 1 THE BENTHIC FAUNA OF THE BERING SEA

BELOW EACH SPECIES NAME IS A LISTING OF THE LOCALITIES AT WHICH THAT SPECIES WAS COLLECTED. LOCALITIES PRECEDING THE BRACKET ARE THOSE AT WHICH THE SPECIES WAS COLLECTED ALIVE. THE LOCALITIES FOLLOWING THE BRACKET YIELDED ONLY UNOCCUPIED SHELLS.

ALL LOCALITIES ARE U.S.GEOLOGICAL SURVEY MENLO PARK REGISTER PALEONTOLOGY NUMBERS, 6000 SERIES. FOR EXAMPLE 149 IS USGS-M-6149.

THE NUMBER PRECEDING THE SPECIES NAME DESIGNATES THAT SPECIES ON THE FOLLOWING DENDROGRAMS (FIGURES 6 & 10) AND MATRICES (TABLES 4 &5).

001 NUCULA TENUIS
095 012 011 083 053 081 078 069 059 058 241 060 063 061 281 288 283 302 234 301
254 325 008 285 316 291 146 176 155 244 292 237 015 088 329 250]178 180 320 065
177 092 089 159 167 141 310 144 341 087 086 303 091

002 YOLDIA SCISSURATA
260 063 060 058 288 292 257 059 316 081 056 307 069 300 302 066]080 322 319 238
236 090 042 250 321 039 087 037

003 LEDA BUCCATA
]013 079 269

004 CHLAMYS PSEUDISLANDICA
275 007]264 274 282 280 267 255 271 273 034 048 005 035 288 045 032 262 021 270
038 304

005 CHLAMYS BERINGIANA
]007 071

006 PODODESMUS MACROSCHISMA
]045 049 047 224 201

007 MYTILUS EDULIS
225]314 032 121 083 129 104 347 234 232

008 MUSCULUS DISCORS LAEVIGATUS SUBSTRIATUS
]210 076 356

009 MUSCULUS NIGER
167 248 302 320]349 236 231 164 091 044 194 159 065 134 234 130 267 162

010 THYASIRA GOULDI
285 347 028 338 134 303 337 118 135 065 081 087 070 069 063 064 060 062 015 260
254 349 255 133 286 008 310 045 029 027 012 058 341 307 011 336 301 331 308 316

027 164] 108 134 238 250 279 085 326 136 140 132 141 112 290 093 001

011 CARDIUM CALIFORNIENSE
101 131 067 148 199 183 211 025] 153 182 001 217 111 234 126 093 091 224 332 002
098 115 125 337 334 333 354 343 336 347 349 006 348 340 362 062 033 095 113 108
106 132 130 117 028 134 232 094 114 112 137 223 188 357 338 179 151 136 148 135
129 339 170 229 197 207 176 190 162 159 160 105 210 218 185 191 228 216 220 215
230 209 087 289 295 355 194 133 261 335 249 034

012 CARDIUM CILIATUM
179 007 054 011 289 342 354 282 310 064 255 014 334 350 284 063 012]067 153 182
302 303 283 290 359 091 087 104 332 337 065 345 088 212 089 085 269 286 044 126
260 258 253 234 351 337 344 262 071 333 015 107 078 070 043 338 357 005 086 080
084 240 053 069 092 061 285 006 205 297 257 301 006 190 151 143 204 174 138 139
203 141 170 158 145 152 144 157 150 166 167 159 206 186 195 194 177 187 175 178
133 181 146

013 SERRIPES GROENLANDICUS
333 271 321 350 143 328 327 334 319 283 314 242 296 318 316 183 013 011 010 337
278 054 034 338 357 174 132 272 266 268 261 349 241 172 192 012 096 152 238 353
166 064 080 008 007 067 267 071 063 009 015 070 059 337 173 135]170 167 171 177
248 178 176 175 180 179 187 188 181 185 184 186 190 240 084 068 193 031 019 039
200 202 205 203 206 210 212 214 215 260 259 250 057 066 006 244 246 237 239 234
235 236 216 006 204 045 053 037 191 194 243 258 257 265 160 002 101 090 104 092
091 093 112 106 107 109 108 131 121 117 113 139 111 110 126 138 133 136 137 141
095 190 163 145 155 154 149 159 157 162 158 041 165 161 156 061 040 086 088 062
082 085 087 142 005 269 274 270 277 279 276 282 293 289 302 290 288 287 301 289
300 289 291 303 305 286 304 311 329 315 342 344 355 326 331 307 259 332 345 358
352 343 347 357 341 351 335 055 308 354 346 056 007 022 077 089 026 066 043 262
168 144 310

014 SERRIPES LAPERUUSI
]038 026 032 023 028 035 306 311 272

015 GOMPHINA FLUCTUOSA
016 284 318 314 320 319 063 303 064 069 011 307 266 243 236 241 160 078 316 067
027 062 029 032 012 280 277 324 044 282 302 308 262 275 261 358]310 322 255 250
028 272 273 026 038 005 079 077 333 045 008 039 037 043 084 086 162 152 158 219
136 175 309 116 342 326 238 271 237 180 095 197 014 345 110 085 087 291

016 SPISULA POLYNYMA
020 028 027 017 121 296]090 139 102 327 077 141 235 299 020 291 072 032 295 297
294 326 246 028 277 245

017 SILIQUA ALTA
127 247 349]232 161 248 358 348

018 HIATELLA ARCTICA
221 225 224 198 179 022 267 285]271 021 028 083 250 227 005 289 290 302 287 286
306 313 314 321 307 311 304 301 288 358 327 322 324 297 291 038 039 061 066 069
067 071 078 079 077 092 115 024 023 043 022 018 013 029 004 121 031 034 033 269

276 274 275 222 265 229 180 227 201 256 263 279 193 223 264 268 255 068 122 257
273 270 026 023 067 032 066 272

019 PANOMYA AMPLA
]007 282 005 264 074 262 272 274 275 315 273 269 268 007 305

020 ZIRFAEA PILSBRYI
]071 289 298 212 229

021 PANDORA GLACIALIS
067 211 238]

022 MARGARITES COSTALIS
232 007 014 038 036 045 304 262] 013 092 089 304 049 085 045 084 298 314 082 079
280 262 077 036 271 324 095 050 066 047 263 325

023 LEPETA CAECA
033] 007 045 027 031 267

024 TACHYRHYNCHUS EROSUS
191 187 165 185 183 244 188 194 214 184 205 079] 234 342 066 045 346 072 087 078
193 088 083 186 148 216 086 179 189 330 037 152 001 111 146 357 341 238 388 204
237 352 343 350 257 335 336 351 347 246 264 069 349 359 153 332 340 345 334 210
255 209 092 044 067 036 303 298 290 288 294 291 245

025 TRICHOTROPIS BICARINATA
321] 054 259

026 CREPIDULA GRANDIS
021 271 270 280 262 263 032] 044 255 267 147 289 273 303

027 CYCLICHNA OCCULTA
347 348 339 236 349 246] 327 034 235 316 335 146 149 159 152 137 134 131 104 117
112 114 091 139 140 235 341 233 248 334 295 141 144 145 142 143 138 355 332 333
336 136 111 133 109 118 001 162 166 160 161 337 335 168 174 180 178 175 219 220
176 295 339 236

028 STRONGYLOCENTROTUS DROBACHIENSIS
231 227 270 223 196 272 273 274 271 276 264 275 198 225 304 279 007 073 340 341
335]

029 ECHINARACHNIUS PARMA
277 288 082 242 261 083 121 127 128 328 077 074 078 119 120 031 348 067 299 296
327 294 295 297 339 326 291] 244 043 330 246 247 219 255 034 077 078 278 329 245

030 BALANUS ROSTRATUS ALASKENSIS
198 262 227 007 225 224 038 049 314 312 032 280] 075 072 005 036 024 014 021 045
034 048 044 046 020 039 201 079 201 033 148 108 197 199 221 282 262 202 228 268
255 274 279 200 275 038 270 031 272 139 263 264 271 167 230 229 226 222 324 288
306 290 357 351 024 026

031 BALANUS CRENATUS
051]083 037 079 246 082 039 257 043 278 077 329 250 291 292 325 027 239 245

032 HEMITHYRIS PSITTACEA
023 049 224 264]290 295 036 038 007 270 048 032 262 294 350 288 217 215 305 045
165 194 209 189 190 228 197 216 021 031 271 036 044 289 193 005 152 113 068 083
205 269 344 255 033 275 074 067 290 295 223 230 272

033 TELLINA LUTEA ALTERNIDENTATA
119 291 121 074 296 295 294 297 339]348 299 067 357 298 335 074 101 219 246 340
072 232 077 120 338 360 336

034 MACOMA MIDDENDORFI
]032 031 026

035 YOLDIA AMYGDALEA
323 252 315 145 088 137 157 140 332 138 180 156 144 236 347 096 135 089 111 171
167 173 104 091 205 333 351 155 251 233 136 141 174]143 131 108 160 129 092 346
250 095 357 355 139 358 168 177 159 158 177 163 161 103 176 152 146 175

036 YOLDIA MYALIS
069 242 066 350 324 210 205 215 211 209 207 234 216 212 218 099 336 349 293 334
285 298 290 353 071 085 079 290 343 354 086 075 090 058 080 345 115 057 165 338
334 151 337 067 301 362 065 289 341 347 157 332 203 197 199 158 204 093 331 106
123 183 096 202 188 166 187 170 131 287 342]142 299 178 149 359 084 101 303 310
174 175 141 176 152 136 088 060 168 181 191 182 133 186 195 148 185 095 132 091
194 092 160 087 033 237 214 206 335 217 167 236 177 156 145 260 250 116 144 145
140 053 241 001 164 193 150 045 044 110 300 286

037 CARDITA CREBRICOSTATA
067 293 077 292 082 266 291 337 246 277 322 319 288 299 339 261 329 269 078 244
338]296 289 294 250 091 236 087 289 170 023 072 345 016 021 349 248 359 237 330
350 336 089 001 168 235 031 057 167 305 289 297 305 349 321 334 036 043 044 245

038 CARDITA CRASSIDENS
032 044 039 197 048 324 280 265 051 264]209 184 002 195 297 006 065 346 045 092
325

039 LYONSIA ARENOSA VENTRICOSA
010 064 008 080 353 336 338]212 214 011 117 066 091 191 337 234 335 093 299 310
139 347

040 DIPLODONTA ALEUTICA
286 283]185 062 264 065 255 092 006 087 064 063

041 THRACIA DEVEXA
032 034 017 314 277 264 282 283 291 296 077]271 289 284 272 298 275

042 ASTHENOTHAERUS ADAMSI
079 269 261 080]085

043 MACOMA OBLIQUA
101 217 224 334 340 115] 097 191 189 210 110 223 186 215 200 098 102 333 174 100
160 358 150 229 232 228 183 114 201 216 222 122 117 229

044 MACOMA BALTHICA
232]

045 MACOMA LAMA
301 119] 072 232

046 MACOMA CRASSULA
006] 106 280 167 141 285 301 214 337 248

047 NATICA CLAUSA
266 317 263 272 030 017 027 335 316 279 264 031 269 196 062 280 008] 060 022 267
139 329 037 043 130 092 061 079 200 256 086 180 072 298 290 293 286 273 289 327
255 324 333 233 088 215 211 175 166 030 271 013 056 303 160

048 POLINICES PALLIDUS
255 302 287 029 347 237 280 271] 342 334 141 214 078 248 301 300 350 315

049 POLINICES MONTERONUS
067 080 284 303 062 069]

050 BULBIS FRAGILIS
304] 160 109 355

051 AMAUROPSIS PURPUREA
]227 011

052 POLINICES NANUS
206 291 358 082]

053 ASTARTE BOREALIS ARCTICA
301 063 070 282 062 193 034 008 234 285 354 070] 139 310 341 234 085 180 216 149
282 186 285 106 092 253 142 179 006 140

054 ASTARTE BOREALIS PLACENTA
354 001] 111 061 234 286 153 286 206 082

055 ASTARTE BOREALIS BOREALIS
153 310 205 185 329 079 341 184 203 208 112 337 185 183 347 349 080 065 234 011
006 284] 165 066 214 346 253 066 187 105 082 343 348 213 348 355 084 210 190

056 ASTARTE BOREALIS
]334 141 092 063 214 146 191 012 109 193 325 332 202 288 184 207 293

057 ASTARTE BOREALIS PSEUDOACTIS
]306

058 ASTARTE MONTAGUI

199 195 214 350 202 289 264 190 183 185 184 106 188 216 093 094 108 304 064 203
187 284 016 290 065 309 006 062 013 011 284 063 080 293 296 229 267 211 176 198
092 187 217 097 148 101 001 005 082 269 359 189 116 194 002 212 100 198 218 193
021 283 310 034

059 LEDA PERNULA
095

060 MACOMA BROTA
155 144 152 068 121 355 333 158 332 304 140 349 284 011 233 254 237 256 241 258
283 176 115 180 174 095 136 104 090 289 028 044 080 309 190 070 179 206 177 158
024 093 140 088 107 248 150 166 357 253 149 151 343 142 143 343 145 139 157 165
154 345 153 351 331 091 112 161 137 085 180 129 138 329 159 131 003 108 171 002
156 106 156 092 087 204 111 178 109 342 354 252 199 181 351 146 346 344 173 182
234 168 193 341 240 205 089 194 167 160 214

061 MACOMA CALCAREA
058 070 320 259 300 131 301 258 314 316 310 322 260 333 309 319 325 315 081 281
009 008 251 006 063 286 172 015 307 110 065 308 036 028 052 039 060 053 011 241
317 054 254 354 350 349 329 055 321 061 284 135 069 259 255 143 012 252 219 056
113 361 068 149 238 332 304 151 149 282 001 271 045 146 167 339 326 130 162 334
164 170 005 145 138 136 126 359 133 108 080 103 212 129 091 179 090 207 139 160
137 270 186 243 155 163 177 176 159 211 240 174 214 280 156 268 262 258 256 180
165 171 157 282 269 283 303 166 175 302 290 158 324 141 038 042 014 048 105 343
349 204 351 152 062 158 041 352 207 013 057 037 161 205 337 132 292 275 317 216
341 169 362 142

062 MACOMA MOESTA MOESTA
075 315 036 309 239 066

063 MACOMA LIPARA
012 250 253 034 288 265 362 293 340 051 187 084

064 MYA TRUNCATA
037 301 034 022 016 268 301 287 264 021 275 274 302 220 315 065 270 327 240 269
098 081 161 207 142 230 308 316 314 236 235 115 068 095 065 296 362 087 085 062
091 307 289 066 108 175 155 152 176 304 248 345 285 341 117 253 124 080 039 129
111 155 298 179 185 188 190 197 174 284 257 291 234 326 081 145 142 168 157 167
133 163 067 158 001 159 109 178 138 157 027 033 186 140 148 324 276 322 143 069
187 321 263

065 MYA ELEGANS
076 033 032 306 267 072 291

066A MYA ARENARIA
291

066B MYA JAPONICA
232

067 MYA PRIAPUS

]306 087 232

068 ASTARTE BENNETTII
335 336 338 348] 244 329 246 357 347 339 337

069 PUNCTURELLA NOACHINA
262 045 279 032 038] 033 036 044

070 ACMAEA TESTUDINALIS
]033

071 MARGARITES FRIGIDUS
049 050]

072 SOLARIELLA OBSCURA
261 237 066 298 326] 212 338 084 277 216 246 144 077 336 013 214 089 296

073 SOLARIELLA VARICOSA
303] 043 086 303

074 LEPIDOCHITONA ALBUS
045 221 274 275 267 270 272 048 224 229]

075 ODOSTOMIA ARCTICA
330] 332

076 EPITONIUM GREENLANDICUM
]067 216 125 088 045 018 268

077 TACHYRYNCHUS RETICULATUS
209 214] 302 293 210 095 038 280 213 155 282 016 013 240 264 265 255 296 036 092
262 269 180 215 211 195 212 207 044

078 TRICHOTROPSIS KRUYERI
054 208] 207

079 TRICHOTROPSIS INSIGNIS
262 179] 024 032 255 361

080 TRICHOTROPSIS BOREALIS
]190 179 201 165 177

081A VELUTINA UNDATA
]271 149 078 165 186 184 216

081B VELUTINA PLICATILIS
]069 303

082 BOREOTROPHON CLATHRATUS
]306 255 037 256 255

Quality of original same as this

083 BOREOTROPHON CLATHURATUS GUNNERI
]066 049

084 BOREOTROPHON PACIFICUS
274] 276 043 178 270

085 BOREOTROPHON TRUNCATUS
]039 271 275

086 BOREOTROPHON BERINGI
066 013] 137 012

087 VOLUTOPSIS DEFORMIS
]288 087

088 BUCCINUM PLECTRUM
077]

089 BUCCINUM GLACIALE
272 262]

090 BUCCINUM TENUE
010 011 009]

091 ADMETE COUTHOUYI
060] 017 300

092 COLUS SPITZBERGENSIS
273 269] 093 070 324 284 145 280 006 282

093 COLUS HYPOLISPUS
069 074 080 310] 012

094 ? APORRHAIS SP.
017]

095 THAIS LIMA
070] 062 061 197

096 PLICIFUSUS KROYERI
302] 288 301 022 264

097 NEPTUNEA HEROS
248 325 243] 302 361 270 065 039 321 331 036 056 355 345 343 344 262 052 152

098 NEPTUNEA BOREALIS
244] 015

099 NEPTUNEA BERINGIANA
]301 268 342 288 108 340 034 300 083 265

100 CYCLICHNA ALBA
327 034 335 244 235 246 295 316] 292 302 220 329 337 237 238 226 157 095 338 315
121 074 077 236 078 115 086 032 066 067 342 246 245

101 ONEOPOTA TURRICULA
265] 067 068 315 092

102 OBESOTOMA SIMPLEX
295 219]

103 OBESOTOMA TENUILIRATA
]019 240

104 OENOPOTA ELEGANS
]205 190 036 185 187

105 NODONTOMA IMPRESSA
]265

SPECIES COLLECTED BUT NOT CLUSTERED
PORTLANDIA ARCTICA
233 132
LITTORINA SQUALIDA
SAFETY SOUND & OTHER COASTAL LAGOONS

Rowland table 4 Data Matrix p. 231

Total fauna data matrix for the 183 samples which were evaluated by cluster analysis. Sample names are USGS M,6000 series locality numbers. The small vertical numbers along the top of the matrix are the species numbers as designated in table 1.

ROWLAND BERING SEA DATA, TOTAL FAUNA

PRINTOUT OF DATA MATRIX FOR CLUSTERED STATIONS

SAMPLES NAME	NO.	CHARACTERS = SPECIES (2=Presence, 1=Absence)
1	1	11111111221111111111111121121111111111221111111111111111211211211211111111111111111111111111111
5	2	11121111112212112211111111111121211111111111111111111111121121121111111111111111111111111111111
6	3	11111111122211111111111111111111111111212111121111212121121111111111111111211111121111111111111
7	4	11122111112211111211221111212121111111111111111111111111111111111111111111111111111111111111111
8	5	21111111211212111111111111111111111111211111211121111112112111111111111111111111111111111111111
13	6	11211111111211112111211111111111111111111111111211111121121111111211112111111211111111111111111
16	7	11111111111112111111111111111111111121111111111111111121111121111111111211111111111111111111111
21	8	11121111111111121111111211121211112111111111111111111121111121111111111111111111111111111111111
26	9	11111111111222112111111111112111211111111111111111111111111121111111111111111111111111111111111
29	10	1111111122112221211111111111111111111111111111111111111122111111111111111111111111111111111
31	11	11111111111121111211112111112212121121111111112111111111111111111111111111111111111111111
32	12	1112112111112221211111111211121212112112111111111111111111111121112111111121111111111111211111
33	13	11111111121111112111121111112121112111111111111111111111111221112211111111111111111111111111
36	14	111211111111221121112111111121211111211111111111111111111211111112111112111111111111111111111
39	15	12111111111212112111111111111122111111111111111111111111211211111111111111111211111111211111111
43	16	1111111111221211211111111111212111111211111111121111111111111111112111111111211111111111111111
44	17	1111111211211211111111212111212111222111111111111111121111111121111112111111111111111111111
45	18	1112121121121211111122211111212111212111111111111111111111121111111211121211111111111111111111
48	19	1112111111111111111111111111212111112111111111111111111111121111111111112111111111111111111111
62	20	1111111122121211111111111111111111111111211111212121112112112111111111111111111111112111111111
63	21	22111111212221211111111111111111111111111211111111111211221121111111111111111111111111111111
65	22	21111112212111111111111111111111111121212111111111111212112112111111111111111111111111211111111
67	23	111111111222121121121121111121122112211111111111121111111111121111111111211111111111111111221111
69	24	22111111212112112111112111111111111121111111111111211111111211211111111111111121111111121111111
74	25	11111111111111111111111111121122111111111111111111111111111111111111111111111121111111211111
77	26	111111111112122121112111111121212111211121111111111111111111111111211111111111111211111111211111
79	27	1121111111111121121112121111122111121111112112111111211111111111111111111111111111111111111
80	28	12111111111221111111111111111111111112112112111112111212221121111111111111111111111121111111111
81	29	22111111211111111111111111111111111111111111111111112112111111111111111111111111111111111
82	30	11111111111211111111211111121211111211111111111212221211111111111111111111111111111111111111
83	31	21111121111111111211111211112122111111111111111111111111111111111111111111111111112111111
91	32	11111111112212111112111111111111211111111111111121211111211111112111111111111111111111111111
87	33	2211111122221211111111211111111111221121111111111111111211121121111111111111111121111111111111
92	34	21111111112211112111212111111111111221212111112111211221211111111111111121111111111111121111
93	35	111111112212111111111111111111111121121111111111111111212111111111111111111111111121111111111
95	36	2111111121212111111211111111111111111221111111111111111112212121111111111111211111111111111211111
106	37	111111111212111111111111111111111111211111111111211112111212111111111111111111111111111111111
115	38	1111111121111111211111111111111111211111211111111111111211121111111111111111111111111111211111
125	39	1111111112221111111111111111111111111111111111111111111121111111111111111111111111111111111111
135	40	1111111122121111111111111111111111111211111111111111111111121111111111111111111111111111111111
144	41	21111111112211111111111111211111111221111111111111111111121111111111211111111111111111111111
155	42	2111111111121111111111111111111111121111111111111111111111221121111111111112111111111111111111
179	43	111111111222111121111121111111111111111111111111211111122112111111111111122111111111111111111
180	44	211111111112121121111111112111111111211111111112112111112211111111111111211111111111111111111
183	45	111111111212111111111112111111111111121111112111111111212111111111111111111111111111111111111
195	46	1111111111111111121111111112121111111111111111111111112111111111111111111111111111111111111
199	47	11111111121111111111111111111111211112111111111111111111212111111111111111111111111111111111111
205	48	1111111111221111111111211111121122111111111111111112111221111111111111111111111111111111121
211	49	111111111211111111111211111111111111121111111112111111121121111111111111112111111111111111111
214	50	111111111112111111111112111111111111121121111121211112221221111111111112111121111111111111111

219	51	111111111111112111111111111212111211111111111111111111111111112111111111111111111111111111112111
223	52	111111111211111121111111112111211111111111121111111111111111111111111111111111111111111111111111
224	53	111112111211111121111111111121211111111111121111111111111111111111111121111111111111111111111111
234	54	211111221222111111111111121111111111121121111111111122211121121111111111111111111111111111111111
236	55	121111121112121111111111112111111111222111111111111111111111111211111111111111111111111211111
237	56	211111111112121111111112111111111112211111111121111111121111111112111111111111111111111211111
240	57	111111111122111111111111111111111111111111111111111111111221121111111111121111111111111111211
242	58	111111111112111111111111111121111111211111111111111111111111111111111111111111111111111111111
244	59	211111111112111111111121111211111111211111111111111111111111111211111111111111111111121211111
246	60	111111111112112111111112111121212111211111111111111111111111111211211111111111111111111211111
245	61	111111121112111211111111111211111111121111111121211111111211121111111111111111111111121111111
250	62	221111112112121121111111111111121112221111111111111111111111211111111111111111111111111111111
255	63	111211112121121121111121211221211111121111112211111111121111111111111112212111111111111111111
257	64	121111111122111121111112111111211111111111111111111111111112111111111111111111111111111111111
262	65	111211111221211121121112111212111111111111111111111111121111111211111122111111111211112111111111
263	66	111111111111111121112111211121111111111111111211111111111112111111111111111111111111111111111
264	67	111211111111111221111211121212111121221111211111121111121111111111211111111111111211111111
265	68	111111111112111121111111111111111111211111111111111111111121111111111111112111111111111112121112
267	69	111211121112111121111211211111111111111111121111111211111121111111121111111111111111111111111
268	70	111111111112111122111111111121111111111111111111111111112112111111111111211111111111111121111111
269	71	112111111122111122111111111111211112111121121111112112112111111111111121111111111112111111111111
270	72	111211111112111121111111121212121111111111111111111111111121121111111121111111211111111121111111
271	73	111211111112121121112111212121211111111121111221111111121111111111111211211111111111111111111
275	74	111211111111121122111111121212111111111211111111111111112112111111111211111112111111111111111
278	75	111111111112111111111111111121211111111111111111111111111111111111111111111111111111111111111
280	76	111211111111211111211121111211111111211111122211111111211111111111121111111111211111111111111
282	77	111211111221211121121111111111111111111111111211111211111111112111111111111211111111111111
284	78	111111111121112111111111111111211121111111111111211111121121212211211111111111112111111111111111
285	79	211111121211111211111111111111111111121111111211112111111112111111111111111111111111111111111
288	80	221211111112111121111121111221211112111111111111111112111121111111111111111211111121121111111
289	81	111111111222111121211111211111211122111211112111111121211121111111111111111111111111111111111
290	82	111111121222111121111121111121211121111111111211111121121111111111111111111111111111111111111
291	83	211111111112122121111121111212121112111211111121111111111122211111111111111111111111111111111
295	84	111111111211112111111111212112211111111111111111111111111111111111111111111111111111111212111
296	85	111111111112112111111111111121112111211121111112111121111121111121111211111111111111111111111
298	86	111111111111111121212111111112112111121111121111111111111112111111121111111111111111111111111
301	87	211111121221111211111111111111111121111112212112111112121211111111111111111111111112121111
302	88	221111211221211211111111111111111111111112111111121121111111111111121111111111111112211211111
303	89	211111121221211111111212111111111211111111121211111121111111111111211111211111111111111111111
310	90	211111121222121111111111111111111112112111111111121212112111111111111111111111111111211111111111
316	91	221111112112121111111111211111111111111111121111111121121111111111111111111111111111121111111
321	92	121111111112111121111112111111111112111111111111111112112111111111111111111111111112111111
326	93	111111121212211111111111112111111111111111111111111121121111111211111111111111111111111111111
329	94	211111111112111111111111121212111112111111111121111121122111112111111111111111111111121111111
332	95	111111111222111111111111211211111122111111111111111211221111111111211111111111111111111111111
341	96	211111121121111111111211221111111211111111111111121211221121111111111111111111111111111111111
348	97	111111112111112111111121211121111111111111111111111121111111112111111111111111111111111111111
349	98	111111222121112111111211211111111221111111111111111211122111111111111111211111111111111111111
350	99	111111111221111111111211111112111221111111111112111111211211111111111111111111111111111111111
351	100	111111111221111111111211111211112111111111111111111111112211111111111111111111111111111111111
354	101	111111111222111111111111111112111111111111112211111221111111111111111111111111111111111111111
357	102	111111111222111111111211111211212111111111111111111111211111112111111111111111111111111111111
358	103	111111111112121221111111111111111211111121111121111111111111111111111111111111111111111111111

The living fauna data matrix for the 97 samples which were evaluated by cluster analysis. Sample names are USGS M.6000 series locality numbers. The small vertical numbers along the top of the matrix are the species numbers as designated in table 1.

ROWLAND BERING SEA DATA, LIVING FAUNA

PRINTOUT OF DATA MATRIX FOR CLUSTERED STATIONS

SAMPLES — CHARACTERS=SPECIES

2=Presence, 1=Absence

SAMPLES NAME	NO.	CHARACTERS (species [illegible])
1	1	111111111111111111111111111111111111111211111111111111111111111111
6	2	111111111111111111111111111111111211111112212111111111111111111111
7	3	111111221111121111121211111111111111111111111111111111111111111111
8	4	211121121111111111111111111121111211111211112112111111111111111111
13	5	111111121111111111111111111111111111111112111111111111121111111111
16	6	111111112111111111111111111111111111111112111111111111111111111111
21	7	111111111111111112111111111111111111111111111111111111111111111111
28	8	111121111211111111111111111111111111111111122111111111111111111111
31	9	111111111111111111112111111111111121111111111111111111111111111111
32	10	111111112111111112111211111212111111111111111111121111111111111111
33	11	111111111111112111111111111111111111111111111111111111111111111111
34	12	111111111111121111111211111211111111111111111111121111111111111111
37	13	111111111111111111111111111111111111111111112111111111111111111111
44	14	111111112111111111111111111211111111111111121111111111111111111111
45	15	111121111111121111111111111111111111111111111111121121111111111111
48	16	111111111111111111111111111211111111111111111111111121111111111111
52	17	111121112111111111111111111111111121212121211111111111111111111111
53	18	221121222111111111111111111111111111111121212111111111111111111111
63	19	111121111111111111111111121111111111111112212111111111111111111111
67	20	111112122111211111112111122111111111112111111111111111111111111111
69	21	221121112111111111111111121111111111112111111111211111111111111111
[illegible]	22	111111111111111111110110111111111111111111111111111111111211111111
77	23	111111111111111111110111121211111111111111111111111111211111111111
79	24	111111111111111211111111121111121111111112111111111111111111111111
80	25	111111121111111111111111121112111121112221111111111111111211111111
81	26	221121111111111111111111111111111111111121121111111111111111111111
82	27	111111111111111111110111121111111111111121111111111111111111111111
83	28	211111111111111111112111111111111111111111111111111111111111111111
84	29	111111111111111111111111111111111111111211111111111111111111111111
87	30	111121111111111111111111111111111111111111111111111111111111111111
93	31	111111111111111111111111121111111111111111211111111111111111111111
95	32	211111111111111111111111111111111111111121212111111111111111111111
105	33	111111111111111111111111121111111111111111211111111111111111111111
113	34	111111111111111111111111121111121111111111121211111111111111111111
133	35	111121121111111111111111121111111111111111112111111111111111111111
144	36	111111111111111111111111121111111111111111121111111111111111111111
153	37	211111111111111111111111121111111111111111121111111111111111111111
177	38	111111121112111111111111111111111111111111111111111111211111111111
183	39	111111111111111111111111121111111111111111112111111111111111111111
193	40	111112121111111211111111121111111111111112211111111111111111111111
193	41	111111111112111111121111111111111111111111111111111111111111111111
197	42	111112111111111111111111121111111111111111121111111111111111111111
205	43	111111111111111211111111221111111111111111211111111111111111111111
211	44	111112111111121111111111121111111111111111111111111111111111111111
214	45	111111111111111211111111111111111111111111121111111112111111111111
217	46	111111111111111111111111111111111111111111112111111111111111111112
223	47	111111111111111111121111111111111111111111111111111111111111111111
224	48	111111111112111111111221111111112111111111111111111112111111111111
234	49	211111111111111111111111121111111111111111212111111111111111111111
236	50	111111112111111111211111211111111111111111111111211111111111111111

ROWLAND
TABLE 5
Page 234

237	51	21111111111111111111111111111111111112111111211111121111111111111111
242	52	11111111211111111111121111211111111111111111111111111111111111111111
244	53	21111111111111112111111111121111111111111111111111111111111111112211
246	54	11111111111111111112111111121111111111111111111111111111111111111211
248	55	11121111111111111111111111111111111111111111111111111111111111121111
250	56	21111111111111111111111111111111111111111111111211111111111111111111
252	57	11112121111111111111111111111111111111211111121111111111111111111111
257	58	12111111111111111111111111111111111111111111111111111111111111111111
252	59	11111111121111211121112111111111111111111111111111112111211211111111
253	60	11111111111111111121111111111111111121111111111111111111111111111111
260	61	11111111111111111111211211111221111121111112111111111111111111111111
255	62	11111111111111111111111111111211111111111111111111111111111111111121
267	63	11111111211121111111111111111111111111111111111111111211111111111111
264	64	11111111211111111111111111111111111111111111111111111111111111111111
259	65	11111111111111111111111111111112111211211111111111111111111121111111
270	66	11111111111111111121211111111111111111111111111111111211111111111111
271	67	11111111211111111121211111111111111121111111111111111111111111111111
275	68	11111111211111111111211111111111111111111111111111111211111111111111
278	69	11111111211111111111111111111111111111111111111111111111111111111111
280	70	11111111121111111121112111112111111122111111111111111111111111111111
282	71	11111112121111211111111111111112111111112111111111111111111111111111
284	72	11111111121211111111111111111111111111211122211111111111111111111111
287	73	21112111111121111111111111211111111111111211111111111111111111111111
233	74	22111111111111111111121111121111111111111111111111111111111111111111
289	75	11111121111111111111111111211111111111111111221111111111111111111111
290	76	11111111111111111111111111211111111111111112111111111111111111111111
291	77	21111111111111111111121112112112111111121111111111111111111111111111
293	78	11111111111111111111121112111111111111111111111111111111111111111212
295	79	11111111212111111111121112111112111111121111111111111111111111111111
298	80	11111111111111111111111112111111111111111111111112111111111111111111
301	81	21112111111111111111111111211111121111111211112111111111111111111111
302	82	22121111211111111111111111111111111121111111111111111111111111211111
303	83	11112111211111111111111111111111111111211111111111112111111111111111
310	84	11112121111111111111111111111111111111111121121111111111111121111111
315	85	22112112211111111111111111111111111121111111121121111111111111111211
321	86	11111112111111111211111111111111111111111111121111111111111111111111
324	87	11111111111111111111121111111111111111111111111111121111111111111111
325	88	21111111111111111111111111121111111111111121121111111111111111111111
332	89	11111111111111111111111112211111111111111111211111111111111111111111
341	90	11112111111111111111121111211111111111111121111111111111111111111111
348	91	11111111111111111112121111111111111111111111111112111111111111111111
349	92	11111211111211211112111111211111111111111121221111111111111111111111
350	93	11111112211111111111111111211111111111111112121111111111111111111111
351	94	11111111111111111111111112111111111111111111111111111111111111111111
354	95	11111121111111111111111111211111111111112211121111111111111111111111
357	96	11111111211111111111111111111111111111111111111111111111111111111111
359	97	11111111121111111111111111111111111111121111111111111111111111111111