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Through three seasons' field work at the Hot Springs site, Port Moller (in 1972, 1974 and 1977), faunal remains composed of fish, bird, land and sea mammal bones were excavated. C-14 dates so far obtained from various layers in test trenches and house floors show that three periods of occupation are represented here: early period, c. 3500–c. 3000 B.P.; middle period, c. 1500 B.P.; and late period, c. 600 B.P.

Analysis of faunal remains shows that a variety of food resources were exploited. Following McCartney's terms [1977], off-shore fishing, on-shore fishing, intertidal and beach collecting, sea mammal and land mammal hunting and bird hunting were carried out. These exploiting patterns strongly suggest that a maritime-oriented economy was maintained throughout the occupation periods at this site.

Problems of seasonal and long-term changes in subsistence activities still remain to be clarified. One prominent feature is the shift in shell midden contents from rocky-bottom or reef dwelling to sandy-bottom dwelling shells. This shift is interpreted to represent large-scale sand accumulation around Bristol Bay presumably taking place between the early and middle periods, c. 3000–1500 B.P. [Alaska Peninsula, Paleoecology, Prehistory]

Throughout three seasons' archaeological excavations at the Hot Springs site, Port Moller, on the Bristol Bay side of the Alaska Peninsula, a fairly large amount of faunal remains have been secured [OKADA and OKADA 1974; OKADA and others 1976; OKADA, OKADA and KOTANI 1979]. Analysis of these faunal remains is being carried out by Toyohiro Nishimoto at Hokkaido University.

Radiocarbon dates so far available from the site indicate that three periods of human occupation are represented here. The early period is from c. 3500 to 3000 B. P., the middle period around 1500 B. P., and the late period around 600 B. P. Stratigraphically the early period corresponds to Layers III-VII of site deposits, the middle period is represented by Layer II, and the late period is correlated with Layer I [OKADA, this volume].

ECOLOGICAL SETTINGS

The Port Moller Bay region is presumed to have been glaciated during Wisconsin

Table 1. List of Fauna from the

Sea Mammals (*)	
Sea otter	<i>Enhydra lutris</i>
Steller sea lion	<i>Eumetopias jubata</i>
Fur seal	<i>Callorhinus ursinus</i>
Walrus	<i>Odobenus rosmarus</i>
Bearded seal	<i>Erignathus barbatus</i>
Ringed seal	<i>Pusa hispida</i>
Harbor seal	<i>Phoca vitulina</i>
Whales, Dolphins and Porpoises	Cetacea fam. indet.
Land Mammals (*)	
Rodents	Muridae gen. indet.
Arctic ground squirrel	<i>Citellus franklini</i>
Bear	<i>Ursus</i> sp.
Wolf	<i>Canis lupus</i>
Fox	<i>Vulpus vulpus</i>
Weasel	<i>Mustela frenata</i>
Mink	<i>Mustela vison</i>
Caribou	<i>Rangifer tarandus</i>
Moose?	<i>Alces alces?</i>
Fish (*)	
Salmon shark	<i>Lamna ditropis</i>
Herring	<i>Clupea pallasii</i>
Salmon	Salmonidae gen. indet.
Sculpin	Cottidae gen. indet.
Common Alaska cod	<i>Gadus macrocephalus</i>
Halibut	<i>Hippoglossus stenolepis</i>
Flounder	Pleuronectidae gen. indet.

(*) Identified by Toyohiro Nishimoto

(**) Identified by David Yesner

time [PÉWÉ 1975; COULTER and others 1965]. Glaciers are estimated to have retreated from the lowlands around 11,000 to 12,000 years ago as the Alaska Peninsula and the eastern Aleutian Islands became deglaciated. With the retreat of ice, sea level became established at the present level around 8000 years ago. The Hypsithermal saw sea levels perhaps a few meters higher than at present from 8000 to 3000 years ago, with a return to the present level around 3000 years ago [BLACK 1974, 1975].

From environmental and ecological points of view, the Port Moller area is characterized by a variety of zones, which are presumed to have been closely related to certain types of subsistence activities. First, Bristol Bay is known for winter pack or sea ice. The average maximum winter extent of sea ice occurs in the vicinity of Port Moller [AMERICAN GEOGRAPHICAL SOCIETY 1975], and this provides an ideal situation for some large sea mammals such as walrus, ringed, and bearded seals which require the presence of pack ice.

Second, Port Moller Bay and the coast of Bristol Bay are spotted with sand dunes and sandy flats which are very extensive at low tide, although the eastern shore of the

Hot Springs Village Site, 1977.

Shells (*)

a. Univalves

Periwinkle
 Frilled dogwinkle
 File dogwinkle?

Littorina brevicula
Nucella lamellosa
Nucella lima?

b. Bivalves

Blue mussel
 Nuttall's cockle
 Cockle
 Alaska surf clam
 Great Alaskan tellin
 Pacific razor clam
 Common soft shell clam

Mytilus edulis
Clinocardium nuttalli
Seripes sp.
Mactromeris vogi alaskana
Peronidia lutea
Siliqua patula
Mya (Arenomya) arenoria oonogai

Sea urchin (*)

Sea urchin

Strongylocentrotus intermedius

Birds (**)

Common loon
 Arctic loon
 Red-throated loon
 Short-tailed albatross
 Double-crested cormorant
 Red-faced cormorant
 Steller's eider
 King eider
 Black scoter
 Red-breasted merganser
 Galucos-winged gull
 Black-legged kittiwake
 Common murre
 Pigeon guillemot
 Parakeet auklet
 Cassin's auklet

Gavia immer
Gavia arctica
Gavia stellata
Diomedea albatrus
Phalacrocorax auritus
Phalacrocorax urile
Polysticta stelleri
Somateria spectabilis
Oidemia nigra
Mergus serrator
Larus glaucescens
Rissa tridactyla
Uria aalge
Cepphus columba
Cyclorhynchus psittacula
Ptychoramphus aleutica

bay is characterized by V-shaped valleys and steep cliffs derived from glacial phenomena. The tidal zone was important for collection of mollusks and echinoderms, which constitute the matrix of the shellmound deposits, and is also significant for migratory water fowl.

Third, the sand dune on which the lower portion of the site is located stretches toward the mountains and provides easy access to the interior where herds of caribou exist [HEMMING 1971] and other small mammals are available.

The site itself is located on both the highland and the lowland portions [see OKADA's map, this volume]. It commands an overlook of the bay, and provides an easy access to the open sea (Bristol Bay). Thus it can be said that the vicinity of the site is characterized by various ecological zones—open sea, bay, edges of sea ice at certain seasons, sandy intertidal zones, tundra, and mountains—in which particular subsistence activities are thought to have been carried out.

SUBSISTENCE ACTIVITIES: ACTIVITY ZONES

Table 1 shows the species of mammals, fish, birds and invertebrates from the trenches cut into shell midden deposits in the highland portion of the site [see also OKADA's Fig. 1, this volume]. From this list the following five classes of subsistence activities can be reconstructed and activity zones can be suggested on the basis of the ecological setting of the site area [McCARTNEY 1977]. These subsistence activities are sea mammal hunting, land mammal hunting, bird hunting, fishing and collecting.

Sea Mammal Hunting

Four kinds of seals, walrus, sea lion, and whales (including dolphins and porpoises) were found at the site, as were a few sea otter bones.

Sea ice is one of the main factors in determining the distribution of various mammals in the northern sea. From this point of view, the occurrence of the edge of the sea ice at its maximum annual extent in the vicinity of the site is noteworthy and the site area can thus be said to be located in the ecotone where both open sea mammals and sea ice mammals are available. This condition accounts for the relative dominance of sea mammals in the site fauna. At the same time, in this ecotone situation, it is reasonable to expect that some kinds of sea mammals were available to the prehistoric inhabitants throughout the year.

We have no direct evidence for the possible existence of a sea mammal rookery near the site. We can nevertheless postulate that at least some of these sea mammals (for example, the fur seal and whales) were hunted in Port Moller Bay itself as well as outside of the bay on the Bering Sea. In any case, some sort of sea-worthy boat (*umiak* and/or *kayak*) must have been in use. Thus we can safely conclude that off-shore hunting was carried out as well as on-shore hunting. In summary, sea mammal hunting, both off-shore and on-shore, must have been the most important subsistence base at the site.

Land Mammal Hunting

Caribou, fox, wolf, bear, weasel, mink, Arctic ground squirrel and small rodents (Muridae gen. indet.) are represented in the faunal sample from the site. Except for caribou and fox, land mammals appear sporadically but continuously throughout the site occupation periods. These fur-bearing animals can be interpreted as having been hunted or trapped for furs, but trapping devices are not available from the site. The existence of moose is not yet confirmed.

Caribou and fox are commonly represented. Of the two, caribou was a source of meat as well as raw material for tools, skin and sinew for thread. Not only bones but also antler, which may be either complete tools or worked pieces, are found. Whether these antlers were freshly cut off or were collected as fallen ones has not been determined, although dry antler is probably unsuitable for tool manufacture and cast antlers naturally quickly decay. Recently some herds of caribou are reported in the Port Moller area [HEMMING 1971], but their past distribution is not known.

From the number of caribou bones and antler pieces throughout the shell midden deposits, however, caribou must have been abundant on the Peninsula since at least mid-Holocene time.

Fox is an animal commonly encountered even now in the vicinity of the site. It is reasonable to postulate that fox was hunted or trapped for its furs.

Land mammal hunting, however, should be regarded as a minor contributor to the total food supply and must be seen rather as a source of material for implements and clothing as well as meat.

Bird Hunting

We secured bird bones both in 1974 and 1977, and those from the 1977 excavations are now being analyzed by David Yesner, University of Maine, Portland-Gorham. According to his analysis [OKADA, OKADA and KOTANI 1979: 49], loons, albatross, cormorants, ducks, gulls, murre and auklets are abundantly represented in the faunal collection and a few geese are also present.

Of the bird species so far identified, albatross, ducks and geese are particularly important for two reasons. One is that these birds are fairly large and must have constituted significant supplies of meat and raw materials for tools. Another reason is that all of these birds are migratory, nesting in the vicinity of the site in summer and flying south early in autumn. It is reasonable to suggest that the hunting of these important birds must have been carried out in the summer months on the open sea, the sandy flats, on the tundra or on the pond behind the site.

Further details of bird hunting activities still remain to be clarified through analysis of samples from the 1977 field season as well as studies of present day bird ecology and biomass on the Bristol Bay side of the Peninsula.

Fishing

Bones of shark, herring, salmon, cod, halibut, flounder and sculpin have so far been identified at the site. Salmon, cod, halibut and flounder are continuously represented throughout the periods of occupation.

On the basis of fishing implements excavated at the site and the ecological requirements of these fish, techniques such as net fishing, spearing, and hook-and-line fishing are suggested. Salmon may have been taken by nets as well as spears at the mouth of streams, although streams are not found in the immediate vicinity of the site. The existence of halibut and cod suggests the practice of hook-and-line fishing in the open sea and probable deep sea fishing line weights and compound fish hooks occur throughout the site occupation. Herring may have been caught by nets or possibly collected in shallow water with herring rakes. Although the migratory patterns of identified fish species have to be further analyzed, it is probable that they were taken in the summer months.

Collecting

Ethnographically, collecting activities consist of the exploitation of tidal zones

on the coast as well as gathering of plant resources. At the Port Moller site, however, only evidence of intertidal zone exploitation is available in the form of univalves, bivalves and sea urchins. Living conditions of these shellfish and sea urchins can be divided into rocky bottom or reef and sandy or muddy bottom in the tidal zone or below it.

In the vicinity of the site, extensive sandy flats are exposed at low tide, and narrow strips of rocky beach or reef are also exposed along the shore. Under the rocky bottom conditions, sea urchins, univalves and blue mussels are found, while other bivalve shells are encountered on sandy flats.

The collecting activities in the tidal zone or below it thus consisted of two kinds. One was the collecting of sea urchins and other rocky bottom dwelling shellfish, and the other was the collecting of sandy bottom living varieties, such as cockles, tellins and clams.

Activity Zones

In summarizing the subsistence activities following McCartney's [1977] procurement systems and habitat locations (Fig. 1), sea mammal hunting is presumed to have been carried out off shore in the bay, on the open water of the southern Bering Sea, and on shore in the bay; land mammal hunting on the tundra and in the mountains behind the site area; bird hunting on sandy flats, the tundra and fresh and salt water; net, hook-and-line and spear fishing, off shore in the bay, on the open sea, and on shore in the bay and in the stream mouth; and tidal zone collecting on rocky reefs or bottoms and on sandy flats at low tides. Collecting of shells and sea urchins show some major changes over time, the details of which will be discussed below.

Of all the reconstructed subsistence activities, sea mammal hunting, intertidal collecting, and fishing must have constituted the major subsistence base. Land mammal hunting was probably only supplementary, although caribou antlers are abundantly represented in partly worked pieces and tools. This is to say that the maritime adaptation or maritime-oriented economy was continuously maintained throughout the occupation periods. The stability of this maritime-oriented economy

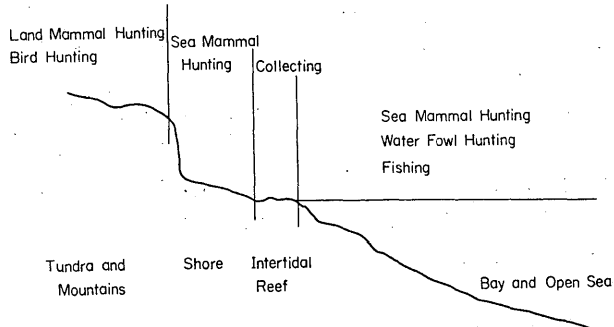


Figure 1. Schematic Activity Zones during the Early Period (After MCCARTNEY 1977).

can be interpreted as one of the major factors that accounts for the large size of the village.

TEMPORAL CHANGES: IMPLICATIONS OF ENVIRONMENTAL CHANGES

The maritime or marine-oriented economy was continuously maintained at the site so far as classes of subsistence activities in general are concerned. Despite this seeming continuity in subsistence activities, the shells in the middens show some significant shifts, particularly in the deposits on the highland portion of the site where cultural layers I through VII have been observed and where the cultural record is of greatest temporal extent.

Stratigraphically, the lower layers (III-VII) of the highland area yielded shells and sea urchins living under rocky conditions. The upper layers (I-II), on the other hand, produced shells from predominantly sandy or muddy environments, although a small quantity of rocky bottom dwelling shells were sporadically encountered.

This shift can be interpreted as reflecting an episode of sand accumulation in the Port Moller area. This accumulation of sand must have taken place between 3000 B. P. and 1500 B. P., when the site was not occupied on the basis of the nature of deposits and associated radiocarbon dates. In other words, large-scale deposition of sand must have started around 3000 B. P. and, as a result, the bay itself was filled with sandy deposits, with extensive sandy flats coming to be exposed at low tide, as now characterizes Port Moller Bay.

Two significant changes, which are closely related to site occupation as well as subsistence activities, must have resulted from this. One is a change in shell species available for collecting activities. As was mentioned above, the majority of rocky bottom dwelling shells and sea urchins were replaced by sandy bottom dwelling ones, and, thus, the focus of collecting activities shifted and the space for such collection was extended (Fig. 2).

The other change was related to the formation of a series of sand dunes between the site area and the mountains. As was briefly mentioned above, the house depressions on the lowland portion of the site are accompanied by layers culturally and

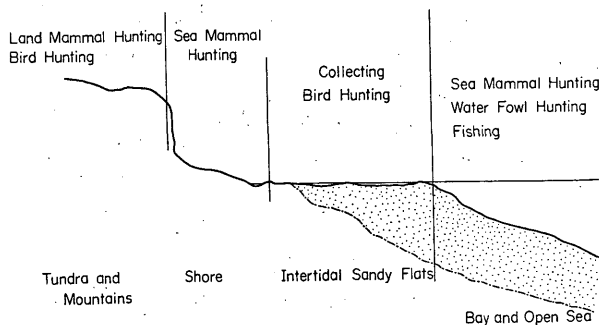


Figure 2. Schematic Activity Zones after Sand Accumulation.

stratigraphically comparable to layers I and II, with layers III through VII totally absent here on the lowland. This is confirmed by the fact that shell midden deposits correlated with layer II directly overlie the sterile sandy deposits. On the basis of the radiocarbon date of 1390 ± 70 B. P. or 560 A. D. (TK-124) obtained from the floor of the lowland house, sand dunes in the site area were available for human occupation at least by 1500 B. P.

With these changes, the potential settlement area expanded from the highland, which is presumed to have once been an island, to both the lowland and highland, and a larger population at the site also become feasible in terms of living space.

After this sand deposition, the site saw two periods of human occupation, which we have named the middle and late periods. The site was finally abandoned, perhaps around 600 B. P. Since no historic artifacts are available this abandonment must have taken place well before white contact. Causes for the abandonment of the site are not clear.

CONCLUDING WORDS

Several important problems still remain to be clarified concerning faunal remains from the Hot Springs site. One such problem is intra-site variation in the occurrence of animal bones. Trench Q-7, for example, is characterized throughout the occupation periods by bulky bones of large sea mammals including walruses and whales. Trench U-7, on the other hand, produced relatively small bones, although a partly cut whale vertebrate was excavated. Closeness of Trench Q-7 to, and relative remoteness of Trench U-7 from, the water may account for such variations. In other words, some parts of the site area may have been utilized for some special purposes, and, therefore, activity zones within the site are postulated to have existed—e.g., certain places for butchering, skinning, preserving, etc.

Another problem is concerned with seasonal variations in subsistence activities, and therefore is related to seasonality of site occupation, as is reconstructed at the coast of Shelikof Strait in the northeastern Peninsula [DUMOND 1977]. Since analysis of growth rings on shells, bird bones, or immature animal bones necessary for determining the time of collecting, fishing or hunting has not yet been carried out, it is too early now to infer seasonality of such activities.

Accumulation of sandy deposits in the Port Moller area is presumed not to be a localized environmental change but rather a widespread phenomenon observable all along the Bristol Bay side of the Peninsula such as Port Heiden Bay [BLACK 1951]. Sites in the Izembek Lagoon toward the tip of the Peninsula, which are radiocarbon dated roughly from 1000 to 500 B. P. [MCCARTNEY 1974], did not yield many sea urchin spicules. Although this fact is interpreted by the investigator as reflecting either the ignoring of these food resources on the part of inhabitants or seasonality of site occupation [cf. MCCARTNEY 1974: 65], I would rather regard it as a result of sandy sedimentation, which must have filled up the rocky intertidal zones before man's occupation took place there. Radiocarbon dates from Izembek Lagoon do not seem

incompatible with the chronology of accumulation of sandy deposits at Port Moller.

Environmental changes reconstructed from the contents of the shell midden deposits at the Hot Springs site should thus be considered in relation to sand dune formations widely observable around the Bering Sea. Study along this line is expected to yield some insight into potential settlement expansion and the dynamic aspects of subsistence activities.

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