2 TECHNO-TYPOLOGICAL COMPARISON OF MICROBLADE CORES FROM EAST ASIA AND NORTH AMERICA

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INTRODUCTION

In the last seventy years, much attention has been paid by many archaeologists in different countries, to the examination, analysis, and comparison of microblade cores, in their attempt to search for prehistoric cultural affinities through time and space. In the incipient stage of microblade research, morphological comparison was the only method for the study of the process of core preparation, reduction sequence, and rejuvenation. Since the wedge-shaped core technology called the Yubetsu technique was first reconstructed and defined by M. Yoshizaki in 1961 (see Morlan 1967:177), an increasing number of microblade techniques has been identified and defined. Techno-typological analysis has become a common approach used in microblade research. Techno-typology is the typology based on manufacturing attributes, in contrast to "morpho-typology" which is merely based on the morphological attributes of artifacts (Hayashi 1968:129). In Western archaeology, this trend of lithic analysis was also emphasized by many scholars. For example, Meltzer (1981:315) argued that archaeologists must recognize that tool morphology is determined by tool technology. Sackett (1989:51) pointed out that typology, as it is currently practiced, investigates stone tool morphology in ever more comprehensive terms, and he emphasized the need to understand the dynamics that underlie their patterning. The techno-typological approach offers a more appropriate way to distinguish the attributes of microblade cores and trace potential prehistoric affinities in time and space. As Sheets (1975:372) has put it, "technological analysis can increase the sophistication of archaeological comparison between specimens or types assessed in terms of how similar they are."

Microblade remains of a more recent period were reported widespread in provinces of North China. Most of them are surface collections with no detailed contextual or chronometric information. Many microblade remains were found either associated with pottery or ground stone tools. Locations were usually situated near dry lakes, river valleys, on sand dunes or small hills, or at the bottom of sand depressions. These remains have been generally called "microliths" in Chinese archaeology and assigned to the Neolithic age. The materials of this period are not discussed in this article.

This paper will first provide an overview of the discoveries and research of microblade remains in East Asia and North America, especially of the many new materials unearthed over the last few decades in China. The methodological consideration will focus on techno-typological approaches dealing with the attributes of raw material, core typology, core technology, edge angle, and dimensional variation. Based on the analysis of these attributes, a general comparison will be made of the similarities and differences between microblade cores found in different countries, in order to trace their development and technological change. A synthetic discussion will then outline the outcome of the comparison. Finally, a brief conclusion will explain the reasons why this technology could be adopted by so many human groups living in di-

Figure 2.1: Distribution map of microblade sites in China mentioned in the text.
1. Chaisi; 2. Xiachuan; 3. Lingjing; 4. Xueguan; 5. Hutouliang; 6. Shizitan; 7. Yaozitou; 8. Yushe; 9. Donghuishan; 10. Youfang; 11. Dabusu; 12. Angangxi; 13. Jiqitan; 14. Tingsijian; 15. Dafa; 16. Dagang; 17. Huilongwan Cave.

verse environments and distributed so widely in China proper and East Asia to northwestern North America during the Late Pleistocene and Early Holocene.

THE MAIN DISCOVERIES OF MICROBLADE REMAINS IN EAST ASIA AND NORTH AMERICA

The following microblade industries were found in the northern, eastern, and southwestern parts of China. A brief description of these discoveries is used for comparative analysis.

North China

Chaisi Locality 77.01 at the Dingcun sites

The Dingcun sites, located in Xiangfen County, Shanxi Province (35°51'N, 111°25'E), were discovered in 1954 and 11 localities were identified (Pei *et al.* 1958) (Figure 2.1). Since then, more localities with Palaeolithic materials have been found and reported in the region. In 1977, Locality 77.01 was found on the second terrace of the right bank of the Fen River near Chaisi. The upper sediment of the second terrace consists of greyish yellow sandy soil about 19 m thick. Stone artifacts, microblade remains, and mammalian fossils were unearthed from the gravel and sandy deposit, which is about 1 m thick and unconformably overlies marly clay sediment of the Lower Pleistocene.

The excavation of Locality 77.01 in 1978 yielded microblade remains, including six microcores, 86 microblades, and blades. Microcores are classified into three types, conical, wedge-shaped, and boat-shaped. Except for one wedge-shaped core of hornfels, most microcores were made of chert (Figure 2.2). Large chipping stone tools such as choppers, scrapers, and bolas were mainly made of hornfels (Wang 1986; Wang *et al.* 1994). A field survey in 1994 discovered Locality 94.01, which yielded a microblade assemblage from the second terrace of the Fen River. One microcore and four microblades were collected (Tao and Wang 1995). These two microblade localities were both dated to the Late Pleistocene. The radiocarbon date for Locality 77.01 is c. 25,000 BP (ZK-0635). Note that all ^{14}C dates in this paper are cited according to Libby's half-life of 5568 years (see The Institute of Archaeology 1991). There is no ^{14}C date for Locality 94.01, and age assessment is based on stratigraphic study.

The Xiachuan Industry

The Xiachuan sites are located in an area covering the three counties of Qinshui, Yangcheng, and Huanqu, southern Shanxi Province (Figure 2.1). Sixteen localities were found during surveys from 1970 to 1975. More than 1800 stone arti-

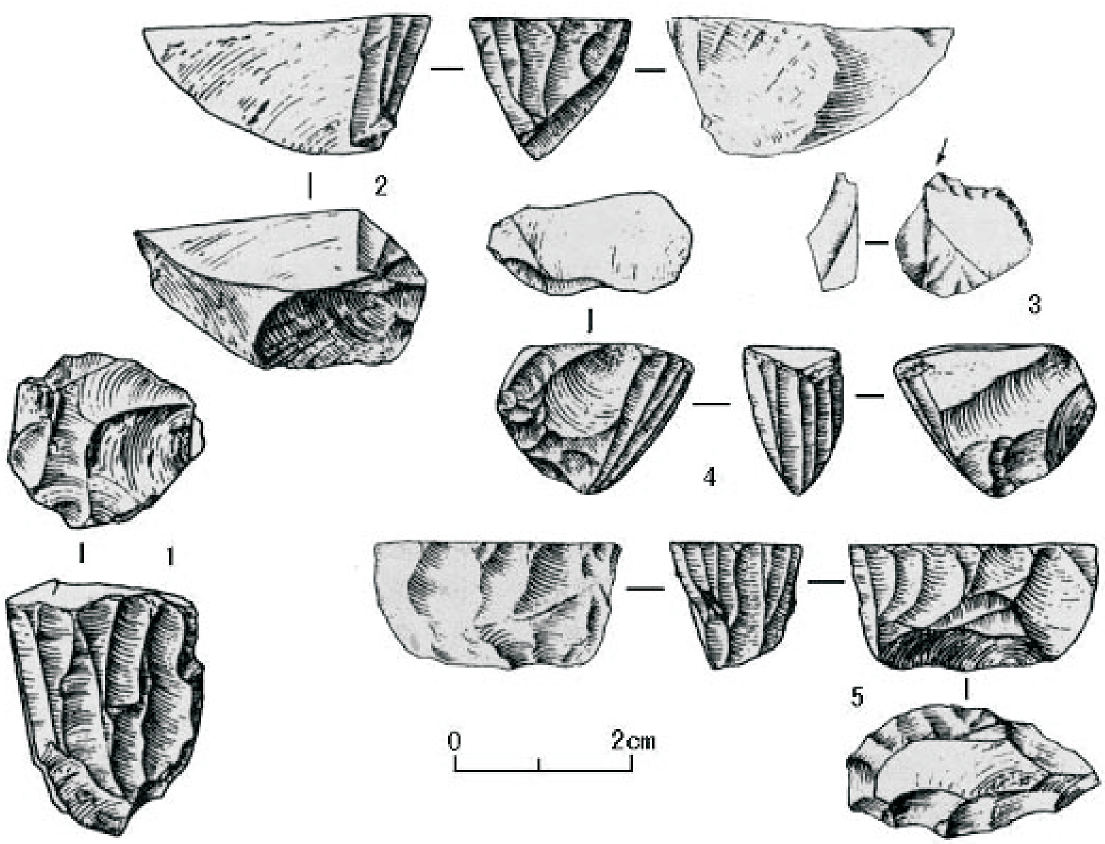

Figure 2.2: Microblade cores from Chaisi (after Wang *et al.* 1994)**.**

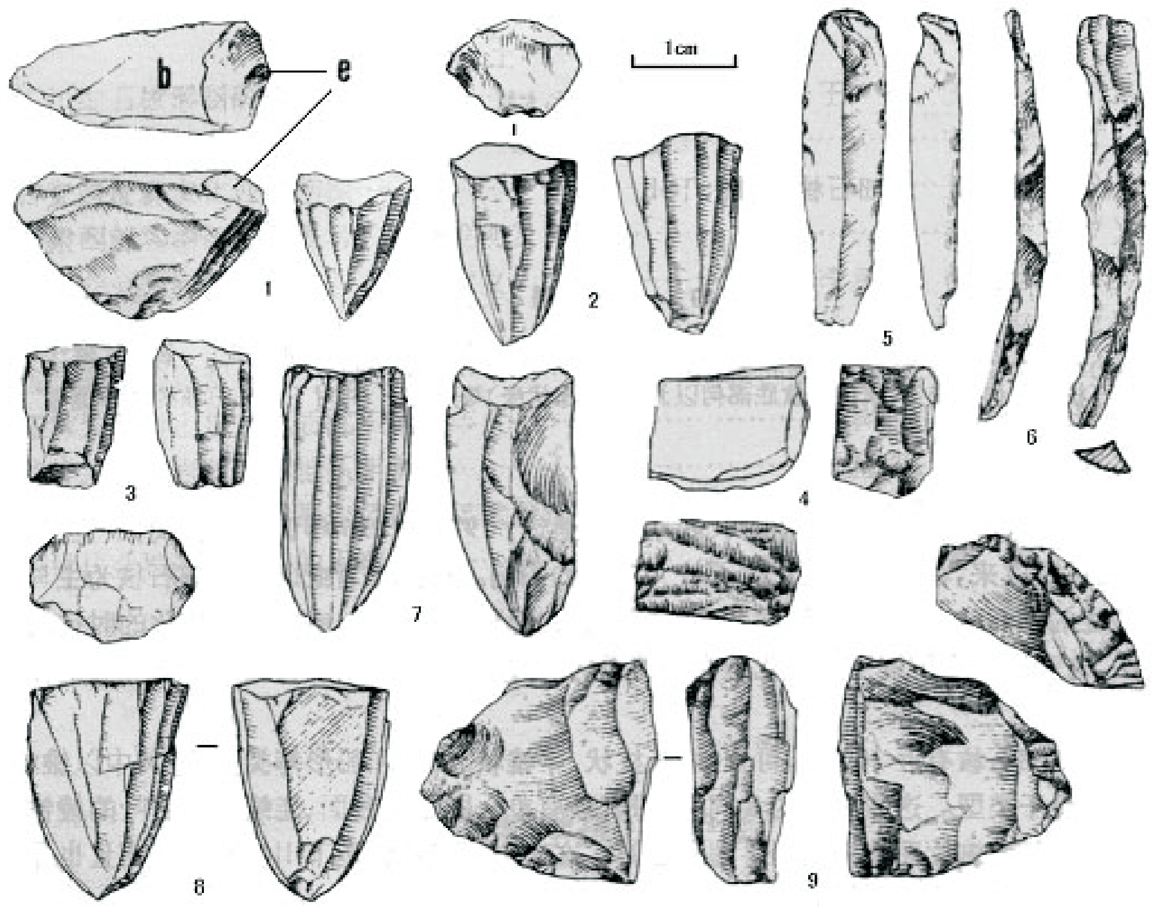

Figure 2.3: Microblade cores from Xiachuan (after Wang and Wang 1991)**.**

facts, including 219 microcores, were found in the 1973–1975 excavations (Wang *et al.* 1978). A detailed description is available in Chen and Wang (1989). From 1976 to 1978, the Committee of Cultural Relics of Shanxi Province and the Institute of Archaeology, Chinese Academy of Social Sciences, conducted excavations at the sites. The report is still pending.

Between 1990 and 1992, Chen Zheying of the Institute of Archaeology in Shanxi Province conducted three field surveys and collected 4415 stone artifacts from nine localities, including 100 microcores, 119 blades and microblades, and many microblade tools. Microcores were classified into wedge-shaped, conical, semi-conical, boat-shaped, and funnel-shaped (Figure 2.3). Other tool types include points, burins, microblade side scrapers, and other tools (Chen 1996). The chronological placement of the Xiachuan Industry is between c. 23,900 BP and c. 13,900 BP (for Lab numbers, see Kuzmin, this volume), with the latter date from the Shunwangping locality (The Institute of Archaeology 1991).

Lingjing Industry

The Lingjing site is located about 15 km to the northwest of Xuchang City, Henan Province (Figure 2.1). A lithic assemblage was collected from greyish silt and orange sand dug up during water storage construction. Therefore, the stratigraphy was disturbed and the original provenance of artifacts is unknown.

A total of 1353 stone artifacts was collected. In addition, two fragments of a human femur and some mammalian fossils were found. The fauna includes 16–17 taxa, for example, *Lamprotula* sp.,

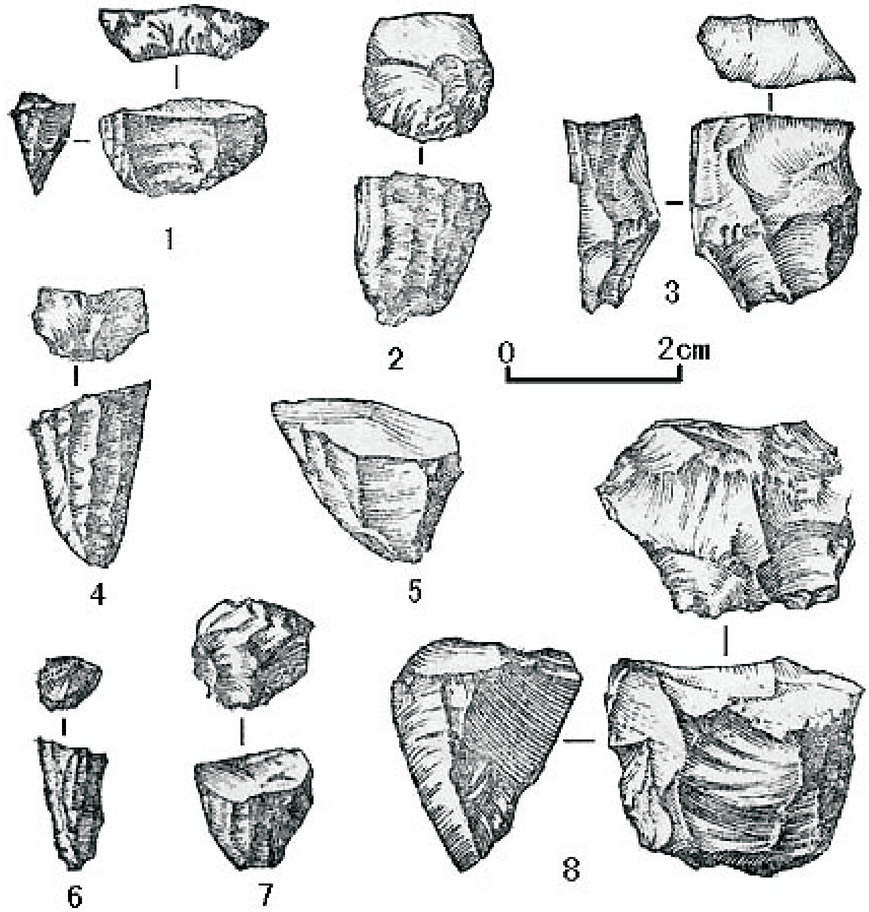

Figure 2.4: Microblade cores from Lingjing (after Zhou 1974)**.**

Ostrea sp., *Struthio anderssoni, Meles* sp., *Coelodonta antiquitatis*, *Equus przewalskyi, Sus seroba, Cervus elaphus, Ovis* sp., and *Bubalus* sp.

The raw materials are mainly quartz (69.6%), chert (20.0%), and quartzite (n=98). The stone artifacts comprise three categories, i.e., gravel tools, microblade remains, and flake tools. Only some specimens were selected for analysis, including seven microcores and 77 microblades. The microcores can be classified as wedge-shaped (n=2) and conical (n=5) (Figure 2.4). Other artifacts are, for example, flake cores, flakes, points, scrapers, burins, and choppers.

Due to the lack of stratigraphic information and absolute dating, the age of the Lingjing industry was assigned to the end of the Upper Palaeolithic or the Mesolithic period on the basis of the absence of pottery and polished stone tools (Zhou 1974).

Xueguan Industry

The Xueguan site is located in the southwestern part of Shanxi Province (Figure 2.1). A total of 4777 stone artifacts including 86 microblade cores were found in the 1979 and 1980 excavations. A single radiocarbon date gave an age of c. 13,100 BP (Wang *et al.* 1982; Chen and Wang 1989; The Institute of Archaeology 1991) (Figure 2.5).

Hutouliang Industry

The Hutouliang site is located in the Nihewan Basin, Yangyuan County, in the northwestern part of Hebei Province (Figure 2.1). More than 40,000 lithics, including 236 wedge-shaped cores were found in the 1972–1974 excavations. A single radiocarbon date gave an age of c. 11,000 BP (PV-4) (Gai and Wei 1977; Tang and Gai 1986; Chen

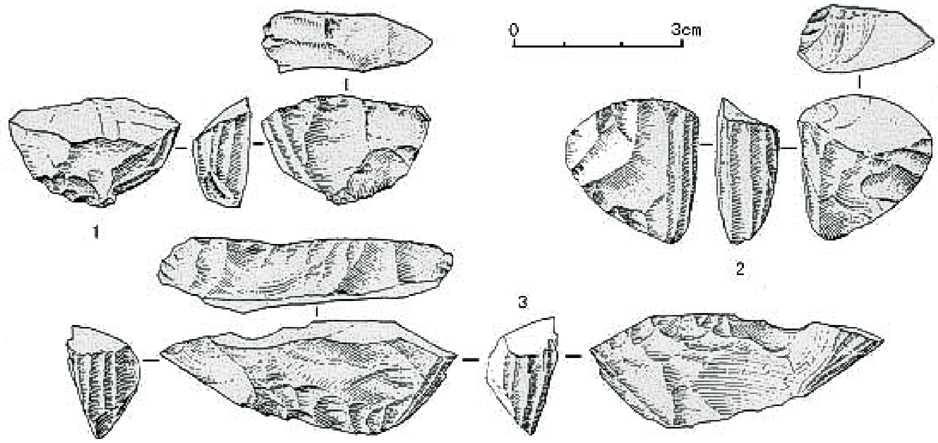

Figure 2.5: Wedge-shaped cores from Xueguan (after Chen and Wang 1989)**.**

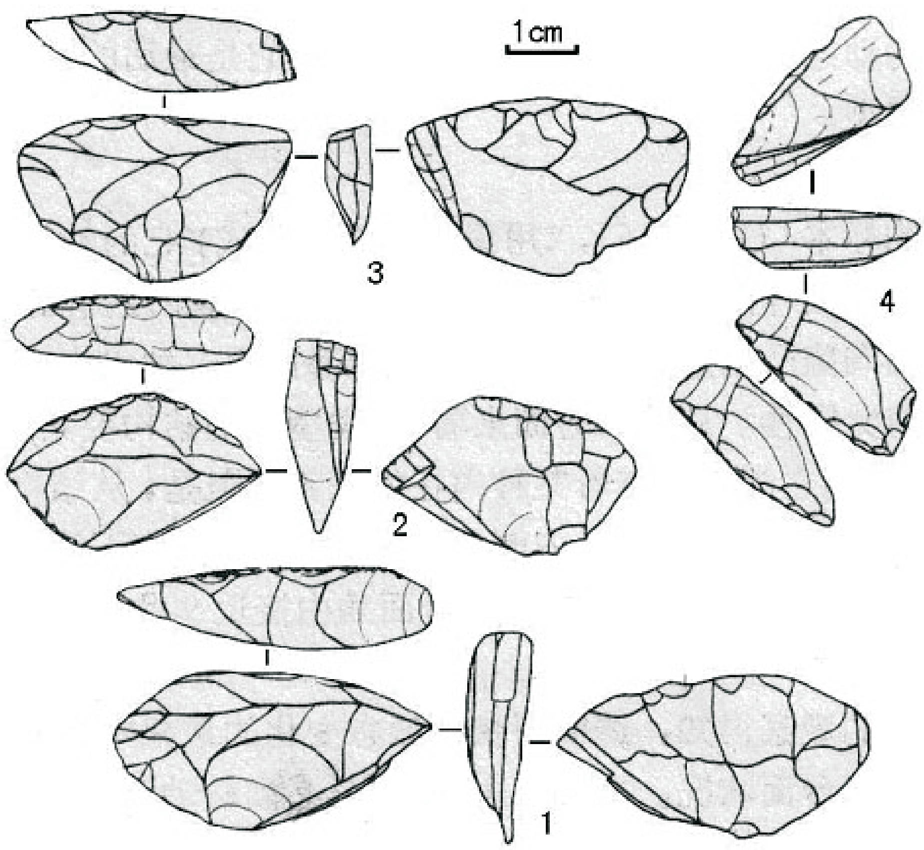

Figure 2.6: Wedge-shaped cores from Hutouliang (after Gai 1984)**.**

and Wang 1989; The Institute of Archaeology 1991) (Figure 2.6).

Shizitan Industry

The Shizitan site is located in Ji County within the southern part of the Luliang Mountains, western Shanxi Province (Figure 2.1). The excavation at Locality 1 in 1980 yielded a microblade industry from the upper cultural layers. Five layers were identified according to the geological attributes. Of these, Layers 2–5 are assigned to the upper cultural layers due to the occurrence of microblade remains with most archaeological specimens found in layers 3 and 4:

Layer 2: greyish sandy soil about 2.5 m thick with sporadic lithic artifacts;

Layer 3: greyish loess about 5.5 m thick with many microblade remains, other stone artifacts, mammalian fossils, ash, and burnt bones;

Layer 4: black loam about 1 m thick with a large amount of microblades and other stone artifacts;

Layer 5: ploughing soil about 0.4 m thick with a few microblade remains.

A total of 1807 stone artifacts were unearthed, including 208 microcores and 547 microblades. Because all microblade remains were lumped together, the numbers of microcores and microblades from the individual layers are unknown.

The raw materials used for producing microblade remains include chert of various colours, hornfels, chalcedony, and quartzite. Four types of microcores were classified, including 79 wedge-shaped, 64 boat-shaped, 35 conical, and 30 funnel-shaped cores. Wedge-shaped cores are subdivided into two styles: broad-bodied and narrow-bodied. Other implements include, for example, bifacial and unifacial points, scrapers, burins, choppers, and grinding slates (Cultural Bureau of Linfen District Administration 1989) (Figure 2.7). The age of Shizitan is based on the stratigraphy (Shi Jinming personal communication).

Yaozitou Locality

The Yaozitou locality (39°53'N, 113°00'E) is located in Huairen County, northern Shanxi Province (Figure 2.1). Microblade remains and other lithic artifacts were collected on the surface of the second terrace of the E'maokou Creek, a tributary of the Sanggan River. This locality is adjacent to the well-known E'maokou workshop. The second terrace is composed of gravel sediments in the lower portion and sandy soil sediments in the upper portion. No lithic remains were found in these deposits (Chen and Ding 1984).

Chert was the main raw material used at this locality, and some large artifacts were made of tuff. The lithic collection includes 10 microblade cores and 30 blades and microblades. Other artifacts include, for example, flakes, scrapers, a stone pestle, and a polished stone tool. The microcores were classified into three types, conical (n=2), short bodied cylindrical (n=1), and boat-shaped (n=7) (Figure 2.8).

Due to the lack of stratigraphic and faunal evidence, it is very difficult to ascertain the age of these cultural remains. It is highly likely that the E'maokou workshop was used for a long period of time during the Late Palaeolithic and the early Neolithic ages. The microblade remains may or may not be related to the workshop (Chen and Wang 1989).

Two Localities in Yushe County: Nanping and Monk Creek

In 1985, two localities were found in Yushe County, Shanxi Province (Figure 2.1). One is Nanping near Zhaowang village (37°08'56"N, 112°59'08"E), the other Monk Creek near Mengjiazhuang village (37°10'22"N, 113°02'04"E) (Figure 2.1). Both localities are located on the second terrace of a tributary of the Zhuozhang River.

The geological profile at Nanping contains six layers from top to bottom of which layer 4, a greyish gravel about 0.1–0.15 m thick, yielded a stone artifact assemblage and mammalian fossils, including *Cricetulus* sp. and *Equus* sp. A radiocarbon date on animal bones gave an age of c. 10,000 BP (The Institute of Archaeology 1991).

The geological profile at Monk Creek shows a thin loess-like sediment overlying a gravel sediment. Stone artifacts and mammalian fossils such as *Equus* sp. and *C. antiquitatis* occur in the gravel layer. A radiocarbon date on a bone fragment is c. 11,900 BP (The Institute of Archaeology 1991).

The stone artifacts of the Nanping and Monk Creek localities were analyzed together by

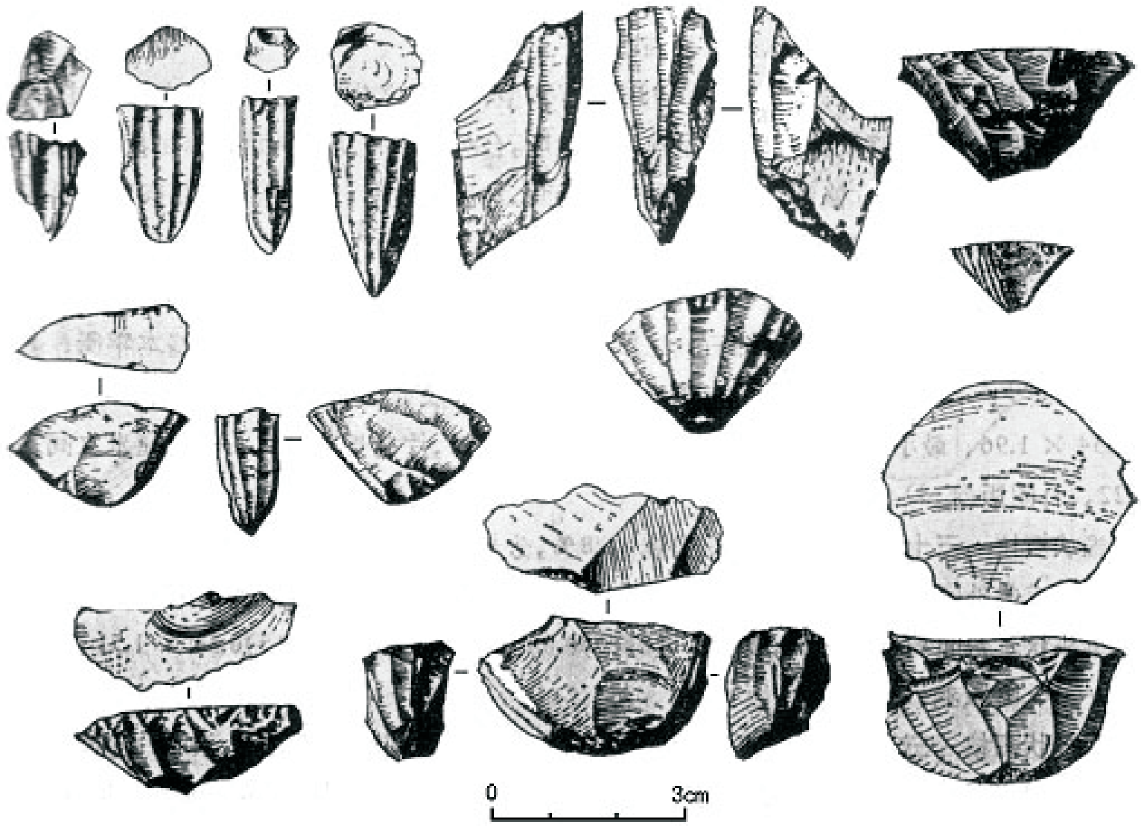

Figure 2.7: Microblade cores from Shizitan (after Cultural Bureau of Linfen District Administration 1989)**.**

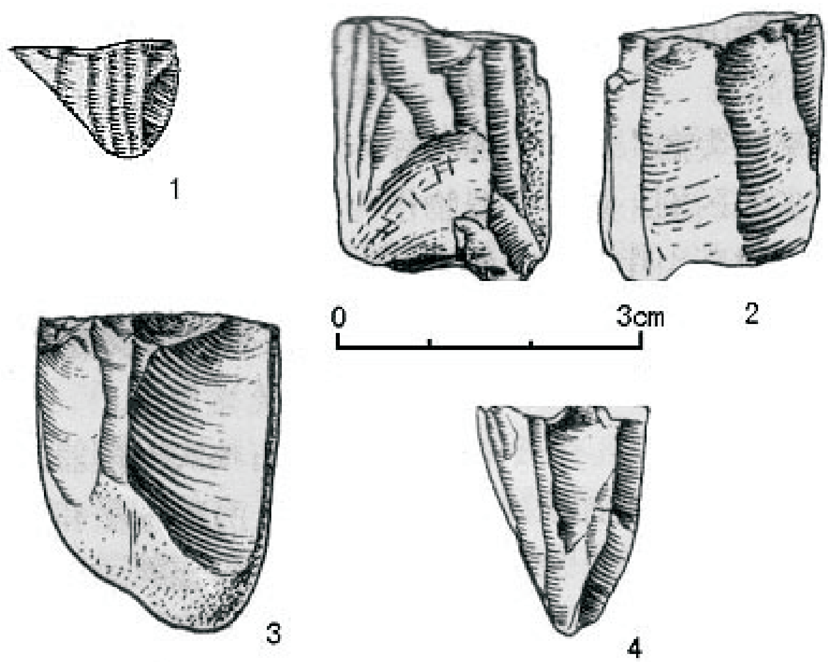

Figure 2.8: Microblade cores from Yaozitou (after Chen and Ding 1984)**.**

Liu *et al.* (1995). The raw materials are chert (84.4%), quartzite (10.5%), and agate, quartz, and chalcedony (5.1%). Stone artifacts were classified as cores (10.55%), flakes (54.43%), retouched pieces (8.86%), and chunks and debris (13.08%). A detailed description is as follows.

A total of 25 cores (14 from Nanping and 11 from Monk Creek) were found, including 17 microcores. Nanping yielded five conical cores, one wedge-shaped core, one atypical wedge-shaped core, one atypical conical core, and three boat-shaped cores. At Monk Creek one cylindrical core, one conical core, and four boat-shaped cores were recorded. The atypical wedge-shaped core shows platform preparation similar to the Yubetzu technique, though its preform is a gravel chunk rather than a biface (Figure 2.9). Other retouched pieces were classified as 17 scrapers of various kinds, nine end scrapers, one burin, one stone point, three arrowheads, and two shell and bone ornaments (Liu *et al.* 1995).

Donghuishan Locality

The Donghuishan site (39°48'N, 118°49'E) is situated in Luanxian County, Tangshan City, Hebei Province (Figure 2.1). The lithic remains were unearthed from the second terrace of the Luan River. Seven layers were divided geologically from top to bottom: Layer 1, surface soil about 0.3 m thick; Layer 2, yellow silt clay about 2.3 m thick; Layer 3, reddish clay sandwiched with thin sandy strips about 1.4 m thick; Layer 4, greyish white sand, containing many lime nodules in the lower part, about 1.8 m thick; Layer 5, brownish

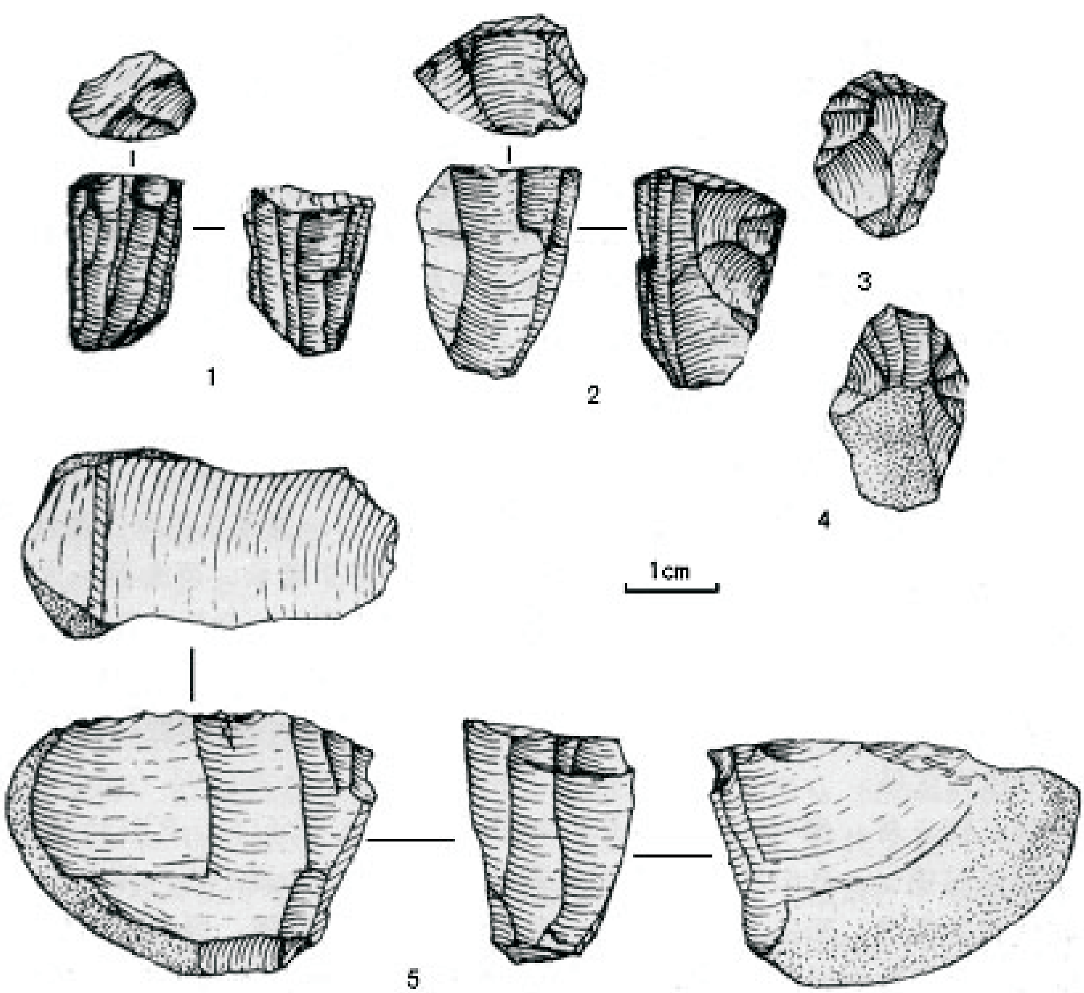

Figure 2. 9: Microblade cores from the Yushe sites (after Liu *et al.* 1995)**.**

clay about 2 m thick; Layer 6, yellow sand sandwiched with thin reddish clay about 4.2 m thick; Layer 7, dark grey clay about 3.0 m thick. Most of the lithic artifacts and fauna were recovered from Layer 4.

The raw materials are mainly chert of various colours and limestone; some quartzite and igneous rock artifacts were also found. A total of 182 lithic artifacts was collected, including three microcores and 10 microblades as well as flakes and other artifacts. The three microcores are boat-shaped and worked in chert.

No absolute dating result is available. On the basis of geological observation and cultural attributes, the age of the collection was assigned to the Upper Pleistocene or the Late Palaeolithic period (Institute of Cultural Relics 1989).

Youfang Industry

The Youfang site (40°14'N, 114°41'E) is located in the Nihewan Basin, Yangyuan County, Hebei Province and situated on the Datianwa terrace 170 m above the riverbed of the Sanggan River (Figure 2.1). The site was discovered in 1984 and excavated in 1985, yielding 697 stone artifacts and 2675 chunks or debris, some animal fossils, ash, burnt bone fragments, and burnt clay. Two natural layers were divided from top to bottom: Layer 1, plough soil about 0.3 m thick; and Layer 2, a loess sediment about 6.5 m thick with cultural remains.

The raw materials are mainly various siliceous breccia, chert, as well as rare siliceous limestone and quartzite. The lithic industry contains 13 microcores and 92 microblades. Associated artifacts are, for example, flakes, scrapers, and burins. Microcores were classified as wedge-shaped, boat-shaped, and cylindrical types. Two subtypes, broad-bodied and narrow-bodied wedge-shaped cores, were identified (Figure 2.10).

Due to the lack of dating materials, the age of the lithic industry was estimated on the basis of geological examination. As the stone assemblage was buried in the upper and middle parts of the Malan loess sediment, the authors assign its age to the late Upper Pleistocene, and possibly earlier than the age of Hutouliang (Xie and Cheng 1989).

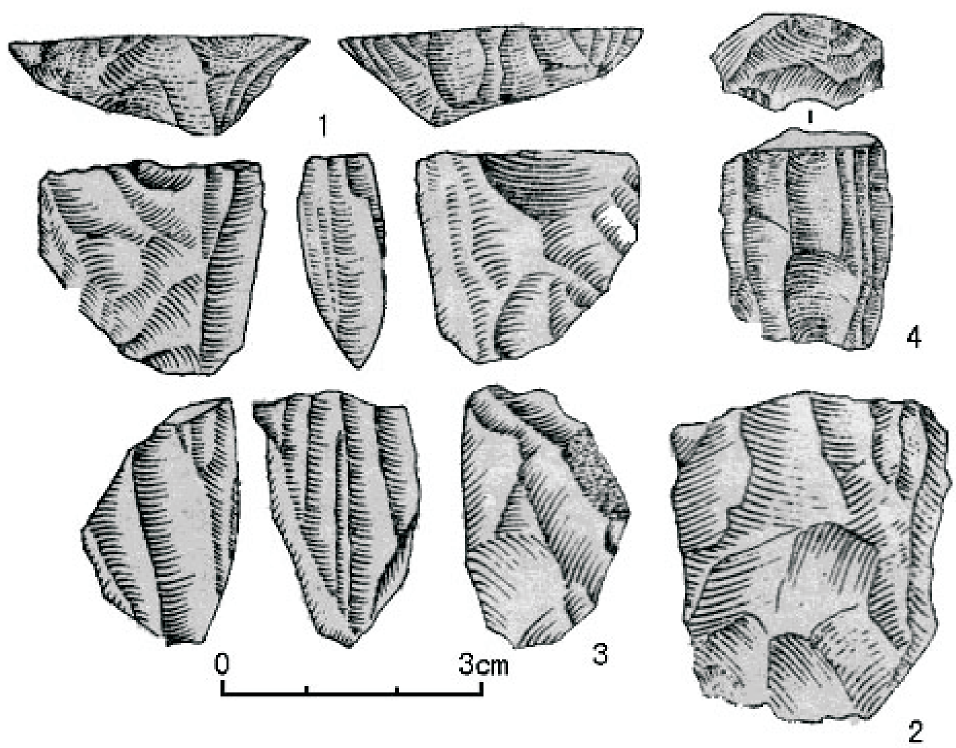

Figure 2.10: Microblade cores from Youfang (after Xie and Cheng 1989).

Dabusu Locality

The Dabusu site (44°48'03"N, 123°42'42"E) is located in the Suozi township, Qian-an County, western Jilin Province (Figure 2.1). A stone assemblage was uncovered in 1985 from the second terrace on the eastern bank of the Dabusu Pond, a salty inland lake covering 56 km^2. Eight layers were identified from top to bottom in the profile of the second terrace. An ancient soil strip about 10–20 cm thick in layer 3, a brownish red ancient soil interbedded with greyish white and greyish yellow sand (about 1.5 m thick), yielded the stone assemblage which occurred within a horizontal area of about 15 m^2.

The majority of stone artifacts were made of chert; other raw materials are quartz, opal, and obsidian. A total of 486 stone artifacts were collected during the excavation, including four microcores and 121 microblades. The microcores were classified into two types: semi-conical (n=2) and wedge-shaped (n=2) (Figure 2.11). Other artifacts include, for example, scrapers and a grinding slate. Mammalian fossils were found associated.

No radiocarbon date is available. Therefore, on the basis of the geological context and lithic technology, the age of the assemblage was assigned to the Late Palaeolithic period. The locality may have been a temporary lithic workshop or a working camp near the lakeshore (Dong 1989).

The Angangxi Localities

The Angangxi (47°02'N, 123°53'E) localities are situated near Qiqiha-er City, Heilongjiang Province, well-known for their occurrence of Neolithic microblade remains (Figure 2.1). In the autumn of 1928, A.S. Lukashkin, a Russian employee of the former Zhongdong Railway Company, discovered Neolithic sites containing microblade remains near Angangxi. In 1933, Liang Siyong conducted a survey and excavation and published his discovery together with the collection he had bought from Lukashkin (Liang 1932). In 1963 and 1964, the Provincial Museum of Heilongjiang carried out surveys in this area and reported 26 localities belonging to the Neolithic period (Provincial Museum of Heilongjiang 1974).

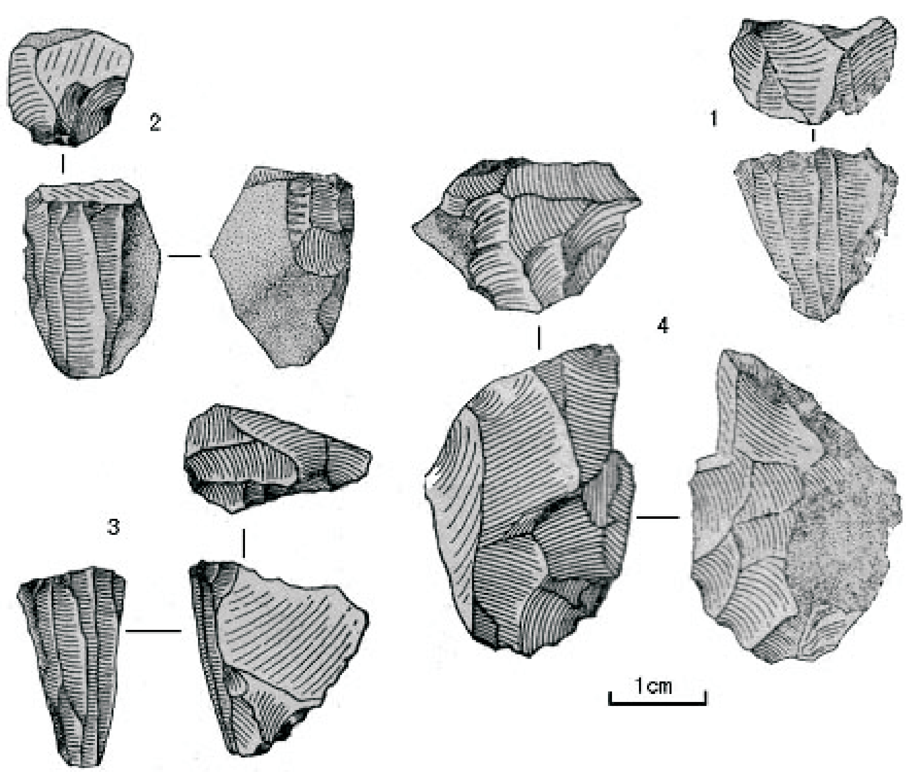

Figure 2.11: Microblade cores from Dabusu (after Dong 1989)**.**

More lithic remains were found at the new locality of Daxingtun during field surveys in 1981 and 1982. The Daxingtun site is located 18 km southeast of Angangxi and situated on the first terrace of the Nun River about 4–6 m above the riverbed. Four layers from top to bottom were identified in the stratigraphic profile. Of these, layer 4 (overlain by loess-like sandy clay of an Upper Pleistocene fluviolacustrine deposit) is the artifactual deposit. Layer 4 contains yellow fine grain sand interbedded with green silt of the Upper Pleistocene lacustrine deposit, approximately 3.0 m thick above the ground. Stone artifacts, mammalian fossils, ash, and burnt bones were found in the upper part of this layer. The mammalian fauna contains about eight taxa, for example, *Ochotona daurica, Microtus epirattceps,* and *E. przewalskyi* (Huang *et al.* 1984). Gao (1988) also reported *Cervus* sp., *Muntiacus* sp., and other species.

The raw materials are mainly chalcedony, agate, and chert. Sixty-eight stone artifacts were reported by Huang *et al.* (1984) and 60 stone artifacts by Gao (1988), including one microcore and 17 microblades. Other artifacts include, for example, scrapers and burins. One microcore can be classified as a short bodied cylindrical core.

On the basis of the examination of the provenance of the lithic assemblage, the Daxingtun locality may have been a temporary camp during the Late Palaeolithic period. A radiocarbon date of a bone fragment gave an age of c. 11,400 BP (Huang *et al.* 1984; Gao 1988).

Jiqitan Industry

The Jiqitan site, located about 7.5 km southwest of the Hutouliang site (40°06'N, 114°26'E), is situated in the Nihewan Basin, Yangyuan County, Hebei Province (Figure 2.1). The site was discovered in 1986 and excavated from 1987 to 1989. An Upper Palaeolithic microblade industry was unearthed from the second terrace of the Sanggan River. Five geological layers were found. Cultural remains were recovered from layers 3 and 4. Layer 3 is greyish yellow sandy clay sandwiched with reddish yellow sand about 1.5 m thick, and layer 4 is a gravel about 0.5 m thick.

The cultural remains include more than 10,000 stone artifacts, charcoal, ash, and broken bones. The mammalian fauna includes, for example, *Myospalax fontanieri* and *E. przewalskyi*.

The raw materials consist mainly of quartzite and hornfels. A total of 2304 lithic artifacts was examined and analyzed, including 121 microblade cores, 452 microblades, and 51 microblade spalls (Figure 2.12). Other artifacts include, for example, projectile points and notches.

The microcores are all wedge-shaped and represent different stages of core preparation and microblade reduction. They can be subdivided into two forms: broad-bodied and narrow-bodied. They share many similarities with those from Hutouliang in typology and technology.

No radiocarbon dating result is available for the Jiqitan industry. On the basis of geological and cultural comparisons with other microbalde sites in the region, the authors assigned an age of 11,000–8000 years for Jiqitan (Institute of Cultural Relics 1993).

Tingsijian Industry

The Tingsijian site (39°44'N, 119°10'E), located in Changli County, Qinhuangdao City, Hebei Province (Figure 2.1), was discovered in 1990 and excavated in 1992 and 1993. Cultural remains were buried in the second terrace of a branch of the Yinma River. A total of 239 lithic artifacts was unearthed from the sediment of brownish yellow and brownish red sandy clay about 1.0–3.0 m below the surface.

The major raw material is chert of different colours. Eight microcores and 36 microblades were identified. Other artifacts include, for example, scrapers and burins. The microcores are all boat-shaped with the largest one measuring 20 x 15 x 11 mm and the smallest one 12 x 8 x 7 mm.

No absolute dating result is available. On the basis of geological and cultural comparison, the age of the lithic industry was assigned to the Upper Pleistocene or the Late Palaeolithic period (Wang 1997).

Dafa Locality

The Dafa site (37°40'30"N, 112°50'10"E) is located on the second terrace of the Xiao River, a main tributary of the Fen River, 15 km to the east of Yuci City, Shanxi Province (Figure 2.1). The geo-

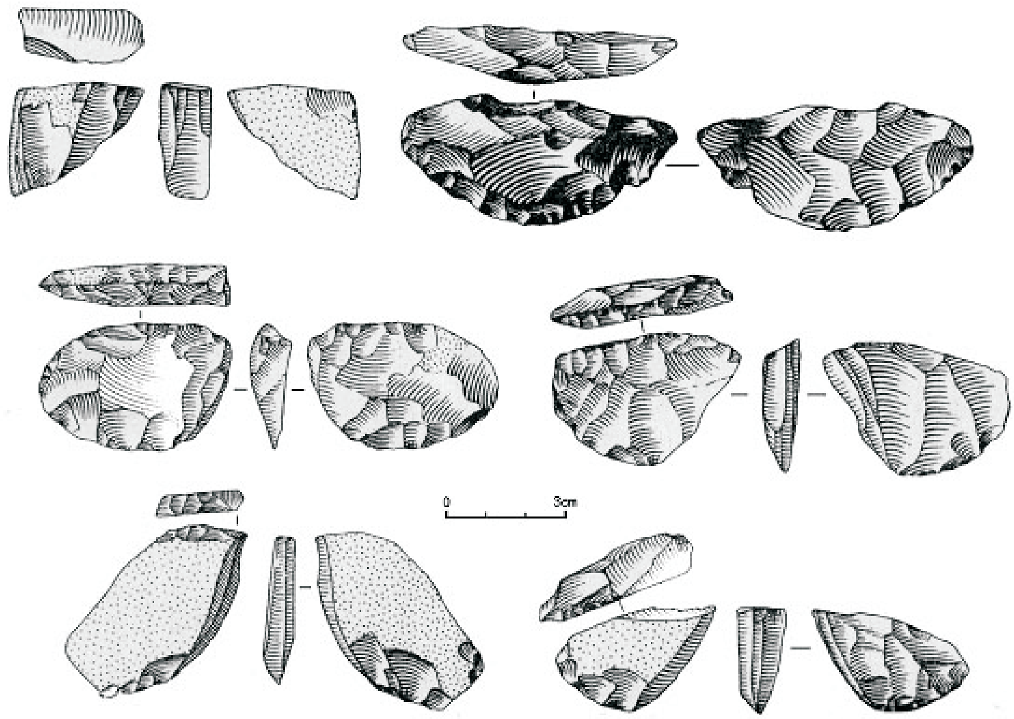

Figure 2.12: Wedge-shaped cores from Jiqitan (after Institute of Cultural Relics 1993)**.**

logical profile of the second terrace comprises six natural layers from top to bottom, of which layer 4, a greyish white sandy gravel, about 0.8–1.3 m thick, contained stone artifacts and mammalian fossils. The mammalian fauna comprises several taxa, including *Canis lupus* and *E. przewalskyi* (Gao *et al.* 1991). During the excavations in 1988 and 1990, more species were found, including *C. antiquitatis* (Li and Wang 1992).

The raw materials are mainly chert and quartzite. More than 1000 stone artifacts were found during the 1980 excavations and 289 specimens were selected for analysis. These include flake cores (n=3), bipolar cores (n=2), microcores (n=5), flakes (n=249), bipolar flakes (n=5), microblades (n=6), side scrapers (n=9), points (n=3), and burins (n=2). Microcores were subdivided into two forms, wedge-shaped (n=3) and short cylindrical (n=2) ones (Gao *et al.* 1991).

About 700 stone artifacts were uncovered during the excavations in 1988 and 1990 and 570 pieces were analyzed. These include 26 microcores and 98 microblades. Other artifacts include, for example, scrapers and points. Microcores were subdivided into four forms, conical (n=9), wedge-shaped (n=13), atypical cylindrical (n=2), and microcores with double platforms (n=2) (Li and Wang 1992).

No radiocarbon dating result is available. On the basis of geological examination and faunal analysis, the age of the Dafa assemblage was assigned to the Upper Pleistocene or the Late Palaeolithic period.

East China

Dagang Locality

The Dagang Locality (33°40'N, 113°42'E) is located in the Houji township, Wuyang County, Henan Province (Figure 2.1). Cemeteries of the Han dynasty and an Early Neolithic site belonging to the Peiligang culture were found between 1985 and 1989. During a field survey in 1989, microblade remains were unearthed from the layer below the Peiligang culture. Two excavations were conducted by the Institute of Cultural Relics of Henan Province and the Museum of Wuyang County in 1989 and 1990 to clarify the stratigraphic relationship between microblade remains and the Peiligang Culture.

The sediment of 1.28 m thickness was divided into five layers from top to bottom with layers 1–3 (0.2–0.7 m) containing Peiligang Neolithic culture artifacts and Han Dynasty potsherds. In layer 4, a brown clayey soil about 0.15–0.40 m thick, microblade remains and other lithic artifacts were discovered.

A total of 327 lithic artifacts were described and analyzed, including 19 wedge-shaped cores, nine conical cores, and 14 microblades. Other artifacts are: bipolar cores (n=22), flaked cores (n=6), flakes (n=118), bipolar flakes (n=31), various scrapers (n=30), end scrapers (n=17), points (n=10), backed flakes (n=3), flake with polished edges (n=1), and chunks and debris (n=47). Raw materials include three varieties of chert (61.5%), vein quartz (35.5%), agate (2.1%), quartzite (0.6%), and crystal (0.3%).

Wedge-shaped cores look more like boat-shaped ones, with a broad unprepared platform or slightly trimmed near the fluted edge. The largest specimen measures 32 x 11 x 13 mm. Conical cores are rather short, with an unprepared platform. The fluted surface usually covers about half of the body. The characteristics of microblade cores are similar to those from the Lingjing site which is about 40 km to the north.

Dagang may have been a temporary working camp based on the presence of chipping debris. No radiocarbon date is available. According to the cultural attributes and stratigraphic evidence, the age of microblade remains was assigned to the end of the Late Pleistocene (Zhang and Li 1996).

Southwest China

Huilongwan Cave Site

The Huilongwan Cave site is located near Panzhihua City, Sichuan Province (Figure 2.1). Three layers were identified and microblade remains were unearthed from layers 2 and 3. Cultural remains include microcores, microblades, large heavy duty stone tools, and bone and antler tools. Neither ground stone tools nor pottery were found. The microcores were classified into four types, that is, conical, wedge-shaped, funnel-shaped, and boat-shaped. The age of the site was estimated by researchers ranging between 20,000 and 12,000 years old (Li 1993).

Japan

Microblade remains occur at many sites in Japan from Kyushu to Hokkaido and comprise the most diagnostic cultural feature from the Late Pleistocene to the Early Holocene (see also Chapter 4). However, precise information concerning their stratigraphic context is not always available. Because of the unavailability of specimens from many collections for study, it is impossible to conduct a comprehensive analysis. In this article, the comparison will focus on microblade cores from a few sites, such as Yasumiba, Fukui Cave, Araya, and Shirataki. Wedge-shaped cores, microblades, and the earliest pottery at Fukui Cave are ^{14}C-dated to about 12,700 BP (Figure 2.13). Wedge-shaped cores and microblades at Araya are ^{14}C-dated to about 13,200 BP (Aikens and Akazawa 1996).

Korea

Microblade remains have been discovered at several localities in Korea, including Sokchang-ni, Saemgol, and Ch'angnae in the central part, Kogchon in the southern part, and Mandal in Pyongyang City in North Korea (see also Chapter 7). Wedge-shaped cores unearthed from the Suyanggae site in southern Korea are available for comparison (Figure 2.14). The microblade remains were assigned to the Upper Palaeolithic period based on stratigraphic considerations (Lee 1989a, 1989b).

Eastern Siberia

Microblade discoveries have long been reported from Eastern Siberia and the Russian Far East. However, detailed reports are not always available. Tabarev (1994) reported a microblade industry from Ustinovka in the Maritime Province. Since 1954, several localities have been found in the region. Subprismatic blade cores and Gobi-type (wedge-shaped) cores were collected and identified in the assemblages.

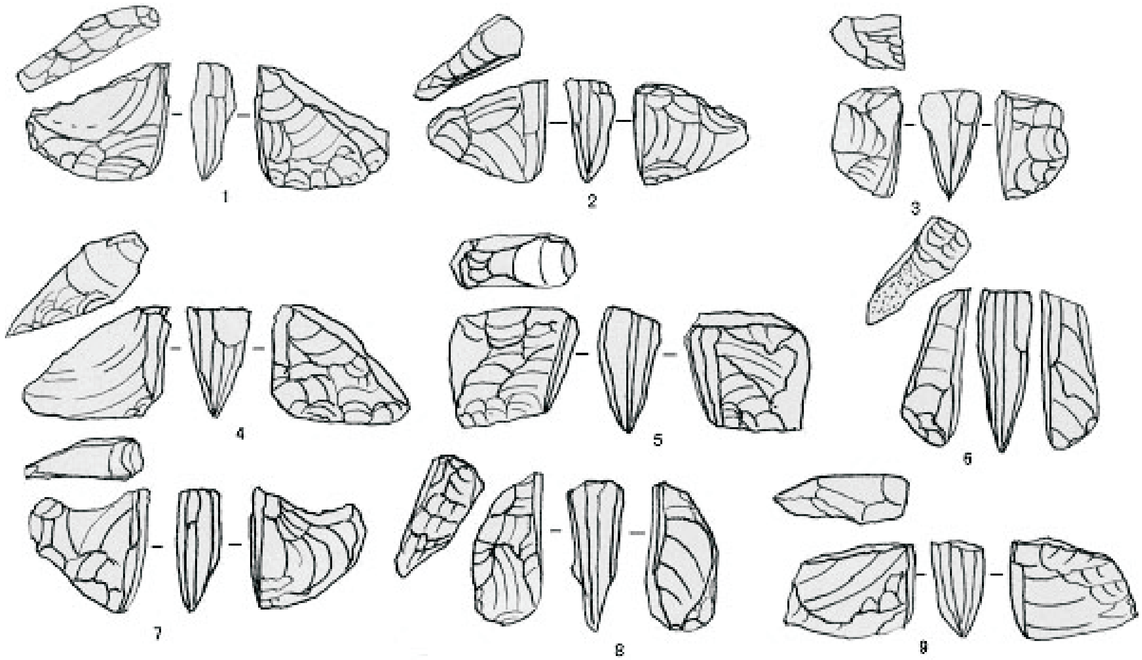

Figure 2.13: Wedge-shaped cores from Fukui Cave (after Hayashi 1968)**.** No scale given.

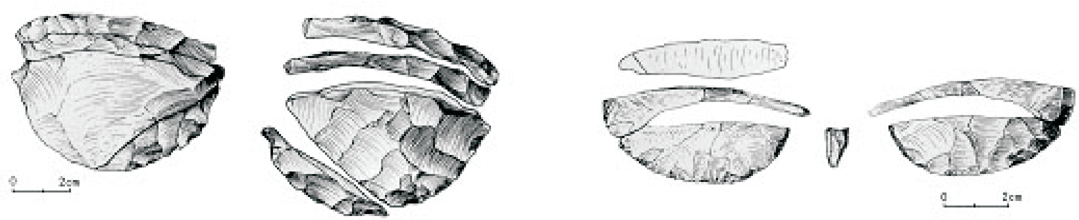

Figure 2.14: Wedge-shaped cores from Suyanggae (after Lee 1989a)**.**

The comparison of the microblade cores from this region will be mainly focused on the Dyuktai culture. According to Mochanov's definition, the Dyuktai culture represented an ethnocultural unit which covered the territory to the east of the Lena River and north of the Amur River, including Kamchatka, Sakhalin Island, and even a large part of Hokkaido, Japan. Wedge-shaped cores were considered the diagnostic element of the culture. The sites which were assigned to the culture include Layers 3–14 of the Dyuktai Cave, Ust-Dyuktai 1, Ikhine 1 and 2, Verkhne-Troitskaya, Sumnagin 1, Ust-Mil, Ezhantsy, Tumulur, Berelekh, and Maiorych. Early chronological placement of Ust-Mil and Ezhantsy was the subject of a heated debate. Layer 7b of Dyuktai Cave containing the classic type for the Dyuktai culture, such as wedge-shaped cores and bifacial knives (Figure 2.15), is ^{14}C-dated to c. 12,690 BP, c. 13,070 BP, and c. 14,000 BP. Berelekh, the most northerly Palaeolithic site in Siberia, is ^{14}C-dated to c. 12,930 BP and c. 13,220 BP. The Sumnagin culture in the Aldan Valley which was dated to about 10,500–6000 BP and Ushki Lake 1 with ^{14}C dates of c. 10,360 BP and c. 10,760 BP for layer 6 yielded microblade

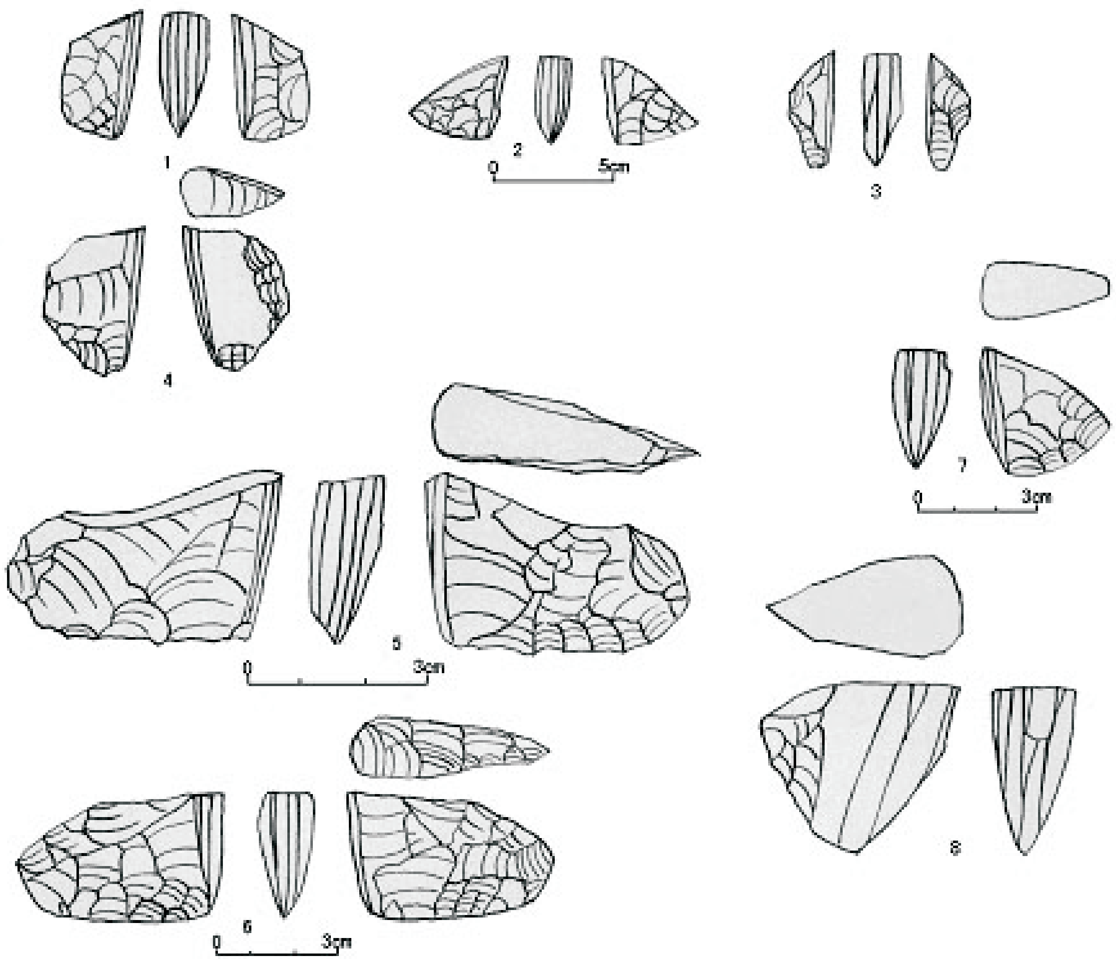

Figure 2.15: Wedge-shaped cores from the Dyuktai culture (after Mochanov 1978; Powers 1973)**.**

technology artifacts represented by conical and cylindrical prismatic cores (Mochanov 1978, 1980; Powers 1973, 1996).

North America

In North America, microblade remains occur in the Arctic and northwestern part of the continent from Alaska southward to the Columbia River and eastward to Greenland. The assemblages with relatively early dates were found in Alaska and the Pacific Northwest dating to about 12,000–11,000 BP and persisting to c. 3000 BP in Alaska. In British Columbia and Washington State, microblades were gradually abandoned by the people of the Nesikep tradition around 1500 BP. In the eastern Arctic, microblades persisted to about 900 BP along with the late Dorset culture (Dumond 1978; McGhee 1978). In this article, microblade cores from the American Paleoarctic tradition, the coastal microblade assemblages, and the Plateau Microblade tradition are analyzed and compared.

The American Paleoarctic tradition is the earliest microblade complex in the western Arctic. The microblade cores analyzed here include those from Dry Creek (Figure 2.16), Ugashik Narrows, Donnelly Ridge, the Noatak Drainage sites, Akmak, Tangle Lakes, Ground Hog Bay 2, Healy Lake, and Small sites in northern Alaska. The Campus site in Fairbanks that yielded classic wedge-shaped cores of the Amer-

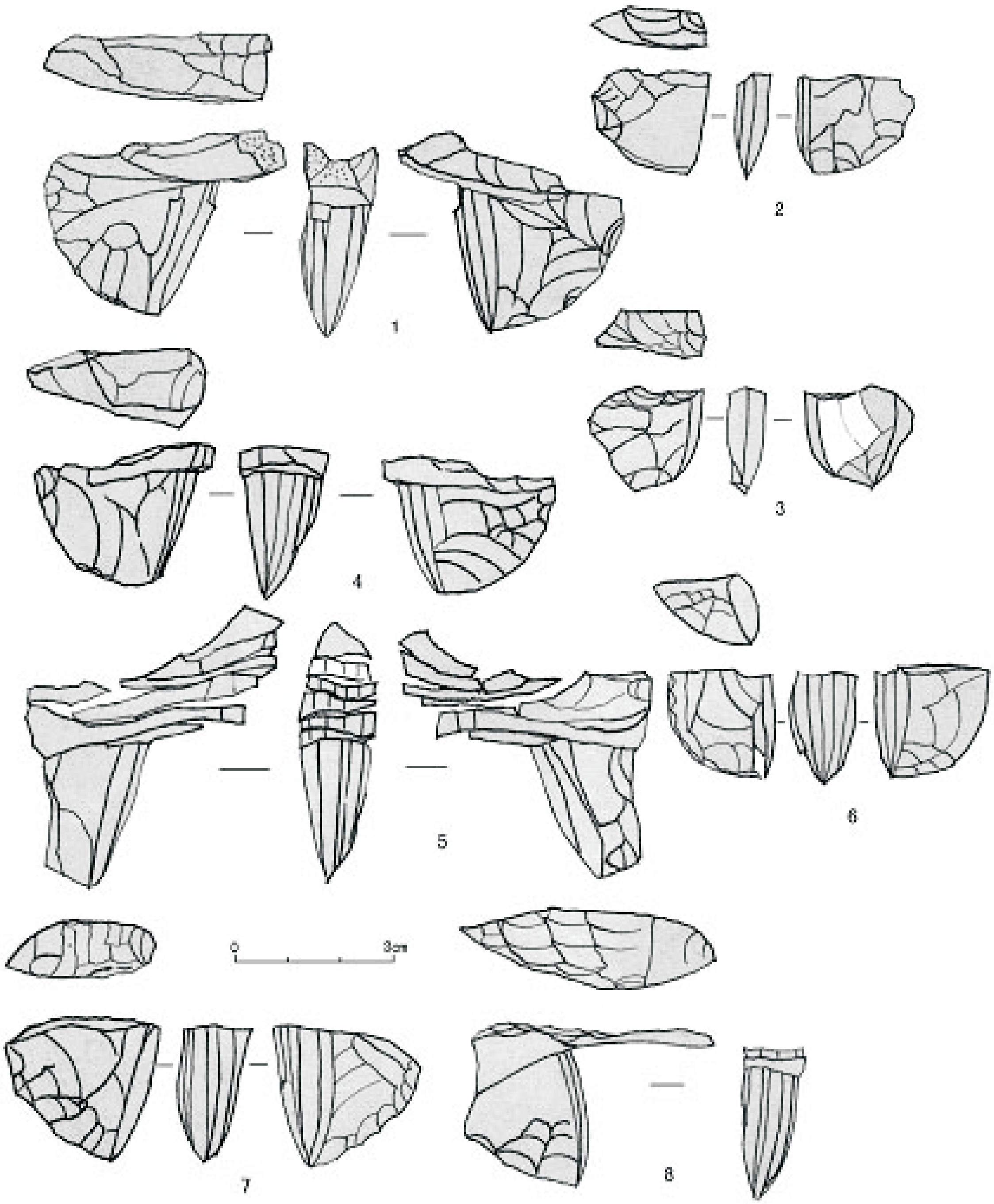

Figure 2.16: Wedge-shaped cores from Dry Creek (by courtesy of the Department of Anthropology, University of Alaska)**.**

ican Paleoarctic tradition seems too young to be a component of this tradition (Mobley 1991). However, this author includes the Campus site into this tradition based on the fact that the Campus core has been a representative of this tradition (Figure 2.17).

Several microblade assemblages along the Northwest Coast characterized by a slightly more recent chronology include Namu, Queen Charlotte Islands (or Haida Gwaii; see Magne and Fedje, this volume), Heceta Island, San Juan Islands, and Cadboro Bay. Microblade assemblages found on the Columbia Plateau were attributed by Sanger (1968a, 1969, 1970a, 1970b) to the Plateau Microblade tradition. They include Ryegrass Coulee, Drynoch Slide, Morron Lake, Windy Springs, and the Lochnore-Nesikep locality.

METHODOLOGICAL REMARKS

Comparative analysis of microblade cores involves several aspects, including raw material, typology, technology, platform edge angle variation, and core dimension. A brief discussion of these aspects is as follows.

Raw Materials

Analysis of raw material variation and spatial distribution will be helpful in assessing such important issues as technological tradition and mobility. Goodman (1944:416) pointed out that "the choice of a certain material may be purely a matter of tradition." This statement is partly true because the selection of a desirable raw material is crucial for a distinct technique or for producing specific

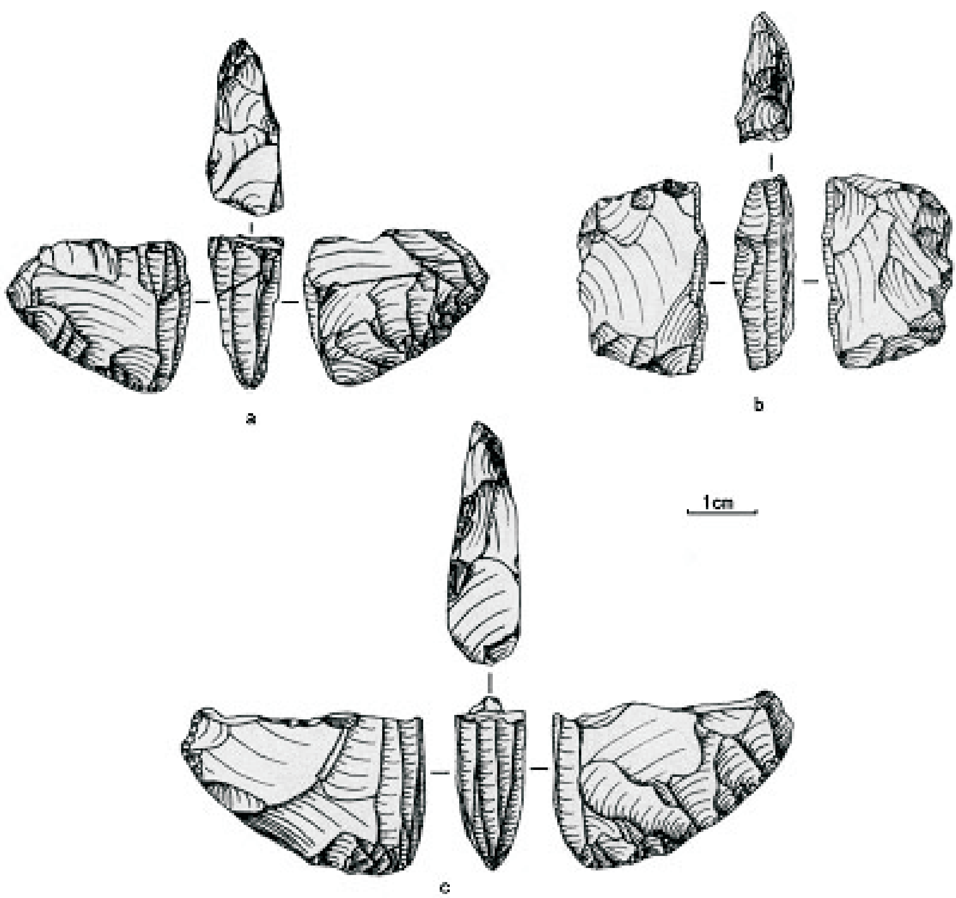

Figure 2.17: Wedge-shaped cores from the Campus site (after Mobley 1991)**.**

tool types. Therefore, a study of technology is not complete without knowing the properties of the raw materials and their influence (Crabtree 1967; Straus 1980; Torrence 1989). On the other hand, inaccessibility of certain raw materials may play a great role in technological change, since technology will be adjusted to fit the specific constraint of a particular situation. In North America, evidence indicates that change in technological tradition might have been a result of a change in lithic quality during the Paleoindian stage (Hayden 1981).

In terms of the relationship to the environment, Hayden (1989) regards lithic raw materials as similar to plant food resources. Suitable raw materials for a distinctive technology or for a specific task are not ubiquitous in the environment. The procurement of desirable raw materials is not a big problem for highly mobile groups but will greatly influence less mobile groups. For the latter, especially those in complex societies who lived in an area lacking suitable materials, long distance transportation and exchange of good quality materials may be inevitable if they want to keep using sophisticated lithic technology. Other adjustments may include the procurement of local materials of quality and economizing the use of desirable materials.

Microblade manufacture can be seen as a kind of highly curated technology. Fine-grained raw materials of good quality might have been crucial to the operation of certain specific techniques of core preparation and microblade reduction. On the basis of his wedge-shaped core reduction experiment, Tabarev (1997) made a comment on the effect played by raw material in microblade reduction and core dimension. The comparison of raw materials may give some insight into the analysis of core typology and technology and human subsistence patterns as well.

Core Typology

In my previous studies, I identified and classified six major microblade core types by examining microblade industries discovered in North China, Northeast Asia, and North America (Chen 1983, 1984). These types are the wedge-shaped, conical, cylindrical, semi-conical (tabular), boat-shaped, and funnel-shaped cores, although irregular forms and forms that fall between these categories can also be distinguished (Figure 2.18). The following is a detailed description of these six major core types.

The Wedge-Shaped Core

This core type is the first to have been identified and is the most extensively studied. There are several alternative names given to these cores, but wedge-shaped is the most widely accepted one and used by archaeologists. The wedge-shaped core is a broad typological category, which refers to the product of different manufacturing processes or techniques, that result in cores that are morphologically similar. Hayashi (1968), Morlan (1970), Sanger (1968a), and Mobley (1991) have provided detailed morphological descriptions of these cores. Here I quote Morlan's definition as an example.

> Wedge-shaped cores have elongate platforms, but the fluting chord is in the short axis of the platform and the flutes are marginally distributed. The broad faces of the specimens are irregularly flaked, and the margin opposite the fluted surface may form either a wedge or a flat surface of some kind (Morlan 1970:18).

It should be noted that the description of wedge-shaped cores given by Morlan (1970) is based mainly on specimens found in North America and Japan. An additional form of wedge-shaped core which is overlooked by Morlan contains an elongate fluted surface, a wedged keel and a short platform which I have called narrow-bodied wedge-shaped core. This form of wedge-shaped core is not the exhausted stage of microblade reduction. Many core preforms give evidence that this is a unique style of this core type.

The Conical Core

This type of microblade core normally has a circular or oval platform with flutes formed on part of the core body. In some, the core body tapers sharply downward to form a point. Thus this type of core is also called a pencil-shaped core (Jia 1978). In other specimens, the body runs parallel

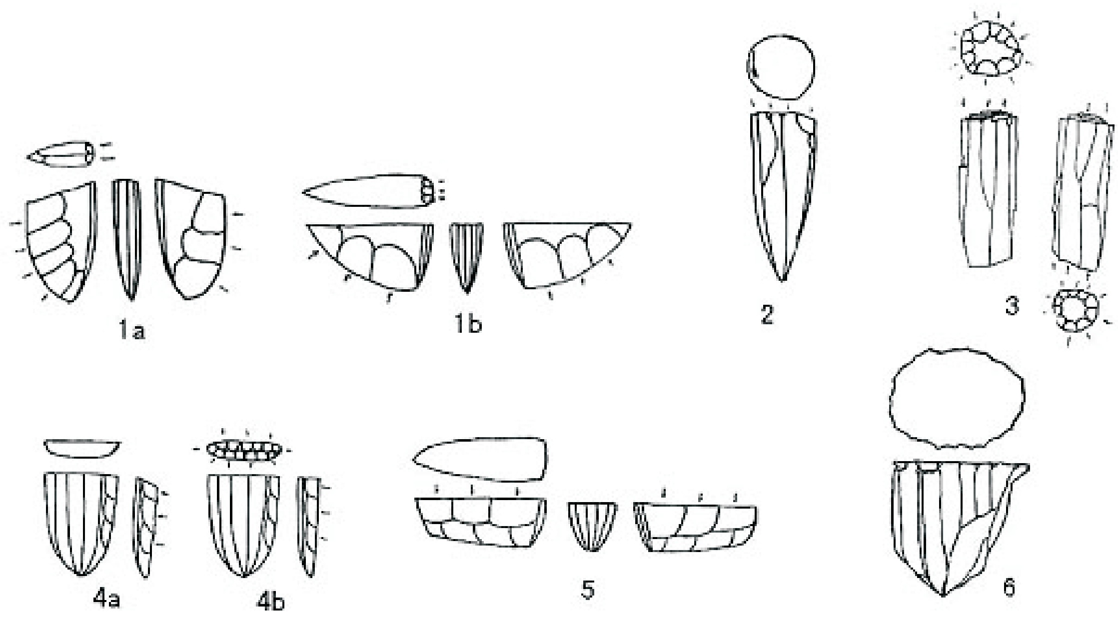

Figure 2.18: Schematic drawing of six major types of microblade cores.
1a. narrow-bodied wedge-shaped core; 1b. broad-bodied wedge-shaped core; 2. conical core; 3. cylindrical core; 4a. semi-conical core with an untrimmed platform; 4b. semi-conical core with a trimmed platform; 5. boat-shaped core; 6. funnel-shaped core. No scale given.

to the long axis and then tapers to a point near the distal end. These are sometimes called prismatic cores (Chard 1962).

The Cylindrical Core
Maringer (1950) and Morlan (1970) placed "cylindrical" and "conical" cores in the same category. In my classification, however, I propose to use the term cylindrical core to define a core type which has a platform on each end and from which microblades were removed alternatively from end to end. This may represent an attempt to rejuvenate a platform on the distal end after the failure of the original platform. However, evidence indicates that they are a distinct core type due to the fact that some core preforms from Inner Mongolia exhibit a prepared platform on each end.

The Semi-Conical Core
This core type is called "tabular core" in North America. In China, we call it semi-conical owing to the fact that this type of core usually has a flat (either an untrimmed cleavage or a trimmed plane) surface opposite to the fluting chord, somewhat like a conical core cut in half in the middle. Exhausted specimens are often thin and quite flat in the cross-section. Morlan has described it as follows:

> Tabular cores have elongate platforms on which the long axis parallels the fluting chord. The fluting chord is a straight line or plane which lies between the ends of a restricted fluting arc. In tabular cores the flutes may be said to be facially distributed in the sense that they occupy a broad face of the specimen. Adjacent smaller faces are irregularly flaked as is the broad face opposite the fluted surface (Morlan 1970:18).

The Boat-Shaped Core
This name has sometimes been used as an alternative one for wedge-shaped cores (Hayashi 1968).

I propose to restrict the term boat-shaped cores to those having a broad body and an untrimmed platform. The two side faces of the core are formed by blows struck on the platform, which consists of either a cleavage plane or a single flake scar. Thus, wedge-shaped and boat-shaped cores are technologically different. The side faces of the wedge-shaped core are mainly formed by flake scars that originate at the keel margin. Morlan (1967) named the manufacturing process for boat-shaped cores the "Horoka technique".

The Funnel-Shaped Core

This type of core has a wide round platform, which is either trimmed or untrimmed. The diameter of the platform is always longer than the height in the initial stage of microblade reduction. The manufacturing process is similar to conical cores, but they have much broader platforms than conical cores. Microblades have been removed from the edge around the perimeter of the platform. The bottom or distal end of the core is either an intact small plane or obtuse point.

Core Technology

Technological attributes are used as a second step in classifying wedge-shaped cores according to their manufacturing patterns. These patterns include preform and platform preparation and platform rejuvenation. Blank shaping and preform preparation is the first step of microblade manufacture and is directly related to the removal process. It constitutes an important element of morphological classification. The platform is one of the most important aspects of core technology. In wedge-shaped cores the patterns of platform preparation and rejuvenation are the main criteria for distinguishing different techniques of core styles.

Edge Angle and Dimensional Variation

Platform edge angle plays an important role in reflecting the technical skill of microblade makers, although the microblade cores examined here are all discarded ones and the measurements derived from these cores might not have represented the effective range of edge angles in microblade reduction. Various kinds of factors could have influenced the abandonment of cores which was not always due to the failure of its edge angle. For instance, access to raw materials must have been an important consideration before a core was discarded. As noted on many specimens, step fractures on the fluted surface may have made microblade removal impossible, despite the fact that the edge angle was still effective. Generally, the more obtuse an edge angle, the more difficult it is for a flake or blade to be removed. Interestingly, Callahan (1984) found that the edge angles of one Danish microblade core ranged from 90° to 113° and that on the basis of experiments, the practical limit of microblade removal could reach around 110°. He also pointed out "rejection will occur because either platform preparation or blade removals fail to maintain a slightly convex blade face, especially at the proximal end, regardless of the degree of obtuseness of the platform angle. However, as that angle approaches 115°, the time of maintenance, or rate of failure, will increase so rapidly that continued production may not be feasible" (Callahan 1984:95).

As far as core dimension is concerned, most examined microblade cores are discarded ones and represent different stages of microblade reduction. Therefore, dimensional comparisons between different cores might not be meaningful. However, judging from the microblade sizes produced from these cores, we can ascertain that cores of different sizes might have been specifically designed to produce the desired products. The only problem is that we are unable to compare these cores by using a uniform rule due to their different processual stages.

The size and quality of raw materials has a direct effect on the form of the finished product (Jelinek 1976). Tabarev (1994) mentioned that raw materials played an important role in the technological characteristics of microblade industries. Because of the availability of large blocks of obsidian, microblade industries in northern Japan contain larger wedge-shaped cores. Continental Far Eastern industries in Russia utilized smaller nodules of chert, flint, jasper, and flinty tuff. Therefore, the microblade cores are relatively smaller. From my examination, the relatively small size of microblade cores from the Xiachuan and the Xueguan sites in North China might not have been influenced by the size of raw materials, because there were plenty of large chunks of chert available at the sites. In this case, it seems that core dimension might have been determined by other factors such as function, technology or even cultural tradition.

COMPARISON OF RAW MATERIALS

China

The raw materials employed to make microblades in North China are mainly chert, although those from Chaisi, the earliest microblade locality so far found in China, are made of hornfels. Other siliceous rocks such as tuff, rhyolite, agate, chalcedony, crystal, obsidian, and opal, were sporadically utilized at different localities. In the Nihewan Basin, a kind of fine-grained quartzite was a main raw material used to produce microblades in the Hutouliang and the Jiqitan assemblages.

In East China, chert is the predominant raw material employed to produce microblades in the region of the Maling Mountains and the Yi-Shui rivers valley. Other raw materials include chalcedony, agate, crystal, and slate.

Japan

In Japan, obsidian is the dominant raw material used in microblade production. At Fukui Cave, high-quality obsidian was employed (Tachibana 1979:109). At the Yasumiba site, 94% of the microcores were made on obsidian. Very few were made on shale, crystal, and silicified wood (Suzuki 1979:109). Microblade remains and other stone tools in northern Hokkaido were mainly manufactured of obsidian, while those in southwestern Hokkaido and northern Honshu are of shale (Morlan 1967; Serizawa and Ikawa 1960:6).

Korea

Shale served as the main raw material for making stone artifacts at the Suyanggae site (Lee 1989b). Although the author does not mention specifically the raw material for microblade production, it seems that all products of the lithic industry were made of the same raw material.

Eastern Siberia: The Dyuktai Culture

Raw materials of the Dyuktai culture are flint, jasper, chalcedony, or some other fine-grained siliceous materials (Flenniken 1987:118). At the Ushki Lake sites, microblades were made on flint, black andesite, chalcedony, obsidian, grey siliceous slate, and grey silicified argillaceous shale (Dikov 1968:194; Powers 1973:83).

North America

Raw materials used in the assemblages of the American Paleoarctic tradition are mainly chert. Very few specimens were made on jasper, obsidian, chalcedony, argillite, and basalt.

In the assemblages of the Northwest Coast, raw materials used to produce microblades were different from place to place. At the Namu site, they include andesite, obsidian, and milky quartz. The complete microcores are all made on andesite. The presence of many obsidian microblades and microflakes led Carlson to suggest that when obsidian microcores were exhausted, they might have been used to produce microflakes by means of bipolar percussion (Carlson 1979, personal communication 1988).

On the Queen Charlotte Islands, argillaceous slate was the common material for microblade production at the Lawn Point site, while chert is the dominant one in the Kasta assemblage (Fladmark 1986:45, 53).

At the Chuck Lake site, fine-grained argillite of black, white, green, and reddish brown colours account for nearly 90% of the sample. Other less frequent materials include obsidian, vein quartz, marble, and chert (Ackerman *et al.* 1985:128).

On the San Juan Islands, raw materials selected for the production of microblades were quartz crystal and obsidian (Carlson 1960). In 1967, Sanger (1968a) found an obsidian microcore during a re-examination of the San Juan Islands collection.

Microcores found at the DcRt–15 site near Cadboro Bay were all of basalt. The presence of a considerable amount of quartz and obsidian microblades indicates that these two materials were also important in local microblade production (Sanger 1968a:105).

Microblade assemblages found on the Columbia Plateau were attributed by Sanger (1968a, 1969, 1970b) to the Plateau Microblade tradition. Basalt was the dominant material used to produce microblades at Marron Lake and the Lochnore-Nesikep locality. At Ryegrass Coulee, Drynoch Slide, the raw materials utilized for microblade production were chalcedony and chert. In central British Columbia, obsidian was the commonly used material (Sanger 1968a).

SPATIAL AND TEMPORAL CHANGES OF CORE TYPOLOGY

China

In North China, the two chronologically earliest sites in Shanxi Province, Chaisi Locality 77.01 at Dingcun and Xiachuan, contain diverse types of microcores. At Chaisi, conical, wedge-shaped, and boat-shaped cores were found. Five microcore types were identified at Xiachuan, including conical, wedge-shaped, boat-shaped, funnel-shaped, and semi-conical types. Conical cores outnumber other core types. Only two core types, wedge-shaped and boat-shaped cores, were identified at Xueguan (Shanxi Province). At Shizitan (Shanxi Province), wedge-shaped, boat-shaped, conical, and funnel-shaped cores were recorded. Microcores from Hutouliang and Jiqitan (Hebei Province) are all wedge-shaped, indicating typological specialization of microblade production. Other North Chinese sites yield a mixture of core types with wedge-shaped, boat-shaped, and conical cores being the three most prominent types.

Japan

Microcores found in layer 4 at Fukui Cave are identified as conical, semi-conical, and cylindrical. Those from Yasumiba can be included in the same category. These cores are either of a rectangular, a short equilateral triangle, or an elongated trapezoid form in cross-section (Hayashi 1968; Kobayashi 1970). I prefer to include all of them in the conical type category.

Microcores found in layers 3 and 2 at Fukui Cave are wedge-shaped (Kobayashi 1970), although some authors refer to them as boat-shaped (Hayashi 1968; Aikens and Higuchi 1982).

There are three core types so far identified in northern Honshu and Hokkaido: wedge-shaped, conical, and boat-shaped. Because of inaccessibility to original data, a comparison based on quantity is impossible here.

Eastern Siberia and the Russian Far East

The wedge-shaped core is the only type identified at the various sites of the Dyuktai culture. Then, about 10,000 years ago, wedge-shaped cores were replaced by conical and cylindrical cores of the Sumnagin culture (Powers 1973). Although no explanation is available about this replacement, the cultural change may have been caused either by a new adaptation in the Early Holocene or by the invasion of immigrants with different microblade techniques.

In the Russian Far East, microcores from the Ustinovka and Suvorovo sites are boat-shaped. These cores seem fairly large and share some similarities to the Horoka core in northern Japan (Powers 1973; Tabarev 1994).

North America

The American Paleoarctic Tradition

Microcores found in the assemblages of the American Paleoarctic tradition are all wedge-shaped forms. The majority of them are broad-bodied with the exception of a few specimens with a narrow body.

Coastal Microblade Assemblages

Microcores found in the assemblages along the Northwest Coast have generally similar attributes. No specific typological designation has been given to these cores. Morphologically, these cores most closely resemble the boat-shaped or funnel-shaped cores of East Asia.

The Plateau Microblade Tradition

Like their counterparts from coastal microblade assemblages, no typological term has been given to microcores from the Columbia Plateau. Sanger stated: “In the north use has been made of terms such as ‘wedge-shaped’ and ‘tongue-shaped’ to describe microblade cores. Although I have employed the term 'tongue-shaped' to describe microblade cores from British Columbia, I now feel it is undesirable to place the Pacific Northwest cores into name types" (Sanger 1968a:94).

TECHNOLOGICAL COMPARISON OF WEDGE-SHAPED CORES

As the wedge-shaped core is a distinctive type widespread both in East Asia and North America suggesting a cultural relationship, the comparison of microblade technology will mainly focus on this core type.

China

Several major northern Chinese sites yielding a large number of wedge-shaped cores are selected here for detailed comparison. They are Chaisi, Xiachuan, Xueguan, Hutouliang, Shizitan, and Jiqitan.

Chaisi Locality 77.01 at the Dingcun sites

Two wedge-shaped cores from Chaisi are broad-bodied forms. On one specimen, a natural triangular chunk appears to have been used as a preform to detach microblades directly. No trimming was made to prepare either the chunk or the platform. The other specimen was bifacially shaped to form a keel. The platform is a natural cleavage plane. No rejuvenation was conducted to adjust the edge angle on the platform.

Xiachuan Industry

Two processes of core preparation were used on both broad-bodied and narrow-bodied cores. The first process began with platform formation. The platform usually consisted of a single flake scar or a cleavage plane. The core body was then bifacially or unifacially worked to shape a keel. Trimming was used to adjust the edge angle. Like the two wedge-shaped cores from Chaisi, this process was somewhat similar to that used for boat-shaped cores, but there are differences that can be observed. First, the body was mainly shaped from the keel rather than from the platform; second, the platform is much more narrow than that of boat-shaped cores; and third, the platform was sometimes trimmed to adjust the edge angle.

The second process was one in which the body was formed first. Cores were bifacially or unifacially prepared, then transversal or longitudinal blows were made on the top to produce either a bevelled or a level platform. Finally, longitudinal trimming was conducted to adjust the edge angle.

Chen and Wang (1989:145) defined the Xiachuan technique based on wedge-shaped core technology at the Xiachuan site: "Small chunks or flakes were prepared unifacially or bifacially to form a keel edge. Natural planes (cleavage or flake scar) or transversely flattened surfaces were used as a platform and then trimmed from the front to adjust the edge angle." The large cores from Xiachuan are all preforms.

Xueguan Industry

Wedge-shaped cores from the Xueguan site are all broad-bodied forms produced by using the Xiachuan technique. Most specimens were bifacially prepared. Some have double fluted surfaces. Like Xiachuan, large cores from Xueguan are preforms.

Hutouliang Industry

Wedge-shaped cores from Hutouliang show diverse patterns of core preparation and platform rejuvenation. One prominent feature is that most core preforms were bifacially prepared. Several core techniques were identified and defined by Gai (1984) and Tang and Gai (1986). A detailed description of the four techniques is as follows (see Chen and Wang 1989:144):

A. The Yangyuan technique: Natural chunks or thick flakes were unifacially worked to prepare a more or less D-shaped preform. A series of blows were directed from the lateral edges to shape a flat platform, then longitudinal blows were delivered from front to back or a tablet was removed and stopped at a notch which was transversely prepared on the upper edge of the platform.
B. The Hutouliang technique: Wedge-shaped cores were unifacially prepared to make D-shaped preforms in cross-section. The platform was trimmed by transverse blows from

one side and was usually bevelled. Rejuvenation of platforms was a successive process carried out in the course of microblade reduction.

C. The Hetao technique: This technique employs bifaces as core preforms. The platform was prepared by the removal of several ski-like spalls to shape a smooth plane passing through the entire lateral edge. Then microblades were detached from one end of the core without any further platform rejuvenation. This technique is similar to the Yubetsu technique in Hokkaido.

D. The Sanggan technique: Core preforms were bifacially worked to a biconvex shape. Small spalls were taken off the tip of the blank to form a narrow platform. Microblades were removed from the front of the platform. Successive rejuvenation of the platform was carried out during microblade reduction. This technique is basically identical to the Oshorokko technique in Hokkaido.

Jiqitan Industry

The technology of wedge-shaped cores of Jiqitan shows many similarities with that of Hutouliang due to their close geographic location, using the same raw materials and of similar chronological placement. Broad-bodied and narrow-bodied forms were identified and accounted for 91.3% and 8.7% of cores respectively. In addition to those prepared by the Xiachuan technique, the Yangyuan, the Hutouliang, the Hetao, and the Sanggan techniques, several broad-bodied wedge-shaped cores contain a body either bifacially or unifacially prepared, a platform consisting either of a cleavage plane or a single flake scar. No edge angle trimming or adjustment was made during the process of microblade reduction. This manufacture process is similar to the Xiachuan technique in core preparation and similar to the Hetao or the Yubetsu technique in microblade reduction.

Most narrow-bodied cores were bifacially prepared, showing a keel basically parallel to the platform and giving a tongue-shaped appearance. Their platforms are rather small and consist of a single flake scar and were never trimmed during microblade reduction.

Japan

Fukui Cave

According to Hayashi (1968:140, 149), the wedge-shaped cores from Fukui Cave were bifacially or unifacially prepared. Three patterns of platform preparation and rejuvenation were identified: (1) platform laterally retouched by multiple flaking; (2) platform formed by multiple flaking at apex; and (3) platform retouched by a longitudinal blow. He called this technique "the Fukui technique."

Another technological term for the Fukui cores is "the Saikai technique" (Akazawa *et al.* 1980; Ambiru 1979). To avoid confusion, I prefer to use the term Fukui technique.

Hokkaido

The four wedge-shaped core techniques identified in Hokkaido are Yubetsu, Togeshita, Oshorokko, and Rankoshi (see also Chapter 4). Morlan (1967:177) translated Yoshizaki's (1961) definition of the Yubetsu technique as follows:

> Beginning with a thick bifacial point, blows are struck longitudinally on the tip of the points so that long narrow flakes are removed from the edge. These flakes are rectangular in cross-section except for the first one which, of course, has a triangular cross-section since it bears the edge of the original biface. These flakes are called ski spalls since they more or less resemble skis. By the time several such ski spalls have been removed the biface has begun to look half its original size, as if it were cut in two longitudinally. The new flat blows are struck at a right angle to the long axis of the original biface. These blows cause the removal of long, thin, narrow (prismatic) flakes resembling microblades, and removal of these flakes gives the end of the biface (core) a fluted appearance.

Morlan (1976:99) outlines the Togeshita technique on the basis of Yoshizaki's (1961) description:

The ventral surface of the flake is nearly always the reverse face of the core, though it occasionally forms the obverse face, and it receives little or no facial retouch. The platform is produced by a burin blow along one long margin and spans 50–100 percent of the platform element. The obverse-reverse junction in the platform element, when it occurs, is a unifacially flaked edge on which the flaking sometimes becomes so steep that it can be described as a laterally flaked part of the platform itself. More frequently, however, the platform consists entirely of a longitudinal burin facet on the proximal end of which blows are struck to remove microblades.

Morlan (1967:188) translated Yoshizaki's (1961) description of the Oshorokko technique as follows:

> They are made on heavy bifacial points by first striking a single blow on the tip and then, using this first facet as a platform, by striking several diagonal blows in the opposite direction on the tip. The result is a burin with a single facet on one edge and multiple facets on the other.

The definition of the Rankoshi technique is as follows:

> This technique began with the preparation of a bifacial preform which was split in half along the short axis. A side blow was then delivered along part of the edge to shape the platform (Chin-Yee 1980:23; Tsurumaru 1979:33).

Korea

Wedge-shaped cores from the Suyanggae site were produced by several different techniques, resembling their counterparts in North China and Japan. However, they also contain some of their own attributes. The Hetao or the Yubetsu technique is the most prominent feature of the Suyanggae industry.

Except for those made by the Hetao or the Yubetsu technique which show very careful bifacial preform preparation, the other wedge-shaped cores were all made on large flakes prepared bifacially or unifacially. The majority of platforms consist of either a cleavage plane or a flake scar formed by a single longitudinal blow, except for one broad-bodied core which shows longitudinal rejuvenation near the fluted surface. These specimens were produced by a technology resembling the Xiachuan technique in northern China.

One narrow-bodied wedge-shaped core was unifacially prepared. The other side of the body is a cleavage plain with a few small flake scars along the keel. The platform is a cleavage plane as well. No platform rejuvenation was carried out during the process of microblade reduction. Lee (1989a) regarded this core technology as resembling the Saikai or Fukui technique in Japan. However, its platform technique differs from that of the Fukui core.

Eastern Siberia: The Dyuktai Culture

Flenniken (1987) defined the Dyuktai technique based on his technological study of the wedge-shaped cores from Dyuktai Cave, Ust-Mil, Ezhantsy, Ikhine II, and Verkhne-Troitskaya in eastern Siberia. The manufacturing process of the Dyuktai technique is summarized based on Flenniken's description (1987:118, 121):

> A biface was produced by direct freehand percussion… When preforms were finished, heat treatment was employed to some specimens to improve the flakeability of the lithic materials… With the blade core platform completedafter the removal of the ski spall, blades were then removed by pressure from the core.

Obviously, the Dyuktai technique is similar to the Hetao or the Yubetsu technique in northern China and Hokkaido.

It is noteworthy that one broad-bodied wedge-shaped core from Verkhne-Troitskaya appears to have been produced with the Xiachuan technique. Its platform was prepared by multiple transversal flaking, then trimmed by longitudinal blows from the fluted end (see illustration in Mochanov 1978:65).

No detailed description is available for wedge-shaped cores from the Ushki Lake sites, however, some general technological attributes can be observed based on the artifact illustrations (Dikov 1985, 1996; Powers 1973). The preforms of wedge-shaped cores exhibit careful bifacial or unifacial preparation. The presence of a large number of ski spalls and core tablets indicates that removal of ski spalls and tablets was the common technique utilized in platform preparation and rejuvenation.

Generally, three wedge-shaped core techniques were identified in the Dyuktai culture. They are the Dyuktai or the Hetao and the Yubetsu technique, the Xiachuan technique, and the Yangyuan or the Togeshita technique. The Dyuktai technique was the most commonly used technique in Eastern Siberia.

North America

The American Paleoarctic Tradition

Wedge-shaped cores of the American Paleoarctic tradition reveal fairly homogeneous attributes and many authors have provided detailed descriptions of their morphology and technology (Anderson 1970a, 1970b; Cook 1968; Morlan 1970, 1976; West 1967, 1981; Mobley 1991). Morlan (1970) defined the Campus technique for this type of wedge-shaped cores. The following description was provided by Henn (1978:61):

> These were most commonly fashioned by bifacially flaking a thick flake to form a keel on the end opposite where microblades were to be removed. The platform was created either by extensive retouch or by removing a large flake (core tablet) from the edge adjacent to the keel. Rejuvenation of the core for further removal of microblades was done by removing another core tablet from the platform or by extensively retouching the platform.

Based on the preceding description, we can see that the Campus technique is similar to the Yangyuan, the Fukui, and the Togeshita techniques in North China and Japan rather than to the Dyuktai technique in Eastern Siberia.

Northwest Coast and Columbia Plateau

Microblade cores from the Northwest Coast and Columbia Plateau look very similar in morphology and technology. Morlan (1970) defined the Lehman technique for these cores. The following description was provided by Sanger (1968a:114, 1970b:108):

> Microblade cores utilized a weathered surface for a striking platform which is usually modified only at the core edge. Multiple blow striking platform preparation is scarce, and core rejuvenation tablets are not known.

Morlan (1970) contends that the nature of the lithic raw material predetermined the form of the core, and that the particular sequence of element formation was not especially important.

Dimensional Comparison of Wedge-Shaped Cores

Microcores found in archaeological contexts may represent different stages of reduction. Some are preforms and some exhausted or discarded cores. Therefore, the measurements of specimens may not be comparable in terms of a dynamic perspective. However, dimensional measurements will give us a general impression of the appearance of wedge-shaped cores of different industries.

In this article, I propose to use a "dimensional index" to express core sizes. The dimensional index of a wedge-shaped core is the sum of three measurements, the maximum length, width, and height of a core. I would like to set up a subjective criterion of index 8 cm for dividing large and small cores. Large cores are those with indices 8 cm and larger, and small cores yield indices 7 cm and less. Sites selected for comparison are those yielding specimens available for measurement. In Eastern Siberia, only wedge-shaped cores from the Dyuktai culture are presented for comparison. In North America, only those from sites of the American Paleoarctic tradition are selected.

SYNTHETIC DISCUSSION

Based on comparisons of microblade technology between East Asia and North America, we suggest that microblades might have been extremely effective and efficient implements favoured by various foraging groups during the Late Pleistocene and Early Holocene in high latitude regions. Blade technology is widely regarded as having many advantages, such as the economic use of raw material. This might have been more important to foragers where raw material was at a premium due either to the scarcity of suitable stone or to limitations imposed by high residential mobility (Bar-Yosef and Kuhn 1999). Like blade technology, the spread of microblade technology may well be related to hafting and the manufacture of composite tools. Microblades are usually too small and narrow to have been hand-held tools. Although it required a greater investment of time and energy, microblade technology might have afforded users increased effectiveness in the procurement and processing of resources.

With regard to hunter-gatherer adaptations, economic risk, and tool design, Bousman (1993) listed four strategies of tool design: expedient tool, maintainable tool, reliable tool, and efficient tool. Reliable tools refer to weapons often functionally specialized and characterized by extra-sturdy construction, over-designed critical parts, high quality fitted parts, and a special repair kit. Reliable tools are used when the risk is great. Efficient tools could decrease the cost of raw material acquisition and the best example is blade technology. It could be argued that microblade technology represents a combination of reliable and efficient tools which were adopted by hunter-gatherers living in environments full of risk and a shortage of good quality raw material.

The increasing domination of wedge-shaped cores in North China, Japan, Korea, Siberia, and Alaska, may have reflected a trend towards standardization and craft specialization of microblade manufacture. Using various types of microcores at a site or at different sites may indicate a process in which individuals had multiple choices. The spatial and temporal predominance of wedge-shaped cores both in East Asia and North America may have been related to a kind of occupational differentiation and craft specialization. The advantage of using wedge-shaped core technology may also tie into other aspects such as their more economic or efficient characteristics compared to other core types with regard to raw material consumption and favouring a specific device (clamp) to hold a core without movement (e.g., Tabarev 1997). The uniformity of wedge-shaped core technology could be seen as both traditional affinity and significant technical success.

Raw Materials

Microblades in East Asia and northwestern North America were predominantly made from good quality microcrystalline silicate minerals such as chert, flint, obsidian, and chalcedony. Some kinds of softer or coarser lithic raw materials such as hornfels, shale, basalt, and argillite, were also used in certain industries.

Chert and flint are the most common raw materials encountered at many sites in China, most Dyuktai culture sites, and almost all American Paleoarctic tradition sites. A fine quality quartzite was predominantly utilized at the Hutouliang and the Jiqitan localities. Quartzite is coarser but workable like chert. In Northeast China and some other parts of China, a series of Mesozoic-Tertiary rocks and minerals such as chalcedony, argillite, agate, and jasper, were widely used.

Obsidian is the predominant raw material in Japan and also commonly encountered in some northwestern North American assemblages, especially in the regions of the Pacific coast and Columbia Plateau. Hard shale was used in Korea, southern Hokkaido, and northern Honshu.

Basalt is a young magmatic rock with rough, uneven fracture characteristics. It is a raw material commonly encountered on the Pacific coast and Columbia Plateau of North America.

Generally, the technologically most suitable raw materials for microblade production include chert, flint, chalcedony, obsidian, jasper, agate, and high quality quartzite. Microblades were also made of some relatively poor quality stones such as hornfels, shale, basalt, and argillite, and certain delicate techniques were obviously unworkable using these materials, especially very delicate platform rejuvenation. The resultant cores sometimes exhibit a rather crude appearance.

Selection of certain raw materials might reflect the adaptation and mobility of ancient microblade using groups in different regions, and utilization of certain coarse raw materials would have had an obvious impact on the performance of certain core techniques.

Core Typology

Core typology is regarded as an important factor in tracing contacts or relationships. Typological variation of microcores is thought to be stylistically significant.

In northern China, conical, boat-shaped, and wedge-shaped cores are the three most common core types in the early microblade industries such as Chaisi and Xiachuan, and the percentage of wedge-shaped cores is relatively low in comparison with the other two types. This phenomenon is, to a degree, also present in Japan. Conical and boat-shaped cores are two early core types encountered in the north of Japan. Conical cores are so far unknown in the more recent microblade assemblages of Japan and North America.

In later times, core typology exhibits a trend of specialization and differentiation. The wedge-shaped core became the predominant core type at the Xueguan, Hutouliang, and Jiqitan sites in northern China. The boat-shaped core became the predominant type at the Yaozitou, Donghuishan, and Tingsijian sites in northern China.

The exclusive use of wedge-shaped cores in the Dyuktai culture, layers 3 and 2 in Fukui Cave, and Senpukuji Cave (see Tang 1985), the Shirataki site cluster on Hokkaido, the Suyanggae site in southern Korea, and in the American Paleoarctic tradition in North America should not be seen as a coincidence with North China.

During the more recent period, wedge-shaped, conical, and semi-conical cores constitute the most frequent typological group in microblade assemblages in northern China.

No specific typological terms have been given to microcores found on the Pacific coast and the Columbia Plateau. The amorphous appearance of these cores might be related to the technological constraints imposed by a shortage of high quality raw materials, perhaps reflecting the lesser mobility or local adaptation of prehistoric hunter-gatherers in these regions.

Core Technology

Technological investigation is considered to be an important supplement to typological studies. The reconstruction of core techniques is regarded as a crucial step in identifying fundamental similarities between morphologically similar cores. The following discussion focuses on wedge-shaped cores.

Wedge-shaped cores from Chaisi, Xiachuan, and Xueguan were made with the Xiachuan technique which seems technologically simple. Those from Hutouliang and Jiqitan were made using various and more sophisticated techniques such as the Yangyuan, the Hetao, and the Hutouliang techniques. Using bifaces as the preform became very common. Various platform rejuvenation methods were employed during microblade reduction. The same phenomenon can be encountered in northern Japan, Korea, and the Dyuktai culture of Eastern Siberia. The Hetao or the Yubetsu technique was widely used.

In North America, the Campus technique and the Lehman technique have been reported. The Campus core shares many similarities with its counterparts in East Asia.

Judging from the procedure of core preparation and platform rejuvenation, I suggest that the Xiachuan, Hutouliang, Yangyuan, Fukui, Togeshita, and Campus techniques are very similar. The principle difference between these techniques is in platform rejuvenation. The Xiachuan and Hutouliang techniques rejuvenated platforms by multiple faceting whereas the Yangyuan, Fukui, Togeshita, and Campus techniques rejuvenated platforms by removing one or more tablets in addition to multiple flaking.

The technical process of the Hetao, Yubetsu, and Dyuktai techniques is identical. These techniques occurred in northern China, northern Japan, Korea, and Eastern Siberia, but are poorly represented in North America, although a few specimens found in Alaska were thought by Morlan (1976:102) to be remarkably similar to the Yubetsu core.

The Lehman technique is quite different from the wedge-shaped core techniques in East Asia and the Campus technique in Alaska. It is possible that it represents a locally developed variant of microblade technology.

It can be concluded that the Xiachuan, Hutouliang, Yangyuan, Fukui, Togeshita, and Campus techniques could be considered a homogeneous technological complex, representing the most widespread and long-lasting wedge-shaped core technology, which extended from northern China to North America, and to the Qinghai-Tibetan Plateau during the Late Pleistocene and the Early Holocene.

Core Dimension

If we use an index of 8 cm to divide large and small cores, a dimensional comparison may provide an additional insight into the relationship between different microblade industries.

The size of wedge-shaped cores from the Late Pleistocene sites such as Chaisi, Xiachuan, Xueguan, and many other localities in northern China, is generally small. The percentage of large cores increased considerably at the Hutouliang and Jiqitan sites, even though most specimens yielding large indices are preforms (Table 2.1).

The percentage of large wedge-shaped cores from Japan, Korea, and the Dyuktai culture in Eastern Siberia is very high. Those from Hokkaido are extremely large due to the availability of good quality obsidian. The wedge-shaped cores from the American Paleoarctic tradition are relatively small. They look similar to those of the Late Pleistocene industries in northern China, but are much smaller than those of the Dyuktai culture and from Hokkaido (Table 2.2).

CONCLUSION

On the basis of the faunal and palynological research so far conducted in Northern Asia and northwestern North America, we can primarily ascertain that microblades in both regions might have represented a technology or a tool kit employed by hunter-gatherers who lived in extremely diverse and severe environments. During the Late Pleistocene, with a few exceptions, the climatic conditions in most parts of northern China, the Qinghai-Tibet Plateau, Mongolia, Japan, Eastern Siberia, and northwestern North America were dry, cold, and continental. The vegetation in these regions was characterized by tundra, steppe, desert, taiga, and forest-steppe. The climate did not change or become warmer until the Holocene. Thus, we could suggest that when microblade technology was flourishing during this period, very few floral resources were available for hunter-gatherers in these regions and that microblades might have represented a technology exploiting mainly faunal resources. Animal resources were usually available year-round and easy to locate, procure, and process as opposed to plant resources in an unknown region. Microblade technology and the subsistence pattern allowed hunter-gatherers to occupy new territories or environments. They did not require new technological adjustments to continue their hunting-gathering lifeways.

Kelly and Todd (1988) pointed out that Late Pleistocene and Early Holocene climatic fluctuations and environmental changes produced periodic declines in local game populations which would impose stress on prehistoric hunting groups. These groups could have coped with periodic resource stress in two ways: switching to different resources in the same territory, or switching territories. In the northern territories, there may not have been adequate plant resources to exploit and changing the territory by migrating may have been the only choice available.

An examination of the selection of raw materials and the curation of lithic technology can help to differentiate between the mobility patterns of hunter-gatherers since recent research into their technology has indicated that mobility and scheduling are the factors that most influence the organization of technology (Koldehoff 1987). High mobility requires a portable technology which allows knappers to produce enough tools from a small amount of good raw material or to manufacture a standardized tool kit that is long lasting and multifunctional (Parry and Kelly 1987). At the same time, a standardized core technology such as microblade technology requires good quality materials.

In contrast, low mobility or sedentism poses other problems. As sedentism increases, tool mak-

Table 2.1: Dimensional comparison of wedge-shaped cores from some major sites in China.

Site	Chaisi	Xiachuan	Xueguan	Hutouliang & Jiqitan	Lingjing	Dafa	Dabusu
Index	7-5	9-4	11-4	13-4	6-4	5-4	6-4
Number	2	19	19	64	2	3	2
Big cores	0%	32%	11%	41%	0%	0%	0%

Table 2.2: Dimensional comparison of wedge-shaped cores from Japan, Korea, Eastern Siberia and North America.

	Japan		Korea	E. Siberia	North America
Site	Fukui	Hokkaido	Suyanggae	Dyuktai	Amer. Paleoarctic trad.
Index	10-5	28-7	15-5	13-6	13-4
Number	23	24	13	46	120
Big cores	57%	98%	77%	61%	10.5%

ers may face raw material depletion within their immediate living areas or face restricted access to necessary resources. Knappers have to resort to using inferior materials or alter the stone to improve its quality (Lurie 1989). On the other hand, increasing sedentism reduced the need for more costly, standardized, portable tools, and expedient tools became more common.

It is reasonable to suggest that the relative consistency of raw material selection and wedge-shaped core technology in East Asia and North America was the result of high mobility and cultural contacts which finally led to the widespread occurrence of microblade remains in these large regions. The change in raw materials and the shift to an expedient technology on the Northwest Coast and the Columbia Plateau may have been a response to decreased mobility when microblade-using groups settled in these regions.

The relative stability of techno-typological attributes of wedge-shaped cores in East Asia and North America indicates a close interaction process. The techniques of Xiachuan, Hutouliang, Yangyuan, Fukui, Togeshita, and Campus share many fundamental similarities in the manufacturing process despite raw material differences. The Hetao, Dyuktai, and Yubetsu techniques may characterize the innovation and sophistication of microblade technology.

In contrast, typological and technical specialization or variation of microcores encountered in Eastern China and on the Northwest Coast and Columbia Plateau of North America may reflect an interruption of cultural interaction or technological attenuation in a region far from the parent tradition.

Metric attributes of wedge-shaped cores, to a certain extent, can provide historically meaningful information which is helpful in verifying cultural comparisons. Four main points are noted below:

(1) Techno-typological similarities of wedge-shaped cores between the Late Pleistocene industries in northern China and the American Paleoarctic tradition are further indicated by their dimensional consistency.

(2) Although the high frequency of large cores in the Dyuktai culture, Suyanggae, Fukui Cave, and Hokkaido may have been the result of either raw material or functional factors, this phenomenon indicates to a certain extent that the Campus core in Alaska is not an exact copy of the wedge-shaped core of the Dyuktai culture. This analysis further supports the argument that the Campus

technique differs in certain respects from the Dyuktai technique in the manufacturing process (Chen and Wang 1989).

(3) Obvious differences in core techniques and dimensions between Fukui Cave and Hokkaido support the assumption that wedge-shaped core technologies in southern and northern Japan had different origins.

It is reasonable to suggest that prehistoric microblade-using groups in East Asia and North America might have adopted a highly mobile subsistence pattern to cope with the uneven distribution and seasonal fluctuation of faunal resources. Adapting to a severe environment with only faunal resources available would force these microblade-using groups to shift their territories frequently, resulting in the widespread distribution of microblade remains. Trigger (1978) has noted that among less sedentary hunting groups, such as the Eskimo, basic tool assemblages range over vast distances cross-cutting obvious cultural boundaries due to unstable band composition and frequent contact. The distribution and similarity of wedge-shaped cores might provide a good example of such a mobility and subsistence pattern.

(4) It is still too early to determine the origin of microblade technology due to incomplete archaeological evidence. Microcores unearthed from Chaisi with the earliest absolute dating result show a fairly advanced technology. Therefore, we can ascertain that the origin of microblade technology must be earlier.

Judging from the widespread distribution of microblade remains, some scholars have argued that there might have been multiple inventions or parallel developments of microblade technology in China (Sichuan Field Team of the Institute of Archaeology 1991; Duan 1989; Li 1992). Although these scholars challenge the traditional model of migrationism or diffusionism, they do not provide us with either powerful archaeological evidence or sound theoretical explanations to support their argument. Due to the complexity and sophistication of microblade technology and extremely diverse environmental habitats, the distribution of microblade remains, especially wedge-shaped cores, was most likely the result of migration. To cope with faunal resources in different environments, prehistoric hunter-gatherers could adopt different ways to pursue them. Therefore, the environmental difference will more likely cause cultural differentiation or divergence rather than analogy or convergence. For this reason, the similarities of microblade technology in East Asia and North America might have had a common origin.

Microblades must have been multifunctional artifacts. The research of these distinct remains should shift from focusing on description and comparison of their techno-typological attributes to a concern of their functions and significance to human adaptation. Usewear and *chaîne opératoire* studies are certainly helpful to solve these problems. This further exploration could finally determine why this technology was so effective, widespread, and popularly employed by hunter-gatherers during the Late Pleistocene and the Early Holocene.