CHAPTER III
The Zhokhov Island Mesolithic Site

3.1. Geography, Palaeoenvironment, and Quaternary Deposits

The De Long Islands, located between 75° and 76°N and from 148°50' to 159°E, are the northernmost part of the New Siberian Islands. This group consists of five small, isolated islands. From Anzhu Island, the main part of the archipelago, the closest island to the group—Vil'kitsky Island—is approximately 60 km, and the farthest—Jeannette Island—is some 200 km. Three of them—Jeannette, Henrietta, and Bennett Islands—were discovered in 1881 during a polar expedition led by George Washington De Long, a U.S. Navy officer. Two others—Vil'kitsky and Zhokhov Islands—were put on the map in a Russian expedition led by Boris Vil'kitsky in 1913–1915 on the icebreakers *Taimyr* and *Vaygach*. For the past 80 years the islands have been rarely visited. The weather station established on Henrietta Island in the 1930s lasted until 1963. Another one, established in 1955 on Zhokhov Island, was closed, as was the logistics camp of the Arctic and Antarctic Research Institute (AARI), in September 1993. The De Long Islands, which have a total area of only about 300 km^2, were closed for decades to non-Soviet scientists, and little has previously been written about them outside Russia.

The polar geography department of the Arctic and Antarctic Research Institute in St. Petersburg conducted an interdisciplinary research project in 1987, 1989, and 1990 on two of the islands of the archipelago—Bennett Island and Zhokhov Island. The program considered many aspects of the Late Quaternary period of the region, particularly glaciology, geomorphology, palaeoenvironment, and the problems of early human occupation of this area of the high Arctic (Verkulich et al. 1989; Verkulich, Krusanov, and Anisimov 1990; Makeyev and Pitul'ko 1991; Makeyev, Pitul'ko, and Kasparov 1992ab; Pitul'ko 1993; and others).

The modern environment of the archipelago is that of a typical polar desert, unfavorable for most species of land flora and fauna and providing poor facilities for human survival. Illustrative of this point are several parameters of the environment. For example, at the weather station on Zhokhov Island, the July mean temperature varies from +0.5 to +1.0°C (32.9 to 33.8°F), while that in January is -28 to -30°C (-18.4 to -22°F). The average annual precipitation approaches 135 mm (8.24 inches).

The ice cover is extensive on Henrietta and Bennett Islands, covering almost 60% of the former and approximately 44% of the latter (Koryakin 1988:97, 98). According to Verkulich and others (190:111–115), there are four major glaciers on Bennett Island: the Toll (55 km^2), the East De Long (5.15 km^2), and the West De Long (1.17 km^2) glaciers, and the Maly ice dome (4.04 km^2).

The vegetation on the islands is sparse; only 30 different species of flowering plants are known to exist in the entire archipelago, while it is observed that the moss and lichen flora are rather diverse. Similarly, there is not a wide variety of mammalian life, which consists mainly of polar bears, foxes, and sea mammals (notably ringed seals, occasionally bearded seals and walrus). The walrus of the Laptev Sea area are believed to differ from the Atlantic (*Odobenus rosmarus rosmarus*) and Pacific (*Odobenus rosmarus divergens*) subspecies, and Chapsky (1940) tentatively describes them as a separate subspecies: *Odobenus rosmarus laptevi.* However, the remaining animals in this group, whose natural habitat extends from the east coast of the Taimyr Peninsula to the De Long Islands area, are generally regarded by taxonomists as *Odobenus rosmarus rosmarus* because of craniological similarities. Reindeer are no longer found in the De Long Islands, although Edward Toll' and his companions reported seeing them on Bennett Island in 1902. Many birds migrate to the De Long Islands in the spring and remain until early autumn.

Since the fundament of most of the islands consists of similar Cretaceous alkali igneous rock formations (in addition, Palaeozoic sedimentary rocks were found on Bennett Island), the islands are similar to each other in topography, appearing as plateau-like surfaces elevated 200 to 400 m above sea level and bounded by steep cliffs. Zhokhov Island is an exception, with a Pleistocene low-lying plain in the southwestern and eastern sections and uplands in the central part. The thin cover of Quaternary sediments overlying bedrock has been surveyed on each island. These sediments are best studied on the largest islands of the archipelago—Bennett Island and Zhokhov Island—where they cover the most extensive areas. There are marine, lacustrine, bog, slope, glacial, and icy loess loam ("yedoma" type) deposits. This composition is assembled as channel sediments in creek and river valleys. Severe permafrost conditions are present in these areas and the fine-grained deposits are often broken by epigenetic polygonal ice veins of several generations, whose thickness can be about 5–7 m and width 3 or 4 m. The average size of the active horizon thickness is about 20 cm.

Marine deposits have been discovered on some marine-cut terrace levels: at elevations 2.5–3 m (I), 8–12 m (II), 25–40 m (III), and 50–70 m (IV) on Zhokhov Island, and at 4–5 m (I), 7–10 m (II), 40–50 m (III), 80–100 m (IV) on Bennett Island. The terraces are primarily bedrock. Marine sediments are not thick as a rule, and in a number of cases they look simply like pebbled surfaces, but sometimes the thickness can be much greater. Thus it could reach about 25 m in buried valleys, where a composition of sand and aleurite deposits, pebble gravels, and boulder sediments have been discovered associated with marine mollusk fauna (foraminifera, ostracodes, and sponges) and fossil pollen associations coming from some layers. At present there are only two levels (the 1st and 3rd), dated respectively to 4000–5000 BP (1st) and 300,000–350,000 BP (3rd). The 2nd terrace is most likely of Kazantsevo age inasmuch as exposed deposits are dated from 29,830 ± 780 (LU-2027) to >40,850 BP, LU-2146 (Makeyev, Pitul'ko, and Kasparov 1992:271, 272).

Drift sediments are represented generally by diverse morainic deposits of ablation, bottom, or rarely, end moraines. There are no fluvioglacial deposits on the islands. The latter probably disappeared due to transgression, being located on submerged lowlands, or eroded and buried by channel deposits in erosional valleys. Moraines located on watersheds are usually represented as single transported boulders and blocks, or as sections with a boulder surface; boulder-loam soils are found on nearby slopes or in topographic depressions. End moraine deposits (boulders, pebbles, and stone blocks with lenses of boulder-pebble-loam soil and sand lenses) have a clear topographic occurrence, being represented by low hills and morainal ridges that sometimes comprise chain structures 400 m long and 50 m wide.

Drift accumulations are believed to have been deposited during two glacial periods, and it is recognized that the most extensive sediments of the earlier one are of the Zyryan glaciation (Makeyev, Pitul'ko, and Kasparov 1992). The recent one, recognized as the Sartan, covered the Bennett Island area almost completely (Verkulich et al. 1989) but was restricted to the central upland on Zhokhov Island, where small glaciers were of both the cirque and slope kinds. According to radiocarbon dates, the last glaciation of the De Long Islands ended at the very conclusion of the Pleistocene. Carbon dates of 12,590 ± 60 BP (LU-2096), obtained from mammoth ivory on Bennett Island (Verkulich et al. 1989), and of 10,960 ± 310 BP (LU-2516), obtained from peat extracted from the banks overlying Sartan moraine deposits on Zhokhov Island, indicate that the local ice sheets had disappeared or were minimal during this period (Makeyev and Pitul'ko 1991).

Both the slope deposits covering the eastern section of Bennett Island and the icy loess accumulations in the southern and eastern sections of Zhokhov Island contain numerous bone remains of fossil faunal species (mammoth, bison, horse). The former are dated to 30,000–29,000 BP and associated with pollen from a predominance of herbaceous floral species (wormwood, cereal plants, and sedge), indicating a rigorous continental climate characteristic of this interval and the tundra-steppe landscapes that occupied the area. They are similar to pollen obtained from loess sediments on Zhokhov Island—although the latter are from a somewhat later period—and are extremely close to pollen associations coming from nonglacial deposits of Sartan age studied on Kotelny Island (Makeyev et al. 1989; Makeyev, Pitul'ko, and Kasparov 1992). All these data show that the mammoth faunal assemblage successfully survived even during the Sartan glacial. But probably some species, such as bison and horses, were already absent.

Boggy lake sediments, widespread on Zhokhov Island in particular, are of special interest. In general, they can be found overlying the rest of the Quaternary accumulations except the most recent sediments or re-depositions. This stratum is composed of well-bedded aleurite and loamy soil with strong ice content and peat (or organic detritus) interlayers. The observed thickness of these sediments does not exceed 3 m. The floral species and pollen frequencies obtained from the column sequences vary markedly.

The Early Holocene deposits, dated in the interval from 11,000 to 7800 BP, are characterized by pollen complexes with herbs predominating (the absolute pollen frequency varying from 60 to 90% in some horizons); cereal plants and sedge represent the greatest part of the composition, although species of wormwood (*Artemisia*), pinks (*Dianthus*), and valerians (*Valeriana*) have peak concentrations in some beds. The pollen content of arborescent vegetation generally fluctuates from 5 to 16%, while spore grains range from 3 to 30%. The layer, dated from 9500 to 8700 BP, is composed of moss-and-grass peat containing willow macro fossils (twigs and leaves). The absolute pollen content of the arborescent group rises sharply, up to 30%. The arborescent composition includes *Betula* sect. *Fruticosae* (36%), *Alnaster* (18%), and *Salix* species 17%. Cereals (*Cyperaceae*) predominate among herbs, while spore grains are only 5–7%.

Pollen associations dated from 8020 to 7800 BP are somewhat different. Herbs and dwarf-shrubs absolutely predominate, their content rising up to 74–87% (cereals up to 39%, pinks up to 20%, valerians up to 28%, and wormwoods up to 9%). Unlike the former horizon, the absolute pollen content of arborescent plants decreases strongly down to 5%; spore grain frequency is at the same level—about 5–7%. In summary, the pollen assemblage characteristic for the interval 8020 to 7800 BP shows that typical polar tundra landscapes existed on Zhokhov Island contemporaneously with the Zhokhov Island Mesolithic sites, and was the natural environment of the early high Arctic natives.

All of the available data make it possible to consider the next succession of the regional climatic-environmental changes in the Late Pleistocene-Holocene.

The continental-type climate of the De Long archipelago area was stable during the major part of the Late Pleistocene, as far back as the post Kazantsev and later. From this time until the Middle Holocene, sea level was significantly below that of the present day. The Arctic Ocean reached its maximal regressive phase 20,000 to 18,000 BP, corresponding with the cold Sartan thermal maximum, and an extensive area of shelf zone (up to 100–120 m depth) was exposed. The shorelines were shifted farther northward, and in the De Long area the shoreline was located somewhere at the latitude of Bennett Island. The New Siberian Islands and, to some degree, the coastal Kolyma and Yano-Indigirskaya lowlands are relics of this Arctic land. The expanded flatland that appeared was an additional factor affecting the climate, which became more continental. The global cold temperature trend that took place in the Late Pleistocene was less important because of the moderating of the regional one. Glaciation occurred twice in that period, but both glacials were rather small in range and did not affect the environment in the least. Later, a warm global climatic trend distinctly occurred in the region.

The climate of the New Siberian region was warmer than the current one during most of the Holocene; the interval from 10,000 to 8500 BP was especially warm. The latter is considered the Holocene climatic optimum of the Siberian Arctic, which is attested to by the correlations with paleogeographical data obtained on the high Arctic islands (Verkulich et al. 1989; Makeyev et al. 1979, 1989; Makeyev and Pitul'ko 1992). Contemporaneous with the Flandrean transgression maximum, which took place about 4000 to 4500 BP, the climate of the New Siberian region was transformed into a marine Arctic type. Climatic conditions remained stable up to the Late Holocene, but some fluctuations are recognized: rises in temperature occurred in 7500, 5000, and 2500 to 2000 BP. Analogous data on climatic changes in the New Siberian Islands area have been obtained from the profile sections of Kotelny Island (Makeyev and Ponomaryeva 1988).

The great Arctic plain was submerged or eroded by the Late Pleistocene-Holocene transgression of the Arctic Ocean, but extensive relic sections existed as recently as 8000 BP. The rate of transgression was irregular throughout the Arctic, owing to the direction and intensity of tectonic movements and glacio-isostatic effects (Ivanov and Makeyev 1987). Transgression was dynamic and reached the maximum about 4000 BP, remaining for a while above the current sea level. The formation of the New Siberian Island chain most likely ended at that time.

Available data (Degtyarenko et al. 1982) provide a poor background for considering the dynamics of this process. Sea-level fluctuations resulted in the development between 8000 and 9000 BP of a sea level 20 to 25 m below the current one in the New Siberian region. That the mean depths (at the shelf) of the Laptev Sea and the East Siberian Sea are generally not more than 20 m indicates that most of the New Siberian Islands as far north as Vil'kitsky Island were a peripheral flatland joining the mainland and are an extensive relic of Arctic land—the "New Siberian Peninsula" (Figure 2)—which was easily accessible for hunting groups penetrating polar areas at least to 71°N as far back as 13,000 BP. It is not quite clear whether Zhokhov Island was part of the "peninsula." Vil'kitsky and Zhokhov Islands were probably separated by a narrow sound 5 to 8 km wide; even if Zhokhov Island was an island, it was still considerably larger than today.

However, it is obvious that some part of the shoreline was located near the current Zhokhov Island in about 8000 BP, which is indicated by the excavated materials: an abundance of driftwood and artifacts made of that material were found as well as the numerous polar bear bones and isolated bones of sea mammals.

3.2. A Story of Research, Site Location, Stratigraphy of the Site, and Dating

It can easily be seen that islands of the De Long archipelago are a rather remote, isolated area that is difficult to reach. They are completely deserted now. Weather stations were established on some islands, which were therefore permanently inhabited. A station existed on Henrietta Island from the mid-1930s to 1963; another was established in 1955 on the southeastern part of Zhokhov Island. (It was moved to the northeastern extremity of the island at the very beginning of the 1970s, and closed, along with the AARI logistic camp, in 1993.)

In summer 1967 I. Ye. Zhidkov, a mechanic operator from the Zhokhov weather station, and a telegrapher from the crew of the vessel *Indigirka* whose name remains unknown, gathered a few artifacts in the southwestern part of Zhokhov Island. A major portion of the artifacts was later lost, but two large tools resembling picks or mattocks made of mammoth ivory were brought by chance to the Leningrad Branch of the Institute of Archaeology (now the Institute for Material Culture History in St. Petersburg) at the beginning of the 1970s; they were reported as surface finds discovered somewhere on Zhokhov Island. Because of fluvial abrasion, the artifacts had smoothed surfaces; it was impossible to advance an idea about how they were processed or, even more, to date them precisely inasmuch as tools of that kind are known from recent Eskimo sites. Taking into account both the first and the second, L.P. Khlobystin, who examined the finds, has advanced a correct but relative interpretation by considering them to be from the Iron Age. Applied to the absolute chronology of Arctic sites, this means within the last

2000 or 2500 years. In exactly that way of interpreting, the finds were put on the archaeological map of the Arctic (*The Arctic Atlas* 1985:Map 20). Although on the map, "scientific discovery" of the site took place about 20 years later. Verbal information about the site circulated among the personnel of the polar stations located on the New Siberian Islands and was collected by palaeogeographer V.M. Makeyev while surveying the southern area of the archipelago in the late 1970s to mid-1980s. Once the exact site location was identified it became possible to survey it, and S.A. Kessel, leading the Zhokhov logistics camp of AARI in 1985–1986, collected some surface finds. The collection, brought to Leningrad (St. Petersburg), was composed of fragmented bones, antlers, and wooden pieces with good preservation, some of them split or with cut marks. Because of that, the material was thought to be rather recent, but the first carbon date obtained from a wood sample was surprisingly ancient (more than 8000 BP). These facts were reported by Khlobystin at the Arctic Meeting in Honor of the 200th Anniversary of Arctic Archaeological Research, which was held in Leningrad in the spring of 1987. However, the report (Khlobystin 1990) appeared when the first results of the excavations were published. I had a chance to excavate the site twice, in 1989 and 1990. The excavations were supported by the Arctic and Antarctic Research Institute as part of the interdisciplinary project conducted on the De Long archipelago in 1987, 1989, and 1990. The field seasons were rather long, occupying five months in 1989 and about four in 1990, although the excavations were significantly shorter—about six and eight weeks respectively.

Zhokhov Island is one of the five islands in the De Long group, which along with the Anzhu and Lyakhovskiye groups comprise the New Siberian Islands. It is situated at 76°N. The island is small; the greatest distance from north to south is about 11 km, from west to east approximately 9 km. The central section of the island is of upland topography, with isolated isometric or ridged hills formed mostly by effusive basalt; the highest elevation is approximately 125 m above sea level. One of the isolated hills, in the southwestern part of the island, has an elevation of 115 m. The Zhokhov Island site is located near this hill (Figure 1:2). A low-lying littoral plain, flat and sloping to the sea, occupies the rest of the island. This plain is probably a remnant surface of the ancient abrading-accumulating terrace of the Pleistocene sea. Its elevation is between 20 and 40 m. The plain's surface is intensively dissected by small, shallow thermokarst depressions and by a system of erosion valleys radiating from the center of the island. The valleys are cut 15 to 20 m in depth; a major part of them have small intermittent rivers or creeks.

A sequence of marine terraces has been distinguished not far from the modern shoreline (see above). They are present in a number of places, including the territory near the site. The two lower ones were most likely formed during the second half of the Holocene. As mentioned earlier, all of the terraces are cut into pre-Quaternary bedrock, commonly basalt. The bedrock is exposed on the surface of the modern terrace in some locations on the west side of the island. Here and there the bedrock is overlain by a thin cover of slope deposits. The cover of Quaternary sediments composed of marine, lake bog, and alluvial deposits (sand, sandy and loamy soils, pebbles, and peats) has a greater thickness in the southwestern, southern, and southeastern sections of the island, including the site location. These areas have severe permafrost conditions, and the deposits are often broken by several generations of epigenetic polygonal ice veins. As a result of thermokarst and other cryogenic processes, karst and pingo-like mesorelief is widespread on the slopes of the river and creek valleys. Since this type of mesorelief is rarely found on valley-side slopes, it is a distinctive feature of this terrain.

The vegetation is sparse on the site and on the island as a whole as well as on other islands of the De Long archipelago. Typical polar floral associations are found on Zhokhov Island; they include mosses, lichens, diverse grasses, and shrubs common to impoverished Arctic tundras.

The site location is east of a small creek valley that crosses the littoral plain not far from the foot of an isolated hill (Figures 1:2; 1:3; 3). In selecting this site, the ancient inhabitants probably took into account some or all of the following factors: (1) the presence of a fresh water spring; (2) the hill might be used as an observation post, or (3) it might provide protection from extreme weather, especially the strong north wind; and (4) the area was naturally well drained. The site today is not far from the beach—about 1 km. While the previous position of the coastline is uncertain, the beach or a lagoon must have been near enough to provide the source of the great quantity of split driftwood used by inhabitants of the site.

The area of the site is about 8,000 m^2 and ranges in elevation from 13 to 20 m above sea level (Figure 1:3). Surface finds are discovered sporadically in this area, but sometimes fragmented bones and pieces of split driftwood, having been pushed to the surface by cryogenic processes, form accumulations within the thermokarst hollows (Figure 4) or in the center of certain shallow round pits (Figures 5, 6). Thirteen such features were found, some of which could probably be dwellings. The cultural layer on the largest part of the site is most probably discontinuous, with material being concentrated around the dwellings (?).I judge that the high part of the site was intensively used. One such location is a cape-like projection turning into the creek valley on the highest part of the site (Figure 7). This area was subjected to intensive destruction from erosional processes and solifluction. Features numbered 1, 2, and 3 are on this "cape" (Figure 1:3). They seem to be dwellings disturbed by solifluction. Feature 1 is a disordered accumulation of bones and large pieces on the cape extremity. Features 2 and 3, on the west slope of the cape, are also disturbed as well as Feature 4, which is exposed in a thermokarst depression (Figure 1:3). The intact portions were excavated.

The excavations were carried on in accordance with methods generally practiced, except for the determination of elevation for each find (only wooden pieces were vertically determined); the latter seems to be senseless for this site because of the peculiarities of a permafrost-affected cultural layer. Though the materials dug out had never been redeposited, none of the artifacts was unquestionably found in its original position. A lot of information was revealed concerning the permafrost-affected orientation or position of the artifacts; thus the small ones "float" in the permafrost horizon. Unfortunately, it was impossible to manage screening or washing the matrix. Excavations in permafrost horizons are site-specific because of excess moisture in the soils owing to melting of dispersed ice, ice veins, etc. Therefore it is sometimes necessary to make artificial drainage for the dig, and areas naturally sloping with an angle of 3° to 5° are the most usable for excavations for obvious reasons. The experience of the Zhokhov excavations shows that the best digging strategy that could be applied by a small team of four members (under the condition that the project was supposed to be of about a two-month duration) was to open 70 to 80 m^2 simultaneously, to a depth of the top of permafrost layer, i.e., the active horizon needed to be dug out. After that, it became possible to excavate in succession the areas that had thawed out (the normal depth of thawing was commonly about 2 to 3 cm per day), but for excavations to start, the thawed areas needed to be drained and dried, which takes 1 to 3 days (Figure 8). The excavation of areas saturated with wooden pieces, where slowly melting lenses of solid ice are concentrated (Figure 9), is most complex owing to the heat resistance of the latter. The slowly melting lenses promote constant surplus moisture in the layer and conservation of a low surface temperature (about 0°C). Excavation was relatively easier on the sloping, well-drained sections, such as 1–8, dug out in 1989, and 24 and 25 in the 1990 dig; these were located on a steep slope of the cape (Figures 10, 11). In contrast, excavations on flat areas were extremely difficult, especially when they were saturated with wooden pieces and fossil ice. However, we succeeded in excavating 144 m^2 during two field seasons in 1989 and 1990, including an area of approximately 20 m^2 in Sections 31–36 covered by a thermokarst depression (Figures 11, 13, 14).

The area excavated in 1989 **(**Figure 12) was put on the general excavation grid, with continuing research in 1990, and the west section, between grid lines 3 and 7, was excavated first. This section was chosen because it was supposed that (1) the cultural layer covering the flat cape surface was thought to be relatively undamaged by cryogenic processes, and that (2) the section of the cultural layer exposed on the northwest side of the thermokarst depression (Sections 26–28, 32, 33) was extremely attractive for excavations, being saturated with wooden pieces, antlers, and fragmented bones (Figures 5, 15, 16). Later, the excavation was extended to the east of the thermokarst depression. The latter, in fact a separate dig, was named the east section.

Our excavations revealed stratification as presented below. Through precise observations, some stratigraphic differences were recognized between the west and east sections of the dig, but they are of little importance. The stratigraphy of the west section is similar to a column already published (Pitul'ko 1993).

Inasmuch as the deposits lying in the direction of Line C are of greater thickness, but still remain in the original position, the cross section done from point C1 to C5 can be considered the reference (Figures 18, 19, 20). The sequence is as follows:

1. Turf cover (often broken).	3–5 cm
2. Modern grey-brown light loamy soil, vaguely bedded and saturated with crumbled stones of a local sort, dense, and rarely pebbles and gravel.[1]	3–25 cm
3. Icy peat moss, fragmented and exfoliating, brown or dark-brown, or almost black in color, containing small bone fragments, wood pieces, and single flints; a contact zone with both overlying and underlying horizons (especially with the latter) is characteristic.[2]	thickness varies from 1–2 to 15–20 cm

4. Ice-cemented bright-brown loamy soil, well frozen and containing artifacts, faunal remains, wood, charcoal (cultural layer); ice is in interbeds, clusters, and lenses; the latter are 4 to 5 cm thick and especially numerous in wood accumulations; ice contains gas bubbles and has flinty fractures; the total ice content is 50 to 70%; both contacts are embayed.	thickness varies from 8–10 to 30–40 cm
5. Bedded composition of dense gravel with an admixture of sand, crumbled rocks, pebbles, and small boulders, and with ice interbedding;[3] bedding is flat, flat-dipping, or inclined and could be observed especially clearly after the melting of the ice interbeddings and lenses; the latter are 1 to 5 cm thick; the total ice content is about 60%; dense gravel and crumbled stones (tuff rocks), primarily red-brown in color, are poorly water-rolled; the thawed layer is of the same color (channel deposits).	15–30 cm
6. Blue-grey hard loamy soil, dense and containing a quantity of pebbles; small (2 to 5 cm) compact lenses of black-brown paper peat (rolls from eroded sediments?); the layer of high ice content has a thick-bedded texture (wavy, fine bedded in spacing).[4]	thickness was not defined

Notes

[1] The thickness of the active horizon does not exceed 20 cm at the site. All of the deposits are in permafrost conditions beginning approximately from this level and saturated with veins of ice (cluster ice, ice lenses, and interbeddings). Discovered there were three generations of polygonal ice veins ranging in thickness of centimeters, decimeters, and meters, which are superposed.

[2] Found discontinuously in the West section of the dig, with varying thickness. The layer is of recent age and carbon dated to 2200 ± 30 (LU-2435). Peat accumulated in some extended thermokarst depressions during the last series of warm Holocene periods, pointed out by Makeyev and Ponomaryeva (1988). The peat layer contains individual artifacts and faunal remains, but by no means can these be considered evidence of recent occupation of the site since they are connected with the commonly observed normal migration process of some objects in permafrost soils. Besides, the artifacts might have been introduced into the peat layer as the result of the kettle cut into a cultural layer. Permafrost affecting the position of artifacts can be seen easily from the position of elongated artifacts or, more often, wood pieces that as a rule are found in a more or less vertical position.

[3] Lenses of the same composition were found while excavating a cultural layer.

[4] Only the upper part of that layer was exposed in the cross section C1–C5. Its genesis is unclear. However, analogous deposits have been described in a major part of the New Siberian Islands and, according to some researchers, indicate a surface drained by the Sartan regression of the Arctic Ocean (Sisko 1970:422–453). Peat sampled from the top level of the stratum was dated to 8790 ± 90 (LU-2502). This provides the earliest date for the site.

The succession described in cross section C is typical for the entire west section of the dig. We found that the cultural layer was disturbed more or less substantially, or almost completely gone, owing to sliding in Sections 9, 10, 13–15, 17–21, and 30. Drawing this conclusion, I take into account observations made while excavating Sections 11, 16, 22, and 29 and the character of the distribution of the finds. The clear thinning of the cultural layer was discovered in the direction toward Line 3 and Line D (Figure 13). Also, the cultural layer excavated in Section 25 was not in its original position. The latter probably contained artifacts transported from adjacent elevated sections. The few finds discovered in Section 26 were obviously washed from the thermokarst depression.

A surface exposure of the cultural layer, observed along the northwestern side of the thermokarst depression (Sections 27, 28, 31–33), appeared owing to the sliding of a number of soil blocks comprising the upper part of the cultural layer and covering deposits. Perhaps a part of the solimixtion was secondarily sod-covered.

In this way it can be concluded that the cultural layer remained relatively undisturbed in Sections 1–3, 8, 12, 23, and 24 (Figure 13). The maximal thickness of the alluvial deposits, which contained very few artifacts introduced to a rather deep level of the stratum, was discovered precisely in that area. Wood pieces were found in great abundance in these and adjacent sections: in 16 and 22—in the area along Line D and in Sections 27 and 28 (Figures 12, 15, 16). The dimensional diversity of the fragmented wood deserves attention. As a rule, there were relatively small wood pieces and slivers, but a considerable quantity of large posts were found too. Both the former and the latter have clear traces of artificial splitting or other processing marks. Many of those excavated were in a vertical position. Still it is doubtful whether these are the remains of dwelling structures inasmuch as this position of wood fragments, as well as elongated artifacts that turn up, can be affected by the natural life of the permafrost layer, expulsion processes, etc. It is difficult to find regularity in the distribution of the wood pieces, but apparently a structure was discovered in Sections 12 and 16 near Line C, bounding them, where some overlapping wooden blocks provided the most productive spot for the cultural layer (Figure 16). Perhaps they can be interpreted as the remains of a roof or wall structure. A similar composition of large wooden blocks is also observed in Sections 1 and 2, excavated in 1989 (Figures 12, 21).

As mentioned above, and what is absolutely obvious from the description of cross section C, all of the excavated deposits are ice-cemented with the ice content often rising to 60–70%. Besides, three generations of polygonal ice veins were discovered ranging in thickness of centimeters, decimeters, and meters, and superimposed. The strata are saturated with segregated ice of different sorts (cluster ice, ice lenses, and interbeddings) making up the ice veins. Owing to the destruction of the strong, three-meter-thick ice vein exposed in Sections 31, 40, and 43, a thermokarst depression occurred sometime at the most elevated area of the site, now covering the central part of the excavation grid (Figure 1:3; 11). A rounded, circular slide depression has a bottom overlaid by a thin cover of wet loamy soil containing few small wood pieces and bone fragments. Its entry, open to the creek valley, was overlapped partly by dump soil left by some amateur excavations about 20 to 25 years ago; the dump had a secondary turf-like crust composed of lichens and mosses. A few insignificant artifacts were found there. The solimixtion covering of the slide slopes of the depression was excavated as well as an undisturbed area.

As for the depression, the most significant results were obtained while excavating Sections 41 and 42, adjacent to the east area of the dig and covering the southeastern slope (Figure 24). The latter is located almost along the Line E10–D10, where posts and large wooden blocks resembling a roof structure or planking were observed in 1989 (Figure 6; Pitul'ko 1990, Field Report: Figs. 25, 26). Surprisingly, nothing connected with the latter was found when excavating Sections 41 and 42 or the adjacent Section 50 (Figure 17).

It was recognized that a considerable part of Section 41 serves as a trap for sediments containing cultural remains, which were accumulated in the accretion vein stretched in the direction from F9 to E10, i.e., along the diagonal of the section. All the pieces found in that vein accumulation are laid out within the limits of a narrow strip 30 to 50 cm wide (Figure 14). Outside these limits the cultural layer is in the original position. Because of the great thickness of deposits, the second reference profile was done from point F10 to point E10 (Figure 24). The stratigraphic succession described for the latter differs slightly from the sequence found in the C1–C5 (west) profile, but it is typical of the east area of the dig, at least with respect to the upper levels. The ice underlying the profile does not extend continuously in the entire east area of the dig; normally there is a horizon of heavy gray-blue loamy soil at the base of the sequence. It is obvious that the major difference between the west and east stratigraphic sequences is the absence of a peat layer in the latter, while other differences are less important. However, the horizon does not have a uniform thickness and has a discontinuous extent even in the west dig area; the maximal thickness of the peat layer was observed in Sections 8, 12, and 25.

The East reference section is as follows:

1. Turf cover (often broken).	0–3 cm
2. Modern grey (with blue tint) heavy sandy soil, fractured; contains grass roots in fractures, and single crumbled stones of local sort, large in size.	13–15 cm
3. Ice-cemented gray (with blue tint) light, clumpy loamy soil, well frozen and containing artifacts, faunal remains, wood, charcoal, hide pieces of hair, dog excrement (cultural layer) as well as peat portions, crumbled stones, pebbles, and cobbles; the lower part of the stratum is poorly bedded due to alternation of extremely thin beds of pure loamy soil saturated with organic detritus; the upper contact is embayed.	37–40 cm
4. Ice-cemented coarse sand with an admixture of gravel, crumbled rocks, pebbles, and small boulders; lenticular interbedded; lenses consisting of beige sandy soil are 1 to 2 cm thick and contain fragments of wood and plant detritus; a few pieces of bone and wood were found, one of the latter dating to 8020 ± 50 BP; detritus, gravel, and crumbled stones (tuff), mainly red-brown in color, are poorly water-rolled; the thawed layer is of the same color (channel deposits).	25 cm
5. Ice horizon, replaced in the rest of the excavated area by blue-gray hard loamy soil, containing some quantity of pebbles and detritus, and small (2 to 5 cm) compact lenses of black-brown paper peat (rolls from eroded sediments?); the layer of high ice content has a thick-bedded texture (wavy, fine-bedded in spacing).	thickness was not defined

All the deposits except the active horizon are ice-cemented with the total ice content varying from 50 to 70%, and saturated with separated ice found as interbeds, clusters, and lenses—the latter 4 to 5 cm thick—and especially numerous inclusions of wood; the ice contains gas bubbles and has a flinty fracture. The entire stratum has a thin interbedded texture as a rule, while thick interbedding is rare.

The finds excavated from Section 41 were not numerous but appeared to be rather interesting. In addition, the faunal remains collected there were numerous (this is one of the most productive sections in that respect). Finally, this place was especially saturated with dog excrement, which was located in a rounded area covering about 1 m^2.

The excavations of Sections 49, 50, 53, and 54 gave poor results. The cultural layer was almost completely absent because of the type of stratification: a solid ice interbed was found immediately under the active horizon from 15 to 20 cm deep. It is most likely that all the deposits slid away inasmuch as there was an ice interlayer 20 to 30 cm thick, whose upper surface was a perfect slickenslide for overlying strata. Obviously, the same theory could be applied to extinct deposits that once covered the south side of the cape, where an analogous ice slickenslide was found in 1989 (Pitul'ko 1990:Field Report, Fig. 15), and perhaps to those of the cape extremity as well.

Few finds were excavated in Sections 49, 50, and 54. They were most likely transported from the remnant of a cultural layer found farther upslope from the thermokarst depression, in the direction of Line 14 (Figures 9, 14). Yet the cultural layer excavated in Section 53 remained more or less undisturbed, though some features of sliding were observed. As the other sections, it should be noted that the layer located between Lines 12 and 14 (Sections 61–64) was never seriously damaged. The composition of the layer found in these sections was characteristic of the site, although neither artifacts nor bone fragments were numerous. Nevertheless, it was exactly there where a unique wooden artifact was discovered—a sled runner (Figure 26; Pitul'ko 1991:Field Report, Fig. 30). Other wooden pieces were abundant; most of them were large fragments of split posts (Figure 17).

Thus it can be concluded that the cultural layer in the West area was excavated completely. It thins out (Figures 12, 13) in the direction to Line F and to the extremity of the cape (Line 1). Considering the wood pieces observed on the surface of the east dig area and the numerous bone fragments found on its slope, the cultural layer remains more or less undisturbed in this section, though it was affected by cryogenic processes and solifluction. To my mind, the flat area lying in the direction toward Line F, where the cultural layer abundant with wood, bones, and artifacts (Figures 14, 17) still remains intact and not affected by sliding, has the best prospects for successful excavations in future.

As is obvious from the foregoing descriptions, a huge amount of diverse organics, including hair and excrement, are well preserved due to the conservative aspects of permafrost. Bone, wood, and charcoal specimens were carbon dated in three laboratories, giving a solid background for dating the site. Besides the above-mentioned dates, there is a large series shown in Table 1 below. Most of the dates were obtained by Yu. S. Svezhentsev, from the Institute for the History of Material Culture in St. Petersburg (lab index LE). Smaller series were obtained by Kh. A. Arslanov from St. Petersburg University (lab index LU) and by L. D. Sulerzhitsky from the Institute for Geology, Moscow (lab index GIN). It can easily be recognized that the dates obtained separately correlate well and, equally important, there are close correlations between dates obtained from organic samples of different origin (bone, wood); however, the only date

Table 1. Radiocarbon dating of the Zhokhov site. Dates are calibrated in CALIB Rev. 3.03c (Stuiver and Reimer 1993). Codes are from: LE—Radiocarbon Lab of the Institute for the History of Material Culture (RAS, St. Petersburg); LU—Radiocarbon Lab of the St. Petersburg State University; GIN—Institute for Geology (RAS, Moscow) Isotope Lab.

			Calendar BP age ranges	
Lab & sample code	**Sample**	**Radiocarbon age BP**	**One Sigma**	**Mid-value**
LE-3527	charcoal	8563 ± 180	9381–8948	9189
LE-3528	fragmented bones	740 ± 190	9446–9270	9377
LE-3529	fragmented bones	8,050 ± 70	8532–8379	8433
LE-3530	wood	12,600 ± 250	14,609–13,912	14,240
LE-3531	wood	7520 ± 150	8080–7782	7920
LE-3532	wood	7640 ± 55	8108–7967	8048
LE-3533	wood	9010 ± 140	9843–9468	9626
LE-3534	fragmented bones	7810 ± 180	8390–8018	8215
LE-3535	wood	7910 ± 180	8492–8127	8328
LE-3536	antler	8610 ± 220	9444–8951	9232
LE-4048	wood	8930 ± 180	9813–9383	9511
LE-4048*		7880 ± 180	8368–8192	8309
LE-4533a	fragmented bones	10,810 ± 390	12,733–11,531	12,311
LE-4533b	fragmented bones	7940 ± 170	8527–8151	8351
LE-4534	wood	7450 ± 220	8079–7634	7879
LE-4534*		7890 ± 150	8424–8133	8315
LU-2432	wood	7870 ± 60	8348–8209	8303
LU-2433	wood	7860 ± 40	8324–8232	8296
LU-2499	wood	8020 ± 50	8476–8370	8409
LU-2502**	detritus	8790 ± 90	9482–9351	9422
GIN-6399	wood	8200 ± 40	8707–8549	8619
GIN-6400	fragmented bones	7930 ± 40	8376–8312	8343
		Average (except LU-2502 sample) from sum of probability distribution	8480–8175	

Notes:
* secondarily measured;
** sample from the underlying stratum; the others are from the cultural layer taken during the excavations.

on charcoal deviates from the mean. The dates are mainly from the interval 7800 to 8000 BP (noncalibrated). Thus the age of the site could be dated to that time, i.e., to the Early Holocene. Besides, sample LU-2502 gives the earliest reasonable date. As far as the few deviations are concerned, their occurrence, in my view, cannot be explained by the presence of some unidentified ancient component since they are older than the LU-2502 sample coming from the underlying stratum. They are not organized in either the stratigraphy or the planigraphy; at least a part of them were sampled under exactly the same conditions as the "normal" dates. The period of habitation of the site (or, most likely, the succession of habitations of different durations) does not exceed the precision of carbon dating and probably covers an interval of 200 to 300 years. The seasonality of the site will be discussed below.

From an archaeological point of view, the fine microprismatic blade assemblage of the Zhokhov Island site, as well as other Early Holocene sites known both in the Arctic and in the

Subarctic areas, can indisputably be interpreted as a site of the Mesolithic period. However, anticipating careful consideration of the materials excavated, I would like to digress from the subject to discuss some problems concerning the term "Mesolithic."

3.3. The Mesolithic as a Division of Archaeological Periodization

It is generally known that some theoretical notions of archaeological periodization, such as "Mesolithic" or "Eneolithic" in particular, remain under discussion because of the divergence sporadically appearing between a research interpretation of assemblages and canonical definitions of divisions. From time to time, discussion focused on regional features of materials requires a general definition. The period from the late 1940s to the early 1980s was very productive in Russia in this respect, and a lot of general theoretical questions about cultural definitions, chronology, and periodization were considered. Although Mesolithic problems were more popular in the 1960s and 1970s, they are still topical.

In my view, the subject of such discussions can be recognized as a problem of transitions (Pitul'ko 1991e) inasmuch as the latter undoubtedly have common features irrespective of chronology. At the same time, it is obvious that classification (periodization) covering global cultural phenomena in general has to be minimized to a few taxonomic divisions. Naturally, Stone Age and Metal Epoch can be recognized as the most general divisions, inasmuch as the Copper, Bronze, and Iron Ages are subdivisions of the latter, and metallurgy as a global cultural phenomenon occurred as a result of the spread of iron metallurgy. But if the Metal Epoch can be structured easily according to a type of ore (more accurately, a type of metal), the classification of Stone Age phenomena can only be based on archaeological criteria. Social or economic grounds are thought to be irrelevant for archaeological periodization since the latter, the result of interpretation of the original archaeological information, became a taxonomic system existing parallel with the archaeological one (Vishnyatsky 1989). But even if they are very often considered criteria for classification (periodization) of the Stone Age, such as the Mesolithic, Neolithic, and Eneolithic (Grigor'yev 1970; Rogachev 1966; Formozov 1970; Dikov 1979), it is obvious that if the general target is archaeological periodization, then archaeological criteria should be chosen for the subdivisions to be defined (i.e., artifacts, structures, faunal remains, etc., differ from others put into neighboring cells of periodization and comprise a different essence).

Of course, features most distinctly characterizing differences between cells, such as ceramics or the processing of metals—commonly in use as firm criteria for periodization—are the most obvious for that of archaeological material in the general sense; still, ceramics remain a secondary (but very distinct) indication of a particular period. But if we recall that the basic principles were advanced in Thomsen's time and developed later, it becomes obvious that the evolution of the manufacture of the raw material of one or another kind, i.e., technology of tool processing, has been permanently considered the most general basic principle of the archaeological periodization. This point of view is popular in Russia (G.P. Grigor'yev, A.N. Rogachev, A.A. Formozov, and others are of this opinion). Taxons recognized in this way present themselves as technological phenomena (for example, Mousterian and Upper Palaeolithic). Logically one could apply technological indications as a basis for periodization in general. Doing it this way, primary (transition from stone-based to metal-based technologies) and secondary (progress, or sequence, of technologies based on stone raw material) transitions can be found. The essence of technological progress is a sequential occurrence of advanced technologies supplanting former ones in the sphere of manufacturing the most important tools, though supplanted technologies can survive for a very long time in parallel with more progressive ones without any regression or regressing gradually, as took place in Northeastern Siberia. The chronological interval covering the transition period can be rather long, and in my view, its end can be marked by a new technology predominating worldwide. Naturally, it is possible to define additional (second order) taxons (such as Neolithic I, II) if necessary for more precise consideration of a transition period, working out the structure of regional periodization or a local sequence. It seems possible that the features of transitions occurred most distinctly during the period of the global spreading of new technological principles, i.e., during the Stone Age–Metal epoch transition (Pitul'ko 1991c; 1991d). The Mesolithic term implies exactly the same well-recognized, but of a second order, transition process.

The term itself was advanced for the first time by A. Brown as far back as in the 19^{th} century regarding some relics found in France, and it was recognized by the European archaeologists. This happened primarily owing to the publications of G. Child, who gave the first real theoretical background for the Mesolithic division and pointed out a strong correlation between the material culture and the beginning of Holocene environmental changes. In Russia, recognition of this term is associated with the publications of M.V. Voevodsky, who applied Child's Mesolithic theory to Early Holocene sites in European Russia (1950). However, it should be noted that the term did not so much naturalize (Koltsov 1989) over time as become a catalyst for the discussion on the Mesolithic as a subdivision of periodization, slowly moving forward. And the discussion still is not finished since participants prefer to retain their own views. Some researchers consider the Mesolithic notion as an artificial one. However, this term is no more artificial than other notions of archaeological periodization. If notions such as Mesolithic, Epi-Palaeolithic, Holocene Palaeolithic were simply synonyms (as can be seen, for instance, from Kol'tsov's publications), discussion would have ended many years ago.

All the various views advanced during the last 25–30 years concerning the Mesolithic can be summarized as follows: (1) the chronological approach—ascribing primarily chronological significance to the term; (2) the ecological approach—the recognition of paleoecology and the correlation between ecology and both social and economic changes; and (3) the typological and/or technological approach.

There is no doubt that in following the first way researchers substitute periodization for chronology. Although the parallel is incorrect in theory, periodization may correspond to chronology, and moreover, each notion of periodization, being a subdivision of some chronostratigraphic system, has a chronological implication anyway, even if we do not like it. The latter is characteristic of the Mesolithic subdivision because as a rule its lower boundary corresponds to the Pleistocene-Holocene boundary. The second way appears to be incorrect as well, because it is based on interpretations of the original archaeological information and not precisely on the artifacts. Therefore, the third way is the only well-grounded approach for working out the archaeological criteria of the Mesolithic subdivision. The typological and/or technological approach has been supported by many researchers, such as A.A. Formozov (1970), G.P. Grigor'yev (1970), V.A. Lynsha (1978), and L.B. Vishnyatsky and Ye. M. Kolpakov (1991). Finally, sporadic attempts to prove that the Mesolithic subdivision is part of global archaeological periodization are the major problem and stimulus for contined discussion. This is a kind of theoretical trap. In this connection Vishnyatsky and Kolpakov (1991) have recently noted that there is no reason to find all of the taxons of archaeological periodization everywhere, and further, that even if they had been recognized, there is no reason for regional or local sequences to correspond to each other. The latter is the natural effect of uneven development that has been noted by G.N. Matyushin (1976) and Yu. A. Mochanov (1977) as early as the 1970s.

In that way, the Mesolithic can be defined as a transition period characterized by widespread prismatic microblade industries and tools made from blades, microliths, and inset tools; the chronology of the period corresponds primarily to the Early Holocene. This notion, due to uneven development, cannot be applied to global cultural phenomena but rather appears to be a subdivision of regional and local sequences (Vishnyatsky and Kolpakov 1991), a view I share. Consequently, other notions advanced by some researchers as a contradiction to the term Mesolithic—the Holocene Palaeolithic, Epi-Palaeolithic, etc.—can be used as well, inasmuch as they are not equivalent to Mesolithic, as N.N. Dikov (1979) supposes, but independent parallel notions in another sense characterizing another cultural phenomenon. Special attention is devoted to this problem not just with regard to the Early Holocene but because a portion of the Late Pleistocene assemblages of Northeast Asia and Alaska are probably illustrative examples for the Mesolithic discussion.

Thus, in Mochanov's view (1977), the Holocene Palaeolithic Sumnagin culture occurred in Northeast Asia near the Pleistocene-Holocene boundary. This view is disputed by Dikov (1979) in comparing the Sumnagin stone inventory with undisputed Palaeolithic and Neolithic materials coming from the same region. It was recognized that the knapping technology had markedly changed in a very short period (wedge-shaped core technology had completely disappeared for some reason and was replaced by micro-prismatic technology). Bifacially retouched tools (knives, points) known both from Palaeolithic and Neolithic complexes are entirely absent. The material coming from the sites dated to the first half of the Holocene can be characterized as a collection of prismatic microblade industries and diverse microblade tools, while the Palaeolithic assemblages contain wedge-shaped cores, series of bifacial tools, etc., and the latter appear again in the Neolithic associated with micro-prismatic technology. These are taxonomic differences and thus a separate—Mesolithic—division could be defined in the creation of a regional archaeological periodization. Another good illustration is the Early Holocene Siberdik culture defined by Dikov (1979). Although this culture is contemporaneous with the Sumnagin phenomenon, it differs sharply from the latter because its assemblages contain wedge-shaped cores, choppers, and bifacially retouched tools, i.e., the Siberdik culture is a direct descendant of the local Palaeolithic. From the point of view of archaeological periodization, it is defined by the researcher as the Relict Palaeolithic, which can not be disputed because this is a true Holocene Palaeolithic assemblage.

At the same time, serious problems arise if one applies a general system of archaeological periodization to the Stone Age of Alaska, where only two major divisions—Palaeolithic and Neolithic—can be accurately recognized. All of the assemblages are of Late Palaeolithic character up to 4000 BP, when more or less definite features of industries of Neolithic type appear among them. In fact, all of the stages up to the Late Neolithic are missing in this area. In considering the materials, A.M. Kuznetsov (1988) concluded that in this case it would be correct to use the combined notion of a Late Palaeolithic–Mesolithic period, though the term Holocene Palaeolithic is absolutely correct. In my view, both the Northeast Asian (Siberdik and Sumnagin) and Alaskan examples illustrate well the thesis under consideration (that is, to recognize the Mesolithic as a notion of a regional system of archaeological periodization).

3.4. The Stone Industry of the Zhokhov Island Site

The finds (artifacts of stone, bone, antler, mammoth ivory, and wood) comprising the Zhokhov assemblage come from both excavations and surface collections; some artifacts were gathered here and there, being pushed to the surface by cryogenic processes, or being redeposited in creek valley accumulations as a result of partial destruction of the cultural layer. The latter are few in number. The major part of the collection, obtained during the two-year excavations (its total quantity is about 1,000 items, excluding faunal remains), is represented by stone artifacts.

Different sorts of raw material were used by the inhabitants for stone tool manufacturing, including some kinds of flint and flinty tufas, sandstone, chalcedony, and obsidian. The obsidian and the high-quality flint were undoubtedly imported, while the other kinds appear to be local. For example, flint pebbles, colored in a range of brown tints, are numerous on the island. Exactly this kind of flint was regularly used for processing stone tools, while the other materials, especially obsidian and high-quality flint, were used more rarely.

The quantity of primary and semi-primary flakes (i.e., those retaining cortex) is extremely low, suggesting that initial stone processing was accomplished either outside the site area or on some specific section(s) of the site. The lithic technology is definitely of Mesolithic character: regularly faceted blades and microblades—mainly fragmentary—constitute about half of the collection (artifacts recognized precisely as microblades constitute 27.4% of the collection, and most of them, both the intact and the broken ones, have a width of about 7 mm, with only isolated specimens wider than 9 mm). Table 2 describes the general composition:

Analysis of the stone inventory from the Zhokhov site allows singling out three narrow technological contexts (this apt term was advanced by E. Yu. Giria [1991]), i.e., three groups of artifacts constituting three basic objectives of knapping: (1) the manufacture of axes and chisels

Table 2. Stone tool collection from the Zhokhov site: Number of artifacts per category.

Pre-cores	15
Cores	
with one flaking surface	8
with two adjoining flaking surfaces	11
with two separate (opposite) flaking surfaces	13
with three adjoining flaking surfaces	11
with four adjoining flaking surfaces	2
Total	45
Lamellar flakes (mainly technological)	199
Blank bladelets	18
Medial blade sections	20
Blade insets	7
Fragment of bifacially flaked piece	1
Polished adzes	
Intact	2
Fragments	4
Flakes	
primary (cortex) flakes	13
with polished dorsal surfaces (flaked from polished tools owing to re-shaping, or sharpening, etc.)	21
other flakes	44
Total	78
Irregular pieces of raw material, crumbled pebbles, etc.	83
Abrasives	5
Pieces of pumice stone	13
Grand Total	**488**

from low-grade siliceous slates; (2) the manufacture of blades; (3) the manufacture of insets for side-bladed tools from flint and obsidian (Giria and Pitul'ko 1994).

The manufacture of adze-type tools was performed in two stages: preliminary flaking and final processing by grinding. These tools are represented by a variety of flakes, finished articles, and abrading tools, as well as flakes resulting from initial processing and reshaping. Thanks to the morphological peculiarity of the products knapped and the specific character of the raw materials, it is not particularly difficult to pick out articles that belong to this technological context.

Adze-like tools are extremely rare in the collection. Intact artifacts (two specimens) of this category are known from the surface collections and only found in the creek valley accumulations. One adze was made by polishing a greenstone slab; it has a sharpened butt, rather symmetrical working edges, and a flattened profile, which follows the outlines of the natural preform (Figure 27:1). The second was manufactured from black tufa (Figure 27:2). A small part of a previous working edge, preserved on the butt of this tool, indicates that it was remade from a broken adze with one convex side; the fractured and rejuvenated tool thus kept its original function. Both tools have ground working edges and butts but the latter, made of black tufa, has polished surfaces partly removed by flaking. Thus one can assume that the adze made of black tufa was polished completely (or almost completely), unlike the other one. It is worthy of note that the age of the assemblage containing the ground tools is abnormally early for Northeast Siberia (although there are some regions where such artifacts dated to 8000 BP are rather ordinary—Karelia, for instance). As far as Northeast Siberia is concerned, the adzes with ground working edges that have been excavated in the region from Early Holocene sites are much younger. Thus, Mochanov, in studying the materials coming from the Sumnagin Mesolithic sites, has come to the conclusion that flaked adzes with ground working edges occurred sporadically in Northeast Siberia during the final stage of development of the Sumnagin culture (i.e., ca. 6000 BP), while serial types of polished tools occurred in later times (Mochanov 1977:222). There is no reason to suggest serial production for ground adzes somewhere around Zhokhov Island. However, it is quite clear that a technology for stone grinding was well known to the natives of the Zhokhov site and was permanently in practice. It needs to be stressed that these artifacts create the impression of a mixed chronology (i.e., provoking the assumption that the assemblage is a composition of two different chronological facies of the material): I myself was under this impression for a short time because these artifacts were in fact found before the first excavations in 1989 during a period of snow melting. However, they are indisputably connected with the main part of the finds discovered *in situ.* Some fragments were excavated, as well as chips flaked off for reshaping (or resharpening) such tools, with completely polished dorsal surfaces and made of the same (greenstone) raw material. As far as the above-mentioned fragments are concerned, especially characteristic pieces were found: a butt section of a large ground tool (Figure 27:4) and the working part of a completely ground adze with a rounded transverse profile. It is interesting that the latter, having completely lost its original function (the working edge had most likely been resharpened several times and finally become blunt), was broken and reused as a core. The feeble attempt to take off some flakes is illustrated by several irregular scars (Figure 27:3).

The manufacture of blades is not represented in full technological context. There are only two lamellar flakes, the distal part resulting from such knapping, and two distal parts of blades (Figure 28:5–9). To all appearances those were rather large flakes (compared with the rest of the materials in the collection); their length was up to 44 mm or even longer and their width up to 18–23 mm. They were manufactured by direct percussion from cores, whose morphology is difficult to ascertain since there are only five fragments of such flakes. The collection also includes a number of flakes that are difficult to attribute to any particular context. These are primary and nonprimary flakes (43 pieces) resulting from direct percussion.

The technological context of manufacturing insets for tools with grooves, i.e., points and knives, is more completely represented. These are insets themselves (in and out of settings), fragments of blades, blades, lamellar flakes resulting from the shaping of the prismatic relief of the flaking surfaces of cores (Figure 28:13–22), cores, pre-cores (Figures 29:10; 30), and flakes from pre-core platform preparation. The association of bladelets and blade-flakes to the same context as the cores found at the site is confirmed by both their morphology and their common dimensions. The technological similarity of the cores and pre-cores singled out in the collection is demonstrated by morphological characteristics and similar dimensions common for both groups, as well as by analysis of the morphology of the flakes that create prismatic relief on the core flaking surfaces, i.e., flakes by means of which pre-cores are turned into cores.

Since the technology of acquiring bladelets in the Zhokhov industry represents a method that has no analogies in the archaeological literature, and moreover, since the integrity of the context of bladelet manufacture singled out in this industry requires special proof, the technological analysis of this stage of the knapping sequence calls for particularly careful description, reasoning about all kinds of technological links, and providing for the established sequence: insets—bladelets—cores—pre-cores.

The raw material for inset manufacture in this industry was flint and chalcedony pieces of slightly rolled rock debris from deposits on Zhokhov Island. Articles made of obsidian have also been found; the origin of obsidian is not known.

Insets in settings, preserved *in situ*, are medial parts of bladelets made of flint or, very rarely, of obsidian. Their length fluctuates within a range of 14–25 mm. The longest ones are usually found broken in the setting; thus both fragments are situated nearby in the groove. The insets' widths are 3.2–7.5 mm. The length of the fragments is more than 11 mm. All insets found *in situ* in the grooves have edge damage on the blade—rather uniform minor faceting on ventral and dorsal surfaces (half-moon scars and facets with various types of termination with a length of no more than 1 mm).

The collection includes 27 medial parts of bladelets. Seven of them have edge damage characteristic of the insets found *in situ* in the tool settings. These items are 11–18 mm long, which makes it possible to identify them as insets that have slipped from the setting (Figure 28:1–6). The remaining 20 medial parts of bladelets do not have characteristic edge damage and are shorter (length of 5.5–8.3 mm). These are evidently waste products or the results of poor breaking of the bladelets.

In this industry insets were manufactured by means of deliberate breaking of the bladelets, which is proved by the rather standard length of the fragments. Most probably fragmentation was not a specialized aspect of production. Bladelets were simply broken; no retouch truncation is found on the medial parts of the bladelets.

Bladelets that are half-finished products for insets are well represented in the collection (Figure 28:7–12). This type of bladelet dominates in number not only lamellar flakes but also when compared with other knapped products. All in all there are 126 such bladelets, which amounts to 63.3% of the total number of lamellar flakes. These are flakes with a length that is 3 to 5 times that of the width, the edges are parallel, the interfacet edges on the dorsal surface are also parallel, and the cross section has the form of a trapezium or triangle. In addition, both edges of these flakes have sharp angles between ventral and dorsal sides. The direction of scars on the ventral surface corresponds to the direction of the knapping of the bladelet itself. The maximum length of bladelets is 37.5 mm, minimum 18 mm. Width is 3–5 mm, thickness 2.2–1.1 mm. Curvature is 2.2–1 mm, that is, minimal. Most bladelets are characterized by a rather straight side view. It is worth mentioning that the medial part of the bladelet is the straightest; the proximal part has the bulb of percussion, and the distal end is the most curved. The projection of most bladelets is almost rectangular, at the same time a slight increase of the flakes' widths (divergence of edges) in the distal part is obvious. For manufacturing insets most correctly, narrow bladelets were used.

The platforms of all bladelets are either processed or retouched; 98% of bladelets with proximal ends (122 items) have traces of overhang removal; among them 24% are characterized by strong reduction of bladelet platforms, 79% by slight reduction or leveling.

The group of bladelets is closely connected with the group of cores. There are no cores in the collection whose morphology showed any other types of lamellar flakes being removed. The bladelets fully correspond to the cores available in the collection, both morphologically and by any other parameter—length, width, degree of curvature.

Items with scars on the surface showing bladelet removal are referred to as cores. Groups of such scars form the flaking surface (front). Flaking surfaces on cores from the Zhokhov industry are wide and flattened. The term "wide" implies that the surface is three or more times wider than the width of blank. Flattened indicates a flaking surface with a small degree of prominence.

The collection includes 45 cores, 9 of which are the so-called "tortsoviye"-type cores with rather narrow flaking surfaces (average 12 mm). In this context the term "tortqoviye"-type does not refer to the core type proper; it only indicates that the flaking surface of this core is situated on the edge facet of the article knapped. All these cores are made of slab raw material—siliceous rock debris—characterized by narrow edge facets (such morphology of cores was largely predetermined by the form of the raw material). The remaining cores have flaking surfaces of up to 27 mm wide. The width of the insets is 3.2–7.5 mm. Hence, flaking surfaces of most cores in this industry are wide enough for three or more blanks.

The degree of prominence of the flaking surface is larger on cores with a wide front (up to 3–4 mm) and smaller on cores with a narrow front (up to 1 mm). The convexity of the core's flaking surface is uniform along the whole flaking surface from its platform to its base. The same can be said about the width of the flaking surface: its dimensions at the platform and at the base are practically the same in most cases, so the flaking surface is almost rectangular in the plane view.

Flaking surfaces of prismatic cores with such morphology allow the removal of bladelets with a straighter profile since a plunging termination of the flake is not possible in this case. Thanks to the strict flatness of the relief of the flaking surface, bladelets taken from these flaking surfaces have the sharpest possible lateral edges, which are caused by the proportions of the thickness and width of such flakes. When the convexity of the flaking surface is great and the front is narrow, the bladelets will be thicker and narrower, while in the case above they are comparatively wide and thin.

When viewed from above the platform, the radius of rounding of the flaking surface with a small degree of prominence is rather large; for cores with a narrow convex front, it is relatively small. If we extend the circle along the arch of the front's convexity, the first type of core will have a large circle and the second type a small one, which is why such cores can be rather tiny, having a round platform. Cores with a flattened wide flaking surface frequently lack such morphology simply because of the large radius of the circle. The diameter of cores with a "round" platform for manufacturing bladelets of the Zhokhov type would have been from 20 to 40 cm. Raw material of such size would not only have created extra difficulties during its processing but is rather rare.

Is a round flaking surface of so important? Such cores have been found in collections representing industries of bladelet manufacture from different periods and regions—an indisputable fact. But how were they manufactured? What was their processing, the sequence of taking off bladelets? Too little reliable information exists to answer these questions.

From the point of view of knapping technology, cores with such flaking surface do not benefit in comparison with unilateral cores; quite the reverse. If we assume that taking off blanks was executed continually around the "circle," then every circuit (row) of blanks should cause a decrease in the core diameter. This would inevitably bring changes to the proportions of the blanks. Flakes taken off in the last instance would be narrower and thicker; thus it would be impossible to get blanks with constant values of width, length, and angle of sharpness on the margins (the latter becoming more obtuse as the blanks are taken off).

By contrast, unilateral cores with wide flattened flaking surfaces guarantee acquiring blanks of standard proportions during the whole cycle of knapping the core. Such flaking surfaces are like fragments of a larger circular surface. After the first row of blanks is taken off, the degree of prominence on such cores does not change; each row is parallel to both the previous one and the next one, with the same degree of prominence and width of the flaking surface.

Therefore, using such a flaking surface, namely flattened ones, is the most expedient for taking off blanks for insets. As insets, it is true that blades of a certain length require not only straightness of the profile, parallel edges, and sharpness but also mass production of standard bladelets.

For consecutive removal of blanks from cores with such morphology of the front, it is essential to have two straight side-edges of the core, without convexity or concavity of relief, that join the flaking surface at this or that angle.

It is supposed that the two edge flakes should be taken off such a flaking surface in each row. It is these blanks that make it possible to raise the flaking surface relief in case it gets too flattened during the removal of bladelets. Both of these flakes should be lamellar—their length should not be less than that of the flaking surface. Otherwise, the hinge termination caused by too short an edge flake would prevent one from taking off bladelets. The collection of the Zhokhov industry sufficiently represents edge flakes of this type. There are 59 such items (29% of all lamellar flakes). It is one of the most representative groups; it is lower in quantity only to bladelets (Figure 28:6–8, 10, 11).

For successful knapping along the plane separating an edge flake from the body of the core, it is necessary for the relief of the flaking surface to be as straight as possible.

Usually edge flakes are two- or three-edged. One facet remains from the scar of the previously removed bladelet, that is, part of the flaking surface. The second (or the rest) facet is part of the side surface of the core. If the relief of the side surface is rough, taking off the edge flake becomes more complicated. If removal is poor, taking bladelets from the flaking surface becomes impossible. That is why straight side surfaces are technologically essential.

For the cores from the Zhokhov Island's collection the following three methods of processing and straightening of the side surfaces are observed: (a) selection of raw material in natural slabs; (b) leveling of side surfaces with transverse flaking; (c) leveling of side surfaces with longitudinal lamellar flaking. None of the three methods was absolutely independent since they were often used in combination on one and the same core.

Selection of the natural form of the material demands no special explanation (Figure 31:1–3). These are not just cores of the tortsoviye type (Figure 31:3). Edge flakes removed during the knapping of these cores are represented in Figure 28:18–20, 26. Leveling of side surfaces with transverse flaking is represented by two cores (Figure 32:1, 2). In both cases the flaking surface is contiguous on one side with the side surface leveled by transverse flaking, and on the other side by the chosen plain natural surface. Figure 28:17 shows an edge flake taken off such a side surface. Flakes resulting from the leveling of side surfaces on both cores are rather lamellar, but at the same time these surfaces do not have the regular cut characteristic of flaking surfaces.

The third type of side surface leveling, represented on most cores, requires a special explanation. Here we actually have cores with two, three, or even four morphologically similar surfaces shaped by lamellar flaking. Most often each pair of such surfaces is situated on the core at a 90° angle to each other. Sometimes bladelets were taken off in different directions on the two surfaces (Figure 33:2C). In such cases it is not always possible with a sufficient degree of certainty to determine which of the two surfaces was the last flaking surface. Edge flakes taken from such side surfaces are well presented in the collection (Figure 28:23–25).

Is it possible to consider side surfaces leveled with longitudinal lamellar flakes and no connection to the flaking surfaces of the blanks? Analysis of individual cores from the collection does not provide an answer to this question. It is possible that some surfaces were really leveled in such a manner while simultaneously there was no intention of getting blanks during the process. From the point of view of its morphology, a core with such a shape is similar to cores with adjoining flaking surfaces.

All cores in the collection can be classified as follows:

1st group	8 items	One flaking surface on the edge facet (Figure 31:1).
2nd group	11 items	Two adjoining flaking surfaces (Figure 34:1).
3rd group	13 items	Two separate flaking surfaces on two opposite edge facets and a single platform (Figure 31:3).
4th group	11 items	Three adjoining flaking surfaces (Figure 33:1, 2).
5th group	2 items	Four adjoining flaking surfaces (Figure 33:3).

The last group—those with four adjoining flaking surfaces—cannot be regarded as cores with a circular front. First, they are really tetrahedral cores with flattened flaking surfaces. Second, removal of bladelets from these cores was performed not along a circle but from one or two surfaces. Lamellar flakes, whose scars are on the remaining flaking surfaces, were removed not from this platform but much earlier when the core was higher.

These typological groups were singled out taking into account only well-shaped flaking surfaces. However, many cores have scars that show evidence of initial shaping of the flaking surface. Such cores already have one or more flaking surface, and shaping of another flaking surface has begun. Thus a core belonging to the first group (Figure 31:1) has one already-shaped flaking surface on one edge facet of the preform and a prepared ridge that levels another flaking surface on the opposite edge facet. An attempt was made to take off a ridged flake from this surface in order to shape the prismatic relief of the second flaking surface. A core belonging to the second group (Figure 34:1) has traces of the shaping of a third flaking surface adjoining the two previous flaking surfaces (Figure 34:1E). And so on.

Taking into account the presence of such transformations, all cores of this industry can be lined up into the following rows:

		2nd group		
1st group		4th group		5th group
		3rd group		

The strength of connection between the groups reflected in the number of core transformations is as follows:

		2nd group		
	3 items		4 items	
1st group		4th group		5th group
	3 items		2 items	
		3rd group		

Thus, there are two possible explanations for the presence of several surfaces shaped with lamellar flakes on the Zhokhov Island cores:

1. Cores with one wide flattened flaking surface required the leveling of side surfaces, which was sometimes performed by the removal of lamellar flakes from the major platform. Thus the processed side surface "imitates" the shape of the flaking surface.
2. Leveling of the core's lateral surfaces was performed by deliberate transfer of the flaking surface. In this case creation of a lateral surface was combined with the process of removing lamellar flakes, and the core's morphology received controlled change during the course of its use.

It is evident that here the simplest way to a comprehensive explanation is refitting. But the collection from the Zhokhov site does not provide us with enough material to carry out refitting. Moreover, refitting a couple of cores could hardly serve as a reliable demonstration of the knapping method for dozens of others.

The first explanation is based on the analysis of the morphology of individual cores, irrespective of other cores and flaking products. Formal typology distinguishes five groups of cores, though there could be more or fewer groups if other criteria were chosen.

The second explanation is based on comparative analysis of the morphology of different cores in the complex with other knapping products. The main criterion for selecting characteristics in this case is not formal similarity of morphology but ascertainment of the technological necessity of this or that morphology for the knapping objectives. Thus this interpretation is based on purely technological criteria. Classification of material based on technological analysis does not single out individual groups of material but is aimed at looking for possible ways to reconstruct their initial integrity (in other words this is also a kind of refitting but in a more general sense).

The above-mentioned schemes indicate that the amount of transformation linking separate groups together is up to 40% of the cores in these groups. This fact alone indicates the non-accidental character of the stated relations, even based on not much material. With the strictest approach, the number of cores that belong to the pure groups (with one, two, or more flaking surfaces) is not that large. On the contrary, during the course of comparison, different cores indicate smooth morphological changes.

Most of the worn-out cores belong to the fourth group, i.e., cores with three adjoining flaking surfaces. By a worn-out core we mean one with its body worn out to the maximal extent from blank removal. Such cores have the least potential compared with other cores represented in the collection (Figure 34:2). The fifth group of cores, i.e., those with four adjoining flaking surfaces, is only a variant of the fourth group. Worn-out cores with such surface distribution do not occur.

The unity of the basic objective of knapping cores is confirmed by the method of shaping their platforms. It is somewhat specific and similar for all the cores. The scars help follow the general tendency; platform preparation was performed in two steps. First, the whole surface constituting the core's general platform was shaped by taking off flakes from one of the lateral surfaces; then the edge of the platform adjoining the flaking surface was processed with fine pressure retouch. Leveling of the platform from its lateral surface is in most cases distinctly oriented transverse to the direction of leveling the edge. In some cases it is possible to judge, based on the model of the platform formation, which of the surfaces of the core was the last flaking surface. On cores having one or two non-adjoining fronts, this dependence is strictly observed. In cases when adjoining flaking surfaces appear, platform edge preparation is the last to cover the surface crosswise. But even then it is frequently possible to find out which of the flaking surfaces was the last to be processed with retouch trimming.

Some idea of the location of former flaking surfaces can be based on the orientation of flakes with which the base of the core was prepared. For cores in the first and the third groups this preparation was exercised on the left side parallel to the initial platform preparation. As the result the base of the core acquired an almost flat surface parallel to the plane of the flaking surface. Such preparation made it possible to use the base later as a platform for a flaking surface on the lateral surface of the core by taking off flakes from the bottom.

These arguments make it possible to consider cores from the Zhokhov Island collection not as a set of typologically different forms but as an evolutionary sequence of core morphologies, while producing blanks was performed by a common technology.

The presence of one or two lateral surfaces, flattened by the removal of blade-like flakes parallel to blades from the current flaking surface, is the most convenient method of leveling. Edge flakes removed from the edge between this lateral surface and the flaking surface are actually blades or bladelets. It is just that one of its edges has a larger angle of sharpness. On the other hand, it is the simplest and most effective method, though it requires either preliminary preparation of the lateral surface or selection of a flat natural surface.

Cores of the first group have just such morphology. Blanks are produced from one flaking surface situated between two natural, plane surfaces. When the body of the blank becomes elongated the second flaking surface, like the first, is formed on the opposite edge facet. Thus, cores of the third group are a version of cores of the first group.

The same lamellar flakes were taken off cores having the morphology of the first and the third groups. It was not necessary for them to be bladelets. At this stage of processing ridged blades, initial, semi-initial, and other types of flakes shaping the prismatic relief of the core were most likely removed. As for the core length, it was somewhat reduced. When the core's body length reached the degree of width necessary for the flaking surface, a new front was formed then on a lateral surface. Its average size for cores from the Zhokhov Island is 20 mm.

The shaping of a new flaking surface was performed either between two previous surfaces (if cores morphologically of the third group were initially used) or between the flaking surface and the back side of the core (in case of cores with first group morphology). The flakes shaping this surface could be directed both from the main platform of the core and from the side of the base.

In this way cores belonging to the second and the fourth groups were formed. Shaping of the side flaking surfaces was performed from edges to the center. The collection includes the flakes that shaped the prismatic relief that probably completed this process. These were three-edged lamellar flakes, whose central edge was the natural surface of the raw material—the remains of the lateral surface of the core (Figure 28:21, 22). There is no absolute certainty that these flakes originated during the course of the flaking procedure since the same flakes could have been produced during the shaping of any other flaking surface.

As already mentioned, the morphology of the cores that belong to the fifth group does not allow them to be regarded as an independent core form. They are a combined version of cores belonging to the second and the fourth groups. When all four flaking surfaces are used on cores of this type, the width of the flaking surfaces cannot avoid being reduced, which in turn would lead to a change in the blank's morphology.

Thus it can be stated that technological analysis of cores produced on the Zhokhov Island has revealed the following:

1. All cores from the collection have wide flattened flaking surfaces.
2. Leveling of the core's lateral surfaces was carried out:
   a. by selection of flat natural surfaces;
   b. by transverse flakes;
   c. by longitudinal flakes;
   d. by regular transfer of the flaking surface to the lateral surfaces of the core.
3. All forms of cores available in the collection represent different stages of a single knapping method.

Pre-cores in the Zhokhov collection were catagorized according to morphological characteristics, dimensional parameters, and morphology of flakes that form prismatic surfaces common for cores; 15 pre-cores have been selected (Figures 29:10; 30:1–5).

The pre-core and core forms were to a great extent dependant on the initial form of the raw material. In the selection of raw material for manufacturing pre-cores, preference was given to cubic and pyramidal forms. Single pieces of rock with one or two flat surfaces were used. Pre-cores were manufactured from thin slabs. If there was no surface to create a platform on a piece of rock to be used for pre-core manufacture, then knapping began most frequently with platform production. The major requirement for a platform was its placement on a plane perpendicular to the lateral surfaces of the preform. So the platform was first shaped with a couple of centralized flakes. Then perimeter flaking took off a flake in the plane of the desired preform's cross section, during which strokes were applied to the edge part of the lateral surfaces. The force of these strokes was not meant to remove a spall that would shape the platform at a single stroke.

On the contrary, perimeter flaking was performed with light strokes from a hammerstone, which created undeveloped knapping surfaces inside the blank—cracks in the form of a cone that fade away without reaching the surface. During such processing, inside cracks that envelope the preform of the pre-core along the plane of the desired cross section were intersected, and at a certain moment after the next light stroke the flake shaping the platform was separated from the preform. Such a flake has a centrally oriented scar on the dorsal surface as well as a rather peculiar appearance on the ventral side that was formed not by the usual single bulb of percussion but by a combination of three to five cones. The collection includes 35 flakes for shaping the pre-core platform with such characteristics, that is, 44.8% of the total number (78) of flakes.

The dorsal surface relief of such flakes fully corresponds to the character of pre-core platforms left at this stage of processing. This can be proved if one compares the character of the pre-core platform relief (Figure 29:10) and flakes of shaping such platforms (Figure 29:1–4). It calls attention to the fact that some flakes with wide platforms have traces of multiple strokes—cone-like cracks; 5 of 35 such flakes have no proximal parts. Of the remaining 30 items, 8 have natural platforms, 21 prepared platforms, and 1 retouched platform.

Many pre-cores were subjected not only to platform shaping but also to leveling of the base. The major part of ready-to-knap cores of this industry have a flat, deliberately leveled base (Figures 31:1F; 33:2E, 3F; 34:1F, 2E, 3F).

The lateral surfaces of pre-cores were most often natural surfaces of well-selected initial forms of the raw material. If the relief of these surfaces did not satisfy the master, they were leveled by flakes whose platforms were natural edges. In other knapping technologies, widely known ridges were formed on pre-cores and intended for removal as the first ridged blade (Figure 30:1C, B).

It is worth mentioning that this industry lacks pre-core edges; its flakes were removed from the perform in two directions (by a cross wise method)—all edges shaped with flakes are unifacial. Most edges between the lateral surfaces of pre-cores are the natural edges of siliceous rock debris selected for knapping (Figure 30:2, 4, 5).

The morphology and metrical parameters of ridged blades, initial flakes, and other flakes shaping the prismatic relief of the flaking surface correspond fully to the morphology of pre-cores. Lamellar initial flakes removed from natural edges are prevalent—five items, or 7.5% of the total number of lamellar flakes (Figure 29:13). Ridged unilateral blades make up 3% of ridged flakes, two items (Figure 29:14, 15). More numerous are blade flakes intended for broadening the limits of the future flaking surface (Figure 29:17–20); they are 41.5% of the total number of lamellar flakes. Some of them (Figure 29:18, 19, 20) could be taken off not only during the course of preparing the first flaking surface but also during shaping of any of the rest of the pre-core. That is probably why these flakes make up such a large percentage of the total number of lamellar flakes.

The technology for manufacturing insets in the Zhokhov Island industry can be summarized as follows.

Pre-cores were manufactured from orthogonal pieces of siliceous rock debris, exposures of which are found in the immediate vicinity of the site. The major steps in their manufacture were preparing the pre-core platform by means of perimeter flaking, leveling the base, and in some cases leveling the flaking surface by removal of edge flakes that were always oriented in the same direction (Figure 29:1, 2).

With the help of blade-like flakes removed from the main and opposite platforms, pre-cores were transformed into cores, the final processing of which consisted of leveling the platform by removing flakes from one of the lateral surfaces, trimming the edges with pressure retouch, and in some cases additional leveling of lateral surfaces with transverse flaking. The last procedure could be exercised during use of the core in combination with leveling of the lateral surfaces by removal of longitudinal flakes during transformation of the flaking surface into the lateral surfaces of the core. The general strategy of core knapping was aimed at obtaining standard blades with rectangular outlines; this was ensured by constant maintenance of a broad flattened flaking surface. During the course of using a core its morphology was changed. Cores with two or three adjoining flaking surfaces can be recognized as complete forms (the version with four flaking surfaces is considered to be a duplicate of one of the two mentioned above). Insets were produced from the medial parts of blades by deliberately breaking those obtained during the knapping process.

Preparation of pre-cores and leveling of the core platforms was implemented by percussion flaking. Normal pressure knapping was used to level the edges of the striking platform that join the current flaking surface, to level the lateral surfaces that show transverse flaking, and to remove bladelets. Analysis of the flint knapping industry indicates that it was oriented primarily toward obtaining insets of a certain size, the process being noticeably standardized; the characteristics of the bone (antler, etc.) mountings fully correspond to the data of the technological analysis.

Inset tools are part of the hunting equipment complex. Many of them were broken during use; others were reshaped after being broken. The tools' proportions suggest that one-third of the inset (base part or point) was broken off. The base, occupying almost a third of the tools' length, normally lacked additional processing (except in two cases). The points were probably mounted lap-spliced on a shaft and tied tightly with a skin strip. It is well known that even stone points were mounted in that way (Gronnow 1988:24–39). Some tools have been distinctly polished by the strip sections. Grooves are made along approximately two-thirds of the side surfaces; very rarely they are made along the whole length of the tool. The depth of the grooves varies from 3 to 5 mm; the width is usually about 2 mm. Insets preserved *in situ* in the grooves usually project 1.5 to 2 mm, sometimes 3 to 4 mm. The number of insets used for one tool has not yet been determined.

Attempts to manufacture any other tools from blades were not noted. A specific feature of the complex is a combination of the microprismatic technique and the tradition of manufacturing polished tools not found earlier in sites of Northeast Siberia, that have been assigned to the same period (Mochanov 1977).

3.5. Assemblage of Hunting Equipment

The collection introduces a series of inset tools (Table 3) that considerably outnumbers all finds known in Middle and East Siberia; besides, the latter go back to different ages (Fedoseyeva 1968; Kozlov 1980:55–61). The collection includes primarily fragments of tools of different sizes with one or two grooves (Figures 35, 36, 37, 38:1, 4, 6) and at the same time intact articles as well as unfinished and reshaped articles (Figure 39:4–6). There are also regular non-bladed tools (Figures 39:3; 40:3) as well as a certain number of tools (Figure 38:3) that cannot be associated with one tool type or another.

Bilateral (with two grooves) and unilateral (with one groove) side-blade points are represented by about an equal number of items (12 and 13 correspondingly). They were manufactured from fragments of large bones, rods of antlers, fossil mammoth ivory, walrus tusk. The last are rare (only 5 items) and the method of their manufacture was evidently similar to that reconstructed by A.K. Filippov (1978) or even simpler. Preforms made of ivory and antler were obtained as the result of longitudinal dissection by sawing with a blade of the same initial raw material; such ivory preforms could also be produced by splitting along their critical axis. The process of manufacturing antler preforms should also include straightening them because of their natural curvature. The sequence of operations and the manner of performing them are well known from ethnography. A detailed description is given by A.P. Okladnikov (1950:205,

Table 3. Inset tools from the Zhokhov site.

	Material of Settings				
Type of Points	**Antler**	**Bone**	**Fossil Mmammoth Ivory**	**Walrus Tusk**	**Total**
Bilateral side-blade points					
with three-edged cross section	1	1	2		4
with unilateral convex cross section	4	4			8
Unilateral side-blade points					
with three-edged cross section		2			2
with unilateral convex cross section	2			1	3
with flattened cross section		7	1		8
Total	**7**	**14**	**3**	**1**	**25**

206). The tool's surface is as a rule polished; its final processing was performed with abrasives of different coarseness (Figure 41).

Bilateral points, characterized by their large size, are most probably spear points. Available tools and their fragments suggest there were only two types:

1. Massive points with three-edged cross section made of antlers (Figure 36:1) and fossil mammoth ivory (Figure 35:3).
2. Points with unilateral convex cross section and curved rear surface caused by scraping out the spongy filling of the antler or preservation of the original cross section of the ivory surface (Figure 35:1, 2, 4). These tools are less massive than those of the first type; their thickness ranges from 5 to 10 mm. As a rule they are large points with a length of up to 568 mm, though examination of the proportions of most fragments indicates that their average length was 240 to 280 mm. The grooves are 3 to 5 mm deep and 1.5 to 2 mm wide. They were evidently sawed with a thin straight blade along two-thirds of the lateral surface of the tool. The points most frequently had a symmetrical, elongated, sharpened outline; the unilaterally sharpened base lacked extra processing.

Only once did a groove look as if it had been sawed along the whole length of the tool and additional processing of the base for mounting the skin strip (Figure 36:2) recorded. But the most likely explanation for this might be the use of the tool after damage.

A decorative element is worth mentioning—a line engraved along the axis of a bone (Figure 39:2, 5) or antler (Figure 35:1, 2, 4) tool; in some cases there is a natural groove on the surface of the bone instead of such line (Figure 35:5).

The settings of inset tools with one groove can vary greatly. They not only have morphological differences but belong to different functional groups—there are spear points, projectile points, and knives (?).

1. Needle-shaped projectile points have a three-edged cross section and are of different sizes: 129:8:5 mm (Figure 38:2) and 174:8:5 mm (Figure 38:6). The groove occupies two-thirds or three-quarters of the tool's length; its depth is 3–4 mm, its width 2 mm. The first point has insets preserved *in situ* projecting 1.5 mm from the groove; the second point has insets projecting 2 to 4 mm (the tool has 8 insets—6 of flint, 2 of obsidian), the wider insets nearer the base.
2. Massive spear points with a unilaterally convex cross section, made of antler (Figure 36:3) and walrus tusk (Figure 36:4) with insets, were preserved *in situ.* The total length of the points was apparently up to 240 or 250 mm; the dimensions of the fragments are 174:24:6–8 mm and 172:25:12–15 mm correspondingly. Approximately one-third of the tips have been broken off. Another point from this group is represented by a small fragment with two insets. The groove was sawed along the side of a whole point made of walrus tusk. The depth of the grooves is 3 to 5 mm, the width 1.5 to 2 mm, and the insets of black siliceous slate project 2 to 3 mm from the grooves. The point made of walrus tusk has the additional shaping of the base found in the group of bilaterally bladed points (Figure 36:2), where three pairs of grooves were cut through for mounting the skin strip (Figure 36:2, 4).

3. Tools with a unilaterally plane cross section are represented primarily by specimens that are assumed to be knives (Figure 37). They are made of bone and greatly flattened; the base is cut straight. Three of them have insets preserved *in situ* that project 1.5 to 2 mm from the grooves. The depth of the grooves is 3 to 4 mm, the width 2 mm.

This group also includes two fragments which we believe to be dart points (Figure 38:1, 4). One of them has a distinct polished zone where the point joins the shaft, fastened together with a skin strip. The point base is cut straight; some slanting furrows are nearby (probably a decorative element). The groove, which is 3–5 mm deep and 1.5–2 mm wide, is at some distance from the point's base (32 mm and 52 mm correspondingly).

Besides numerous inset tools, some regular non-bladed specimens are included in the collection. They are not numerous. Only four items were found—both fragmented (2) and whole (2). One of the fragmented tools, made of a reindeer metapodial split lengthwise, belongs to the simplest type of bone points, which are extremely widespread. The preform was chosen because of its suitable shape (outlines, sharpness, size), almost completely lacking additional processing. Only the tips and basal parts are worked on points of this type. These points are symmetrical and usually have diverse cross sections, following the original ones of the preform (Figure 38:5).

A fragment of another point made of a thick piece of massive bone seems to be more interesting. This is a three-edged point with both ends truncated (Figure 39:3); the length of the preserved part is 92 mm. A natural groove on one of the edges is slightly widened artificially. This is most likely a fragment of a long, narrow three-edged projectile point of a type well known from Eskimo sites (Arutyunov and Sergeyev 1969; Stanford 1976; and others).

The intact points are significant. One of them, made of split reindeer metatarsal, has a perfectly ground surface. This long (135 mm length), narrow point can be recognized as a needle-shaped point (Figure 40:3). It is noteworthy that its shape is very close to that of an inset projectile point with one groove and a three-edged cross section (Figure 40:6), and this one is probably a preform of the same kind of tool. It must be stressed that, except in the most obvious cases, it is difficult to understand whether the non-bladed tools were really non-bladed. As a rule, the opinion that some artifacts are non-bladed is relative.

Another intact specimen was made of a massive bone and, like the former, has carefully worked surfaces (Figure 40:4). The massiveness of the bone used, as in the case of the preform of the large inset spear point (Figure 39:6), makes it possible to assume that massive fossil bones of some Pleistocene animals—most likely mammoth—were used in both cases. The point (Figure 40:4) has a variable cross section—rounded at the tip and unilaterally convex near the base; the latter is flattened (Figure 39:4). Four small transverse engravings are visible on the flattened side of the base.

Three other specimens that are probably either non-bladed points or preforms are assumed to belong in this category as well. As mentioned above, it is difficult to classify some tools exactly, especially if they are fragmented. These three items made of bone most likely have symmetrical outlines; one of them has a basal part rounded in plan.

But the most interesting and unexpected for the high Arctic site—among artifacts of non-bladed types belonging to hunting equipment—is a harpoon, or most likely a fish-spear point (Figure 40:1). The tool differs markedly from specimens known from cultures whose bearers based their survival strategy on sea-mammal hunting. The bilaterally barbed point, made of antler, is 112 mm long and 12 mm wide and has a variable thickness (3 to 8 mm). Eight barbs, 2 by 3 mm in height, are placed on each side asymmetrically at a distance of 10 to 12 mm from each other. The surface was subsequently carefully planed and polished. The wedge-shaped base constitutes about half of the artifact, the cross section is unilaterally slightly plano-convex, and the profile is spindle-shaped. It should be noted that there is a lack of artifacts that could be considered analogous to the find from the Zhokhov site. However, it is generally close to some Mesolithic harpoons known from South Siberian sites (Medvedev 1980:25, 26). The characteristic shape of the basal part of the Zhokhov harpoon indicates that the tool had been used as a prong of a double-pronged fish-spear point. The complex composition of fish spears and bird darts is well known from both ethnographic and archaeological data obtained in the North Pacific region. It is worthy of note that exactly the same reconstruction is proposed by G.I. Medvedev for one of the most ancient artifacts from South Siberian sites (Medvedev et al. 1975).

3.6. Tools of Fossil Mammoth Ivory Flakes

One specific feature of the rich collection from the Zhokhov site is the lack of tools (particularly stone tools), except the inset tools described above, stone adzes, and ivory or antler picks. The bifacially flaked preform mentioned in Table 2 cannot be considered a tool since it could be a core preform or something else; the large flake of greenstone with an irregularly faceted edge (Pitul'ko 1993:Fig. 3:3) could be somewhat dubiously identified as a rough atypical side scraper. Surprisingly, the collection contains no scrapers, though this tool category is usually represented by a great number of items. Perhaps the category is absent because the natives used some unusual materials for making scrapers. Or because of the specific character of the spatial distribution of finds, tools of this category might be concentrated somewhere in an unexcavated area (Pitul'ko 1993).

Thus some flattened pumice-stone items were also found that could be interpreted as scrapers. Abundant flakes of bone, ivory, and antler, diverse in size and shape, were found while excavating the site. Through precise use-wear trace analysis, two artifacts belonging to the missing category were identified (Giria and Pitul'ko 1993:33–36). Both were purposefully made for skinning and hide processing, respectively. The artifacts are made of fossil mammoth ivory. Massive ivory flakes struck off fossil mammoth tusks were detached along the longitudinal axis of tusks by a strong blow (Figure 42). One of the tools is identified as a skinning knife (Figure 42:2). It was secondarily retouched for to shape a handle. The traces of use-wear recognized on the surface cover the whole perimeter of the working edge of the knife blade as well as the lateral surfaces. The following are recognized: (1) smoothing of the working edge; (2) linear scratches oriented along the working edge; (3) fluid polishing that follows the micro relief of the flake surface.

Another one (Figure 42:1) is identified as a side scraper for hide processing. This is a large ivory flake lacking secondary retouch but with a series of small stepped scars and facets on the dorsal surface. The flake was probably struck off during the reshaping of some artifact (a pick?). The use-wear traces are identified as (1) smoothing of the working edge, (2) linear scratches oriented perpendicularly to the working edge, (3) intensive polishing of both the working edge and the adjacent surfaces.

Besides the use-wear traces, some marks emerged due to contact with the soil of the cultural layer. These were clearly recognizable on both the former and the latter, being markedly differ from traces of utilization.

During the site excavation, diverse flakes of ivory, bone, and antler were found besides those mentioned above. These obviously demonstrated permanent and intensive use of these raw materials and probably pointed to some standardization in methods of manufacture. Exactly the same methods can be found many millennia later in Eskimo sites that contained both the flaked artifacts of walrus tusk and the flakes.

3.7. Pickaxes of Mammoth Ivory and Antler

Twenty-eight implements, both fragmentary and whole, belonging to this category were excavated or collected from the surface (including two items presented to the Institute for the History of Material Culture by those who wintered over at the Zhokhov weather station in the 1970s). The frequencies of the finds suggest that fossil mammoth tusks and antlers were used equally. At least a part of the latter were collected by natives. The very characteristic stubs of antlers (the butts of dehorned antlers), used partially as clappers (see below), indicates that the dehorned antlers, as well as the antlers from wild animals, were used as a raw material.

Fifteen pick-like tools made of antler were found that vary in size and weight but share one style. The various beams and tines of an antler were used for this purpose. The diameter of the tools is 20 to 60 mm, the length 150 to 270 mm. Unused specimens indicate that the upper part of the tools did not exceed one-third of the total length and, therefore, it is possible that many of these tools were sharpened repeatedly. Thus some pick implements are disproportionate. Antler picks are usually 220 to 240 mm long. The sharpened working (distal) ends are wedge-like in profile, while the upper (proximal) parts are prepared for attachment to a handle or a shaft. Three ways of such preparation are recognized (Figures 43, 44).

Fewer pickaxes made of fossil mammoth ivory were found (13 items). Available fragments suggest that various parts of mammoth tusks were used. The largest fragment (the working part of some tool) is 268 mm long, though the implements are primarily 200 to 220 mm long and resemble the antler artifacts in some respects. The diameter of the used tusk stubs varies from 60 to 88 mm. The working (distal) ends are usually sharpened into a cone. The cone is, as a rule, somewhat aside the longitudinal axis of the tool (Figures 45:2; 46:2). Only one item has a wedge-like profile of the working end (Figure 46:1). The proximal ends of all the tools, except the last, are prepared for attachment to handles or shafts in the same style as was observed on the antler pickaxes. These tools, like the antler pickaxes mentioned above, were repeatedly sharpened. Thus the implements look disproportionate, and the working sections are of one-half to one-third of the total length of the artifacts.

Unfortunately, the surfaces of the tools are usually damaged, which makes it difficult to interpret their function. However, some of them have definite linear marks or scratches on the surface of the distal sections, which indicate contact with soil—perhaps due to digging. Inasmuch as such traces were found on both antler and mammoth artifacts, they could be interpreted in only one way. On the other hand, some tools are similar in morphology to the above-described artifacts that in fact have another function. Some of the antler pickaxes could be interpreted as strong bear-spear points (Figure 43:1). In all probability, one of the mammoth ivory pickaxes differs in function from other tools of this category, though it appears similar to them. This ivory artifact has a working section that is unilaterally convex, sub-triangular in profile without any signs of utilization (Figure 46:1). Perhaps it was never used, or might have been carefully reshaped. Such tools might be used as adzes for splitting the driftwood abundant at the Zhokhov Island site. It must be stressed that the wooden pieces saturating the cultural layer have numerous marks of artificial splitting, although the reason for this operation remains unclear. The wooden pieces discovered at the site could be waste fragments as well as the result of attempts to make the most efficient use of driftwood, which was probably rare near the site location.

3.8. Other Artifacts Made of Bone or Antler

Other bone or antler artifacts discovered at the site are represented by both finished artifacts whose function is clear and preforms or unfinished items. At the same time, there are also a couple of completely processed articles whose function is unclear.

Describing the artifacts making up the group, one should note the ground awl made of a thick piece of strong, massive bone. Its handle section and tipped point occupy about half of the total tool length. Both were shaped by grinding (Figure 40:2). This tool is 155 mm long, 11 mm wide, and 4 mm thick.

Antler handles for hafting stone adzes or chisels (?) are represented in the collection by nine items, two of them almost whole. They vary in size and have outlines resembling the letter L or T. The transverse brace has a flattened section or a cavity for attaching a stone tool; the end of the brace has a knobby bulge that was needed for locking the strip safely between the handle itself and the bulge (Figure 47). Both the beams and the tines were used for manufacturing these artifacts. The handles are 200 to 300 mm long.

Clappers were both excavated and collected from the surface (Figure 48:1–3). They are made primarily from the basal stubs of cut-off antlers; they total five items in various conditions of preservation. Such tools are typical for the Siberian Mesolithic and are found in some sites in South Siberia (Medvedev 1966). Their function is not quite clear. However, it is obvious that they cannot be interpreted as hammers since the traces of use wear observed do not correspond. Still, the working surfaces of these tools have definite marks of utilization indicating a percussive function. In my view, one can assume that these clappers were used for splitting or breaking up bones for various purposes, including cooking.

The function of some bone or antler artifacts among the finds remains unknown (Figures 48:6; 49; 50:1). Two of them are most interesting, especially since wooden artifacts were found that are completely analogous to them. A series of items are identical to each other in size, exterior details, and style of damages but made of different raw material—mammoth ivory (Figure 49:1), massive, solid bone (Figure 49:2), and wood (Figure 49:3, 4). They resemble unilaterally flattened handles with a knobby bulge on one end, while the other is cracked. The handles are undoubtedly fragments broken from some tools by a standard method. The fragments are not large, measuring 77 to 133 mm in length; the maximal width is 35 to 40 mm.

Also found were a series of four items made from distal epiphyses of reindeer metatarsal bones: the lateral sections of the articular surfaces were struck off, and V-shaped cavities were engraved at the center of the articular blocks (Figure 48:5). They are actually of the same size and represent completely processed artifacts, but their function is absolutely unclear.

3.9. Wooden Artifacts

A lot of artifacts made of wood were found besides the above-mentioned handles. These are dart and arrow shafts, a spoon, a fragment of a sledge runner, household equipment, and other artifacts of unclear function, both whole and fragmented.

Arrow shafts. Only ten fragments were excavated. They are of different lengths (Figure 51:5–8), and from 6 to 9 mm in diameter. It is very characteristic that Eskimos used arrow shafts of exactly the same diameter in historic times (Anderson 1970). The most interesting fragment has a wedge-like cavity engraved on the end made for hafting the point. The surface of the shaft has a section prepared especially for attaching the latter (Figure 51:8).

Dart shafts (?) are much stronger and represented by fragments of different lengths. Only two pieces were found.

Spoon. A flattened spoon or cooking ladle, slightly curved in profile, is made from a thin sliver (Figure 51:3). Its bowl has a rounded outline. The handle is well processed and a little pointed. The artifact is 215 mm long (total). The length of handle is 75 mm; the blade is 55 mm wide.

Household equipment. Three fragments of wooden vessels were excavated (two more were collected on the surface); one of them has a hole drilled by the inhabitants of the site for refitting the cracked vessel (Figure 51:1, 2, 4). Six artifacts are preserved completely or in significant part (Figures 52–57). They differ markedly both in size and shape. No two vessels are of the same type. However, one can generally note that various wooden pieces were used to manufacture the vessels, and both the shape and the size strongly depended on that of the preform. Thus they are elongated owing to the form of pieces of soft, straight, and fine-grained types of wood chosen for making the vessels. Undoubtedly driftwood was used. The vessels have no definite typology but can be classified as follows: slightly deep with a handle or trays with no handle (Figure 52); scoops of different capacity (Figures 54, 57); and a bowl (Figure 53). Some of them are considerably long, up to 665 mm (Figure 57).

Sledge runner. One of the most interesting artifacts excavated is a large fragment of sledge runner (Figures 26, 58) made of fine-grained, compact, hard wood. Probably a piece of larch was used for this purpose. It can easily be seen that the underside of the runner is finely polished by use and has distinct linear traces of rubbing. The working surface is clearly beveled from the external to the internal edge, which indicates that it is the left sledge runner. At 1,110 mm long, the fragment has the turned-up forepart with notches for the first cross-brace or the traction bow, where the running trace was attached and the sledge runners were fastened together with a sinew cord or rawhide strip. The turned-up section is 160 mm high and 200 mm long. From the distinct marks on the side surfaces, we can conclude that the runner was pressed into the snow cover to a shallow but constant depth (about 100–120 mm). Other elements of construction can also be described. The conically bored hole on the upper margin of the runner is a distance of 280 mm from the fore-end and has a maximal diameter of about 21 mm and a depth of about 15 mm. The purpose of the socket was to hold in place the sledge's frame—the first upright or a curved cross-brace supporting a freight platform. A small, narrow slit (10 mm wide) was cut from the upper surface to the inner side at a distance of 490 mm from the conical socket (Figure 58).

Also collected were a considerable number of worked wooden pieces of diverse forms. Their sizes vary. The largest is 1,050 mm long and 32 to 35 mm in diameter. Many of them have sections prepared for fastening together with other parts. Some of the numerous wooden artifacts are probably parts of the sledge's frame but are not clearly identifiable.

3.10. Faunal Remains and Seasonality at the Zhokhov Site

Preliminary information concerning the faunal remains excavated from the Zhokhov site was published earlier. It was noted there that most of the bones belong to polar bears and reindeer (Makeyev, Pitul'ko, and Kasparov 1992; Pitul'ko and Kasparov 1996). Other animals are very rare (Table 4). The minimal number for each is calculated according to the widely used method described by Sh. Bokonyi (1970), R. Chaplin (1971), and others. Animals were calculated on the left (or right) bones within categories. Size and age data were also taken into account when necessary and possible.

Special attention was paid to the main species, which were important food sources for the ancient natives of Zhokhov Island. The bones are often destroyed and some kind of damage is identical on others. This suggests a connection with the particular butchering methods. Ethnographic data confirm that it is possible to reconstruct the butchering practice used by hunters for cutting up prey. Some items (both bear and reindeer bones) have clear butchering marks. It is unlikely that the damages observed on the polar bear bones are enough to understand the

Table 4. List of fauna remains from the Zhokhov Site (1989–1990).

	Species	Number of Bones	Number of Animals
MAMMALS*			
Wolf	(Canis lupus)	3	1
Arctic fox	(Alopex logopus)	6	1
Polar bear	(Ursus maritimus)	397	21
Reindeer	(Rangifer tarandus)	450	20
Seal	(Phocidae sp.)	1	1
Walrus	(Odobenus rosmarus)	4	2
Dog	(Canis familiaris)	3	2
BIRDS**			
Tundra swan	(Cygnus bewski)	3	2
Goose	(Ancer tabalis)	19	6
Goose	(Ancer albitrons)	4	2
Sea-gull	(Laridae sp.)	1	1
Other birds	(Aves sp.)	4	3
TOTAL		902	

* Identification by Aleksey Kasparov (RAS, Institute for the History of Material Culture)
**Identification by Olga Potapova (RAS, Institute for Zoology)

hunting methods practiced by the natives. Only one skull fragment, pierced by a strong sharp tool in the occipital region, can be pointed out. It was probably done during hunting; on the other hand, it might have happened after the animal was taken. In this connection we need to point out the specific artifacts that were previously discussed as equipment for digging (Pitul'ko 1993). Some of them have undamaged surfaces with clearly identifiable linear wear traces that confirm such a point of view. But could they have been re-utilized? The item in Figure 43:1, which has never been used in any function, looks strong enough to wound a bear and make the hole in the skull.

It has also been mentioned that bones of polar bears are extremely numerous at the site (Makeyev, Pitul'ko, and Kasparov 1992:302–303; Pitul'ko 1993:20). At the same time, fossil bones of polar bears occasionally discovered in Pleistocene or Holocene sediments are not numerous. Thus B. Kurten (1964) described only a few finds of polar bears in England and Sweden that dated to the Pleistocene and eight fossil bones from Sweden and Denmark belonging to Holocene sediments. The latter collection consists of one fragment from the lower left jaw and five fragments from postcranial bones of a polar bear.

The only bone of a Pleistocene polar bear (a left ulna) known from Russia was discovered on the Yamal Peninsula; on the Yamal and near the Kolyma River estuary were found some non-fossil polar bear skulls killed 200 to 300 years ago (Vereschagin 1969; Vereschagin and Tikhonov 1991).

The great number of polar bear bones emphasizes the unique character of the Zhokhov assemblage. A site where polar bears were the permanent food source for ancient hunters is discovered for the first time. The bones of polar bears dug out of the few Arctic sites are not numerous or are absent. For example, we note two skulls and some postcranial bones of polar bears excavated from the Eskimo site at Cape Baranov near the Kolyma River estuary and dated between AD 1000 and 1600 (Okladnikov and Beregovaya 1971; Vereschagin 1971). The ratio of the paleozoological materials from Walakpa site (Alaska, Bering Strait area) is more graphic: excavated there were 9,477 bones of seals, 6,076 reindeer bones, 236 bones of domesticated dogs, and 172 bones of polar foxes, but there were only 37 bones of polar bears from all horizons (Stanford 1976).

Though the bones from Cape Baranov have specific cooking marks (Vereschagin 1971), they are not evidence of the constant polar bear hunting. Nevertheless, these strong and dangerous animals were common prey for the ancient natives of Zhokhov Island.

Polar Bears (*Ursus maritimus*)

As mentioned above, the bones of polar bears are very numerous at the Zhokhov site (Table 4), and both the cranial and the postcranial bones are examined (Tables 5, 6; Figures 59, 60). Skull (cranium) fragments are rather numerous among the bones. They are:

1. fragments of the frontal section of the upper jaws, often with fangs and incisors—19.6% of cranial fragments;
2. skull fragments with the molar and premolar line and a section of palate; sometimes a piece of cheek bone—25.0%;
3. fractured frontal bones with supraorbital processes—19.6%;
4. fragments of parietal bones (as a rule, the extensive fragments of parietal bone are joined to the upper section of the occipital bone); the parietal bones are often joined along the natural central commissures—17.8%;
5. fractured temporal bones with small sections of the cheek bones and the articular surfaces for the condyles of the mandibles—10.7%.

The enumerated fragments resulted from the destruction of skulls, and it can easily be seen that the natives repeatedly used the same methods to break down the skulls of polar bears. The process included several operations; the directions for destruction are shown in Figure 59 (the totally crushed zones are cross-shaded). Besides these fragments, there are two skulls in the collection where the operation of dismembering was not completed.

Skull 1. The facial part is practically absent: it was broken off along line Pm_2–Pm_3 on the right, but the cheek bone is undamaged and a fragment of temporal bone is intact. On the left, the facial part of the skull was completely destroyed, including the cheek bone and the supraorbital process. The vault with the saggital crest and the sphenoid bone of the skull are intact, though the laterals of the parietal bone and the upper section of the temporal bone are broken off. The occipital bone with the condylus and the spinal cord hole are not damaged. Evidently, the bones were crushed by piercing extensive holes from the lateral side of the brain case.

Skull 2 was broken down by the same method, but the facial part is well preserved. The cheek bones and the vault are absent. The occipital bone is slightly damaged (the left condylus is broken off). The skull cup is broken. This was done by piercing an opening from the lateral side, as in the first skull.

Table 5. Some parameters measured on polar bear skulls (1–16) and mandibles (17–26) from the Zhokhov Island site, in comparison with data on modern polar bears of the New Siberian Islands (after V. V. Pitul'ko and A. K. Kasparov, 1996).

		Zhokhov Island (Early Holocene)		New Siberian Islands (modern)*, N=7		
	Measurements	**N**	**LIM**	**M**	**males (?)**	**females (?)**
	CRANIUM					
1.	Condylobasal length	1	–	320[1]	368.4	327.6
2.	Basal length	1	–	300[1]	338.4	301.4
3.	Breadth of the canine alveoli	2	77.7[1]; 93.0	85.4	92.4	77.2
4.	Least palatal breadth: measured behind the canines	1	–	80.0[1]	–	–
5.	Breadth at postorbital constriction	2	67[1]; 73.7[2]	70.4	–	–
6.	Facial length: Frontal midpoint—Prosthion	1	–	63.1[1]	–	–
7.	Upper neurocranium length: Akrokranion—Frontal midpoint	2	180[1]; 196.6[2]	188.3	–	–
8.	Breadth of the choanes	2	18.7[1]; 16.6[2]	17.7	–	–
9.	Greatest breadth of the occipital condylus	3	71.3[2]–82.5	78.1	–	–
10.	Alveolar length of cheek tooth row: measured on the buccal side from oral border of the canine alveoli	5	111.8–140.0	124.8	150.4	135.8
11.	Length of the molar row along the alveoli	9	63.4–82.5	69.8	–	–
12.	Length of M_1 crown	18	21.0–30.5	25.2	–	–
13.	Alveolar length of M_1	17	21.8–36.1	26.9	–	–
14.	Greatest breadth of M_1	2	112.8–15.4	14.0	–	–
15.	Basal length of canine crown	4	17.5–21.4	20.2	–	–
16.	Breadth of canine crown	4	13.6–15.0	14.4	–	–
	MANDIBLE					
17.	Total length: condyle process—Intradental	3	233.0–268.0	230.5	251.0	220.8
18.	Alveolar length of cheek tooth row: from oral border of the canine alveoli	12	125.8–160.3	137.9	149.6	135.4
19.	Crown length of the molar row	5	66.4–74.7	70.0	–	–
20.	Alveolar length of the molar row	22	66.3–76.5	69.4	–	–
21.	Length of Pm_4 crown	18	19.0–22.0	20.4	–	–
22.	Length of M_1 crown	21	18.6–21.6	19.9	–	–
23.	Greatest breadth of M_1 crown	20	10.1–11.4	10.8	–	–
24.	Height of the mandible behind Pm_4 measured on the lingual side	20	36.0–57.3	41.8	–	–
25.	Basal length of canine crown	12	18.5–26.0	20.8	–	–
26.	Breadth of canine crown	10	13.1–17.0	14.4	–	–

Notes
After F. B. Chernyavsky (1969).
[1] Measurements taken from Skull 1.
[2] Measurements taken from Skull 2.

Comparing the dimensions of the fossils from the Zhokhov site with the modern skulls of polar bears from the New Siberian Islands described by F. Chernyavsky (1969:54–67), one can conclude that both the fossil and the modern skulls have no sharp differences in morphology. Accordingly we can judge that Skull 2 belongs to a female, while the other (Skull 1), more poorly preserved but with approximately the same dimensions, possibly also belongs to a female.

The average dimensions of the fossil skulls appear smaller than those of modern male animals (Table 5). The average data are close to those for modern female bears. Perhaps specific hunting practices might explain it; females with cubs might have been killed more often since they would be more vulnerable. It is well known that modern hunters shoot both females with cubs and old male animals that inconvenience people. Besides, female bears visit the Arctic coast or high Arctic islands, where they look for a place to give birth to their cubs. The ancient Arctic hunters of Zhokhov Island were evidently able to kill them at this time.

The parameters of the dental system of polar bears from the Zhokhov site have no strong differences from data obtained by Kurten (1964) on Late Pleistocene fossils from the Göteborg Museum (Sweden). The total skull length of the Pleistocene female is equal to the modern and the Early Holocene items from Zhokhov Island as well. Those of Zhokhov Island differ slightly from Pleistocene fossils. Both have the same width, but the length of M_1 measured on the skulls from Zhokhov Island is larger. The same proportions are typical of modern polar bears.

In summary, the morphology of the polar bears killed ca. 8000 BP on Zhokhov Island appears very similar to that of modern polar bears that typically inhabit the region of the New Siberian Islands.

Mandibles *(Mandibula)*, both intact and fragmented, are abundant in the collection (Figure 60; Table 5). They are broken primarily by specific methods near the location of the coronoid processes.

Sections of the coronoid process are broken from 33 mandibles having well-preserved dental lines, while 18 pieces are from the back of the mandible. The coronoid process with articular condylus are present, but the largest part of the mandibles is broken off. Two kinds of damage are noted: (1) the front and/or upper edges of the coronoid sections of the mandibles are chipped slightly or broken off entirely (12 items); (2) the articular condyli are broken from nine bones. The dimensions indicate that the animals were of mid-size (Table 5) and probably female.

The characteristics examined on the fragments of skulls and mandibles of polar bears make it possible to advance some conclusions about the operations used for skull destruction. Unfortunately, it is difficult to understand the succession of the operations; moreover, no one can confirm that any succession took place at all. But the great quantities of standard fragments of skulls and mandibles confirm that a specific operation was used regularly, and some suppositions may be advanced.

Evidently the initial operation of cutting up the killed animals was carried out at the kill site. The head was removed from the carcass after skinning. The method of this operation has not been identified since cervical vertebrae are rare in the collection. The occipital condyli of the skulls and atlases are usually intact. Either the head was carefully cut from the spinal column or, more probably, the spinal column was chopped near the second vertebra. Thus the latter was destroyed almost completely and the fragments were left somewhere beyond the living site.

After carcass parts were brought to the site, dismemberment was continued. Some procedures are identified for cutting up the heads of polar bears (Figure 59):

1. The protruding parts of the muzzles were broken off, evidently to extract the canines. The latter were probably valuable for the hunters as adornments or talismans. It is interesting to note that bear fangs are numerous among teeth found separately from jaws (more than 30%).
2. For the mandible and strong masticator muscles to be dismembered, the cheek bones were destroyed near the middle. During this operation the coronoid process of the mandibles was chipped, while the mandibles were broken in two. The probable secondary purpose of such action was to extract the tongue.
3. Then, for extraction of the brain, holes were pierced in the sides of the skulls. The actions were not careful and the skulls were broken into several parts (frontal, occipital, and temporal bones). Evidently during this process sections of cheek and temporal bones were destroyed to a great extent, and the characteristic marks appeared. The temporal sections of the skulls were chosen for striking because the thickness of the skull on the point at the juncture of the frontal, parietal, and temporal bones is extremely small (only half a millimeter) and this section of skull is very durable.

These procedures were in practice for a long time. Thus two skulls excavated from the Eskimo settlement at Cape Baranov and dated to later than the Zhokhov site—between AD 1000 and 1400—were broken in the same way. Both have holes pierced in the sides and the cheek bones broken off, though the ends of the muzzles are intact. The lateral holes are not as extensive as the holes in the skulls from the Zhokhov site; the diameter of the openings varies from 7 to 10 cm, i.e., the skulls were little damaged in comparison with the Zhokhov finds (Vereschagin 1969).

It should be noted that the bear skulls collected by N.K. Vereschagin from the Nenets sacrificial sites on the Yamal Peninsula and dating from the beginning of 14th century AD or later have almost no traces of damage at all. Thus the lateral bones were pierced on only three of 58 skulls collected. As a rule, the cheek bones are intact. The fangs were extracted from 35% of the skulls. Evidently, we can assume that the custom of total destruction of polar bear skulls was gradually vanishing.

The atlas *(Atlas)* and other vertebrae are rare in the collection (Figure 60). Atlases are well preserved as a rule, 10 of them have both ventral and dorsal arcs; the articular surfaces are mainly undamaged although four bones have marks of striking. Only two items have seriously damaged frontal articular surfaces. No fewer than half of the lateral processes of the atlases are broken off; some have no lateral processes at all. Nevertheless, we suggest that the latter defects are not connected to human activity. Other sections of the bear's spinal column are rare in the collection: there are only three fragments of the facial part of the axis and two ventral arcs of lumbar vertebrae, which had been gnawed by dogs.

Shoulder blades *(Scapula)* are also not numerous (Figure 60). All of them are fragmented.

Three fragments are from very large animals; the others belong to mid-size bears. The bones are poorly preserved. Only five items have intact or lightly damaged articular surfaces. The others are forepart fragments of shoulder blades—the neck of the scapula with the beginning of the shoulder crest, at the caracoid process, are always broken off. The crests are always extremely damaged on the external edges. Consequently we can assume that the destruction of shoulder articulations took place during dismembering of the humerus bones. We should note that proximal humeri are nearly absent in the collection, and only one proximal fragment was found. Some dimensions were measured (Table 6).

Humeri *(Humerus)* are abundant in the collection (Table 6; Figure 60). As mentioned earlier, a single scorched fragment of a proximal articular head was found. The others are the distal ends (section of diaphyses with distal epiphyses). The fragments are not large in size. The length of the fragments is no more than one-quarter or one-third of the normal length of intact humeri. Most of the bones, except one item, are badly damaged. The articular blocks are usually crushed, and only three bones have the medial section of the articular surfaces. Most of the items have clear traces of canine gnawing. Since this is true not just for this category, we have to explain such a conclusion. Of course, we cannot state unequivocally that each bone with chewing marks was gnawed by a dog. But at the same time, the teeth marks (their size and especially the distance between fang marks) indicate that marks on bones gnawed by a carnivore are significantly larger than those of an Arctic fox. It is possible that it might have been a small wolf, but we tend to suppose that it was a dog since dog bones were discovered at the site (see above). At the same time we need to point out that the chewing activity of a dog (or other carnivore) did not substantially affect the preservation of the bones. It should be pointed out that there are no items where the surfaces or articulations were terminated by chewing activity.

The ulnae *(Ulna)* are numerous (Figure 60). As a rule, they are seriously damaged. Two parameters were measured (Table 6). Damages clearly indicate the operations used for cutting.

Table 6. Measurements on postcranial skeletons of fossil polar bears from the Zhokhov site by category (after V.V. Pitul'ko and A.K. Kasparov, 1996).

DIMENSIONS	N	LIM	M
SCAPULA			
Articular length	3	60.5–74.0	68.7
Articular breadth	6	32.4–50.6	38.9
HUMERUS (distals)			
Greatest length	2	103.6; 107.0	105.3
Articular breadth	4	65.4–89.5	74.5
Diameter of mid-narrowing of articular block	9	22.8–33.0	25.9
ULNA (proximals)			
Greatest articular length: at the external border of olecranon	12	65.1–90.1	72.0
Greatest articular breadth	16	54.5–71.6	59.6
RADIUS			
Frontal diameter	2	30.9; 41.0	–
Transversal diameter	2	43.5; 55.2	–

Thus, the distal sections of bones are usually broken off: there are 40 items without distal sections (about one-third the normal length of the bones is lost) and only two distal fragments of ulnae. Besides these items are seven proximal fragments with the articular part and eight fragments of diaphyses. Most of the bones are proximals having very specific damages: the olecranons are much damaged near the articular surfaces or completely broken off together with the latter. Only five ulnae have intact olecranons. The damages are undoubtedly butchering marks and their regular character confirms it. The described indications show that, as a rule, the forelegs were chopped off, usually unbent at the elbow joint. The blows were struck at the junctions of the articular parts of the humeri and the olecranon of the ulnae was destroyed as described above. But sometimes forelegs were not unbent before the chopping and another feature of damage appeared—only the upper sections of the olecranons were broken off. Evidently the absence of distal humeri shows that the metacarpal parts of the legs, of little value as a food source and causing a heavy load, were chopped off before the prey was transported to the living site. Thus these bones might be abundant at kill sites.

Radial bones *(Radius)* are few in number (Figure 60) and much fragmented. There are five proximal fragments, only one distal fragment, and two pieces of diaphyses. This can also probably be explained by butchering at the kill sites. Though the radial bones are fragmented, some dimensions were measured (Table 6).

Fragments of pelvises *(Coxae)*, femurs *(Femur)*, and tibiae *(Tibia)* are extremely rare in the collection (Figure 60). No regularity of destruction was observed. It could be noted, however, that the pelvic bones are represented only by fragments of the pelvic joint cavity and the tibiae by distal fragments. Some items (primarily femur fragments) have clear marks of canine gnawing. At the same time, the quantity of fibulae *(Fibula)* is unexpectedly large (Figure 60), but they are diaphyses. Only two epiphyses were found (proximal and distal).

The heel bones *(Calcaneous)* are not abundant (Figure 60). All of the bones are damaged: the rear section of the bones is broken off, and it looks like the heel bones were chopped in the middle. The external surfaces are definitely damaged; the others are much gnawed by dogs, and identification of cut marks is impossible. We assume that the damages appeared as a result of chopping off the lower parts of hind legs. However, the operation took place at the living site since both the distal bones of the heel and the chopped parts were found. Evidently the Achilles tendons, which fastened to the rear parts of the heel, were cut along with the latter.

The ankle bones *(Astragalus)* are fragmented and extremely rare (Figure 60). Metatarsals and metacarpals *(Metapod)* are also few in number. Both the first and the second were damaged by the distal epiphyses being broken off. All of them are much gnawed by dogs. Phalanges *(Phalanx)* are numerous (Figure 60). There are 20 front and 14 rear phalanges I, 13 front and 10 rear phalanges II, and 9 front and 6 rear claw phalanges. Some observations are in order. Phalanges I are generally intact; the surfaces of some bones seem slightly dissolved by canine (?) gastric juices—evidently the bones were gulped down by dogs. Phalanges II are intact and have the marks of canine gastric juices also. The claw phalanges are not damaged; one bone has a well-preserved claw. As an indication of the age of the animals that were killed by Zhokhov natives, we can point out that the rear phalanges II (1 item) and the rear claw phalanges (1 item) with sclerotic excrescences belonged to a very old polar bear.

Keeping in mind that phalanges are the most numerous bones (along with ribs and vertebrae) of the skeletons of predators, the quantity of collected phalanges is admittedly extremely insignificant. Probably, as mentioned above, the small quantity of phalanges at the site was determined by the initial butchering of killed bears at the kill sites, where the lower parts of legs were chopped off and abandoned. The latter were rarely brought to the living site: for example, if a bear was taken nearby or directly at the site location.

As can easily be seen from diagrams (Figures 60, 61), the fragments of cranial bones were extremely abundant in the excavated area. The atlases are also numerous. Distal humeri and proximal ulnae are the next most abundant. The diagrams (Figure 60) show that the bones from the front parts of carcasses prevail among the bone remains of polar bears.

This can probably be determined indirectly by assuming that the primary butchering of taken animals was at the kill location. Hunters used the following operations: they skinned the bear and then dismembered the carcass into several portions rich in meat; then they cut off the legs and head. To make transportation of the prey easier, they chopped off and abandoned some inedible sections (for example, the lower parts of paws). Butchering was finished at the camp, where hunters chopped off the legs at the knee or elbow joints. Concerning the latter, it can be said that the operation was carried out after straightening the paw. The skulls were broken down entirely for extraction of the brain and the tongue. The canines were probably also of some value. Surprisingly, the bones of the front part of the bear skeleton predominate at the site. The ancient hunters of Zhokhov Island were undoubtedly able to bring to the site both the front and hind paws of the bear, but we have no evidence of the latter—probably due to the small excavated area of the site. But specific features of the spatial distribution of bones still remain unidentified. At the same time, some observations on the spatial distribution of reindeer bones tend to support this idea. For example, locations abundant with skull fragments were discovered, but there were places without or with an extremely small number of them, yet the shoulder blades (e.g., metatarsal bones) were abundant. At some localities bones were entirely absent.

Consequently, it can be assumed that the missing bones of polar bears might be concentrated somewhere in the unexcavated area of the site. The indirect cause of this might also be connected with primary butchering away from the site.

Reindeer (*Rangifer tarandus*)

The second food source used by Zhokhov Island hunters was traditional to all Northern peoples: the cultural layer of the site was very rich in the bone remains of reindeer (Table 4; Figure 61).

The skulls *(Cranium)* are always fragmented. Most abundant are the antlers (115 items). Fourteen of them retain pieces of frontal skull bones; the others are only broken antlers. About 30% belonged to does and young deer (in general, the section of antler directly exiting the skull). But 15 fragments are from large reindeer; 10 fragments are from the mid-part of the antler shafts, and the others are fragments of upper tines. Most of the antlers are chaotically fractured, although some of them were cut or chopped around before breaking.

Skulls and upper jaws (only 18 items) are much fragmented and any measurements are impossible. The small quantity of skull fragments seems strange in comparison with the abundance of antler fragments. However, observations by Binford and Bertram (1977) show that the Eskimos of northern Alaska only rarely use caribou heads as a food source. They kill a large number of caribou during migrations and then preserve the meat by freezing it in pits dug into permafrost or by making jerky by drying it on stands near the houses. Unfit for jerking, the heads were rarely preserved by freezing; usually these parts of caribou carcasses are fed to dogs. A large number of heads with antlers are piled over meat pits so that the antlers stick out of the snow, marking the place.

Evidently, the hunters of Zhokhov Island did not use reindeer heads as food either, inasmuch as an abundance of meat was standard during the period of reindeer hunting. But in contrast to modern American Eskimos, who are well equipped with a variety of goods, the prehistoric natives of the De Long Islands needed bone raw material for manufacturing different equipment. There is much evidence of the use of reindeer antlers and bones for tool making (see above). Thus antlers were brought more often than unbroken reindeer heads to the living site. Moreover, it must be emphasized that the statistics of broken antlers may misrepresent the facts since the fragments might result from more than one breaking of the antlers. It must be noted that naturally lost antlers were used as well.

Reindeer mandibles *(Mandibula)* are very abundant (Table 7; Figure 61) and extremely informative since the examination of teeth gives a chance to define the season when the reindeer were taken. There are 26 fragments of young or sub-adult animals, where the replacement of milk teeth was not yet complete. No jaws of old animals were identified.

The damages to mandibles are of a specific and regular character; a kind of standardization of damages is identified both for reindeer and bear mandibles in general. Mandibles with a complete line of teeth are abundant—22 items, each without coronoid process and articular condyli, which are rarely found separately. Only two mandibles do not have the latter broken off. Evidently the mandibles were crushed by hard blows for removal from the skulls and forobtaining the tongue. Most of the mandibles are broken in half. The fracture is always located near

Table 7. Parameters measured on fossil reindeer mandibles from the Zhokhov site (after V.V. Pitul'ko and A.K. Kasparov, 1996).

	VALUE		
DIMENSIONS	**N**	**LIM**	**M**
Length of the molar row along the alveoli	8	91.0–103.0	95.5
Crown length of the premolar row	11	37.7–44.1	40.7
Crown length of the molar row	12	55.0–62.4	57.3
Distance from the rear border of the nutrient hole to the front border of P_2 alveoli	10	42.7–52.7	47.4
Crown length of M_3	13	20.2–25.5	22.2
Height of the mandibles: P_4–M_1	2	28.1; 25.0	26.6

the line of M_1 or P_4–M_1. The lower part of each mandible is broken off or seriously damaged. Such operations were necessary to reach the cavity rich in marrow and blood vessels. The incisor zone of the mandibles is usually damaged (except in four items). The alveoli are extremely crushed or broken off together with an extensive section of diastemus. L. R. Binford, describing methods of butchering among the Caribou Eskimos, notes that the custom of careful dismembering of the heads of killed caribou and especially the same methods of extracting the caribou tongue were known by Alaskan natives beginning in the Late Palaeolithic (Binford 1981). It is very significant that fragments of reindeer mandibles from the Mousterian layers of the Comb Grenal site in Europe, published by Binford in comparison with the Alaska finds, were broken near the position M_1, i.e., the same method was used. But in contrast to the Zhokhov finds, the mandibles from Comb Grenal have marks of striking inside on the line M_2. Nevertheless, the general operation used for breaking reindeer mandibles by both the Zhokhov natives and the Mousterians at Comb Grenal were similar to each other—differing only in a few details.

Examination of the reindeer mandibles allows proposing assumptions about the seasonality of the Zhokhov site. To provide grounds for these, we examined the mandibles of the sub-adult animals. Inasmuch as the calving of reindeer takes place from May to June, the starting point for the chronology is well known. The examination of the reindeer dental system shows that a lot of animals were killed during one period: 26 mandibles of semi-adult reindeer were examined, of which 13 either have the third and fourth milk teeth coming out or have already come out. The second and the third premolars (and sometimes the third molar) of these mandibles are erupting. Such a situation is typical for reindeer during the third year of life. There are also two mandibles of very young animals with M_1 teeth erupting. The appearance of the latter is also typical for the beginning of the summer period, but it takes place in the first year of life. Inasmuch as three fragments of mandibles with erupting M_2 teeth were found, it can be assumed that some animals were killed in the first half of summer.

Finally, several fragments with teeth indicate another season of killing. Thus the upper surfaces of the M_2 teeth examined on three fractured mandibles are worn off, while the M_3 teeth have not erupted at all. The eruption of M_2 teeth is almost complete on three other specimens. The described indications of dentition are typical for reindeer from August to October and may be observed respectively in the second and third years of life.

Most subadult animals were killed in spring or early summer, i.e., during the period of spring migration. In fact, reindeer are rarely taken in fall. But it does not mean that spring hunting was more effective than an autumn one. In all probability, the conclusion advanced is correct not only for young animals. The elicited facts confirm the well-known tradition of killing reindeer during their seasonal migrations, which is generally practiced among Arctic peoples as the basis of the subsistence economy.

The postcranial bones of reindeer are also abundant, but some categories (especially the vertebrae) are scarce (Figure 61). One fragmented and two intact atlases *(Atlas)* were collected. Because both of the intact items are damaged, they were measured in two positions (Table 8). Only one fragment with an undamaged frontal part of the articular surface of the axis *(Epistro-*

Table 8. Parameters measured on reindeer postcranial bones from the Zhokhov site (after V.V. Pitul'ko and A.K. Kasparov, 1996).

DIMENSIONS	VALUE					
	N		LIM		M	
ATLAS						
Frontal articular breadth	2		64.8; 73.0		68.90	
Ventral length	5		39.0–47.6		44.50	
SCAPULA						
Ventral angle length	6		31.2–40.5		35.00	
Articular length	7		23.6–39.4		30.20	
Anterior-posterior length	4		24.0–33.5		28.60	
HUMERUS (distal)						
Greatest breadth	20		41.2–52.3		47.00	
Total articular breadth	22		37.7–48.0		43.7	
Middle articular diameter	25		23.2–30.0		24.70	
Breadth of diaphisis	7		20.2–25.3		22.30	
ULNA (proximal)						
Greatest articular height	10		35.0–45.0		38.50	
Greatest breadth	13		22.6–28.8		26.20	
RADIUS						
Total proximal breadth	12		42.7–51.3		47.80	
Breadth of proximal articular surface	13		40.8–47.5		44.20	
Ant.-post. diameter (proximal)	13		24.5–30.2		27.20	
Breadth of diaphyses at mid-section	9		21.8–34.0		26.90	
Total distal breadth	15		40.0–49.5		43.90	
Ant.-post. articular diameter (distal)	16		25.6–34.2		28.50	
TIBIAE (distal)						
Total breadth	14		38.0–45.5		41.60	
Ant.-post. diameter	17		24.5–37.0		33.4	
Breadth of diaphyses at mid-section	4		20.8–32.0		26.4	
ASTRAGALUS						
Total lateral length	13		43.0–50.5		46.6	
Upper articular breadth	14		23.1–27.8		25.4	
Bottom articular breadth	13		26.6–33.1		29.00	
CALCANEUS						
Greatest articular breadth (frontal)	12		24.7–32.4		27.2	
Greatest height of rostrum	10		32.2–36.8		35.20	
METACARP (*) / METATARS (**)	*	**	*	**	*	**
Total length	5	–	196.6–304.2	–	225.3	–
Greatest proximal breadth	23	4	31.7–40.0	29.0–35.8	35.2	32.5
Proximal ant.-post. breadth	18	2	23.0–29.5	32.1; 36.6	25.9	–
Breadth of diaphyses at mid-section	20	13	17.8–29.0	18.3–26.4	22.3	21.9
Greatest distal breadth	23	31	37.6–48.6	38.1–46.5	42.1	42.6
Ant.-post. articular diameter (distal)	25	29	20.1–25.0	21.1–26.5	22.3	24.7

pheus) was found; it is 64.4 mm wide. Besides these bones, two broken lumbar and one fragment of sacrum vertebra were excavated. To sum up, both reindeer and polar bear vertebrae are extremely rare in the collection. Evidently, it is not accidental and may have been affected by the general strategy or procedures of butchering that were in practice.

In contrast to the bones completing the spinal column, the shoulder blades *(Scapula)* of reindeer are rather numerous (Table 8; Figure 61). All of the bones are broken and 23 items are fragments of scapula necks with the articular surfaces. The latter are intact or damaged slightly on 13 items; 8 bones have damage on the upper section of the articular surface, which is broken off on two items. The scapula neck with articular surfaces is completely terminated on 13 bones.

The crests of the shoulder blades are damaged except on two bones. These sections are chopped off on seven shoulder blades. Only six items have intact or lightly damaged crests. Generally, the middle sections of shoulder blades are broken out on most items. At least one shoulder blade was pierced from the ventral surface.

Though Binford (1981) notes that the destruction of suproglenoid tuberals and coracoid processes generally indicates the gnawing of bones by dogs (or wolves), it is evident that such damage observed on bones from the Zhokhov collection is undoubtedly the result of human activity since gnawing marks were identified on only three fragments. In general, shoulder blades are crudely fractured. The damage is of an unmethodical character. The articular sections were damaged or broken off together with the procedure of breaking a shoulder joint.

All of the collected shoulder bones *(Humerus)* are distinctly fragmented (Table 8). There are only distal fragments of humeri; no more than the distal third of the diaphyses are preserved. The distals are intact or lightly fragmented on 25 bones; five items were greatly damaged. The rest of the shoulder bones (11 items) are distal fragments of diaphyses, sometimes split lengthwise. But what is important is that the proximal sections of humeri were not found at all.

Such disproportion within the categories of osteological materials (for example, the proximal/distal ratio) looks standard for archaeozoological materials. It is well known that distal humeral fragments of diverse ungulates excavated from sites dating to different times and located in different regions are more abundant then proximals. Thus, the quantity of distal fragments of caribou humeri regularly prevails over the proximals. The same was noted for bones from the Mousterian Comb Grenal site in France, where the osteological materials comprise reindeer, horse, and prehistoric bos remains (Binford 1977, 1981). Exactly the same was revealed on bone remains of domestic sheep and goats excavated from Neolithic and Eneolithic sites in Turkmenistan (Kasparov 1989), where the number of distal epiphyses extremely outnumbered the proximals.

Finishing the description of shoulder bones, we note that both the described disproportions and the specific damages on reindeer humeri are determined by the dismembering of forelegs and shoulder blades, when the humeral proximals were lost. After the dismembering, the diaphyses of the reindeer humeri were broken unsystematically by the Zhokhov natives for the marrow to be extracted. Some bones were split lengthwise.

There are few ulna bones *(Ulna)* (Table 8; Figure 61). Only 13 proximal fragments were found.

The olecranon processes on bones are always damaged; the upper part of the articular surface is broken off on one item. The others have either an intact or a slightly damaged articular surface.

In contrast to the ulnae, the radii *(Radius)* are abundant in the collection (Table 8; Figure 61). Some of them are attached to lower sections of ulnae. There are 17 proximals and 22 distals. An intact ulna-radius juncture, or just the upper part of the latter, was not found. The radii are broken off at a distance of 10 to 12 cm from the proximal articular surface, which is not usually damaged. It is interesting that the ulnae described above are fractured just there. But in contrast to the proximals, the distals are split or cracked lengthwise. The distal fragments are usually about 10 cm long and look like long bone slivers. The described specific damages indicate that the lower section of the bone (about one third of the normal length) was chopped off for extracting marrow. This section is accessible for breaking because the ulna attaches to the radius here and does not rise over the latter.

Pelvis bones *(Coxae)* are much fragmented and rare (Figure 61). Besides five fragments of pelvis bones and four intact joint cavities, there are fragments of iliac bones. The fragments have no specific dimensions or outlines, and the pelvis bones were evidently broken without any standard process. Femur bones (*Femur*) are also especially rare (three fragments—two articular heads and one distal epiphysis).

The tibiae *(Tibiae)* are represented by 21 distal fragments (Table 8; Figure 61). The distals are almost completely undamaged and usually have a 4 to 6 cm long section of diaphyses—17 items. The fracturing is similar to the marks observed on the radii. Evidently these bones were also broken for the extraction of marrow. However, the extremely small fragments of diaphyses are a doubtless result of damage to the ankle joint (see below).

Ankle bones *(Astragalus)* are few in number (Table 8; Figure 61). Most of them are intact; two bones were gnawed by dogs. The latter is unusual for reindeer bones excavated from the Zhokhov site.

Heel bones *(Calcaneus)* are also not abundant (Table 8; Figure 61). They are broken in one way: the rear sections of the bones (where the bone and the strong tendon straightening the talocrural joint are attached) were broken off 13 items. Others (two items) are damaged more extensively and look like small fragments of the articular surface with the rostrum. It should be said that six fragments have been gnawed a little. Keeping in mind the regular character of damage, we can assume that the ankle joints were dismembered by the slashing of the tendons of the powerful muscles holding the joints. The rear parts of heel bones were broken off together with the tibiae distals. The greatest frontal width of the articular surface and the greatest rostrum height were measured (Table 8).

The metacarpal *(Metacarp)* bones are abundant (Table 8; Figure 61). Both proximal (67) and distal fragments (39) were found, and six fragments of diaphyses were dug up as well. The damages on the proximals are of a random unmethodical character (Figure 17), while the distals are always intact. Most of the distals are no longer than 10 cm; longer fragments (about 20 cm long) are rare (seven items). Evidently the breaking of the metacarpal bones was transverse, but sometimes they were split lengthwise by striking on the proximal ends.

Metatarsals *(Metatars)* are also numerous (Table 8; Figure 61). They are always fragmented, and both proximals (19) and distals (31) were found. All of the proximals (except two items) are broken, but the breaking is irregular. Both the distal and the proximal fragments are rather long (10 to 20 cm), though very short fragments were also collected. The character of the damages evident on the metatarsals indicates that the principal idea of the fracturing, in contrast to the metacarpals, was the splitting of bones from the proximal ends. Only two metatarsals were broken by striking on the middle section of the diaphyses.

It should be noted that there are metatarsal or metacarpal fragments that cannot be defined (long strips of bone). On the one hand, it may be assumed that metacarpals and metatarsals were split for extracting marrow. On the other, the elongate and sharp bone strips were excellent raw material for making such things as awls, needles, and hunting equipment. Artifacts made in this way are known from as early as the Iron Age. Even in the ancient states of the Black Sea region bone carving was based on the use of metacarpal and metatarsal bones of ungulates (Peters 1986).

Bones in the phalanx (*Phalanges*) category are rare. Phalanx I are the most numerous (3 intact, 14 fragments), but they revealed no intention of breaking. The other bones in this category, both the phalanx II and the hoof, are generally intact. They have no marks of artificial processing or canine gnawing. However, fossil canine feces excavated from the Zhokhov site contain crumbled phalanx, reindeer hairs, and small fragments of the horny cover of reindeer hooves.

Some general remarks on the morphology of the fossil reindeer from Zhokhov Island should be noted before discussing butchering practices. Data obtained on Late Pleistocene reindeer from the North and Middle Urals (Kuzmina 1971, 1976), the parameters of Final Pleistocene reindeer from the East Baikal Region (Kasparov 1986) and, of course, the well-known morphology of modern animals were compared with the collected items. Pleistocene Ural reindeer look slightly smaller in comparison with the Zhokhov fossils, while the fossil reindeer from the Baikal region are even much smaller. All the dimensions of fossil reindeer from Zhokhov Island are almost identical to the dimensions of animals inhabiting the tundra zone today (Table 9), though the Zhokhov fossils are more gracile. Thus the average length of metacarpals discovered on Zhokhov Island is 225.3 mm, while those for Pleistocene Ural and modern tundra reindeer are 190.6 and 203.2 mm respectively. Animals inhabiting the forest zone now look much larger: the average length of metacarpals is 229.3 mm; the length of metacarpal proximals and distals is 43.9 and 50.0 mm respectively (mid-value). The same dimensions for fossil Zhokhov reindeers are 35.2 and 42.0 mm respectively. The described morphological differences might have been determined by the natural environment (both the paleo and the modern) of the different regions, or by something such as the differences in depth of snow covers. At the same time, we acknowledge that the selection for discussion is too small, which often happens for fossils, and do not suggest the noted features to be regarded as facts.

The character of the fossil osteological remains from the Zhokhov site and the spatial distribution of bones make it possible to draw a significant conclusion. Careful examination of the bone remains—of both reindeer and bear—shows that the Zhokhov site was not a hunting camp where skinning and primary butchering of animals took place. It was evidently a living

Table 9. Dimensions of some reindeer bones from different regions.

REGIONS	Zhokhov Island site*		North Ural area***		Transbaikal area***		MODERN***			
DIMENSIONS	Early Holocene		Late Pleistocene		Late Pleistocene		Tundra zone (R. t. tarandus L.)		Forest zone (R. t. fannians L.)	
	N	M	N	M	N	M	N	M	N	M
MANDIBLES										
Alveolar length of the molar row	8	95.5	4	101.2	–	–	14	96.2	–	–
HUMERUS										
Distal breadth	20	47.0	27	45.1	3	40.54	48.0	2	51.2	
Length of the ventral angle	5	44.5	2	42.9	3	50.2	–	–	–	–
Distal height (epiphyses)	4	44.5	3	50.2	2	42.2	–	–	–	–
RADIUS										
Proximal breadth (epiphyses)	12	47.8	14	45.6	2	41.2	4	47.6	2	50.8
Distal breadth (epiphyses)	15	43.9	14	42.0	1	41.3	4	44.9	2	48.8
METACARPALS										
Total length	5	225.3	14	190.6	–	–	4	203.2	2	229.3
Proximal breadth (epiphyses)	23	35.5	17	34.3	–	–	4	36.5	1	43.9
Distal breadth (epiphyses)	23	42.0	14	41.6	1	41.8	4	44.0	1	50.0
TIBIA										
Distal breadth	14	41.6	30	40.2	2	38.7	4	41.5	2	45.5
ASTRAGALUS										
Total lateral length	13	46.6	103	45.6	4	45.0	4	47.0	2	51.9
Distal breadth (articular block)	13	29.0	103	28.4	4	26.2	4	29.4	2	32.6
METATARSALS										
Proximal breadth	4	32.5	12	30.8	1	24.3	3	31.5	2	35.4
Distal breadth	31	42.6	3	42.6	1	38.3	3	44.0	2	47.7

* after Pitul'ko and Kasparov (1996)
** after Kasparov (1986)
***after Kuzmina (1976)

site. To support this idea we refer to the data obtained by researchers at hunting camps of the Alaska Eskimos, who have a centuries-old history of caribou hunting. The hunting traditions determine the standard butchering procedures, and a specific spatial distribution of bones was associated with the kill sites and the living sites.

Thus Binford (1983) notes that the butchering of caribou occurs at a special temporary camp (kill site) and begins with the skinning; when it is done, the hunters put the hide away. They then butcher the skinned animal and remove the dismembered parts, liver, and fragmented bones to the border of the butcher area, creating in this way the circular feature. When the butchering is finished, the spinal column with skull, pelvic bones, and fragmented ribs are left at the center of the butchering area. Binford suggests that perhaps prehistoric hunters did the same. Accordingly, the circular distribution of bones and the abundance of intact vertebrae, pelvic bones, and other bones might be considered clear indications of kill sites. Describing their distinctive features, Binford notes another specific indication of kill sites—the abundance of fire places. The hunters spend a long time in the open air in the very cold Arctic spring and need warmth when skinning a large number of killed animals.

Taking into account Binford's observations, we examined the spatial distribution of the archaeozoological materials at the Zhokhov site. Though some specific concentrations were revealed, the spatial distribution for categories of skeletal remains in general is chaotic, as mentioned above, and clearly differs from the circular planigraphy of kill sites. Neither intact spinal columns nor abundant separate vertebrae (of either reindeer or bear) were found at the site. The latter are mainly atlases and axes, and generally very rare (Figure 60, 61). A large number of the excavated bones are broken. Thus reindeer metacarpals and metatarsals were doubtless split and broken to extract marrow. According to Binford (1981), such a method of fragmentation is customary only for the base sites of northern hunters; at the kill sites they are able to use more accessible food sources such as the tongue, liver, and blood.

At the same time, it is obvious that a large number of bones (both polar bear and reindeer) were concentrated at the central part of the excavated area (Figures 11, 13, 62) in Sections 12, 16, 22–26, 28. But this area is rich in artifacts and wooden pieces, and perhaps the spatial distribution of faunal remains discovered at the Zhokhov site repeats a common feature of spatial distribution. Other sections, excluding Section 49, have a more or less constant number of bones. The nature of this difference is unclear. This is probably the result of human activity, but at the same time it could be some kind of natural accumulation (solifluction or something similar).

The recurring character of damage on bones from the Zhokhov site makes it possible to advance some conclusions on butchering practices. Some marks could be connected with other processes (cooking, eating, canine gnawing), but certain traces of dismembering were discovered in the different categories of bones described above. The methods of butchering presumably might be reconstructed. The general succession of butchering used by modern native peoples for ungulates has been described by Binford (1981:91–92) in this way: (1) All groups ideally separate the head from the neck between the occipital condylus and the atlas vertebra. (2) All groups except the Navajo separate the neck from the remaining vertebrae. (3) All groups separate the front legs from the axial skeleton. Those that further cut the front legs into upper and lower segments generally do this between the carpals and the distal radio-cubitus. (4) All groups separate the rear legs from the vertebrae; however, there is considerable variability in the degree to which half the pelvis is left attached to the rear leg as opposed to the axial skeleton. In all the ethnographic cases recorded—where either axes, adzes, or large cleaver-type knives were used in butchering—the pelvis and/or sacrum were cut from the rear leg. Where small knives were used, the pelvis and/or sacrum were cut from the lumbar vertebrae or as a separate unit distinct from the rear leg. (5) All groups generally treat the spinal column with ribs and brisket distinct from the other major parts of the anatomy, but there is considerable variability in the way the thorax and spine are cut into small units. Most, but not all, cut the ribs and sternum off as independent units.

Perhaps the prehistoric natives of Zhokhov Island used the same strategy, but the information is not complete enough to draw such a conclusion. Nevertheless, some methods of butchering can certainly be specified.

Taking into account Binford's ethnological observations and the osteological collection where some categories of bones are missing (Figures 60, 61), it can be assumed that the hunters of Zhokhov Island, like the modern Eskimos, rarely cut the heads of reindeer from the spinal column and brought the heads to the living site even more rarely. Nevertheless, the method of removing the heads was standard and used in butchering both reindeer and polar bears: the heads were cut off near the atlases by chopping the axes, which are always very fragmented. But nothing can be said about the cutting of the neck.

Several steps are identified for cutting off the forelegs. (1) They were carefully cut from the body without breaking the shoulder joint. This probably took place at the kill site. The succession of other steps was not revealed, so we will consider them in anatomical order. (2) Dismemberment of the shoulder joint was executed by rough slashing of the proximal sections of the humeri, clearly marked by standard marks on the latter. (3) The elbow joints were dismembered carefully by dissecting the strong tricep tendon that attaches to the olecranons of the ulnae, and the latter were regularly chopped off together with the tendons. Taking into account that the epiphyses of the bones in the elbow joint (the ulnae and radii proximals and the distal humeri) are intact or lightly damaged, we can assume that the joints were carefully broken without striking, and then broken to extract marrow. (4) The cutting of the carpal joints was also careful inasmuch as both the proximal epiphyses of the metacarpals and the distals of the radii are usually intact. However, some epiphyses of metacarpals are broken. Obviously, the latter is not a sign of butchering technology; the damage appeared when the bones were split lengthwise for extracting marrow or for some other purposes.

Information on butchering the hind legs is very scanty. The hunters undoubtedly detached the femurs from the pelvis and then left the latter together with spinal column somewhere beyond the living site. This is indicated by the extremely small number of pelvic bones. The order of butchering the hind legs is uncertain since only a few fragments of reindeer femurs and tibiae were collected. Rich in marrow, these bones were evidently greatly fragmented. The same categories of bones are absent among bear skeletal remains. But perhaps their absence may be explained by the characteristics of spatial distribution.

The cutting of reindeer ankle joints can be described in more detail. First, the abundant components of the joints are less damaged. The only regular deficiency is the absence of the rear section of the heel bones. On the other hand, the intact ankle joint consisting of the tibia distal section, the talus, and the central tarsal bones was found. All bones are nearly intact. The above facts allow one to assume that the hunters cut off the intact ankle joints together with the metatarsal bones. To execute this procedure they had to break off the distal section of the shank bone and to dissect the Achilles tendon fastened to the head of the heel bone. A similar procedure was followed to break the elbow articulations.

The breaking of the shank bone and the cutting of the strong Achilles tendon might have been done when the ankle joint was straightened. In this position, the head of the heel bone and the distal extremity of the shank could easily be detached in one blow. The procedure results in the occurrence of very short distal fragments of the shank bones. Thus the latter are most abundant, and the described procedure was evidently in practice at the Zhokhov site. Keeping in mind the longer distal fragments, however, we need to note that sometimes procedures might be executed separately.

As a valuable food source and raw material, the metatarsals they were carefully separated from the ankle joints without striking and slashing. Their proximal epiphyses are almost all intact.

Describing the strategy and procedures of the butchering technology that is practiced by the Eskimos, Binford wrote that they dismember the legs of animals by inserting the knives into the bent joints. However, he notes that this is doubtful when using stone tools, because the applied pressure is too large and consequently the method is suitable only for the iron knives. Keeping the above in mind, Binford assumes that the general strategy of butchering with stone tools which took place in prehistoric times was based on superficial cutting of tendons. Then further separation of the bones might be accomplished. The results of the examination of the archaeozoological collection from the Zhokhov site tend to support this conclusion.

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Though materials from the Zhokhov site show that human occupation of the territory occurred near the Early Holocene climatic optimum, key questions about initial migrations into the East Siberian high Arctic have not been answered definitively. On the one hand, the area was accessible and the natural environment was more or less favorable during the Sartan Glacial. Yet nothing is known about Late Pleistocene human migrations to these territories other than the location of broken bones of large mammals discovered by Mochanov at one of the southern islands of the New Siberian archipelago in the 1970s (Mochanov, personal communication). The finds from Zhokhov Island force us to remember the information obtained as far back as 200 years ago by the pioneers of Russian explorations on the New Siberian archipelago—Matvey Gedenshtrom and Yakov Sannikov, who found some interesting objects on Novaya Sibir' (New Siberia) and the Kotelny Islands from 1809 to 1811. Gedenshtrom (1822:300, 301), who was the leader of the expedition, wrote in his notes that Sannikov found "an axe made of ivory resembling tools used by the Chukchi" on the west part of Kotelny Island. In addition, Gedenshtrom was informed about some camping places found both on the Kotelny and Novaya Sibir' Islands and ascribed by Sannikov to the Yukagir. But the latter (and the Yakut as well) never occupied these islands. Perhaps Sannikov and Gedenshtrom saw the locations of ancient sites with abundant split wood, broken bones, and other artifacts lifted to the surface by permafrost, as was the case for the Zhokhov site. I believe other traces of early human migrations to the region of the New Siberian archipelago will be found during future explorations.