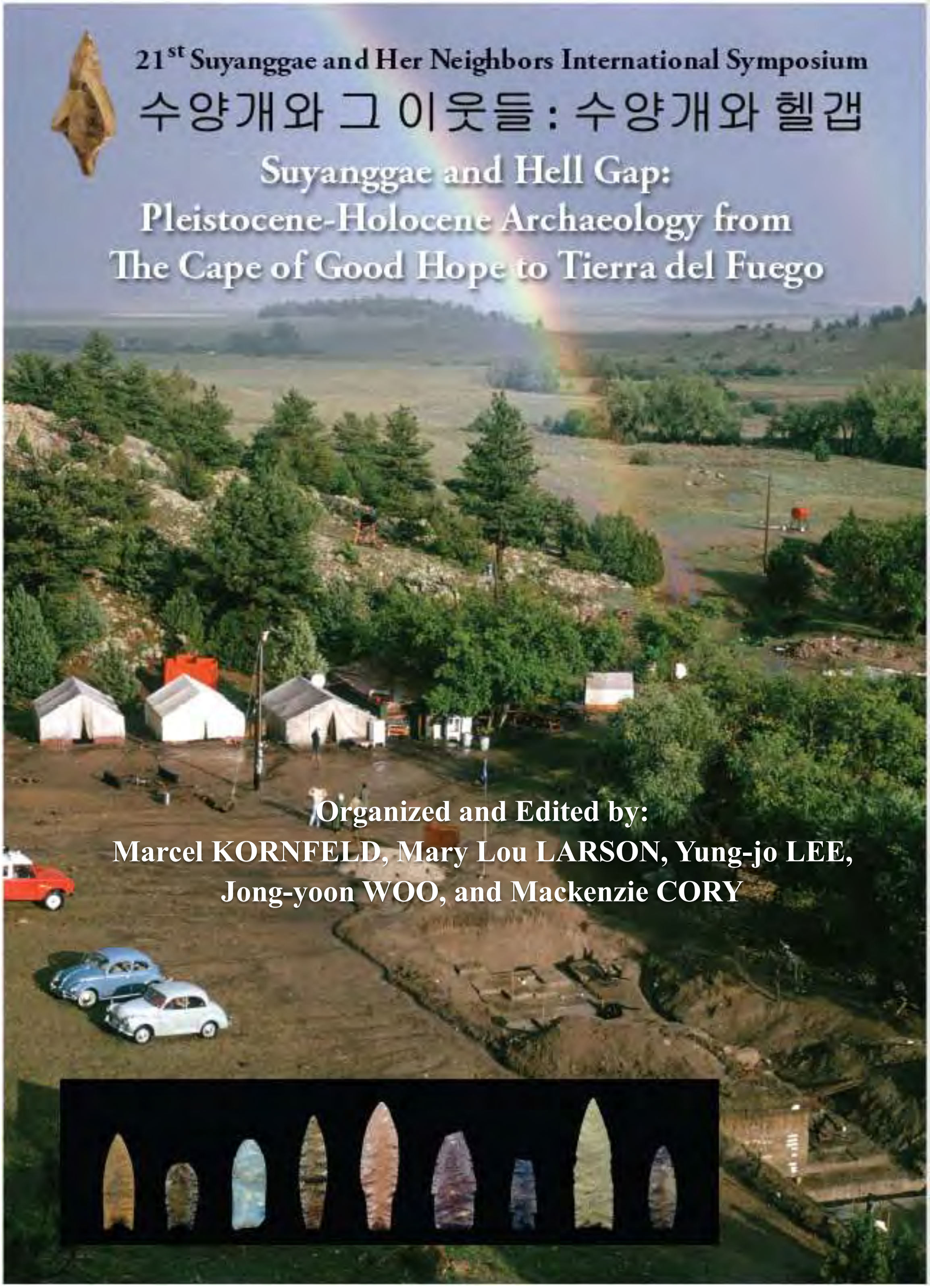
PROGRAM AND PROCEEDINGS of the

21st Suyanggae and Her Neighbors International Symposium

수양개와 그 이웃들: 수양개와 헬갭

Suyanggae and Hell Gap: Pleistocene-Holocene Archaeology from The Cape of Good Hope to Tierra del Fuego



Organized and Edited by:
Marcel KORNFELD, Mary Lou LARSON, Yung-jo LEE, Jong-yoon WOO, and Mackenzie CORY

Paleoindian Research Lab

Laramie, Wyoming U.S.A. • 26 July–3 August, 2016

Welcome to the Laramie Valley

We will be staying in nearby Centennial, Wyoming, underneath the 3000 m peaks of the Snow Range (http://www.centennialwyoming.com/). Our conference Hotel is the Old Corral Hotel and Stakehouse (http://www.oldcorral.com/), about 20 minutes west of Laramie. All the symposium events (Opening Ceremony, presentations) will be at the University of Wyoming's Berry Biodiversity Conservation Center (http://www.uwyo.edu/biodiversity/). Laramie and Centennial are at a relatively high elevation of nearly 2500 m. some people from low elevation experience discomfort and headaches at this elevation, so you might want to visit your physician and consult about possibly medication to prevent your discomfort.

Organizing Committee:

Paleoindian Research Lab, University of Wyoming,

Director of the Lab – KORNFELD, Marcel, Prof. anpro1@uwyo.edu
Assistant, Dr. Elizabeth Lynch
Assistant, Brigid Grund

Institute of Korean Prehistory:

President of the Institute – LEE, Yung-jo, Prof.: leeyj@ikp.re.kr
Director of the Institute –WOO, Jong-yoon, Prof.: woo10@hanmail.net

University of Wyoming, Anthropology Museum

Director of the Museum – LARSON, Mary Lou, Prof.: mlarson@uwyo.edu

Sponsors:

College of Arts and Sciences, University of Wyoming, Laramie, U.S.A.
Anthropology Department, University of Wyoming, Laramie, U.S.A.
Paleoindian Research Laboratory, University of Wyoming, Laramie, U.S.A.
Institute of Korean Prehistory, Cheongju, Korea
International Programs Office, University of Wyoming, U.S.A.
Terry and Jim Wilson – Vee Bar Ranch, Thermopolis, U.S.A.
Deer Creek Heights Ranch, Fresno, California, U.S.A.
Mike Toft, Sterling, Colorado, U.S.A.
Russel L. Tanner, Rock Springs, Wyoming, U.S.A.
Jim Wear, Wooden Shoe Ranch, Laramie, Wyoming, U.S.A.

Emergency Contact in Laramie, for Arrival, and During the Symposium

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PROGRAM AND PROCEEDINGS of the

21st Suyanggae and Her Neighbors International Symposium:

Suyanggae and Hell Gap

수양개와 그 이웃들 : 수양개와 헬갭

July 26-31, 2016

Organized and Edited by:
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General Symposium Schedule

July 26: Arrival and Registration
July 27: Opening ceremony and keynote session, scientific papers (Berry Center)
July 28: Field Trip 1: Medicine Bow glaciation, paleoclimate, southern Laramie Basin
July 29: Scientific sessions and closing ceremony (Berry Center and CH)
July 30: Field Trip 2: Hell Gap and eastern Wyoming
July 31: Departure

Post-symposium excursion

July 31- August 2
August 3 – departure from Laramie

Conference Schedule

<u>Wednesday, July 27, Morning (Berry Biodiversity Center)</u>

8:00 Registration
9:00 Opening Remarks
Laurie NICHOLS, President, University of Wyoming
Paula LUTZ, Dean, College of Arts and Sciences, University of Wyoming
James AHERN, Chair, Anthropology Department, University of Wyoming
Mary Katherine SCOTT, Director, International Programs, University of Wyoming
Sara NEEDLES, Director of Cultural Resources, State Parks and Cultural Resources
Mary HOPKINS, State Historic Preservation Officer, Wyoming
Greg PIERCE, State Archaeologist, Wyoming
Carlos MARTINEZ del RIO, Professor and Director of Berry Biodiversity Center, University of Wyoming

10:00 Suyanggae Awards (Presided by: Yung-jo LEE and Jong-yoon WOO)

<u>Session I</u> – **Keynote Addresses: Archaeology and Archaeological Problems from Bay of Biscay to Sea of Okhotsk**
Chair: Jirí A. SVOBODA

10:30 **Fumiko IKAWA-SMITH**, Peopling of the New World as Seen from the Japanese Archipelago
11:00 **Kidong BAE,** Post-depositional Processes and Explanation of Hominin Activities at Paleolithic Sites in Korea

11:30 **George C. FRISON**, The Powars II Site: Red Ocher, Tool Stone, Early and Late Paleoindian Procurement Activities on the High Plains of North America

12:00 **Lucyna DOMANSKA,** Change and Continuity: Traditions of Flint Processing from the Perspective of the Tążyna River Basin in Kuyavia, Poland

12:30 **Michael JOCHIM,** Palaeolithic and Mesolithic Colonization of the European High Alps

13:00 LUNCH, Geology Museum Tour and Anthropology Museum Tour

Wednesday, July 27, Afternoon (Berry Biodiversity Center)
Session II – Neighbors from Cape of Good Hope to the Caucuses
Chair: Hiroyuki SATO

15:00 **Robert K. HITCHCOCK and James I. EBERT,** People of the Desert, Dunes, and Deltas: Landscape Archaeology in the Interior of Southern Africa

15:20 **Lawrence TODD, John KAPPELMAN, Neil TABOR, Marvin KAY, and Mulugeta FESEHA,** Middle Stone Age in the Horn of Africa: Research Along Tributaries of the Blue Nile, Northwest Ethiopia

15:40 **Avraham RONEN and Yamada SHOH,** The Akhziv Tsunami (?) Deposit

16:00 COFFEE BREAK

Session III – Neighbors from North Sea to South China Sea
Chair: Ju-Yong KIM

16:20 **Marcel BARTCZAK,** Comparison of Tanged Points from Korean and Polish Areas - on the Basis of Two Distant Stone Age Sites

16:40 **Jirí A. SVOBODA,** Hunting strategies in Late Pleistocene Landscapes. Case of the Middle Danube Basin

17:00 **Elena VOYTISHEK and Anna SHMAKOVA,** Epigraphic Memorial Stele 埋香碑 Mehyangbi («Incense Burial») as an Archaeological and Cultural Heritage of Medieval Korea (Compared to Chinese and Japanese Traditions)

17:20 **Wei WANG,** Recent Discovery of Paleolithic Sites in Bubing Basin, South China

17:40 COFFEE BREAK

18:00 **WANG Chun-xue, WANG Xiao-kun, CHEN Quan-jia, TANG Zhuo-wei, and WEI Jian,** Human Behavioral Adaptation on Jinsitai Cave Site, Northern China

18:20 **Meng ZHENG**, Microblade-based Societies: A New Perspective on Roles of the Microblade Technology in Northern China after the Last Glacial Maximum

18:40 **Guangmao XIE and Qiang LIN,** A Study on the Neolithic Chipped Stone Tools from Lingnan (South China)

00:00 **Weiwen HUANG, Marcel OTTE, Yue HU, and Ya-Mei HOU,** Panxian Dadong Cave: Levallois Technology in Southern China (Poster)

19:30 DINNER **-** Laramie Railroad Depot

<u>Thursday, July 28</u> – Field Trip I: Laramie Basin/Medicine Bow

DINNER – Old Corral

<u>Friday, July 29, Morning (Berry Biodiversity Center)</u>

9:00 University of Wyoming Archaeological Repository Tour

<u>Session IV</u> – Neighbors from South China Sea to Bering Strait
Chair: Brigid GRUND

10:00 **Ju-Yong KIM, Yung-jo LEE, Jong-yun WOO, Seungwon LEE, and Keun Chang OH,** Landscape and Soil-Sedimentary Matrix-Forming Processes of Sorori Paleolithic Site in the Miho River Since MIS 5, Korean Peninsula.

10:20 **Seung-won LEE, Yung-jo LEE, Jong-yoon WOO, Joo-hyun AHN, and Kyong-woo LEE,** Suyanggae, Why so Important (X)? With the focus on Tanged-points from Cultural Layer 4 at SYG - 6

10:40 **Hiroyuki SATO,** Pleistocene to Holocene Archaeology in the Japanese Archipelago: An Overview

11:00 COFFEE BREAK

11:20 **Pei-Lin YU,** The First Floating Farmers: Tempo and Mode of the Neolithic Transition in Taiwan

11:40 **Byeongil YUN, Hyeongil JANG, and Jong-yoon WOO,** Stone Artifacts Analysis from Re-deposited Sediments in Seochon Paleolithic sites, Cheongju, Korea

12:00 **Alexander A. VASILEVSKI and V.A. GRISCHENKO**, Chronology, Periodization, and the Main Features, of Sony Culture (early Middle Neolithic Sakhalin Island)

13:00 LUNCH, SHPO Tour

Friday, July 29, Afternoon
Session V – Neighbors from Bering Strait to Tierra del Fuego
Chair: YU

15:00 **Rachael Lea SHIMEK,** Useful Companions: Domestic Dog Use on the Northern Great Plains
15:20 **Marcel KORNFELD and Mary Lou LARSON,** Hell Gap Zooarchaeology: A Time to Reconsider
15:40 **Mackenzie CORY,** From Home to Hearth: Expanding on a Model of Tipi Transformation
16:00 **Brigid GRUND,** Behavioral Ecology, Technology, and the Organization of Labor: How a Shift from Spear Thrower to Self-Bow Exacerbates Social Disparities

16:30 **Session VI – Discussion:** Avraham RONEN, Robert HITCHCOCK, Wei WANG, Lawrence C. TODD, Chun-xue WANG

19:00 DINNER and CLOSING CEREMONY – Crazy Horse Way

Saturday, July 30 – Field Trip II: Hell Gap

DINNER – Hell Gap

Suyanggae International Symposium
Executive Committee (SISEC)

CHINA: **Xing GAO *(VICE CHAIR)*,** (Professor, Institute of Vertebrate Paleontology [IVPP], CAS)
Chang-zhu JIN (Professor, [IVPP], CAS)
Shejiang WANG (Professor, [IVPP], CAS)
Fei XIE (Director, Hebei Provincial Bureau)

ISRAEL: **Avraham RONEN** (Professor Emeritus, Zinman Institute, Haifa University)

JAPAN: **Masao AMBIRU** (Professor, Meiji University)
Hiroyuki SATO (Professor, Tokyo University)
Kaoru AKOSHIMA (Professsor, Tohoku University)

KOREA: **Kidong BAE** (***VICE CHAIR*** Professor, Hanyang University)
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Marcel KORNFELD (Professor, University of Wyoming)

















SISEC: Top row, left to right: Prof. Kaoru AKOSHIMA, Prof. Masao AMBIRU, Prof. Kidong BAE, Dir. and Academician Anatoly DEREVIANKO; 2nd row, left to right: Prof. and Dir. Lucyna DOMANSKA, Rector and Prof. Nikolay DROZDOV, Prof. Xing GAO, Prof. Ted Goebel; 3rd row, left to right: Prof. Michael JOCHIM, Prof. Chang-zhu JIN, Prof. Marcel Kornfeld, Prof Gi-kill LEE; 4th row, left to right: Prof. Heonjong LEE, Prof. Yung-jo LEE, Prof. Avraham RHONEN, Prof. Mohd Mokhtar SAIDIN; 5th row, left to right: Prof. Hiroyuki SATO, Prof. Alexander VASILEVSKI, Dir. Jong-yoon WOO, Prof. Shejiang WANG, Dir. Fei XIE.

Congratulatory Remark

Yung-jo LEE

President,

Suyanggae International Symposium Executive Committee

Institute of Korean Prehistory

I feel full-hearted to watch the Suyanggae International Symposium held at the Hell Gap site after 56 since the first excavations. It also gives me deep emotion that it would have taken 7 or 8 thousand years for Suyanggae people 18,000 ago to arrive at the Hell Gap, thinking we were able to come here only by 15 hours flight.

Since the 1st meeting had been held in Danyang where Suyanggae site is located, two decades of the one and only annual Paleolithic symposium in the world has passed. Now we meet for the 21st time here in Laramie, Wyoming. As research at Hell Gap has inspired all of us studying the Paleolithic Archaeology, this means a lot for opening a new era for the symposium.

Meeting the opening the symposium, we, SISEC, proudly present the 10th Suyanggae Academic Award to Prof. Marcel KORNFELD, organizer of this symposium, whos research focuses on Paleoindians and the First Americans. We are all very grateful for his effort to organize the symposium and for the great achievement of Paleolithic study.

And we also would like to present a Certificate of Merit to Prof. George C. FRISON to honor his pioneering work not only for the American archaeology but for study of the World Prehistory.

I sincerely hope that all participants can share each other's lifetime works and enjoy delightful companionship in the learning world. Once again, I express my deepest gratitude to Prof. Kornfeld and other staff for helping this symposium come here.

Thank you. June 15, 2016

Dear Prof. Yung-jo Lee and Prof. Marcel Kornfeld July 1, 2016

Dear friends and colleagues:

The 21st Suyanggae International Symposium will be held in Laramie, Wyoming, U.S.A., from July 26-31, 2016. It will be an important event in the history of Suyanggae and Her Neighbors symposium series. It extends the scope of academic communications and collaboration beyond Eurasia, all the way to North America. Just like the theme of the symposium "*From The Cape of Good Hope to Tiera del Fuego: A Human Journey*" tells us, human journey from Africa to all the continents and corners of the globe was a series of marvelous episodes, and we Paleolithic archaeologists have the privilege, obligation and opportunity to trace our ancestors' footprints all over the world, investigating their technologies, lifestyles, adaptive strategies, social structures, and discussing the significance of their history to modern human societies.

The symposium is not only an academic gathering, but also a family and friends reunion. In the past twenty years, Professor Lee has worked endlessly with great enthusiasm to promote the Suyanggae and Her Neighbors concept and academic activities, and to bring scholars and friends together for information exchange and collaboration. In the course of such series events, cooperation and friendship developed among us, and the Suyanggae family expanded.

It is really a pity that I cannot attend the Suyanggae and Hell Gap symposium and therefore will miss the opportunity to interact with old friends and make new friends. Here, as a member of Suyanggae International Symposium Executive Committee (SISEC) and the current president of Asian Paleolithic Association, from the bottom of my heart, I want to convey my warmhearted congratulations to the opening of the 21st Suyanggae International Symposium and to Prof. Marcel Kornfeld for receiving the Suyanggae Academic Award.

I wish a big success for the Suyanggae and Hell Gap symposium and a pleasant and fruitful time in Wyoming for all the participants!

Gao Xing, President of APA

Professor, Institute of Vertebrate Paleontology

and Paleoanthropology, CAS

N. I. Drozdov

Krasnoyarsk. Russia

GREETINGS TO THE PARTICIPANTS

Dear colleagues and friends,

The 21st Symposium "Suyanggae and Her Neighbours" is to be held rather far from the Korean site that gave the name to the International Conference of archeologists. This time it is to take place on the American continent, in the USA, in the State of Wyoming. And I believe it is meaningful and quite symbolic!

The first humans also came to America from Eurasia. It happened during the Paleolithic. There is an opinion that blade technology of Asian Paleolithic cultures was brought to the American continent by those "Columbuses". Probably some group related to the Suyanggae humans reached the territory of America via the Bering Strait in prehistoric times. It is difficult to affirm this with assuredness, but such a supposition has the right to exist.

This time people from Eurasia are again coming to America, but their purpose is not to settle here, the" Suyanggae Neighbours" are getting together to make one more contribution to the further development of archeology and related sciences. A great amount of work has been done over the 20 years of our cooperation. And all of us are particularly grateful to the man who united us and made the" Suyanggae and Her Neighbours" Symposium a regular scientific event of outstanding importance. Of course, you understand that I mean the President of the Institute of Korean Prehistory, Professor Yung-jo LEE. It was his idea to bring us all together and join our efforts in studying neighbouring Paleolithic cultures of Eurasia and America. Dozens of renowned scholars and their post-graduate students from various countries of the world annually present their research results at the "Suyanggae Symposia". The results of our research show that mutual interpenetration and enrichment of cultures as well as technological exchanges began on the planet long ago – in the prehistoric times. Just one example: until recently we thought that in ancient China there was no Levallois technology and there was a particular kind of people living there at those times, but the latest discoveries made by Chinese scientists showed the presence of this technology in various parts of China.

One of the most important results of “Suyanggae and Her Neighbours“ Symposia, I believe, is that not only archeology but anthropology, paleobotany, paleozoology and other sciences became enriched with new scientific knowledge.

Scholars from all over the world have become friends and like-minded people while studying prehistoric past of humankind. During these twenty odd years we have become a united Suyanggae family!

I wish you all fruitful work at the Conference at the University of Wyoming!

Nikolai Drozdov

On the 21st Suyanggae and her Neighbors Paleolithic Symposium,

Dear our family and friends,
I am very pleased to have this great Paleolithic symposium of the 21st Suyanggae and her Neighbors gives us opportunity to see our dearest friends, Suyanggae family, and to expand our knowledge of our prehistoric past in Laramie, Wyoming. It is very memorable and meaningful for the history of this symposium too, considering this is a new beginning of this symposium in New World after the 20th in Korea last year.

I sincerely express all my respects to Prof. LEE, Yung-jo for his passion and great efforts during the last 20 years to make this special SYG symposium continued up to present. This symposium has been a solid platform for concerned Paleolithic archaeologists in diverse areas in the World. We have travelled to cities of major Paleolithic sites for deepening our archaeological knowledge and discussed for better explanation of Paleolithic past of human in very friendly atmosphere. Here in Laramie again, we are expecting wonderful time to see best archaeological sites and researches done by our colleagues and to make significant advancement of understanding of evolution of Paleolithic culture through our sincere discussions.

Along with all our colleagues from outside, I am very grateful to Prof. Kornfield who is hosting us very kindly as organizer of this symposium. I believe everyone participating this 21st SYG symposium would very appreciate what he prepared for us and will be delighted of wonderful sites and beautiful nature in Wyoming that I have dreamed of since I lived in California.
Thank you.

Bae, Kidong
Chairperson, ICOM ASPAC

The 10th Suyanggae Academic Awardee

Marcel Kornfeld is a professor of anthropology at the University of Wyoming in Laramie, Wyoming, U.S.A. He received his BA in anthropology at the University of New Mexico (Albuquerque, New Mexico, U.S.A.), MA from the University of Wyoming (Laramie, Wyoming, U.S.A.), and PhD form the University of Massachusetts-Amherst (Amherst, Massachusetts, U.S.A.). He has been a board member of the Plains Anthropological Society and the Rocky Mountain Anthropological Association, including a founding member of the latter. He is also a member of the Suyanggae International Symposium Executive Committee. He serves or has served as editor of the Plains Anthropologist and the SAAs Council of Affiliated Societies Newsletter, associate editor of Reviews in Anthropology – an international journal, book review co-editor of Plains Anthropologist, and special editor for Quaternary International. He is currently on the Wenner-Gren proposal review panel. He has been the President of the Plains Anthropological Society, Secretary of the Rocky Mountain Anthropological Conference, and vice-Chair and Chair of the SAAs Council of Affiliated Societies. Kornfeld has organized or co-organized six national and international conferences and 26 symposia including several international. He has made 162 professional presentations many with students and colleagues as well as numerous invited speeches to archaeological and civic groups, as well as the general public. He has also served as the member of the Albany County Preservation Board, represented the Wyoming Archaeological Society at the SAAs Council of Affiliated Societies since the mid-1990s, was a founding member of the June Frison Chapter of the Wyoming Archaeological Society. He has received a number of awards Including Loveland Archaeological Society Certificate of

Appreciation, University of Wyoming Thumbs-Up award, Wyoming Atl-atl and Social Club Honorary Membership, University of Wyoming Anthropology Department Service Award, and U.S. Department of the Interior 'Making A Difference' award from the Bureau of Land Management.

Kornfeld's area of interest include: the First Americans and peopling of the Americas, hunter-gatherers, cultural evolution, chipped stone technology, gender, landscapes, archaeological taphonomy, rockshelter use and formation, and theory and method. He has published widely on these topics in 11 books and 120 journal articles and book chapters. Kornfeld has mentored 20 masters and doctoral students and introduced and trained 100s of students for field work, laboratory analysis, and other professional preparation. His field research is in the Rocky Mountain region and adjacent plains of Montana, Wyoming, and Colorado. However, he has participated in projects or visited sites from California to Texas in the U.S.A., as well as in Canada, France, Croatia, Russia, Korea, China, and Germany. In the Rocky Mountain west he has studied open air sites and rockshelters including bison bone beds and kill sites, bighorn sheep bone beds, camp sites, game traps, seasonal camps, prehistoric landscape use, prehistoric gender roles, high altitude adaptations, landscape distribution of isolated projectile points, and the significance (or not) of continental glaciers to the peopling of North America. This work has been funded by the National Science Foundation, Wyoming Council for the Humanities, Wyoming Cultural Trust Fund, National Endowment for the Humanities, South Dakota Council for the Humanities, Colorado Historical Society – State Historical Fund, and federal and state agencies in Wyoming, Colorado, and Montana (including Bureau of Land Management, Bureau of Reclamation, US Fish and Wildlife Service). Results of much of this work have been documented in 110 technical reports from 1978 to 2016.

Response from Awardee

As Winner of the 10th Suyanggae Academic Award of 2016

Please accept my sincere appreciation for this prestigious and important international archaeology award. I wish to thank SISEC for bestowing such an honor on me. I have been a member of the Suyanggae Family only since 2008 the, joining the 16th symposium in Myazaki, Japan, certainly one of the most recent family members. I am further humbled by the fact that this award was made by such a distinguished group of international scholars. Since that first Suyanggae symposium that I attended I have learned a great deal from all the symposium participants. And I have been privileged to see, what for some qualifies as the Seven (actually many more) Wonders of the World. I will remember forever sites such as Zhoukoudian, Shuidonggou, Saitobaru Mounds, Suyanggae, Kurtak sites, Afontova Gora, Gdansk, Nehewan Sites, and much much more. And a special thanks to Professor Yung-jo LEE. He has been the driving force and an insipiratioin of this important international conference. As important has been his insistence on prolific photographic documentation of all the conferences I will remember the Suyanggae family for a long time to come. I am happy to be a member of the Suyanggae Family and hope to see you all for the 21st symposium in Laramie and at many future conferences, so we can learn and profit from each other's discoveries and studies.

Marcel Kornfeld

Papers

Alphabetical by Author

Post-depositional Processes and Explanation of Hominin Activities at Paleolithic Sites in Korea

Kidong BAE
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Archaeological sites without exception have been transformed after primary deposition resulted by human activities at site. Most of archaeologists aware well post depositional processes in explanation of process of human activities at site since this topic had been discussed intensively in 1960s to 1980s by many distinguished archaeologists. Many Early Paleolithic sites in Korea are very likely transformed heavily. However, it is often found that patterns and pseudo-patterns of stone artefacts observed at sites are interpreted as resulted directly by human activities. Moreover, even if transformation is considered in interpretation of archaeological feature exposed at site, how much time elapsed and how much different from original contexts have been estimated in very few articles.

Heavily transformed contexts in Early Paleolithic sites excavated during the last several decades have been observed in numerous Paleolithic sites in Korea. Comparing to Early Paleolithic site, Late Paleolithic sites are much well preserved in terms of its primary context. There are radically different views on chronological and behavioral interpretation of layers and stone tool assemblages from each layer of sites. In addition, some stone artifact assemblages found even in fine grained layers do not often represent any clear evidence of particular human activities at each locality due to very poor association of artifacts on a single horizon.

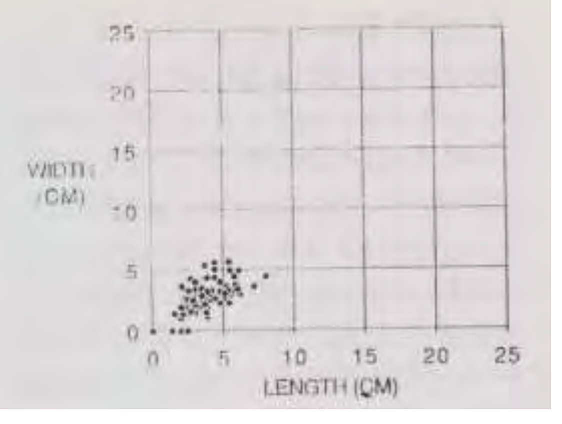
Various contexts of accumulations have been observed at the Chongokni site in the series of excavations at different localities. Loose and dense concentration of stone artifacts in fine clay sediments have been observed, while relatively high concentrations of artifacts were in sandy layers. An isolated big stone boulder was observed without any modification in clay and some cobbles were concentrated on a single horizon. They were clearly transformed contexts through fluvial actions as well as surface water actions and gravity. Concentration of stone artifacts in gravel layers are often observed at many sites in western part of the Korean peninsula, in particular, at some sites in lower reach of the Han river basin in central part of the Korean peninsula. The contexts and condition of artifacts witnessed heavy transformation processes even though they are often classified as a single 'culture' or 'industry' in reports. Patterns observed at the Chongokni site and some sites in the lower Han river basin are expected to provide guiding examples to make better inference human activities from archaeological features by eliminating transformed elements from archaeological contexts under consideration in sites in similar environment as well as sites in other part of Korea.

Geological contexts and patterns of stone artifact assemblages of the Locality II at the Chongokni site

The channel bed of the ancient Hantan river was raised by uplifting tectonic movement of basalt flows during the middle Pleistocene. Fluvial and lacustrine deposits on the top of basalt bed at the Chongokni site are observed at about 30 M above current channel. Stratified sandy deposits at the bottom of sediments in the Locality II indicate relatively strong fluvial action in lower part of basalt bed the locality II while lacustrine deposits were formed by very low energy water at the early stage of sedimentation on the top of the basalt bed. Above these alluvial deposits, thick fine grained clay Aeolian deposits are observed.

Three different patterns of stone artefacts were observed in excavated area of the Locality II; dominance of small artifacts, dominance of big pieces and many small pieces with some big ones. Dominance of small stone artifacts was observed in stone artifacts assemblage found in a dark brown coarse sandy layer of the TPIIIB. This layer was relatively thin and slightly tilted toward south, the direction of hanging valley on basalt cliff. Most of stone artifacts found in this layer are flakes and small pieces except few cores and chunks. Majority of artefacts are shorter than 5 cm and lighter than 50 g in their weight. It is very striking that majority of stone artifacts were oriented in direction of North and South (Figure). It coincided with direction of pebble stream in the layer. From this context where the assemblage was found, the feature does not indicate any human activity at the locality, but it is highly probable that the pattern, dominance of small pieces in a thin horizon of sandy deposit was resulted from sorting by fluvial action when stream stayed on basalt bed.

Orientation of Stone artifacts of TPIII



Size distribution of stone artifacts of TPIII

The second one, dominance of big stone pieces, was observed at several layers in the locality II including TPI and TPIIIA. Stone artifacts found in the two excavation pits showed very wide distribution in their size and weight, from ones smaller than 5 cm to 25 cm and from ones less than 50 g to one weigh over half kilo. They were not concentrated in a thin single horizon but loosely distributed nearby with slight variation in horizontal level. None of pieces in each pit has been conjoined. Notably, stone artifacts from the TPI show wide variation in their size. Stone assemblages from the both pits were found in lower part of fine clay deposits which overly clayish sand. It hardly assumes any particular activities from these stone artifacts compounds, but probably very complicate post-depositional processes had been involved including human activity.

The third one is one found in the LIISI pit which is situated on highest area of the locality II. Size of stone artifacts from this pit varies from shorter than 1 cm to longer than 15 cm, which is a size variation from small spalls to large cobbles. It is very likely tool making activities were taken place at this locality on basis of size variation. However, no clear horizon of dense concentration of artifacts was found even though numerous stone artifacts were found in different levels in the deposit. Artifacts were loosely distributed without any clear associations. Among 3 conjoined sets, distal and proximal pieces of a flake were found in different levels, about 30 cm. These findings indicate some post-depositional process forced the two pieces apart each other even in fine grained clay sediment. Although variation of types and size of stone pieces is more or less relevant to primary context of human activities at the locality, some sorts of transformation were evident from context of stone artifacts. Several different processes can be assumed; moved by surface water action such as rill process and also by bio-turbation such as plant root and earthworm action.

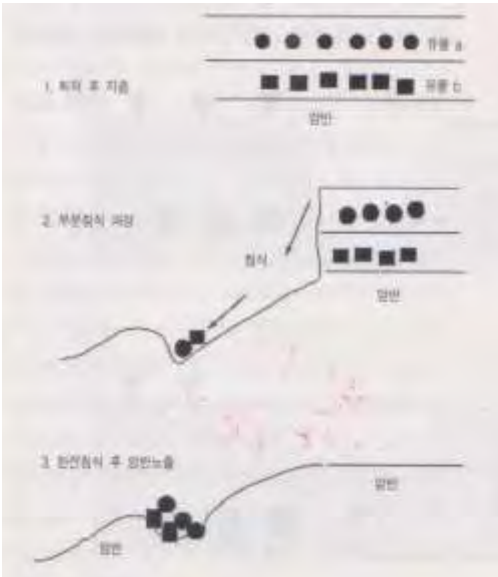
Cases observed at the Chongokni site indicate that post-depositional transformation was taken place even in fine grained sediment that is considered preserve well primary context. A big boulder in fine clay sediment which was absolutely transported by several hominins to the place from nearby active river channel does not have any associated feature in the layer. It clearly indicates associated features of hominin activities disappeared during transformation processes.

Origin of artifacts in gravel deposits at bottom

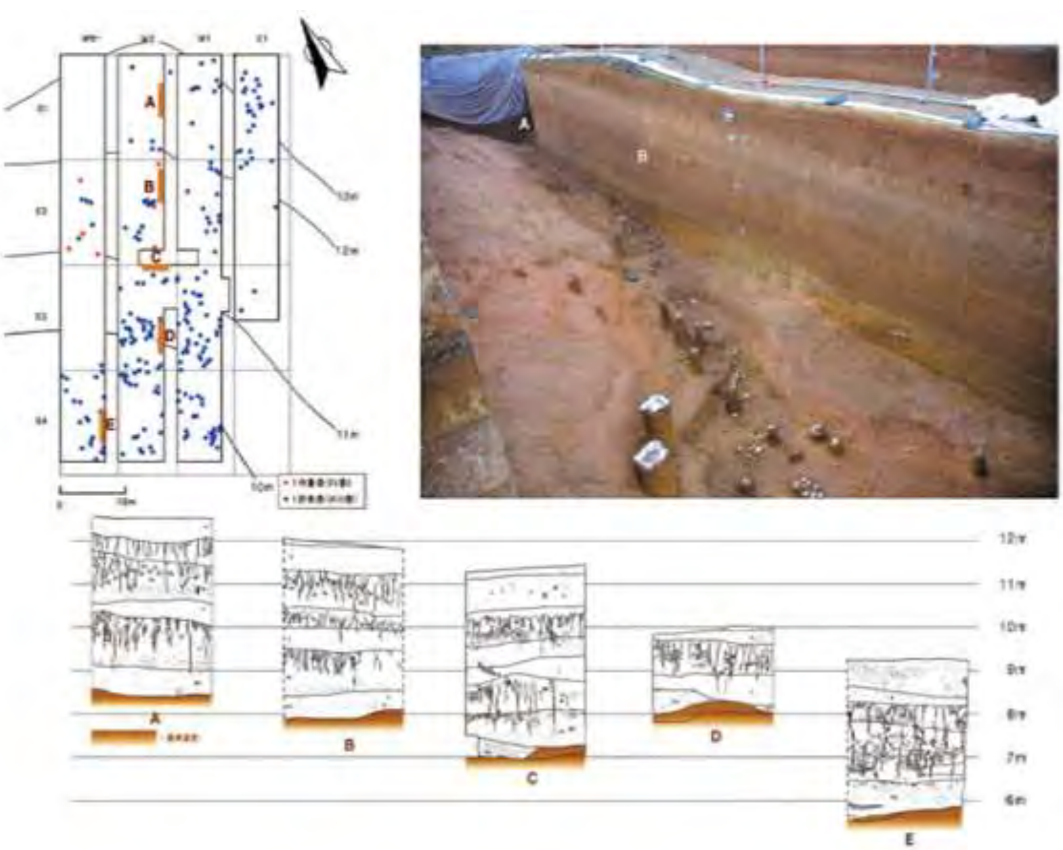
Many stone artefacts, mostly big pieces including bifaces, were retrieved from sandy gravel or gravel layers at the bottom of sediment. It is very common among Paleolithic sites in the lower Han river basin, Kimpo and Paju. In addition sites in this region, similar deposition contexts are observed in sites in central and southern part of the Korean peninsula. These gravel deposits were apparently formed by water flows with high energy. Gravel deposit at the bottom of small valley indicates clearly a remnant of ancient channel bed. Considering some gravel deposits consist of mostly angular gravels with some river gravels, they are clearly mixed origins. Stone artifacts found in the deposits have very likely experienced complicate geological processes for a long time. Some stone artifacts curated couple of times with long intervals between artificial modifications indicate that stone artifacts from a layer were probably not originated from same period. They may have derived from different sediments formed in different time, but no clue for how much different in time. It is assumed that these stone artifacts experienced many different stages of geological erosion from its original primary deposition at sites before which cannot be observed anymore. As blade technology has not been observed in these gravel deposits, they are often claimed 'Middle Paleolithic'. However, real ages cannot be obtained from any chronometric dates of sediments in which they were found. It is not relevant to consider age of sediment as the age of stone artefacts from the layer. Definitely some of artefacts from gravel layers could be much older than the age of formation of the gravel layers.

Artifacts concentrations in depressions

Concentrations of artifacts have been found in shallow depressions formed in very fine grained sediments. They look very much remains of human activity because diverse pieces were concentrated in a single horizon. The most typical



Translocation of stone artifacts in stages of erosion



Stratigraphy and artifact concentration at the bottom on the top of bedrock at the Shingokni site, Kimpo, Korea one was found at the Kumpari site. Large pieces were concentrated in a depression looking similar to those of Neolithic pit dwellings in Korea. There are several different views on formation of such depressions; pit made by tree root, water basin used by animals, ephemeral dam by land sliding, etc. It is less likely that these concentrations were formed by human activities, but rather moved from exposed layers on slope to the bottom of depression. They may have moved from upper part of same deposit, but more often from different layers. Very similar processes can be observed in the Isimila site in Tanzania where all stone artefacts at the bottom of valley were derived from different layers exposed in both sides of the valley.

Implication of observations of post depositional transformations

It is often said that heavy duty components represent early Paleolithic while small tools late Paleolithic. However, continuous processes of erosion and redeposition may result in very different assemblages which had been formed with materials from various sources possibly of different period. And also, they sometimes reduced to quite few in numbers of distorted proportion from normal size variation resulted by human activities, and even single isolated piece at site. Diverse processes of sorting may result in quite different pattern of distribution of artifact size in assemblages excavated from a single locality in a single layer, sometime resulted in dominance of heavy duty components while some other time dominance of small pieces such as occasion of stream of moderate energy. Paleolithic sites in Korea, especially in western part of the Korean peninsula, in most cases have been transformed seriously by erosional processes. In order to reconstruct human activities at the site, special attention to post-depositional processes should be made to avoid irrelevant explanations.

It also needs to be aware very seriously that ages obtained from sediment or other material in the sediment may not represent the age of industry at all. Original deposits from which some stone artifacts were derived do not exist anymore due to erosions occurred long time ago. The gravel layer at the bottom of deposit on bed rocks found in many sites in Korea not only in the lower basin of the Han river, may be a compacted accumulation of materials from different stage of industrial development before appearance of blade or late Paleolithic.

It is very notable that degree of transformation of sites is different between sites on basalt plateau in the Hantan-Imjin river basin and sites on Precambrian Gneiss and granite in the lower basin of the Han river. The two groups may have experienced difference degrees of erosion due to different geomorphological contexts such as condition of slope, relative elevation to channels and drainage systems. Much higher erosions have been observed in sites in lower basin of the Han river, Kimpo and Paju. It is thought that heavy erosions were occurred periodically by climate oscillation during Pleistocene. Heavy concentrated rainfalls in the Korean peninsula after cold period in Pleistocene may have contributed rapid and heavy erosion in especially western part of the peninsula.

It needs to be very careful to explain functions of sites on basis of stone artifacts composition and presence of certain type of tools without understanding post depositional processes involved in contexts under consideration. More experimental and activating observation of geological and biological processes in fields would be necessary for better understanding of archeological contexts of Early Paleolithic in Korea.

Comparison of Tanged Points from Korean and Polish Areas - on the Basis of Two Distant Stone Age Sites –

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The aim of my presentation is to compare two very distant flint industries, which are characterized by the presence of tanged points. In this case I will use the flint materials from two sites: Suyanggae site from Korea (Lee, Kong 2003, 2004; Lee, Woo, Lee, An 2014; Kim, Lee, Woo 2015; Lee, Woo, Lee 2015) and Całowanie site from Poland (Fiedorczuk 2006; Schild 2014). These two sites represent different Palaeolithic cultures, located on the two ends of Eurasia.

Suyanggae complex

The Suyanggae site is located at Aegok-ri, Jeokseong-myeon, Danyang County, Chungbuk Province, by the South Han River (Figure 1). This site was investigated by Chungbuk National University Museum led by Professor Lee Yung-jo, and the work is still ongoing. It is one of the biggest Palaeolithic sites in East Asia. This complex contains over 100.000 lithic artefacts, excavated from three Palaeolithic localities (I, III, VI). In this group, among the others, there are also tanged points.

The biggest assemblage of tanged points was discovered in cultural layer IV from locality I, and in cultural layer IV from locality VI. The first one revealed approximately 60 pieces of tanged points, and the last one revealed over 50 pieces. Layer IV from locality I is dated to 18.600 - 16.400 BP, while layer IV from locality VI is much older, obtained dates are within the range 39 – 44 ka. It seems this can be the oldest layer containing tanged points.

Tanged points from the site Suyanggae, locality I

Between quartz, obsidian and rhyolite the main raw material which was utilized to make these tools was siliceous shale. Most of them were made on blades. The average size of tanged point is: length - 6 cm, width - 2.4 cm, thickness - 8.2 mm. The weight is about 11 g.

Tangs of these tools were formed by direct retouches, and their angles were steep. The classification of Suyanggae tanged points was created on the basis of retouched edges of a points:

I. Tanged points with natural (unretouched) edges (Figure 2)

II. Tanged points with partially retouched edges: a) on the right side, b) on the left side, c) on both sides. (Figure 3)

III. Tanged points with completely retouched edges: a) on the right side, b) on the left side, c) on both sides. (Figure 4)

To the type I belong 50% of tanged point from the site Suyanggae, locality I. Type IIa and IIb are relatively common - about 31%.

The site Całowanie

The site of Całowanie is located in Otwock County, Masovia Province, about 6 kilometers to the right bank of Vistula River, approximately 40 kilometers from Warsaw southwards (Figure 5). The white sandy spots is what remains of a fossil sandy spit of the Vistula as it was in the last interstadial, overlain by a dune formed in the last stadial, and now this area is known as Pękatka Hill. A large rectangular lake, which we can see on the map near dunes, is a man-made reservoir. In the 1970s Pękatka Hill was listed by the Ministry of Culture and National Heritage as an archaeological monument.

The first Stone Age artifacts in area of Pękatka Hill was found by Professor Andrzej Kempisty who led surveys of dunes along the Vistula right bank in 1961. The field works begun in 1962, and the systematic excavations continued over the next eight seasons (1962 – 1969) and in 1983. Excavations were founded by Institute of Archaeology and Ethnology, Polish Academy of Sciences and led by Professor Romuald Schild.

Całowanie site is part of a large complex of the Palaeolithic and Mesolithic sites near Warsaw. The site was used from the period of Final Paleolithic to the early Mesolithic. This site was a hunting camp for the Paleolithic reindeer hunters, seasonally used by Sviderian culture community. This culture covered vast areas of Poland, Lithuania, Belarus and part of Ukraine, and is mainly recognized due to its hunting camps.

Tanged points from the site Całowanie

The site lies on sandy peat subsoil, formed on late glacial fossil Vistula channel. There were done a 13 cuts 22 test trenches and 10 peat trenches. In total, 17 stratigraphic units, or complex beds have been defined.

What is most interesting for this article are the layers III, IVa, V and VI because in these layers there were finds of tanged points. The radiocarbon dates of these levels obtained from different peat trenches and cuts, for the study site, show time interval of occupation between about 12.000 - 9.500 BP for Sviderian culture.

The lithic assemblage contains a few thousands artefacts including cores, flakes, blades, burins, end-scrapers, backed pieces, points, truncated blades, willow leaf, tanged points, and other Final Palaeolithic implements. The most interesting among them are tanged points.

In level III there was only one tanged point which shows very wide tang in comparison to the point. Level IVa provided with two small tools, made from cretaceous flint and represented Lyngby type of tanged points (Figure 6). One of them was made on flake, the second one on a blade. Level V contains thirteen of these types of tools including four of Lyngby (made of cretaceous and chocolate flint), three of Ahrensburgian type (made of cretaceous and chocolate flint) and six of Sviderian (made of chocolate flint).

The level VI which is dated to 10.455 - 9.510 BP provided with a relatively big collection of tanged points and willow leafs. In this level were found very interesting Sviderian types of tanged points (Figure 7, 8). They were subjected to use-wear analysis. Analysis revealed the other function of tanged point besides hunting. This other function is connected with cutting meat, so this described tools could be used like a knives. Most of these tools from level VI were made from chocolate flint. Total number of tanged points in the site Całowanie is more than 25. The artefacts are shown in table below:

Layer	Type (culture)	The number of specimens	Raw material (flint)
IVa	Lyngby	2	cretaceous
V	Lyngby	4	cretaceous / chocolate
V	Sviderian	6	cretaceous
V	Ahrensburg ian	3	cretaceous / chocolate
VI	Sviderian	about 13 (without Willow leaf)	chocolate

Comparison

These two, described above sites have a few similarities and differences in context of tanged points.

First of all, a large number of lithic assemblages with 50 flint workshops for tool production found in Suyanggae locality I, can confirm this open site to be a huge workshop. On the other hand, Całowanie site shows a large number of flint tools, but with only one flint workshop. Besides, these two sites probably were used seasonally. In Suyanggae, surrounding caves may have been used as shelters when the climate was cooler. The seasonal nature of Całowanie site had connection with the movement of herds of reindeer.

A large number of deer bones was found in Gunang-gul cave, in the vicinity of Suyanggae. This discovery can be related to the specific type of usage of tanged points, which was proven in the European lowlands to be used mainly for reindeer hunting. Some use-wear analyses show that they were used as a knife, while the tanged points from Korean Peninsula were used in broader spectrum. It can refer to incidence of much more tanged points in one layer of Suyanggae, than in all layers of Całowanie site. The utilization of tang in Suyanggae site was wide. Some types of tools have a tang, like tanged end-scraper, or tanged point with truncation.

The main difference is the time in which these tools occurred. The Suyanggae tanged point complex is much older than all tools from Całowanie site. The oldest tanged points from Suyanggae locality VI can be dated to about 40.000 years ago, and the main period of usage dates to 18.600 - 16.400 BP, as it is shown by layer IV in locality I. In Całowanie site, the older tanged points exhibit features of Lyngby points. These tools are approximately 13.000 - 12.000 years old, while the younger horizon of tanged points related with Sviderian culture is dated to about 11.000 - 9.500 BP.

Conclusions

Despite of some similarities, these two tanged points complexes represented by the selected sites show two different "worlds". On the one hand - we see the tundra games hunters, and on the other hand - people who lived in highland valley areas, after whom a numerous tool-making workshops remained.

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Figures

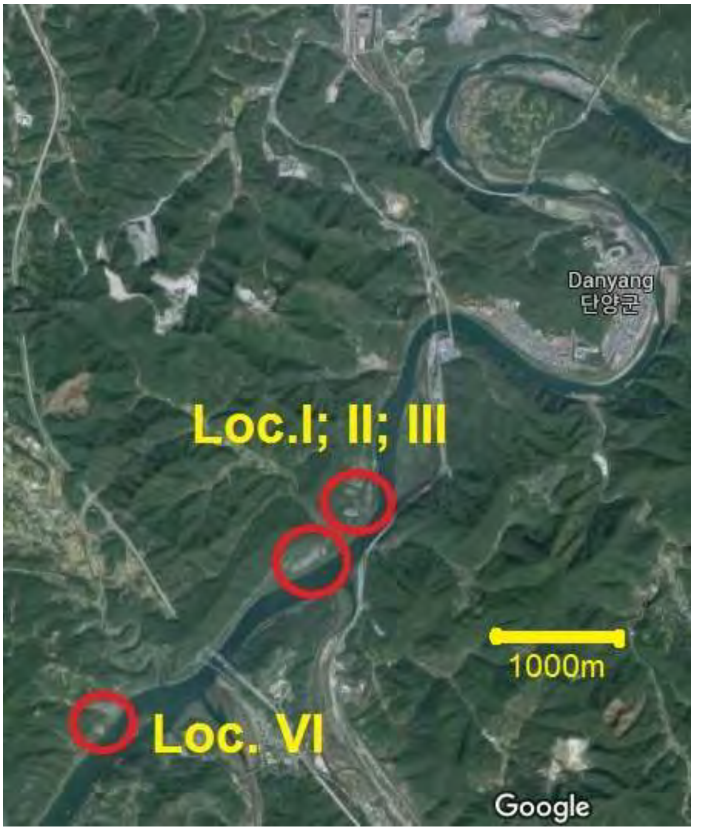

Figure 1. Suyanggae site complex

Figure 2. Suyanggae tanged point - type I (after Lee, Kong 2004).

Figure 3. Suyanggae tanged point - type IIb (after Lee, Kong 2004).

Figure 4. Suyanggae tanged point - type IIIb (after Lee, Kong 2004).

Figure 5. The site Całowanie.

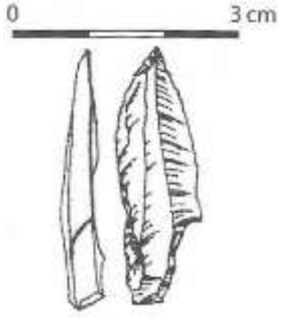

Figure 6. Lyngby tanged point from Całowanie site (after R. Schild 2014).

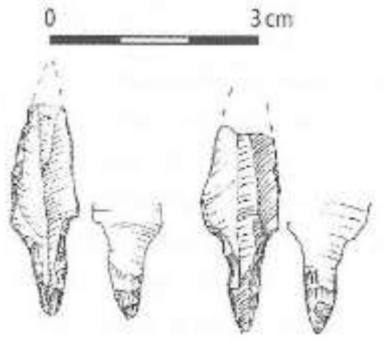

Figure 7. Sviderian tanged point from Całowanie site (after R. Schild 2014).

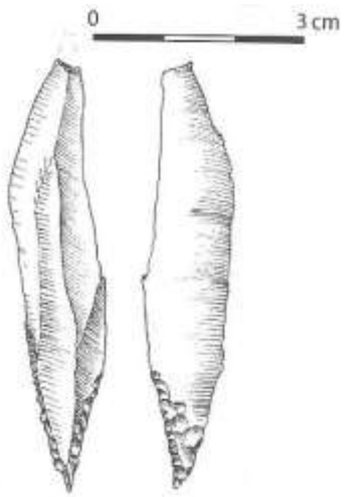

Figure 8. Sviderian tanged point from Całowanie site (after R. Schild 2014).

From Home to Hearth: Expanding on a Model of Tipi Transformation

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Abstract
Stone circles of the North American plains and mountains were the subject of much archaeological research and debate from the 1940s through the 1980s. Although a handful of scholars continued to research this ubiquitous feature from the early 1990s continuing to the present, much of the field's attention has shifted towards other interests. However, stone circle studies are still useful to the field as a whole. The large amount of data that can be gained from the study of stone circle sites is enormous, especially when it is considered that much of this data is obtainable through non-destructive means. For this presentation, I propose one small way in which stone circles can be better understood by expanding upon Finnigan's 1983 model of tipi ring formation.

I suggest that the destruction of stone circle sites, although unfortunate, allows us to further examine the transformational model from tipi to tipi ring and beyond. Specific processes of interest include archaeological context to systematic context transformations as well as archaeological context to archaeological context transformations. In addition to expanding a tipi ring transformational model I also suggest that understanding the driving factors behind the anthropogenic destruction of these stone circle sites could provide better solutions for the preservation of the sites as well as implications for public education regarding these sites.

Change and Continuity: Traditions of Flint Processing from the Perspective of the Tążyna River Basin in Kuyavia, Poland

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The Tążyna river basin is one of the characteristic elements of the north-eastern part of Kuyavia (Figure 1). This region is located in the eastern part of the pre-valley zone of the Polish Lowland, between two pre-valleys: Toruń-Eberswalde to the north and Warsaw-Berlin to the south. The main feature of the environmental context of the Tążyna river valley is its topographically close proximity to two natural niches. The first of them is formed by very fertile black soils, the other – agriculturally poor podzols which are a characteristic feature of the bottom of the valley (L. Domańska, J. Forysiak, S. Rzepecki, and J. Twardy 2013).

The aim of the article is to characterize the development of flint industry related to the Neolithic communities inhabiting the study area in the period c. 5400-3000 BC. The first date marked an appearance of groups of farmers, representing the Linear Band Pottery culture (henceforth: LBK), in the area of black soils surrounding the Tążyna river valley (L. Czerniak 1994; J. Pyzel 2010). The latter date is associated with the decline of intensive colonization of the sandy bottom of the valley by the community of the Funnel Beaker culture (henceforth: TRB) (S. Rzepecki 2015). Also, an attempt will be made to explain a relationship between the flint industry connected with the local Mesolithic communities and represented by the groups of farmers.

Change…

In the area of the middle Tążyna river valley, single Mesolithic artefacts – mainly microliths were discovered at many sites. On most of these sites, remains of Mesolithic campsites were destroyed by the later intensive neolithic occupation, though. The only exception is the site Dąbrowa Biskupia 71. This site indicates many convergences with Maglemose inventories (L. Domańska, M. Wąs 2009).

Quite different situation was observed in the neighbouring Toruń Basin. In this area numerous sites of different Mesolithic cultural tradition have been recorded (L. Domańska 1995). They confirm the constant presence of hunter-gatherer groups in the discussed region during the Boreal and Atlantic periods. Most of the sites yielded thousands of flint artefacts occurring in very unreadable arrangements.

The discussion on the relationship between flint production by the hunters and the first farmers in the region, representing the LBK culture, resulted from the surveys at the site Podgaj 32, Aleksandrów Kujawski commune (L. Czerniak 1994). The site, located in the sandy bottom of the Tążyna river valley, revealed some remains of a small encampment.

Among the artefacts derived from the site Podgaj 32, the following artefacts deserve particular attention (Figure 2): 3 microlithic blade cores, 2 blades, a fragment of a microlithic triangle as well as a retouched blade and flake. These specimens may be deemed as an assemblage of Mesolithic artefacts. The following features of the proposed study assemblage seem to support this option: the local raw material from which they were made, the presence of a triangle, the retouched flake which can be also counted as a Mesolithic side-scraper as well as the retouched blade referring in terms of technology to the cores present in this assemblage. These observations became the basis for the recognition of the study inventory as an example of the cultural changes taking place within the LBK culture. This was associated with an attempt to colonize the sandy areas of the Tążyna river valley and establishing, during this process, some closer contacts with the local Mesolithic population (L. Czerniak 1994; L. Domańska 1995, 2003).

In the hitherto studies (L. Czerniak 1994; L. Domańska 1995; S. Rzepecki 2013), the inventory of flint collected from the site Podgaj 32 was considered homogeneous. The main argument in favour of such an interpretation of the study materials was, among other things, the overlapping ranges of pottery and flint in the area of the site and their planigraphic interdependence with a series of post-holes forming a structure defined by L. Czerniak as a hut (L. Czerniak 1988).

A microwear analysis of the materials described above showed that two of the microlithic cores possess intense traces of secondary use as tools. One of these specimens was probably used for striking a fire (Figure 2: 4) and was mounted on an undefined holder or stored in a sheath made of soft material (K. Pyżewicz 2016). Unfortunately tough, it is not possible to clearly define the user of the tool. Perhaps the artefact was employed for striking fire by a dweller of the study encampment or, alternatively, it might have been abandoned there by an undefined user.

The remaining Mesolithic specimens from the study site seem to show the closest analogies to the site Wilkostowo 23/24 (L. Domańska 2013). The extensive territory of the Funnel Beaker culture settlement yielded a relatively small assemblage of the Mesolithic artefacts, which includes a microlithic core blade, at least one blade, 2 triangles and a microlith with a retouched base. These products can be associated with the Maglemose culture of the Early Mesolithic period (L. Domańska, M. Wąs 2009). Similarly, some small groups of Mesolithic artefacts were discovered in other parts of the Tążyna river valley (L. Domańska 2003). All these findings point to an intensive penetration of the Tążyna river valley bottom by the communities representing the Early Mesolithic period.

Given the foregoing observations, the hypothesis stating that the LBK culture community, that colonized the Tążyna river valley, utilized the experiences of the local Mesolithic groups in the flint working, does not seem plausible. The Mesolithic group of artefacts obtained from Podgaj 32 suggests that the Early Mesolithic hunters had a relatively short presence at the study site – which occurred before the groups of farmers representing the LBK culture appeared there. The latter communities, presumably, did not use flint tools. If they did – it must have been a very small collection of products – limited to barely a few flakes produced from local raw materials.

Flint industry existing in the community of the LBK culture can be exemplified by the two inventories coming from the classical long-term settlements located in the area of the black soils, near the edge of the Tążyna river valley, and these are: Grabie 4 – representing the oldest sites of the LBK culture in the Polish Lowlands (about 5400 BC) and Przybranowo 3, dated to about 5000 BC (L. Czerniak 1994; J. Pyzel 2010).

The inventories of the study sites show a different structure of raw materials. In the case of both of these sites, the raw materials imported from southern Poland to the Lowlands prevail, however, they differ in terms of the structure of the imports. Considering the matter of materials from the site Grabie 4, a presence of artefacts made from Jurassic flint is clearly distinguishable (41.3% of all specimens). In turn, the site Przybranowo 3 is distinctive by its high share of artefacts made from chocolate flint (over 75%).

In terms of technological structure, both inventories are close to each other. The group of flake core exploitation prevails, the least numerous is the group of blade core exploitation and the products of splintering technique occupies a middle position here. It should be noted, however, that the quantitative share of the groups associated with the classical core exploitation would rise substantially if the group of tools would be included. The blade and flake tools clearly dominate in this group. The splintered-based tools were recorded only in the inventory of Przybranowo 3 and these specimens comprised of not more than just over 4% of all the tools.

At both sites, the largest group of artefacts consist of tools (Figure 3-4) – which cover almost half of all the specimens (Grabie 4 – 49.4% and Przybranowo 3 – 45.5%). Among the tools, atypical tools prevail. In the inventory from the site Grabie 4, they represent over 50% of all tools and in the materials obtained from the site Przybranowo 3, the ratio for these specimens exceeds 80%. This group of tools is formed out of the atypically retouched blades and flakes. The group of typological tools is dominated by end-scrapers and truncated blades.

To sum up the comparative analysis, it is worth re-emphasizing the elements linking the two inventories; these are: (1) a clear prevalence of products made of imported raw materials; (2) a dominance of classical methods of core exploitation; (3) a clear advantage of atypical tools over conventional ones; (4) a dominance of end-scrapers and truncated blades in the group of conventional tools.

… and continuity

C. 4200 BC – the area of the Tążyna valley became inhabited by the communities of the TRB culture, which were using this territory quite extensively throughout the next millennium (4000 – 3000 BC). The intensity of this settlement can be evidenced by, among other things, a high number of sites (more than 150) and the emergence of the first stable forms of settlement in this area (S. Rzepecki 2015). The remains of the oldest settlements of the population representing the TRB culture in the valley of the Tążyna river was discovered at the site Przybranówek 43 (L. Czerniak, A. Kośko 1993; L. Domańska, S. Rzepecki 2001).

A specific feature of the flint inventory from this site is a position of chocolate flint. Artefacts produced from this raw material made up over 70%

of all the artefacts. This proportion concerns the raw material structure supplemented with, most probably, overheated specimens.

The products of classical methods of exploitation (blade and flake ones) definitely prevail in the analysed inventory. The rate for the group of splintering technique only slightly exceeds 10%.

Totally, 232 tools were identified, which make up 22.2% of the inventory (Figure 5-6). Within this group, specimens made from chocolate flint decidedly prevail: 158 tools – which makes up for 68.1% of the group. Actually, the index was even higher. It seems to be indicated by numerous overheated specimens from among which some were probably made from chocolate flint. Tools made from local Baltic flint only occupy the third place, 33 such specimens were distinguished. Moreover, 1 example of a tool of Jurassic flint from the Cracow area and 1 tool of Volhynian flint were recognized.

The group of tools was divided into two subgroups. The first of them includes conventional tools. It includes 81 specimens. Among them end-scrapers (37 items) and truncated blades (26 items) prevail. The other group includes the so-called atypical specimens. They are atypically retouched blades, flakes and products of splintering technique, as well as some specimens with traces of use in the form of the so-called use retouch and polish. This group of tools decidedly prevails at the site. 151 of such specimens were distinguished, which makes up 65.1% of the tools group.

Flint materials from the site Przybranówek 43 continue traditions of the Early Neolithic model of the flint production. This is indicated by the flowing characteristics of the study inventory: (1) a clear preponderance of artefacts made from chocolate flint; (2) a dominance of classical methods of core exploitation; (3) a clear predominance of atypical tools over conventional tools; (4) a dominance of end-scrapers and truncated blades in the group of conventional tools.

Quite soon after the encroachment of the first settlers of the TRB culture in the Tążyna river valley, the analyzed communities introduced modifications in the Early Neolithic model of the flint industry (L. Domańska 2013). Probably, it is associated with the period of 4000 – 3800 BC. The main purpose of this modification was to better adapt the flint processing to the local conditions in the Lowlands. This is primarily observed in the wider use of the local raw material – Baltic flint and the splintering technique in processing the aforementioned raw material. The result of this process was a development of the Late Neolithic model of flint industry.

This process is evidenced by the flint materials obtained from the two settlements situated in the middle section of the Tążyna river basin, representing the TRB culture: Poczałkowo 38 (Figure 7) and Wilkostowo 23/24, Aleksandrów Kujawski commune (Figure 8-9). One site is dated to the period 4000-3800 BC, and the other one to c. 3500 BC (S. Rzepecki 2004, 2015; L. Domańska 2013). The most important features characterizing the flint production in the case of both settlements include: (1) decided predominance of artefacts made of local Baltic flint, the share of products of this raw material exceeds 70%; (2) an advantage of the products of the splintering technique over the products of classical methods of core exploitation; (3) distinct predominance of atypical tools over conventional ones; (4) permanent presence of end-scrapers, truncated blades, blades with continuous retouch made of Volhynian flint and projectile points in the group of conventional tools.

Conclusions

To sum up the characteristics of the flint industry of the inhabitants of the Tążyna river valley in the period 5400-3000 BC, it should be emphasized that:

1. The LBK culture community which colonized the Tążyna river valley about 5400 BC did not utilize the experiences of the local Mesolithic groups in the flint processing.

2. An adaptation of flint production to the range of raw materials accessible in the Polish Lowlands led to the development of the Late Neolithic model of flint industry (L. Domańska 2013). This model was characteristic not only among the communities of the TRB culture but also in other Late Neolithic groups inhabiting the Polish Lowlands.

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Figures

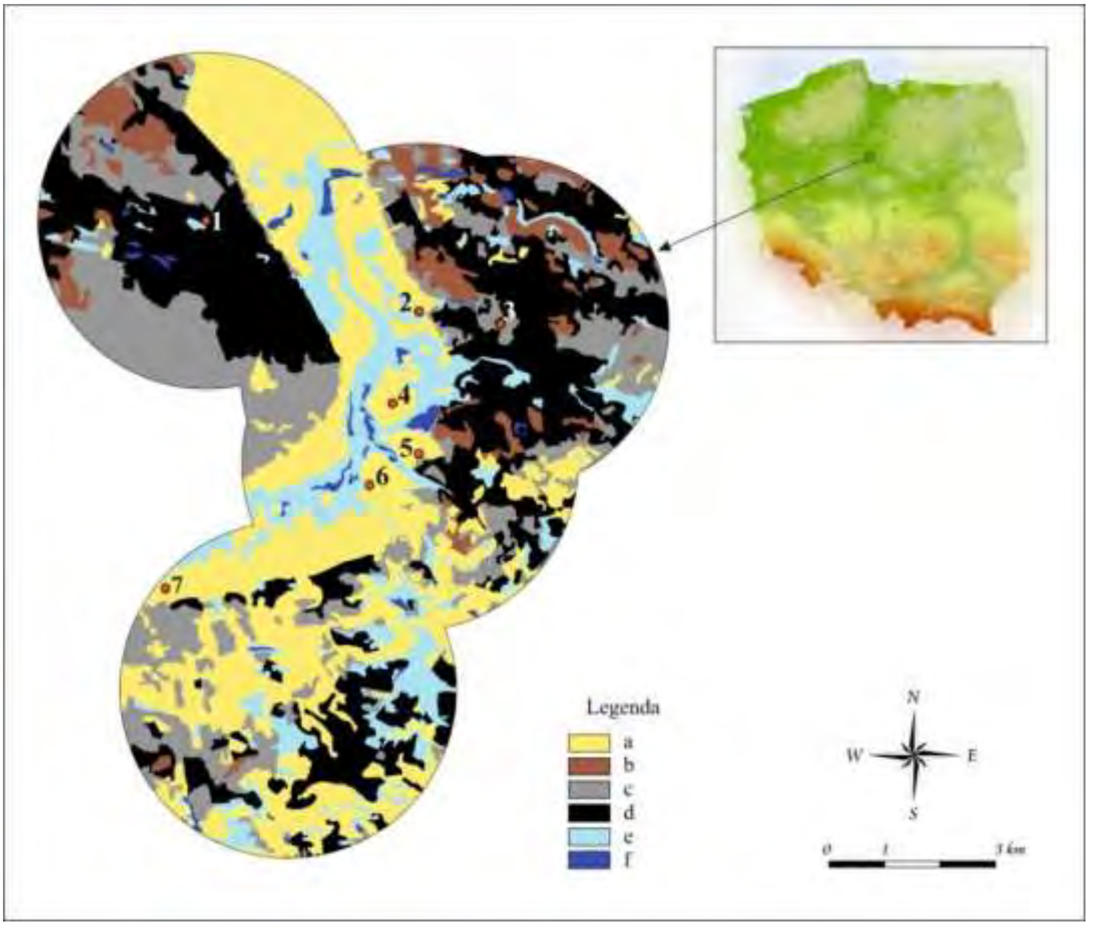

Figure 1: The location of discussed sites in the middle part of the Tążyna river valley: 1 – Grabie 4, 2 – Podgaj 32, 3 – Przybranowo 3, 4 – Poczałkowo 38, 5 – Przybranówek 43, 7 – Dąbrowa Biskupia 71. Soil types in the area of sites: a – podzols soils, b – brown soils, c – luvisols, d – black soils, e – fluvisols, f – waters (after S. Rzepecki 2013).

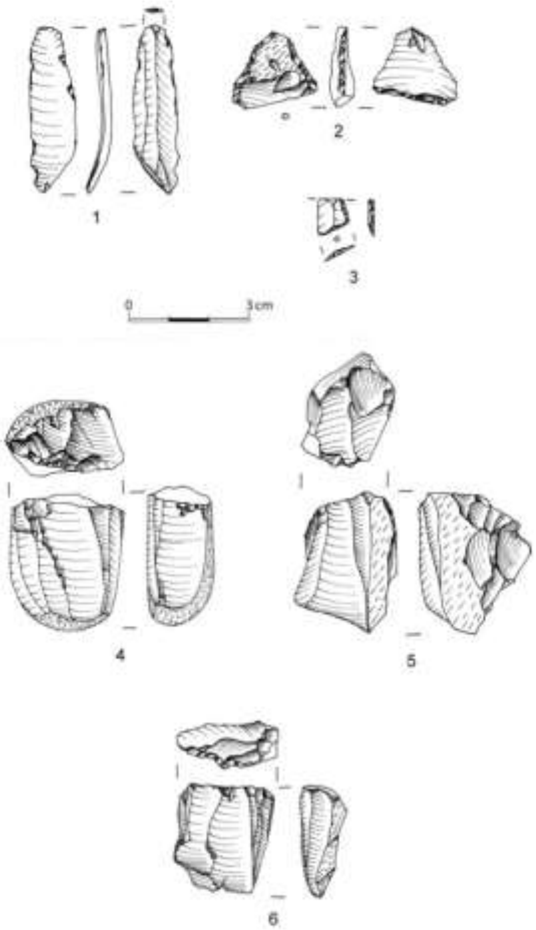

Figure 2: Podgaj 32. Blade with use retouch (1), flake retouched (2), triangle (3), blade cores (4-6). Baltic flint (1-6).

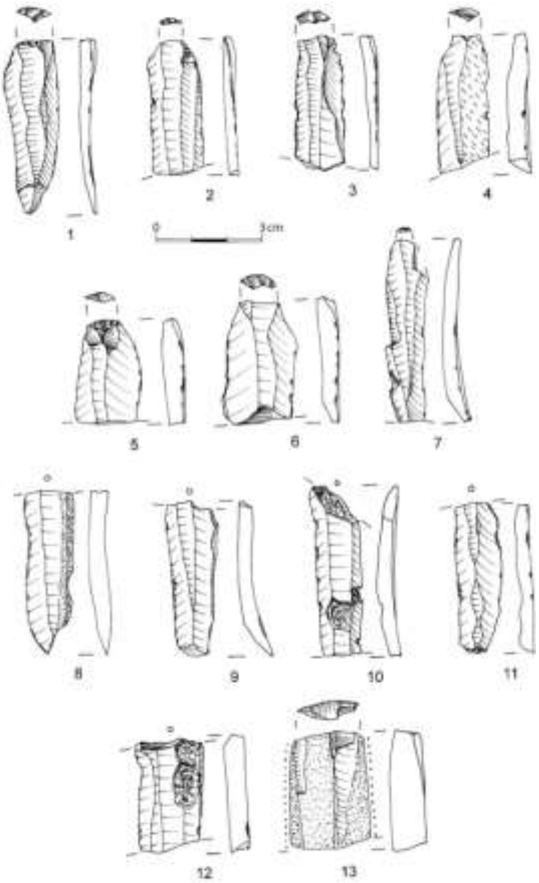

Figure 3: Przybranowo 3. Blades with use retouch (1-12), blade with polish (13). Chocolate flint (1-2, 5-11, 13), Baltic flint (3-4), Burnt (12).

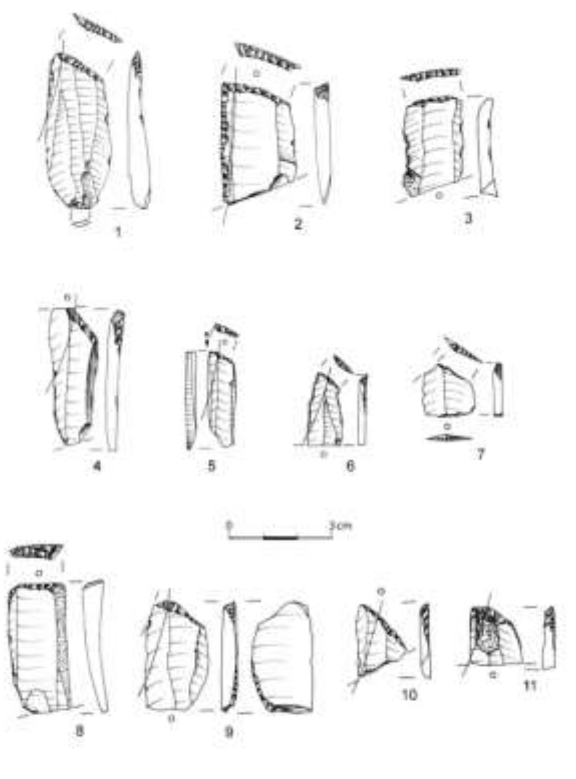

Figure 4: Przybranowo 3. End-scrapers (1-6), flakes retouched (7-8), flake micro-retouched (9), core (10), splintered piece (11). Chocolate flint (1-4, 6-11), Baltic flint (5).

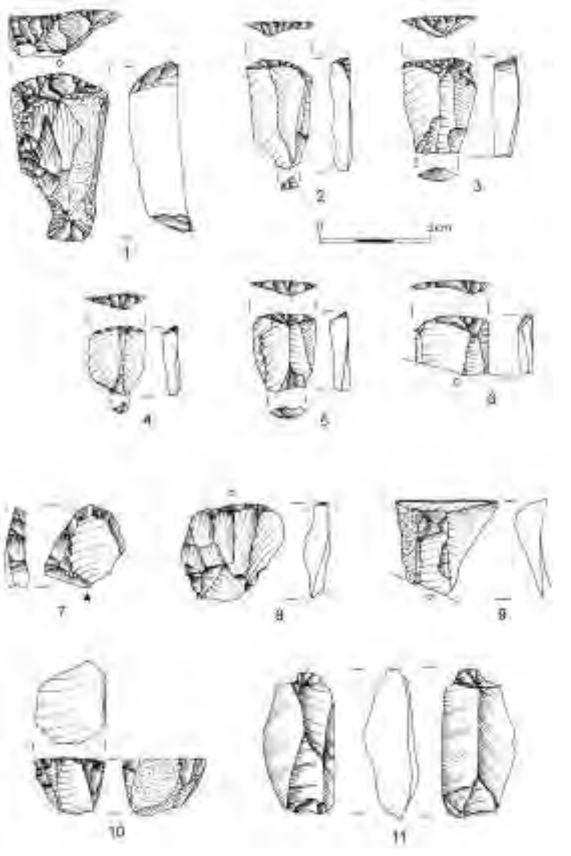

Figure 5: Przybranówek 43. Truncated blades (1-11). Chocolate flint (1-9), burnt (10-11).

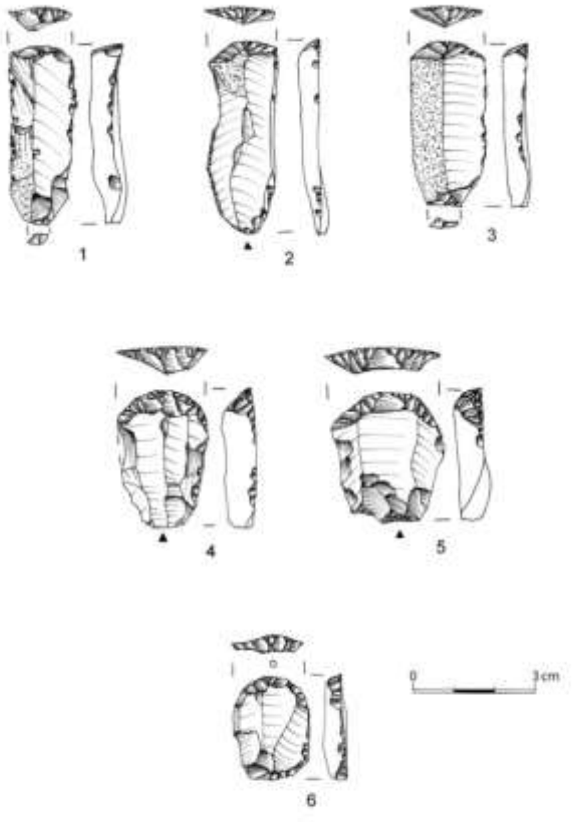

Figure 6: Przybranówek 43. End-scrapers (1-6). Chocolate flint (1-6).

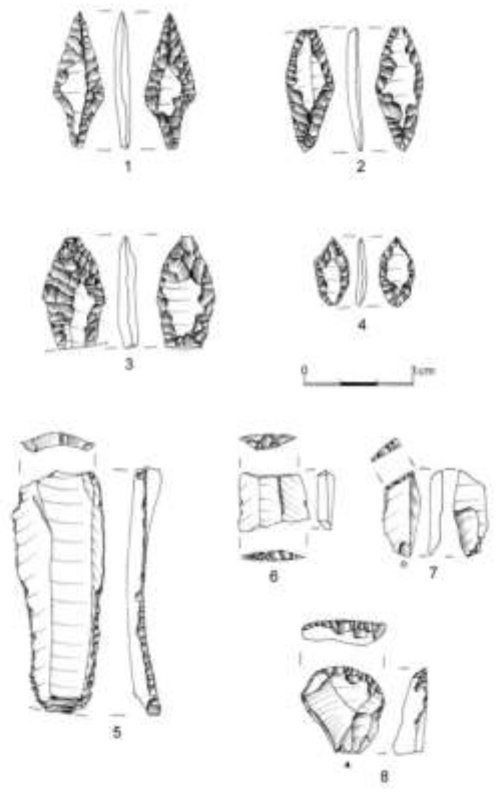

Figure 7: Poczałkowo 38. Projectile points (1-4), blade with continuous retouch (5), truncated blades (6-7), end-scraper (8). Baltic flint (1-4, 6-8), Volhynian flint (5).

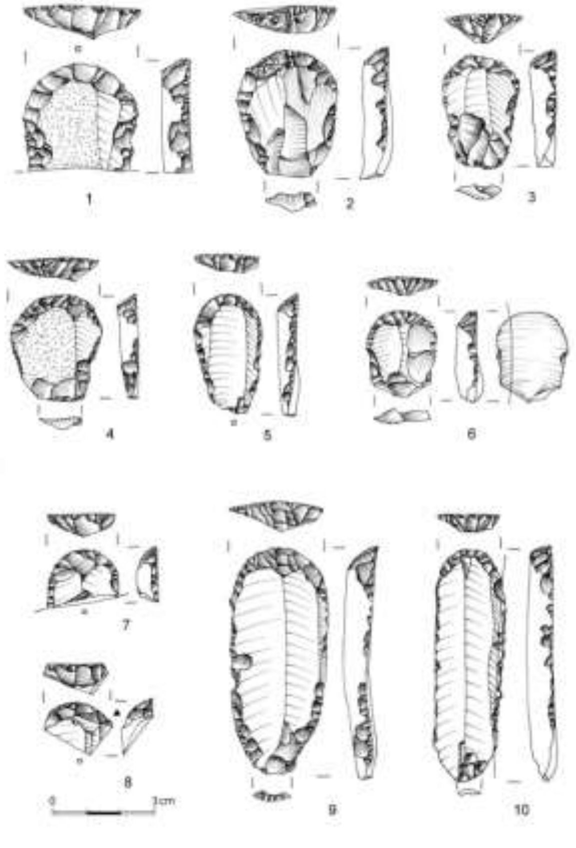

Figure 8:. Wilkostowo 23/24. End-scrapers. Volhynian flint (1-10).

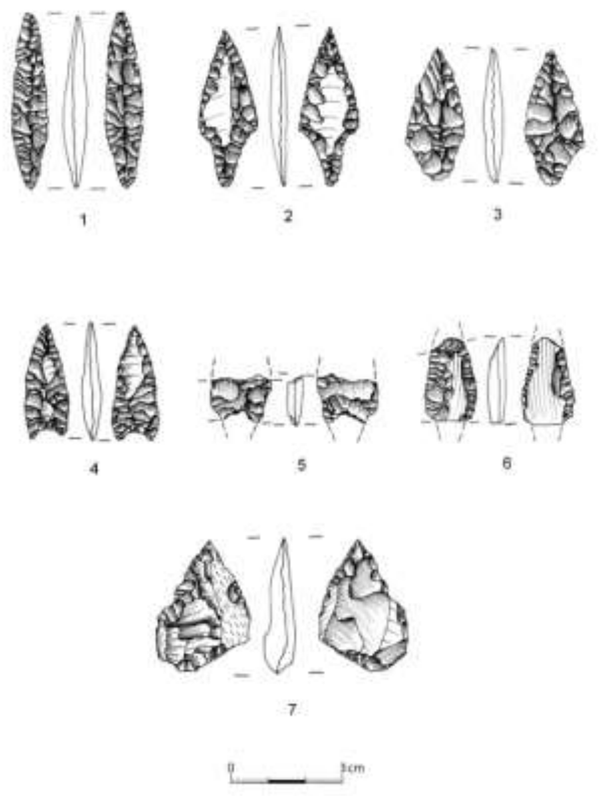

Figure 9: Wilkostowo 23/24. Projectile points (1-6), half-finished projectile point (7). Volhynian flint (1-2, 6), Baltic flint (3-5, 7).

The Powars II Site: Red Ocher, Tool Stone, Early and Late Paleoindian Procurement Activities on the High Plains of North America

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The Hartville Uplift in southeast Wyoming was the location of the largest iron ore (hematite) deposits west of the Mississippi River. The Sunrise Mine from 1900 until it was shut down in 1980, was the major source of iron ore for the Colorado Fuel and Iron blast furnaces in Pueblo, Colorado. Sunrise, Wyoming immediately adjacent to the Sunrise Mine, was a well-developed town with good schools, stores and community services (Figure 1).

Wayne Powars was an artifact collector from Greeley, Colorado who was hired by Dr. Frank H. H. Roberts from the Smithsonian Institution in Washington DC, as part of the excavation crew at the Lindenmeier, Colorado Folsom site from 1935-1937. In 1939, Powars was hired as a teacher and coach at Sunrise, Wyoming. He was later drafted into the military and spent his military service in Washington, DC.

In 1980, Mr. Powars brought a collection of Paleoindian artifacts to Dr. Dennis Stanford, the Paleoindian Curator at the Smithsonian. Powars claimed he had found them along the railroad right of way between Sunrise and the town of Hartville, a distance of about 1.5 km. Searching the area proved unproductive but in 1986, Mr. Powars returned to the area for a school reunion and discovered the site location to be in danger of immediate destruction by Abandoned Mine Land Reclamation work. Strangely enough it had been overlooked by professional archaeologists hired by the agency in charge of the reclamation work and only immediate action by Federal and State officials managed to halt further reclamation work.

The Paleoindian artifacts were apparently eroding out of a meter or more thick deposit of unconsolidated mine tailings resting on a steep slope and an extremely unlikely camping spot (Figure 2). The only conclusion we could immediately envision was that the deposits were the result of digging for red ocher. Artifacts eroding out of the deposits and resting on the steep talus below closely duplicated those recovered earlier by Mr. Powars (Figure 3). A small test into the mine tailings confirmed our conclusions but before any proposal for future investigations could be made, the land status changed and it reverted to private ownership with a landowner unsympathetic to research. This situation remained unchanged until 2012.

A survey of the site area in 2013 convinced us that railroad, mining, and building construction had disturbed the Paleoindian deposits and caused them to move downslope. In 2014, we initiated a salvage program to recover diagnostic artifact material well aware that they were out of context. We were surprised by the amount of diagnostic artifact material recovered that, in quantity, was dominated by Clovis. Except for Clovis, all of these could be identified by type to those recovered in stratified and dated components at the nearby Hell Gap Site 48GO305 (Figure 4).

We had underestimated the amount of material that had moved down the talus slope and came to rest adjacent to the railroad bed so that salvage operations required most of the 2014-2015 field season. However, a random back hoe trench on the opposite side of the valley from the red ocher deposits revealed a large and completely unexpected source of high quality chert and quartzite unrelated to those known and recognized from the better known geologic formations in the Hartville Uplift (Figure 5). The 2016 site work should complete salvage connected with the red ocher deposits and better define the tool stone source that appears to somehow be related to an iron ore source.

We think a large part of the Paleoindian mine tailings are still undisturbed and, in addition, some are probably covered by mine tailings from recent mining. In addition, we think the possibilities are high for deeply-buried and undisturbed cultural deposits throughout the area that will most likely be exposed only by a long term and well-funded testing effort

Figures

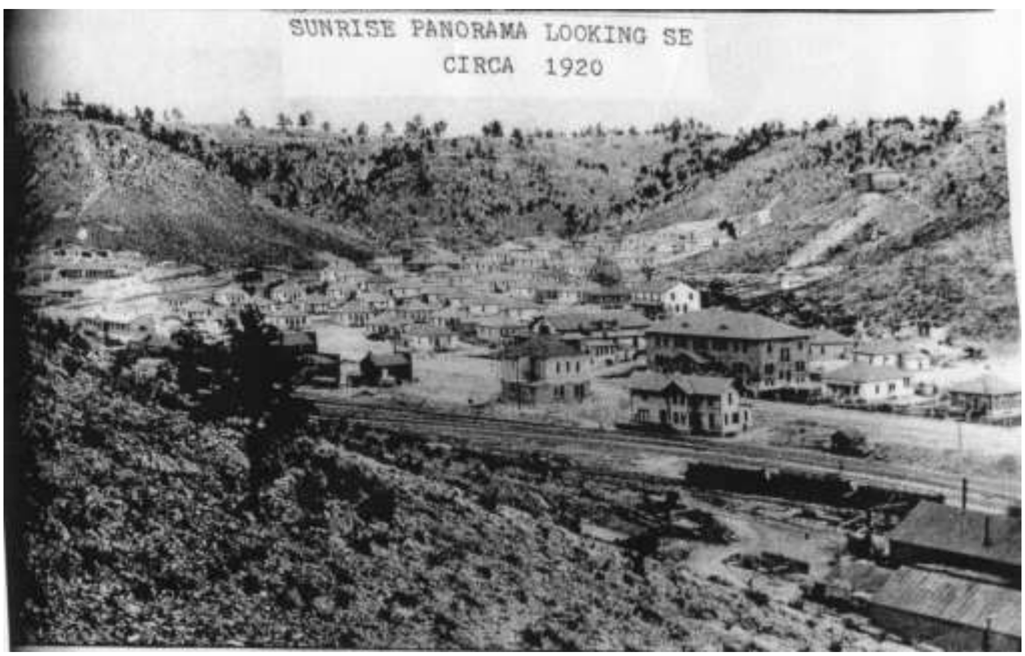

Figure 1. The town of sunrise in its heyday.

Figure 2. Sunrise mine prehistoric site (arrow)

Figure 3. Selected artifacts from the Wyne Powars collection.

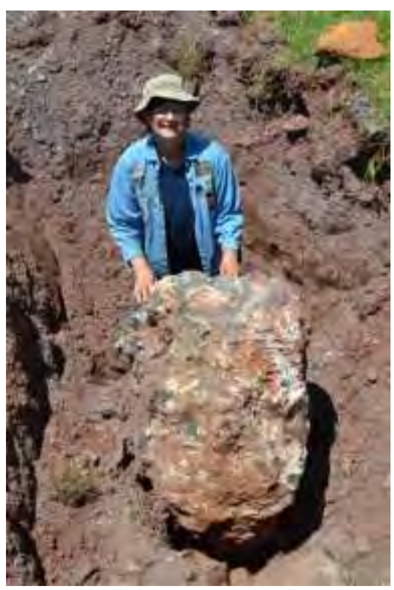

Figure 4. Chert material recovered from valley bottom.

Behavioral Ecology, Technology, and the Organization of Labor: How a Shift from Spear Thrower to Self-Bow Exacerbates Social Disparities

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Abstract
Self-bows replaced spear throwers as primary terrestrial hunting weapons on nearly all continents at different time periods throughout human prehistory. Many scholars have debated whether this transition occurred because of a shift in resource exploitation towards smaller fauna or because of the bow's supposedly superior performance in warfare. Before causal hypotheses explaining this technological shift can be tested, performance characteristics of atlatls versus bows must be well understood. Studies of performance characteristics often address topics such as the range, accuracy, or maintainability of weapons systems, but this study quantitatively compares the learnability of each weapon. Learning curves for spear throwers and bows are established using contemporary data generated by archers from the Society for Creative Anachronism and atlatlists from the World Atlatl Association. The hypothesis that spear throwers are easier to learn and can be wielded effectively by a wider segment of human populations than bows is supported. Implications for the organization of labor are contextualized in light of socioecological changes generally characterizing the conditions under which shifts from atlatl to self-bow technology occurred in prehistory.

One globally relevant example of prehistoric technological change is the shift from the spear thrower to self-bow as primary terrestrial hunting weapons (Cattelain 1997; Blitz 1988; Hughes 1998). Most archaeologists hypothesize that this technological transition occurred because of changes in subsistence practices, social organization and/or warfare, or some combination of these factors.

In order to test these alternative causal hypotheses, atlatl and bow performance characteristics must first be well understood. Performance characteristics obviously include the inherent qualities of each weapon (such as accuracy, range, velocity, and penetration), but also the strength, dexterity, and weapons proficiency required to successfully wield projectiles at their intended targets. In this paper, I focus on one generally neglected but significant performance characteristic of bows and atlatls: the learnability of each weapon. It is debated whether atlatls are easier to learn and/or more accessible than bows. However, no long-term longitudinal studies comparing atlatl and bow skill acquisition exist.

The purpose of this research is to quantitatively establish the shape of the learning curve for each technology in order to test which is easier to learn how to use, and to explore potential social implications of this widespread technological change. To do this, pseudo-experimental data from contemporary atlatlists and archers participating in the World Atlatl Association (WAA 2015; atlatl) International Standard Accuracy Contest (ISAC) and the Society for Creative Anachronism (SCA 2015; open handbow) Inter-Kingdom Archery Competition (IKAC) were compiled and analyzed in order to determine whether maximum atlatl or bow skill is approached more rapidly within a large sample size of users. Adult data are considered in cross-sectional and longitudinal analyses and juvenile data are examined in a separate, cross-sectional analysis.

Theoretical Background

The shift from atlatl to bow as primary terrestrial hunting weapon occurred on nearly all continents at different times throughout prehistory, with few exceptions. Bows never gained widespread importance in Australia, even though the technological system was apparently known in northern portions of the continent (Mason 1928:292). Early ethnographic work considering Australian Aboriginal projectile technology commonly assumed that the bow is technologically superior to atlatls in all respects, and hence the "degraded, or rather extremely backward, Australians use the spearthrower [because they are] ignorant of the bow" (Mason 1928:292). This diffusionist argument suggests that bows replace spear throwers simply because they are better. But if this were the case, Australian cultures would not have retained spear throwers as primary hunting weapons after exposure to knowledge of archery.

In recent years, the diffusionist approach has declined in favor of the notion that every technology is characterized by its own costs and benefits which vary depending upon the task at hand (Cundy 1989:8-10, 124-126, Shott 1993:437-8). In general archaeological theory, this notion is captured by Michael Schiffer's (2001) concept of *application space.* According to Schiffer (2001), any given technology's application space consists of all the tasks which that technology could possibly be used for. Many different forms of projectile technology, for example, could potentially be used for hunting large game or small game, terrestrially or in aquatic environments, by groups of hunters or by single hunters working alone. Though atlatls or bows could be employed to complete any of these tasks, one technology's application space will inherently be better suited to each particular circumstance given the complex combination of social, environmental, and task-specific variables surrounding its use in that context.

Performance Characteristics and Application Spaces

The discrete advantages and drawbacks of bow and atlatl technology are frequently summarized as hypotheses or assumptions but rarely quantitatively tested (Table 1). There is general consensus that atlatls may be superior to bows when taking down large game because of the increased force, shock and hemorrhaging that darts cause as compared to arrows within their presumed application space of medium to large game hunting at short- to mid- range (e.g. Bergman 1993; Bergman et al. 1988; Churchill 1993). However, since atlatls are less accurate than bows and have a slower reload rate, favorable atlatl performance may be limited to group hunting scenarios (e.g., Bettinger 2013).

Bows may be superior to atlatls when targeting smaller, faster prey because they are more accurate than atlatls and have a more rapid reload rate (Bergman 1993; Bettinger 2013; Churchill 1993) and may be better suited to hunting alone (Bettinger 2015:44-8). It has also been suggested that bows are more versatile than atlatls, offering more “flexibility of use contexts” (Yu 2006:209).

This brief summary of bow and spear thrower performance characteristics indicates that neither technology emerges as superior in every application space. However, if bows are truly more accurate, reliable, and versatile than atlatls, they would seem to be superior weapons in more situations than they are inferior. But this conclusion hearkens back to hundred-year old diffusionist arguments that bows are simply better, and does not explain why some cultures that must have been exposed to bow technology did not always immediately adopt it.

As mentioned earlier, most studies of bow and atlatl performance characteristics focus on the inherent qualities of the weapons themselves, neglecting to consider that functional weapons are wielded by capable individuals of various ages, sexes, strengths, dexterities, and skill levels. Hence, a weapon’s costs and benefits are also influenced by whether a group’s current social organization and demographic composition suitably furnishes an adequate number of individuals capable of wielding projectile weapons effectively enough to complete a successful hunt, within that hunt's actual or anticipated application space.

Juvenile Development and Subsistence

Analyzing learning curves for bows and atlatls requires some understanding of the context in which projectile technologies and subsistence behaviors are learned in hunter-gatherer societies. In cultures where the use of projectile technology is embedded in subsistence behaviors, children tend to learn atlatl or bow-wielding skills throughout years of behavioral, cognitive, and physical development (MacDonald 2007). Ethnographic, experimental, and anecdotal data indicate that children begin participating in food acquisition behavior and learn to use hunting technologies long before physical maturity.

Juveniles in many if not most non-industrial settings are economic producers, but it is widely recognized that age, strength, and size play important roles in juveniles' effectiveness at performing subsistence-related tasks (e.g. Bock 2006). In societies where juvenile labor is valued as a form of economic production, learning, manufacturing, processing, and/or foraging tasks are often embedded into adult activities (Gaskins and Paradise 2010:92-3) but vary depending on age-related capabilities. Juveniles may preferentially target different resources or use different foraging strategies than adults. Regardless of the locally-specific resources involved, juveniles' time allocation to subsistence behaviors generally aims to maximize age-specific return rates (Blurton Jones 1994; Blurton Jones, Hawkes, and Draper 1996; Hawkes, O'Connell, and Blurton Jones 1995). Existing literature suggests that hunter-gatherer children begin gathering as early as 1.5-5 years old, generally before they begin to hunt (MacDonald 2007:394; Kaplan et al. 2000:159-160), often focusing on low-ranked resources such as such as shellfish (Bird and Bliege-Bird 2000, 2002; Bliege Bird and Bird 2002), tubers (Tucker and Young 2005), or lizards (Bird and Bliege Bird 2005).

Scholars generally imply that atlatls can be used effectively by young juveniles, perhaps between 6 and 12 years old (Cattelain 1997:219; Whittaker and Kamp 2006:220), but this is based on pseudo-experimental rather than ethnographic data. Informal reports from contemporary atlatl users also anecdotally suggest that juveniles as young as 7 are sometimes capable of killing deer with this weapon (Crable 2007). Ethnographic evidence from bow-hunting cultures suggests that bows are generally not used to take down highly ranked prey until juveniles possess the strength and dexterity required to shoot adult-sized weapons, perhaps around age 10-15, though children often begin practicing with smaller, weaker bows at much younger ages, targeting low-ranked prey such as small mammals and birds (Blurton Jones and Marlowe 2001:217; Cattelain 1997:227; MacDonald 2007:294; Walker et al. 2001:642).

In sum, our understanding of juvenile subsistence behaviors, including archery and atlatl skill acquisition, is currently incomplete. However, the limited information available suggests that at least some children are capable of taking down large prey with atlatls before the age of ten in contemporary contexts. In general, children embedded into foraging cultures may begin bow-hunting at young ages, but do not appear to target the same prey in the same contexts as adults until they are able to shoot adult-sized bows effectively, after age ten. Taken together, this information suggests that children may be able to acquire resources from similar application spaces as adults at younger ages with atlatls than they are with bows. However, existing data alone are not strong or complete enough to actually test the hypothesis that atlatls are easier to learn.

Projectile Technology and the Sexual Division of Labor

Males are consistently reported to perform significantly better than females in sex-based assessments of ballistic skill, throwing velocity, and accuracy in Western and Asian cultures, regardless of age group, even while correcting for differential recruitment of males and females (Duffy, Ericsson, and Baluch 2007). However, it is unclear whether sex-based disparities in ballistic (and hence projectile weaponry) skill are primarily biological or related to processes of enculturation and opportunities for practice (Thomas et al. 2010).

One study of throwing skill and velocity among Australian Aboriginal girls and boys found that the sex disparity in throwing was significantly narrower in Aboriginal Australian children than in American children, and that "many girls could throw as effectively and efficiently as boys" (Thomas et al. 2010:440). Incidentally, the authors hypothesize that historic reliance on hunting in Australia (using, for example, throwing sticks or spear throwers) would have supported a culturally relative emphasis on female throwing skill that continues to be perpetuated within contemporary Australian Aboriginal societies (Thomas et al. 2010:434). Historically, Alyawara women occasionally hunted kangaroo (a relatively large game animal in Australia) with dogs and firearms (Denham 2014:22-3; Denham 1971:14; Denham 1972:8-9), but I am unaware of any ethnographic accounts of Australian Aboriginal women hunting with spear throwers.

The ethnographic record indicates that among known hunter-gatherer groups, archery is generally a male-dominated activity (Deaner and Smith 2012), although many Agta women hunt (Estioko-Griffin 1986). Several experimental studies indicate that males perform significantly better than females in target or distance archery (Beer, Fleming, and Knorr 1989), presumably due to sex-linked biological differences. For example, arm muscle strength is positively correlated with archery achievement (Humaid 2014).

At present, contemporary data suggest that a sex gap in strength, dexterity, and ballistic skill exists. Males tend to outperform females in experimental measurements of ballistic skill. Ethnographically, men utilize both bows *and* atlatls more often than women. Processes of enculturation and opportunities for practice undoubtedly enhance the apparent magnitude of this gap in many cases, but a biological component appears to remain even when correcting for differential opportunities for practice. Therefore, between atlatls and bows, the easier weapon to learn and use would inherently increase the proportion of *potential* female hunters in any given population.

Methods

To construct the learning curves used in this study, score data were compiled from contemporary bow and atlatl competitions. The atlatl competition is called the ISAC and the bow competition is called the IKAC. In the IKAC, bows must be consistent with pre-17th century technology in looks and construction (Society for Creative Anachronism 2003).

These datasets are long-term (up to eight years) and longitudinal, following a large sample size of competitors. The competitions are both standardized, but scored differently. The atlatl competition strictly measures ability to hit a target while the bow competition measures some combination of speed and ability to hit a target. My analysis operates under the assumption that each competition adequately measures atlatl or bow proficiency in a manner appropriate to each weapon's unique application space. Rapid reload rate is considered an advantage of hunting with bow technology but is presumably not a limiting performance characteristic of atlatl hunting. It therefore makes some sense to include speed in an assessment of bow skill but exclude it from an assessment of atlatl skill, although this represents an inherent limitation of this study since similar competitions might be preferable. Learning curves were created with the assumption that scores earned in the competitions are an adequate proxy for atlatl or bow skill within each weapon's application space.

Results and Analysis

Part 1: Cross-Sectional Analysis of Adult Scores

In cross-sectional analysis, adult atlatl scores produce an S-shaped (logarithmic) score curve (Figure 1a, b) and adult bow scores produce a C-shaped, concave (logistic) score curve (Figure 1c, d).1 The hypothesis that atlatls are easier to learn than bows is supported, since atlatl scores initially increase rapidly whereas bow scores do not begin approaching maximum skill level until the fourth year of competition.

Part 2: Longitudinal Analysis of Adult Skill

This longitudinal analysis uses the same adult data as in Part 1, but is analyzed longitudinally rather than cross-sectionally. The graphs in Figure 2 a and b illustrate the mean of the percent change in individual score for each person separately across all years they competed as compared to their own score in the previous year of competition. High values for y show a relatively high rate of skill improvement and low values for y show a low rate of skill improvement.

Learning curves for each weapon (Figure 2 c and d) show the total skill accumulated per year of competition, on average, for the entire sample of atlatl and bow users, respectively.2 The atlatl learning curve is convex or "steep" (logarithmic) while the bow learning curve is concave or “shallow” (logistic after year 2). Atlatl skill is initially acquired quickly and approaches maximum individual skill level relatively rapidly. Bow skill is acquired rapidly in the first year, followed by gradual, slow improvement that spikes after year six and (presumably) plateaus thereafter as maximum individual skill level is approached. The hypothesis that atlatls are easier to learn than bows is also

1 The logarithmic atlatl curve fits median scores across competition year with an R^2 of 0.95. The bow curve is best modeled with a generalized logistic function, which fits median scores across competition year with an R^2 of 0.98. Using mean rather than median values produces a similar result.

2 These are cumulative integrals of the rate of improvement functions shown in Figure 2 a and b, respectively.

supported by this analysis, since maximum atlatl skill is approached more rapidly than maximum bow skill.

Part 3: Cross-Sectional Analysis of Youth Bow and Atlatl Scores

The results reported above suggest that for adults, atlatls are easier to learn how to use than bows. Cross-sectional analysis of youth data from the atlatl competition largely supports this impression (Figure 3a). By age 7, the majority of youth atlatl scores (interquartile range $Q_{3min} – Q_{4max}$) lie within the middle 50% of adults (interquartile range Q_{2min} - Q_{3max}) in their first year of competition. There seems to be an abrupt rise in youth atlatl scores after age 10, and youth scores are statistically undifferentiable from first-year adult competitors by age 13 (Mann-Whitney U: n_1= 176 youths, n_2= 753 adults, $\tilde{x}_1$=32, $\tilde{x}_2$=37, U = 60500.5, p=0.07).3

The juvenile archery data from the IKAC is inherently biased, so could not be analyzed here. However, at age 10, children are bumped from the children's division (where targets are placed half as far away as they are for adults) to the youth division (where targets are placed at the same distance as they are for adults). This rule implies that children generally cannot successfully hit targets at distances equivalent to adults until age 10. Juvenile archery data collected among the Hadza by Blurton Jones and Marlowe (2001:219) indicate that an abrupt rise in bow skill does not occur until after age 12 (Figure 3b).

Based on the available but admittedly imperfect data, a majority of youths therefore wield atlatls at a level comparable to low-ranking (unskilled) adults by age 7, and by age 13-14 young atlatlists can throw as effectively as unpracticed adults during target shooting. Youth archers may not reach skill levels comparable to low-ranking adults until age 10 or later. My intention is not to claim that prehistoric juveniles began hunting with atlatls at age 7 and bows at age 10. However, these data do support the

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3 This age increases to 14 when zero values are included in analysis

hypothesis that *younger* juveniles could learn and use spear throwers within an application space similar to adults.

Discussion and Conclusion

Scores from the ISAC, IKAC, anecdotal and ethnographic data indicate that atlatls are easier to learn than bows and can be shot effectively by weaker, less dexterous individuals, including younger juveniles. Sex differences in atlatl and bow scores could not be compared for the ISAC and IKAC datasets because sex data are not available for the hand bow competition. However, at present, accepting that the sex gap in strength, dexterity, and ballistic skill includes a biological component leads to the conclusion that atlatls are more accessible to a larger segment of any population than bows, including weaker or less dexterous individuals, women and/or the elderly (Doucette 2001), for the same reasons as atlatls are more accessible to juveniles.

To put this technological transition in environmental context, the adoption of bow technology is often temporally associated with increased sedentism and/or intensified food processing, increased diet breadth, a paucity of large game, and subsequently higher reliance on low-ranked resources. If atlatls are truly better suited to an application space of highly ranked, large game and bows to lower ranked, smaller game hunting, then atlatls should be favored in environments where highly ranked prey is abundant and bows should be favored in environments where highly ranked prey is scarce.

When large game is abundant, as seems generally characteristic of atlatl-hunting times, hunter-gatherer women tend to focus on similar resources as men. Societies under these conditions tend to be more egalitarian with less sex-based division of labor. Analogously, many atlatl-hunting, prehistoric women likely targeted similar resources as men, whether as hunters or by filling support roles. Furthermore, juveniles in terrestrial atlatl-hunting cultures would likely become embedded into hunting systems at earlier ages than in bow-hunting cultures because atlatls are more easily learned and can be used effectively at younger ages than bows. When large game is scarce, as seems generally characteristic of bow-hunting times, the sexual division of labor among foraging populations increases. Women tend to focus on low-risk, reliable resources with relatively low return rates, such as plants, shellfish, and small mammals (or non-caloric production tasks; Waguespack 2005), while men focus their attentions on risky, irregularly obtained resources that yield bursts of abundant calories, such as large fauna (Bliege Bird and Bird 2008; Codding, Bliege Bird, and Bird 2011; Hawkes, O'Connell, and Blurton Jones 1991; Hawkes et al. 1991; Kelly 2007:297-2).

We do not know whether or to what extent women and juveniles actually participated in prehistoric hunting behaviors. This must be tested regionally with archaeological investigations explicitly geared towards answering this question. However, bow technology is more exclusive than atlatl technology in the sense that it inherently precludes weaker, less dexterous, and less ballistically inclined individuals from wielding it effectively within its presumed application space. Combining the biological exclusivity of bow technology with a consideration of environmental conditions favoring age- and sex-based divisions of labor highlights the importance of the interaction between environment and technology in fomenting social change, and vice versa. The abandonment of "equalizing" spear thrower technology in favor of more exclusive bows at the very least exacerbated prehistoric social disparities and likely catalyzed emergent age- and sex-based social divisions in prehistory.

The evidence reported here suggests that spear throwers are easier to learn how to use and can be wielded effectively by a larger segment of human populations than bows. When considered in a wider, dynamic context of resource exploitation and environmental change, the transformation of atlatls' application space to exclude terrestrial hunting would have precluded younger or weaker individuals from bow-wielding resource acquisition tasks, thus intensifying prehistoric divisions of labor by age, sex, or other biological attributes. Fluctuations in the age structure of populations, the organization of labor, and other demographic factors are therefore either proximately or causally linked to the optimal conditions under which a shift from atlatl to bow technology occurred in different times and places throughout prehistory.

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Tables

Table 1: Suggested advantages of atlatls and bows. Many have been proposed but not empirically tested. Hughes (1998) and Whittaker (2013) provide the most complete summaries of the advantages and drawbacks of each technology.

Suggested Advantages of Atlatl	Suggested Advantages of Bow
Can be used one-handed (hold a shield or paddle)	Higher velocity
Easier to use with heavy gloves	Longer range
Less susceptible to wet weather	Easier to shoot upward
Projectile hits with greater force (causing more hemorrhaging in large game)	More accurate
Easier to make and maintain	Shoots multiple projectiles faster
Easier to learn (Evans 1959)	Easier to use in brush/forest
Can be effectively used by young juveniles and women (Doucette 2001:167-171; Whittaker and Kamp 2006:219-220)	Stealthier (requires less motion)
	Better for smaller, faster game
	Better for warfare
	Better for hunting alone
	Easier to master
	Easier to learn (Cattelain 1997:231; Whittaker 2013)

Figures

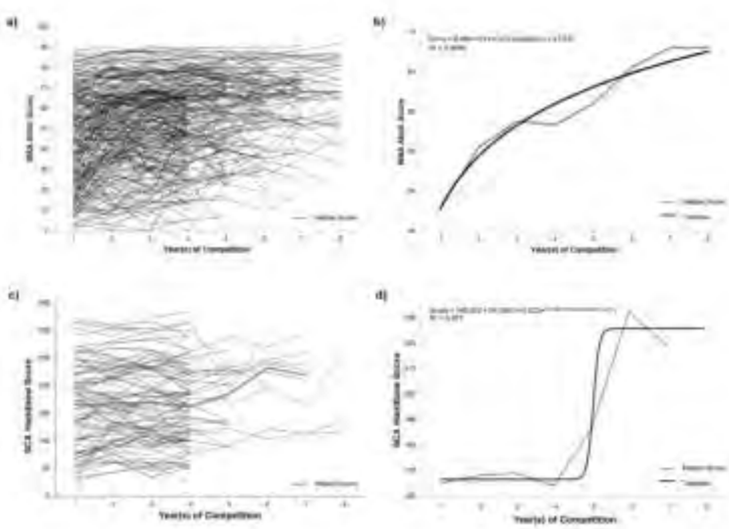
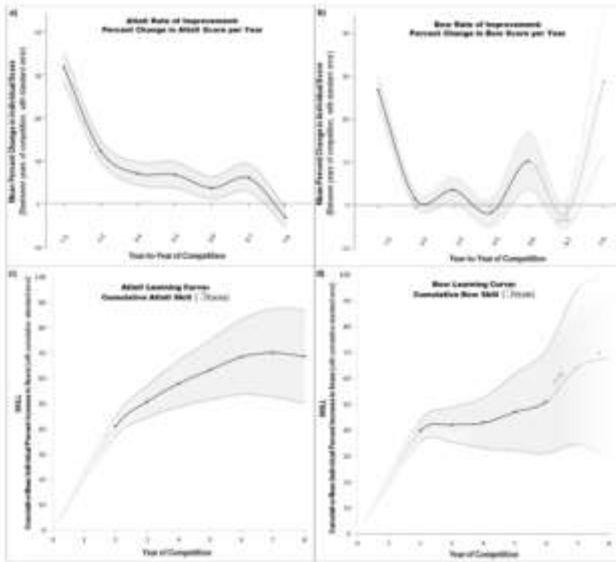


Figure 1: Score curves for projectile weaponry. (a) Individual atlatl scores (n=277) and median score by year, (b) median atlatl scores with logarithmic trendline. (c) Individual bow scores



(N=88) and median score by year, (d) median bow scores with logistic trendline. Mean scores show a similar trend.

Figure 2: Rate of improvement and cumulative skill for atlatl and bow weaponry by year of competition. (a) Atlatl rate of improvement by year, represented as the mean percent change in individual score per year. (b) Bow rate of improvement per year. (c) Cumulative atlatl skill over time, represented as the integral of the function show in (a). (d) Cumulative bow skill over time, represented as the integral of the function shown in (b).

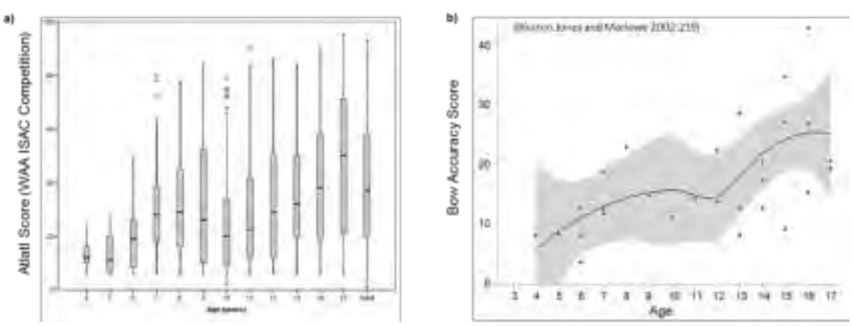


Figure 3: Youth atlatl (a) and bow (b) scores. The x-axis demarcates age. (a) Cross-sectional atlatl score by age for 4-15 year olds from the WAA ISAC. "Adult" shows scores from adults in their first year of competition for comparison. Scores of zero have been removed from the dataset. There appears to be an abrupt rise in atlatl accuracy after age 10. (b) Ethnographic data collected among the Hadza indicating score in target archery by age for 4-17 year old boys (Blurton Jones and Marlowe 2002:221). Each point represents one individual's score. The juvenile data are fitted with a localized regression estimate (LOESS) curve and 95% confidence interval (created using the ggplot2 package

in R; Wickham 2009). Note that there seems to be an abrupt rise in bow accuracy after age 12.

People of the Desert, Dunes, and Deltas: Landscape Archaeology in the Interior of Southern Africa

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The University of New Mexico Kalahari Project (UNMKP) began carrying out interdisciplinary investigations of the archaeology, ecology, history, and ethnology of people residing in the north eastern, central, and eastern Kalahari Desert regions of Botswana in 1975-76 (see Figure 1). Part of the focus of this work was on the Makgadikgadi Pans region of north central Botswana, the world's largest salt-pan complex. This area is relatively dry today but in the past the region experienced substantial environmental and tectonic changes, including periods of heavy rainfall and in-flow from rivers on the peripheries of the pans, resulting in what some analysts have described as a mega-lake, Lake Paleo-Makgadikgadi (LPM). Human populations utilized this area extensively, sometimes operating as classic desert foragers, moving from place to place depending on the distribution and abundance of surface water, wild plants, animals, and other resources necessary for providing a livelihood. Groups of people and individuals exploited the varied habitats of the region, including small pans, areas between dunes where concentrations of resources could be found, and places near the deltas of seasonal rivers that flowed into the Makgadikgadi Basin. Archaeological materials identified ranged from large scatters of stone tools and debitage to specialized ambush hunting localities and quarries. This paper assesses some of the findings of the project, drawing on archaeological, paleoenvironmental, and ethnographic information.

The Study Area and Archaeological Findings

The Makgadikgadi Pans region of northern Botswana is considered to be the world's largest salt-pan complex (see Figure 2). Today, this area exhibits many of the attributes of semiarid savanna and desert ecosystems (Noy-Meir 1973, 1974; Harris 1980; Thomas and Shaw 2010). In the past, however, notably in the late Pleistocene and Holocene, the basin contained substantial bodies of water with large fauna such as hippopotamus (*Hippopotamus amphibius*), crocodile (*Crodylus niloticus*), and various species of lacustrine fish and fresh water mollusks.

The Kalahari landscape below 950 meters above sea level in the north-central portion of Botswana is dominated by a vast complex of saline beds surrounded by scarps and dune ridges. This large internal drainage basin today covers some 4,900-8,400 km^2. The interior basin is made up primarily of two huge pans, Ntwetwe in the west and Sua in the east. These pans today are largely salt flats that support little or no vegetation. The Makgadikgadi Pans make up the remnants of what has been described as a mega-lake, which is estimated to have ranged in size from 34,000 to 66,000 km^2 (Ebert and Hitchcock 1978; Cooke and Verstappen 1984; MacFarlane and Segadika 2001; Burrough, Thomas, and Bailey 2009; Moore, Cotterill, and Eckardt 2012; Reidel *et al* 2014; Podgorski *et al* 2014; Burrough 2016). There are numerous features in the region that suggest the former presence of large bodies of water, ranging from paleo-shorelines to wave-cut beaches, small islands, and rounded boulder beds. Remains of extinct mammals and fish have been found, along with mollusks and diatoms, some of which have been dated (Reidel et al 2014:30). Various kinds of dating techniques were employed to determine the geological ages of the lake system, including radiocarbon, Accelerator Mass Spectrometry (AMS), optically stimulated luminescence (OSL), and potassium argon (KAr) for basement rocks. Palynology has been employed in order to determine vegetation changes over time.

While the detailed chronology of the region is still being worked out, it is apparent that lake level fluctuations reflect both climate variability and also tectonic events (Reidel *et al* 2014:33). Some of these changes occurred during Marine Isotope Stages (MIS) 6 to 2, in other words, over the period from approximately 190,000 to 12 kya. When combined with the Okavango Delta, Lake Ngami, and Lake Mababe, the lake that existed in the late Pleistocene and early Holocene in central southern Africa may have covered an area as large as 90,000 km^2 during this period (Podgorski *et al* 2014:1155, 1158).

It is apparent from the paleoenvironmental evidence that there were complex cycles of wet and dry periods, punctuated by catastrophic tectonic events which helped shape the interior basins. Periods of aridity can be seen in the presence of linear dunes that were formed by aeolian processes. Some of these linear dunes are found north of Sua Pan, many of them now vegetated. Cores from boreholes in the Makgadikgadi reveal bands of thick layers of intercalated clay, limestone, and saline-water saturated sand along with fine sands that may be a product of aeolian processes ((Podgorski *et al* 2014:1158). Both the Okavango and Makgadikgadi have experienced periods of subsidence and sedimentation as well as tectonic events such as earthquakes.

Even today the Makgadikgadi Pans region is sometimes covered in parts by shallow ponds of saline water. This is particularly true in places near the mouths of the Botletle and Nata Rivers which flow into the basin from the west and north east, respectively. The Nata River mouth resembles an inland delta and had water in it from 1973 through at least 1977 (see Figure 3). A shallow lake ranging from 400-800 km^2 at the mouth of the Nata served as a focal point for large numbers of flamingos (*Phoenicopterus minor and P. ruber*) and other waterfowl which congregated in the area in order to feed on brine shrimp and fish as well as to breed. This area is now a bird sanctuary which attracts sizable numbers of tourists.

Present-day rivers in the Makgadikgadi region area are ephemeral, flowing only after rains if at all. The largest of these seasonal rivers is the Nata in the north east, which has a catchment of approximately 23,000 km^2, much of it in western Zimbabwe. Peak flow on the Nata River is generally between January and March each year. In 1975 the river began to flow in December and was still flowing in March, 1976, while in other years it has been known to flow from November through April or even May. The Nata River itself has a sandy bed up to 100 meters wide, with banks sometimes as high as 5 meters. At the mouth of the Nata there are outcrops of silcrete and calcrete. These outcrops are important in that they help to pond water which flows below the surface even in the dry season. These aquifers can be tapped by digging shallow wells in the sandy bed, thus providing water year-round in all but the driest years. Sand rivers have long served as fallback watering places for both animal and human populations in north eastern Botswana (Hitchcock and Nangati 2000).

To the north of Sua Pan are smaller pans which in the past served as focal points for human use. Hunting and gathering took place around these pans, as did bone collecting. In the past 40 years some of these pans contained water long enough during the year to support the growth of reeds (*Phragmites mauritianus*) which were used in the construction of houses and shade facilities. In the shallow ponds there were edible water lilies known as *tswii* (*Nyamphaea caerulea*). In the immediate area of some of these pans are thickets and, in some cases, dense stands of trees which provide good cover for wild animals which came to these places to drink during the rainy season and to obtain salts and other minerals throughout the year. The remains of brush hunting blinds and animal processing localities have been found at several of these pans.

As Weare and Yalala (1971:138) point out, the area to the north of the Makgadikgadi Pans system is true savanna, merging at some points into savanna grassland and savanna woodland. The Makgadikgadi Pans system itself is complex in terms of vegetation cover, with Delta Grassland and Vlei Grassland found there. The open grassy flats support such grasses *as Cenchrus ciliaris*, *Sporobolus spicatus*, *Heteropogon contortus*, *Chrysopogon montanus*, and *Bothriochloa radicans*. Some wildlife species such as eland (*Taurotragus oryx*) and hartebeest (*Alcelaphus buselaphus)* tend to be found in areas where open savannas merge into more densely wooded places, while kudu (*Tragelaphus strepsiceros*) are found in more wooded places. Habitat diversity and availability of surface water and mineral-rich earth are important determinants of antelope density. A large number of rodents including springhares (*Pedetes capensis*) attracted predators such as bat-eared foxes (*Otocyon megalotis*) and black-backed jackals (*Canis mesomelas*) which were often seen in the evenings or at night.

Many species of felids (cats) such as caracals (*Caracal caracal*) are found in these areas, which historically were hunted frequently at night, sometimes with the aid of domestic dogs. The region contains the full array of southern African predators, from lions (*Panthera leo*) to leopards (*Panthera pardus*) and cheetah (*Acinonyx jubatus*). Elephant (*Loxodonta Africana*) numbers declined considerably in the late 19th century due to intensive hunting, but in the second decade of the 21st century large numbers of elephants were found along the Nata, extending as far south as Molapo in the Central Kalahari Game Reserve in 2011-2012.

Archaeological Findings

Based on archaeological and ethnoarchaeological investigations along the Nata River, in the Makgadikgadi Pans and the east-central Kalahari region, a number of different types of archaeological localities and landscapes were identified (see Figure 4). Sites found by previous researchers were located, including some Middle and Late Stone Age sites along the Nata River and in the Nata River Delta, the Botletle River Delta, and near Lake Xau in the south eastern part of the region (see, for example, (Bond and Summers 1957; Cooke 1967, 1979; Cooke and Patterson 1960; Helgren 1984). A variety of different types of archaeological localities were identified. These included the following: (1) open sites containing Stone Age materials, mainly lithics, cores, and debitage; (2) Iron Age sites that contained ceramics, metal, ostrich eggshell beads, and sometimes faunal remains; (3) specialized sites such as salt collecting camps in the Nata River Delta, (4) ambush hunting blinds around pans such as Mumpswe, Gutsa, Ngxaishini, and Kudiakam (Robbins 1987; Robbins and Murphy 1998) (see Figure 5); (5) small rock shelters in the hills along the edge of Sua Pan and in some of the granite kopjes to the east of Mosetse, some of which contain rock art, mainly paintings, (6) shrines, a number of which were found in rock shelters along with some in open areas, often on ridges, (7) fishing sites, such as ones around Dzivanini (Tsebanana) Pan, close to the Botswana-Zimbabwe border as well as at places near pools in the Nata and Botletle River Deltas, (8) agricultural sites, where food production and processing took place, (9) cattle posts, where cattle owners kept their livestock, recent residential sites that were occupied by Tshwa, Kalanga, and Ngwato agropastoralists, and (10) scatters of materials indicating short-term presence of humans and both wild and domestic animals (see also Main 2008).

In addition, there were archaeological materials the Makgadikgadi Pans region which include large pits that may have been used as traps for wildlife, recent bone beds that may be a result of group processing of wild animals, stone walls and other archaeological materials near baobabs (*Adansonia digitata*) such as those at Gutsa Pan south of Gweta and ones on Kubu Island on the western edge of Sua Pan north of the mining community or Orapa (Reidel *et al* 2012; Ebert and Hitchcock, field notes). Both

Kubu Island and Kakonje, a small island in south eastern Sua Pan, contain shrines that according to oral history information were visited by contemporary Tshwa and Kalanga and possibly others.

The materials found in the Makgadikgadi range from Early Stone Age (ESA), including hand axes, cleavers, and scrapers, along with extinct fauna, as seen, for example, at Kudiakam Pan (Robbins 1987; Robbins and Murphy 1998) and localities near Gweta (MacFarlane and Segadika 2001) to numerous localities with Middle Stone Age (MSA) materials, including bifacial points, denticulates, scrapers, cores, flakes, backed blades, and what may have been used as cutting tools. While precise dates on the MSA materials are largely lacking because most of them were surface finds, it is likely that they were utilized from around 240,000 to approximately 40,000 kya.

Late Stone Age (LSA) (40 kya – 2 kya) materials were found in specific areas such as ones between linear and barchan dunes, in the deltas of what are now seasonal rivers such as the Botletle, Nata, and Lepasha, around places that contain water for extended periods such as Lake Xau, and scattered around the edges of what used to be Paleo-Lake Makgadikgadi and in the open base of Ntwetse and Sua Pans.

Late Stone Age materials found in the region include microliths such as crescents, small backed blades, bladelets, cores, truncated flakes, adzes, gravers, cores, flakes, and debitage as well as ostrich eggshell beads and bead blanks (see Figure 6). Some of Late Stone Age foragers evidently used spears while others used bows and arrows, some of which were tipped with poison from the larvae of beetles such as *Diamphidia nigroornata*. It is interesting to note that by the late 19th century in the Makgadikgadi Pans region, none of the foraging peoples residing there used bows and poisoned arrows, most hunting being done with spears, traps, horses, donkeys, and dogs.

There is some evidence to suggest the early (past 2,000 years) presence of livestock in the Okavango-Lake Ngami-Makgadikgadi Pans region (Robbins *et al* 2005, 2008). Some of the archaeological localities that contain the faunal remains of cattle also have ceramics, copper, iron, ostrich eggshell beads, and red ochre, among other materials. It is interesting to note that today diverse groups occupy the same areas, as can be seen, for example, at Mogapelwa in the Toteng region near Lake Ngami where the various groups (Bakgalagadi, San, Tawana) all have similar technological items which they exchange regularly (Robbins *et al* 2014). These groups all have mixed production systems involving agropastoralism, foraging, fishing, and wage labor.

Droughts, Floods, Catastrophic Events, and Their Impacts

Questions about the paleoenvironmental history of the Makgadikgadi Pans and the lakes which existed in the past in the central southern African region revolve around the drivers of environmental and cultural changes. Were these changes due to catastrophic events or cycles of wet-dry oscillations, including periodic floods, droughts, and aeolian winds that dried out the soils and resulted in linear dune formation (Thomas, Burrough, and Parker 2012; Thomas and Burrough 2012)? Burrough et al (2009) and Reidel *et al* (2014:48) suggest that there were mega-lake phases at various points in time, one of them being 23-17 kya and another around 8.5 kya. There is also evidence that suggests that the Makgadikgadi Basin was dry at various times during the early Holocene. It appears that the evolution of Lake Paleo-Makgadikgadi during the past 50 kya was characterized by strong lake level fluctuations along with intermittent periods when there was little or no water in the basin. Human populations had to adjust to these different sets of conditions, underscoring their resilience in the face of substantial environmental change.

Campbell and Child (1971) attributed many of the changes in faunal distributions in the region to the impact of humans and their domestic animals on the Kalahari ecosystem. Catastrophic events such as outbreaks of rinderpest and foot-and-mouth disease which led to large-scale die-offs of wild and domestic animals in the 19th and 20th centuries, as seen, for example, in the Nata River area in 1970 and another in the Lake Xau area in 1972 (Child 1972). A drought in the first decade of the 20th century was so severe that local people resorted to eating *motlhope* (*Boscia albitrunca*) roots and ground up Acacia pods (Parsons 1973:326). The droughts in 1947, the mid-1950s, and 1961-65 saw widespread die-offs of antelopes (Alec Campbell, personal communications). In the early 1970s wild animals were in such emaciated condition that they fell prey to people who simply walked up to them and clubbed them to death. The bones of dead animals were collected by Tshwa and taken to the bone meal factory in Francistown in order to earn extra income. Judging ethnographic materials on the subsistence of Tshwa collected in 1975-76, they exploited a large number and variety of mammal, reptile, fish, and insect species (Hitchcock 1982).

Tshwa, Kalanga, and Ngwato Informants suggested that a number of biogeophysical changes occurred in the region as a consequence of environmental transformations, shifts in technology, increased livestock densities in the area, government policies, and expanded numbers of people residing there. One important change they remarked on was a decline in the water table. Pans which formerly had held water throughout the year were now only seasonal, and in some years they contained no water whatsoever. Another change related to fire frequency and severity. Whereas in the past local people burned off small areas to attract game or to encourage the growth of specific kinds of plants, this is now considered a criminal offense. As a result, today there are more fires which burn over large areas with such high heat levels that important edible and medicinal plant species are lost. High rainfall resulted in floods in the Nata River region in 2015 resulted in losses of both wildlife and crops.

Based on ethnohistoric data, archival research, ethnoarchaeology, oral histories, and interview data, in the mid-to late 19th century there were approximately 1,000 – 1,200 Tshwa and other people occupying the region north of the Makgadikgadi region. Some of these groups resided near small pans when they held water part of the year, and they fell back on the rivers where they resided much of the rest of the year. Some of the places had as many as five different groups that claimed rights to various sides of the pan, resulting in a kind of flower-petal type land use pattern. Most of these pans are no longer used, in part because of the presence of game scouts, large predators, and competition with elephants, which have increased substantially in number in the past two decades, resulting in substantial human-wildlife conflict.

An examination of the pans north of Sua and Ntwete Pans reveals a jumble of remains representing complex cultural and natural formation processes. A variety of activities are represented there, ranging from long-term residence by foragers to ambush hunting and herding. Trampling by livestock, collection of bones by Tshwa and other people, the actions of scavengers (e.g. hyenas, jackals), and wind and water erosion have all had significant impacts on the archaeological remains that exist. When combined with a history of land use by foraging, agropastoral, and wage earning populations, the result is a complex landscape with a wide array of cultural and other materials.

The north eastern Kalahari Desert, like many semi-arid savanna regions, is a highly fluctuating environment (Thomas and Shaw 2010). Animal and human populations and vegetation expanded and contracted through time, with some periods in the past so dry that large areas of the region were abandoned or were utilized only sparingly by groups moving out from places with permanent water. Today, foraging exists mainly as a buffering strategy, and mobility of contemporary groups is uncommon except for small-scale logistical trips to places where wild natural resources can be obtained for domestic use and sometimes for sale.

Both the Botswana state and private companies have had significant impacts on the peoples in the Makgadikgadi Pans region, with major efforts to resettle people away from mines and commercial livestock operations. The people of the deserts, dunes, and deltas are no longer living as they once were, moving around the landscape in search of wild resources and engaging in trade, exchange, and sharing of land and resources with other groups. Global political, economic, and environmental forces continue to affect local communities, much as has been the case for the past 200,000 years.

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Figures

Figure 1. Aerial view of Makgadikgadi Pans region, Botswana

Figure 2. Eastern Kalahari Botswana Study Area showing location of the Makgadikgadi Pans Region.

Figure 3. Nata River Delta in the north eastern part of Sua Pan, Botswana

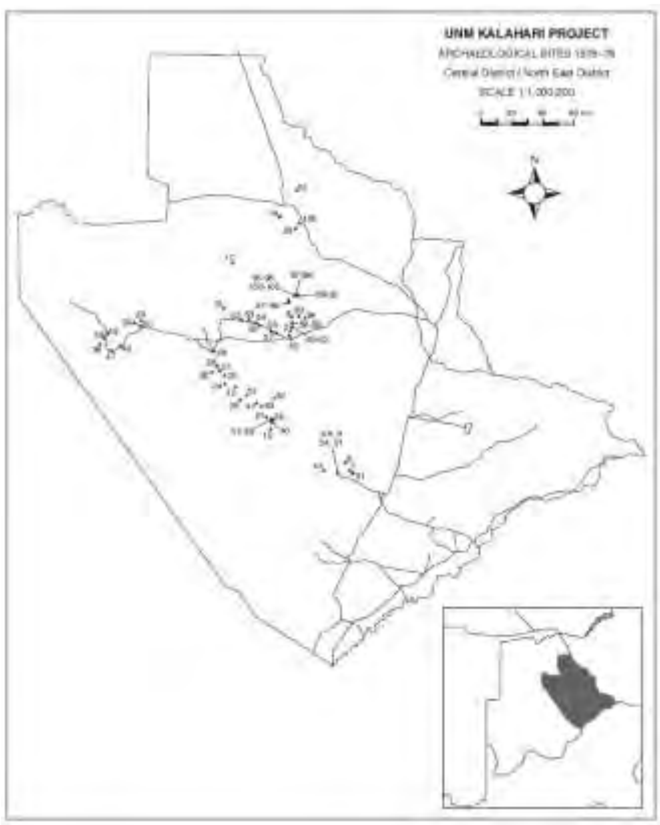
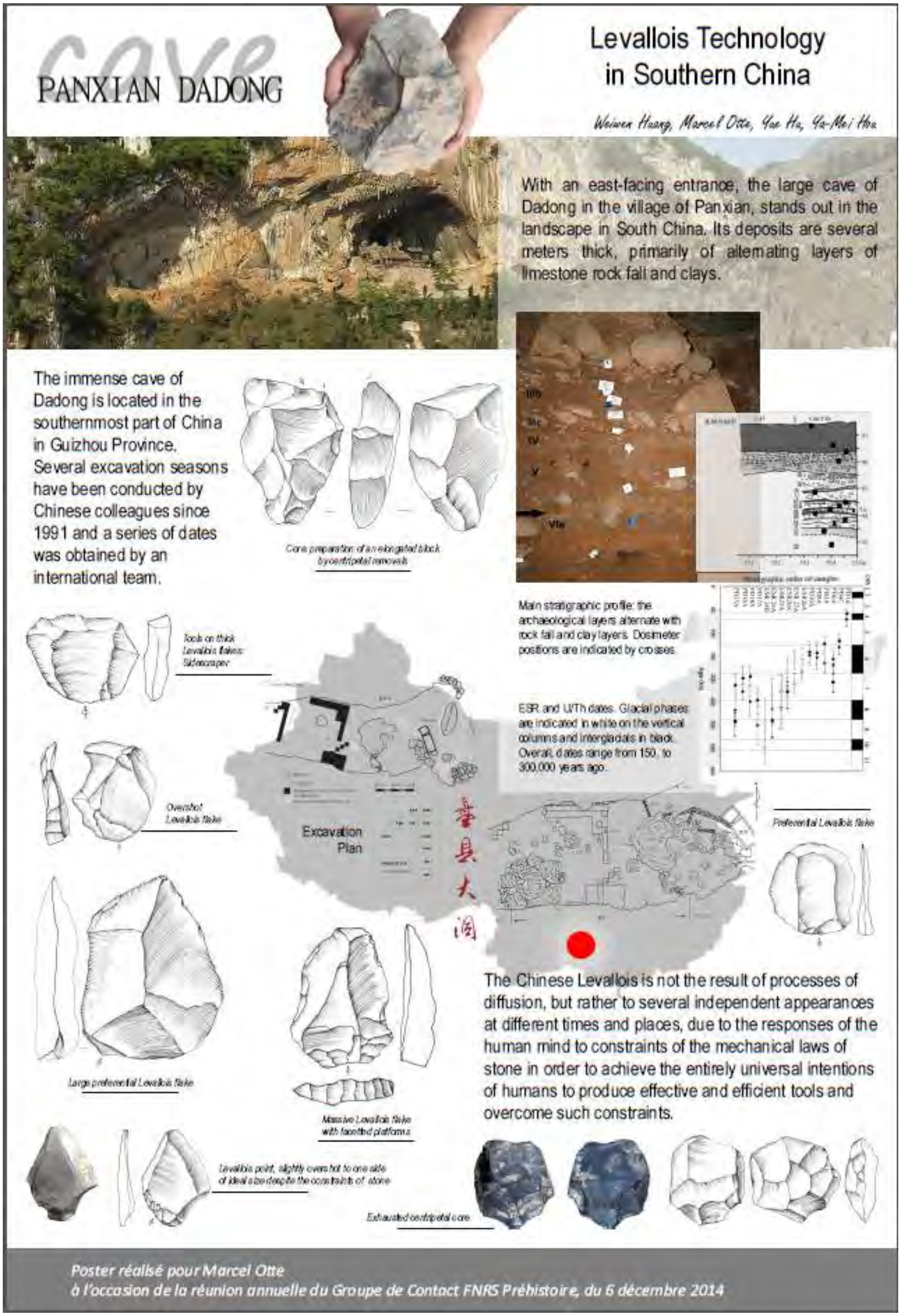


Figure 4. Map of Locations of University of New Mexico Kalahari Project Archaeological Sites.

Figure 5. Hunting Blind in Ngxaishini Pan, Makgadikgadi Region, Botswana

Figure 6. Late Stone Age Microliths from Mogapelwa, Lake Ngami region, Botswana


cave
PANXIAN DADONG
Levallois Technology
in Southern China
Weiwen Huang, Marcel Otte, Yue Hu, Ya-Mei Hou
With an east-facing entrance, the large cave of Dadong in the village of Panxian, stands out in the landscape in South China. Its deposits are several meters thick, primarily of alternating layers of limestone rock fall and clays.
The immense cave of Dadong is located in the southernmost part of China in Guizhou Province. Several excavation seasons have been conducted by Chinese colleagues since 1991 and a series of dates was obtained by an international team.
Core preparation of an elongated block by centripetal removals
Main stratigraphic profile: the archaeological layers alternate with rock fall and clay layers. Dosimeter positions are indicated by crosses.
Tools on thick Levallois flakes: Sidescraper
ESR and U/Th dates. Glacial phases are indicated in white on the vertical columns and interglacials in black. Overall, dates range from 150, to 300,000 years ago.
Overshot Levallois flake
Excavation Plan
盘县大洞
Preferential Levallois flake
The Chinese Levallois is not the result of processes of diffusion, but rather to several independent appearances at different times and places, due to the responses of the human mind to constraints of the mechanical laws of stone in order to achieve the entirely universal intentions of humans to produce effective and efficient tools and overcome such constraints.
Large preferential Levallois flake
Massive Levallois flake with facetted platforms
Levallois point, slightly overshot to one side of ideal size despite the constraints of stone
Exhausted centripetal core
Poster réalisé pour Marcel Otte
à l'occasion de la réunion annuelle du Groupe de Contact FNRS Préhistoire, du 6 décembre 2014

Peopling of the New World, as Seen from the Japanese Archipelago

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Abstract
The archaeological remains dating to the Pleistocene are reported from over 14,500 sites in the Japanese Archipelago. They are relatively well-dated by means of tephrochronology, thus providing convenient reference points of the time-frame for technologies available to human groups in the area just southwest of the Bering Strait. About 50 of the assemblages, consisting amorphous flakes and pebble tools, are thought to date earlier than 40,000 cal. BP, but opinions are divided as to the artefactual nature of many of the specimens. In contrast, there is consensus regarding the arrival of behaviorally modern *Homo sapiens* about 40,000 years ago. About 500 assemblages, dating to 40,000 - 30,000 cal. BP, consist of amorphous and blade-like flakes, that were made into projectile tips. The indirect evidence for the use of watercraft is also present. The overwhelming majority, however, of the Paleolithic assemblages date to the period after the massive volcanic eruption, marked by the AT tephra, of about 30,000 cal. BP. The densely packed human groups, more sedentary after the extinction of large mammals, left assemblages that are highly diversified, in terms of the primary as well as secondary reduction techniques. They include the classic blade technique, bifacial thinning of projectile points, and microblade production. The Paleolithic Period ends with the appearance of ceramics in the Paleo-Honshu about 16,000 cal. BP, and in Hokkaido and the Ryukyus about 10,000 ca. BP.

For the relatively short history of Palaeolithic research, that began in earnest with the 1949 excavation of the Iwajuku site, Archaeological remains dating to the Pleistocene are reported from over 14,500 sites in the Japanese Archipelago, with the surface area of 3,700,000 km^2. This high concentration of Palaeolithic sites occurs in the chain of islands situated in the "Pacific Ring of Fire", where numerous volcanos have been spewing out emissions over the years. The deposits of the volcanic ejecta have been well studied, in terms of chemical composition, distribution ranges, and the origins and their ages (Figure 1), with the results that a large proportion of the Palaeolithic assemblages could be placed in a tephrochronogical framework.

In this presentation, I focus on some of the key technological traits which could be relevant in the discussion of hominin dispersal into the New World by way of the Bering Strait area, and assess the dates when such traits were available to human groups occupying the area southwest of Beringia. The traits to be considered are:

- "Early "Palaeolithic" Flake and Pebble-Tool Industry
- Blades and Blade-like flakes made into spearheads
- Selective procurement of lithic materials
- Use of watercraft
- Bifacial thinning of projectile points.

Before going on I should qualify my use of the term "Japanese Archipelago" because my information is based only on the area south of the current Le Perouse Strait between Sakhalin and Hokkaido, as I do not have access to the Russian language literature on Sakhalin.

Flake and pebble tools

The earliest indication of hominin presence in the Archipelago is in the form of assemblages composed of flakes and pebble tools, which I referred to the Early Palaeolithic Tradition of East Asia (Ikawa-Smith 1978). The flakes and pebble tools appear to have been used as expedient tools, and may have served to make tools out of organic materials, such as bamboo, that could have served as hunting weapons. While the exposure in 2000 of the infamous "Fujimura Scandal" resulted in nullification of over 200 purported "Early and Middle" Palaeolithic assemblages, and had negative impact on archaeological research in Japan, the search for the evidence for the early hominin occupation of the Archipelago went on. Work continued at such sites as Sozudai (Akoshima 2015) and Kanedori (Kuroda *et al.* 2016) where investigations had begun before “the Scandal” and are known to have been untainted by Fujimura’s activities. New locations that have been identified since, such as Sunabara, Komaruyama, and Ohno (Wada 2016) as reported at the last Suyanggae Symposium (Matsufuji *et al*. 2015, Uemine *et al*. 2016). At the 6th Worldwide Conference of the Society for East Asian Archaeology in Ulaanbaatar in 2014, Hiroyuki Sato and I organized a session, reporting on the current state of Early Palaeolithic research In Japan. Some of the papers are now published in the electronic Bulletin (http://www.seaa-web.org/bulletin2016/BSEAA3).

At this time, approximately 50 assemblages characterized by amorphous flakes and pebble tools are known. Among the oldest are the 36 specimens recovered from two levels of the Sunabara site in Shimane Prefecture (Figure 2) during the excavations in 2009. The strata from which the specimens were contained were estimated to be 120,000 and 110,000 years old, respectively, on the basis of the presence in the upper Cultural Layer of characteristic volcanic glass of the 110,000-years old Sanbe-Kisuki tephra (Uemine *et al.* 2016). Matsufuji and his colleagues point out that a possible indication of even older presence of hominins in the Archipelago has been picked up at nearby Itazu. The evidence, however, consists only of a single pebble tool, collected at the site during construction, and it’s estimated age of MIS 6 (186-127 ka) is based on comparison of the soil and sand adhering to the specimen with those taken from the supposed matrix stratum (Matsufuji *et al.* 2015: 205, Uemine *et al.* 2016: 17).

In Central Honshu, there are several well-dated “Early Palaeolithic” sites, such as Komaruyama in Nagao Prefecture and Tsurugaya-Higashi in Kiryu City, reported at the 20th (2) Suyanggae Symposium (Akoshima, 2015; Matsufuji *et al*. 2015). Further to the north, there is the multi-component site of Kanedori in Iwate Prefecture, from the lowest two cultural layers of which were recovered 40 and 8 pieces, respectively, of flake and pebble tools (Figs.2, 3). The younger of the two layers, called Cultural Layer III, falls between 35,000 and 68,000 years ago, because Yk-M tephra, dated to be 68,000 and 78,000 years ago is deposited in the lower part of the stratum. This is consistent with the radiocarbon date of 46,480 $\pm$ 710 on a sample from the lower part of the layer. The older, Culture Layer IV is estimated to be between 68,000 and 85,000 years ago, because of the presence of the Yk-M tephra deposits just above the Culture Layer, and because volcanic glass from Aso-4, dated 85,000 years ago and other dated tephra have been found in the Culture Layer itself (Kuroda *et al*. 2016:11).

At this time, the Kanedori assemblages are the northernmost indication of the "Early Palaeolithic" Flake and Pebble Industry presence in the Archipelago. It is possible that early hominins, who may have reached the Archipelago via a southern route, did not venture further than northern Honshu. It is conceivable, however, that the remains of their presence along the former coast lines of the North Pacific have been obliterated by the subsequent rise of sea level, and are waiting to be identified by the under-water detection efforts, such as those discussed by Gron (2015) at the last Suyanggae Symposium.

As has been noted before (e.g. Ikawa-Smith 2015), these early assemblages share certain features with some of the early assemblages in North China, such as Xibaimaying and Houjiayao of Nihowan Basin. They include (1) absence of standardized flake removal methods; (2) predominance of minimally retouched small flake tools; and (3) frequency of denticulates, notched scrapers, and becs (Takehana 2012). Nevertheless, as noted before as well, the Japanese archaeological community is divided into two camps: those who accept the evidence and continue to search for more, and those who hold that peopling of the archipelago did not take place until after about 40,000 years ago.

Arrival of Behaviorally modern humans -- Blade-like flakes made into spearheads; Procurement and Mobility Strategies, and Watercrafts

The first unambiguous evidence of hominid presence in the Archipelago is represented by the assemblages, about 500 in number, which date to the latter half of MIS 3, from about

40,000 to 30,000 years ago, which I referred to as the Late Palaeolithic I stage (Figure 2). The terminal date of this segment is the transition to MIS2, which more or less coincides in Japan with the massive eruption of the volcano at the southern end of Kyushu that resulted in the wide-spread Aira-Tanzawa Tephra (AT for short, Figure 1). Even though skeletal remains are not associated with the assemblages in the Paleo-Honshu Island and Paleo-Hokkaido Peninsula, the assemblage contents strongly suggest that these were left by behaviorally modern *Homo sapiens.* The assemblages often contain elongated flakes of blade proportions, some of which are parallel-sided to be called “classic” blades (Figure 4). They are found at a number of sites, such Happusan site in Nagao Prefecture, where they were recovered from the stratum, dated to be 32,000 RCBP, clearly below the horizon-maker AT tephra (Saku City Board of Education 1999). At the same time, the “amorphous “ flakes continue to be made, and both were minimally retouched around the base. Experimental studies ((Midoshima 1996) and use-wear analyses (Yamaoka 2012) suggest that the flakes and blades were hafted to serve as spearheads.

While the locally available rocks were used to produce the amorphous flakes, special efforts were made to obtain suitable lithic materials, such as obsidian, hard shale or glassy andesite, for blades and blade-like flakes. There is a large body of literature on procurement, transportation, and consumption of these preferred lithic materials, based on physico-chemical analyses and painstaking work of refitting artifacts with trimming flakes at the source and at a series of workshops. A variety of mobility strategies models for procurement of food stuff, combined with acquisition of lithic materials, have been presented.

It was in this connection that indirect evidence of the use of watercraft came to light. It was Masao Suzuki (1973, 1974), in his pioneering work on obsidian sourcing, who pointed out that hunter-gatherers of the central Honshu used obsidian from Kozushima, a small island off the coast of Honshu, which remained separated by some 30-40 km of ocean even during the LGM (Figure 5). The presence of Kozushima obsidian at various Honshu sites has since been confirmed by a number of studies, and recent radiocarbon dates indicate that the use began as early as 37,000-38,000 cal. BP (Shimada 2012:231). We do not have the actual evidence of the watercraft used, but they could be a dug-out canoe, and if so, the edge-ground axe, another unusual feature of these assemblages, would have been a useful equipment for its construction. About 1,000 of these axes have been recovered from about 200 Late Palaeolithic I sites in Japan, and the use-wear analysis by Tsutsumi (2012) suggests that one of the functions of these tools were in heavy-duty work, such as felling trees. The watercraft may not have served in a major trans-oceanic voyage, but could have served well enough for short-distance island hopping. For example, if a human group venturing eastwards from Beringia and then southward down the western coast of the American Continent along the narrow coastal plain found the passage blocked by a protruding ridge, they could have continued the journey by taking to water by constructing a simple boat.

Regional Variability, including Backed Blades, Microblades, and Bifacial Foliates

The massive volcanic eruption, that brought the AT tephra all over the Archipelago about 30,000 cal. BP, seems to have had devastating effects on the human population, causing depopulation in some areas. The Archipelago, however, was quickly repopulated, with some 14,000 assemblages dating to the last segment of the Palaeolithic Period, from about 30,000 to 17,000/10,000 cal. BP. New arrivals from the continent, both via the Korea and Sakhalin-Hokkaido Peninsulas, may have contributed to the population influx, as the brief but wide-spread appearance in Kyushu of what is called "hakuhen sentoki" (flake point), a tanged point very similar to the one known at the Suyanggae site, indicates. In the northern part of the Archipelago, appearance in Hokkaido, about 25,000 cal. BP of the microblades detached from wedge-shaped cores, to be inserted into slotted point-heads, probably represents population movement out of Siberia, with the advent of the cold phase of MIS2. As the large mammals disappeared from the Paleo-Honshu Island, more sedentary human groups there left assemblages that are highly diversified, in terms of the primary as well as secondary reduction techniques. They also exhibit what appear to be stylistic differences in the way the primary blade blanks are steeply retouched to form point heads, possibly as expressions of group identities in the closely packed environment.

In addition to the regionally diversified styles of steeply retouched backed blades, bifacial leaf-shaped points were made, in some parts of the Paleo-Honshu Island, from about 22,000 cal. BP (Kudo 2006), and continued to be used during the very early phase of Jomon Period. Nagai (2007, 2016) presented fascinating observation on the Incipient Jomon versions of the bifacially pressure-flaked points, when he noted that there were distinctive regional patterns in the orientation of flake scars on the tanged bifacial points of the Incipient Jomon Period (15,000-12,000 cal.BP): the points recovered from the sites in the southern part of the Archipelago exhibit diagonal flake scars running from upper-right to lower left (URLL, Figure 6, Left), while those from northern Japan, including Hokkaido, tend to have scars oriented from upper-left to lower-right (ULLR, Figure 6, Right). Citing experimental studies that suggest the URLL and ULLR patterns of flaking scars are the products of different pressure flaking techniques, Nagai proposes that they probably indicate difference in cultural tradition and motor habits. Nagai (2007:3-4; oral communication in 2016) further notes that the URLL pattern was noted on some of the points from the Korean Peninsula, and the ULLR pattern on those from Sakhalin as well as from Broken K in Alaska. I am intrigued to know how far down south into the New World such patterns could be traced.

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Figures

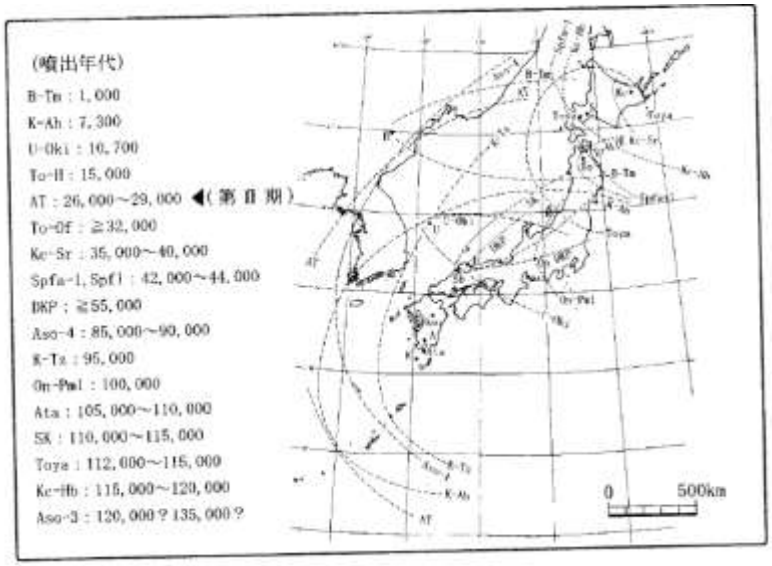

Figure 1. Late Quaternary widespread tephra in the Japanese Archipelago (after Anbiru 2010:69)

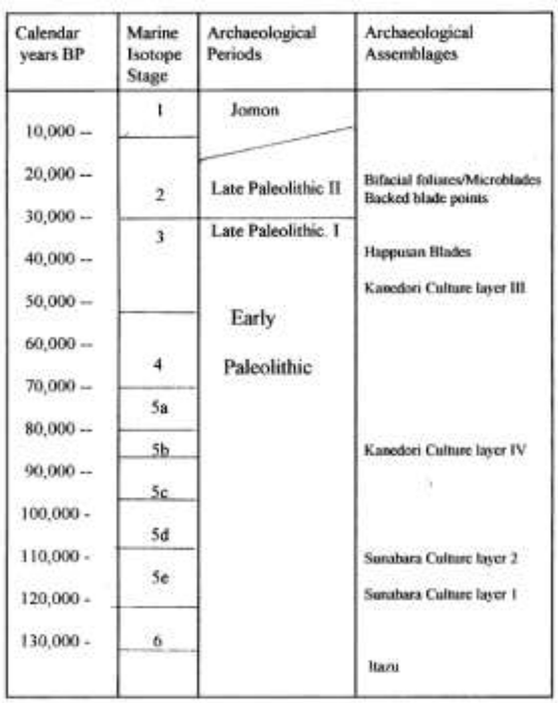

Figure 2. Chronological Positions of Some of the Palaeolithic Assemblages

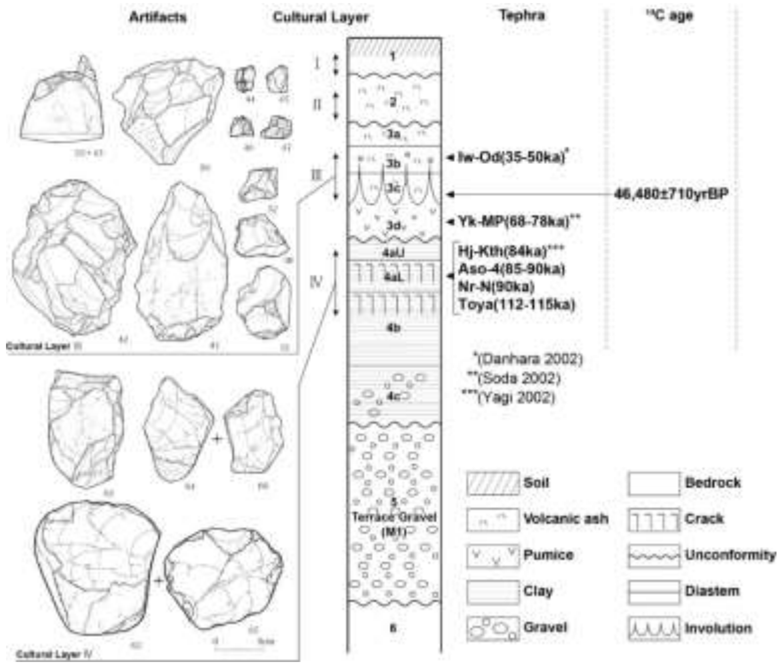

Figure 3. Cultural Layers, Tephra and ^{14}C ages of the Kanedori site (Kuroda *et al.* 2016)

Figure 4. Blade tools from Happusan, Nagao Prefecture (Saku City Board of Education 1999)

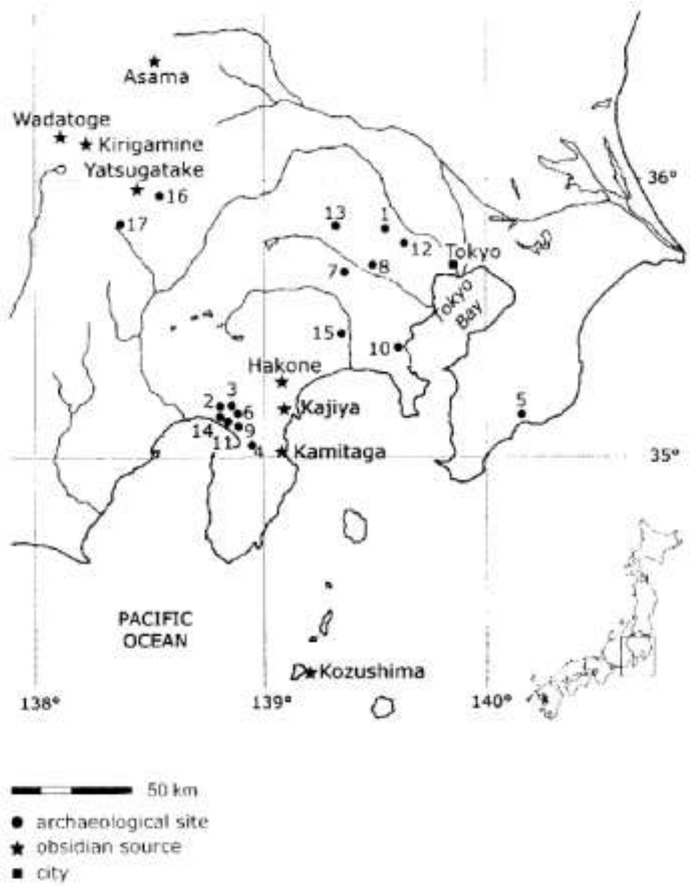

Figure 5. Map showing the location of Kozushima

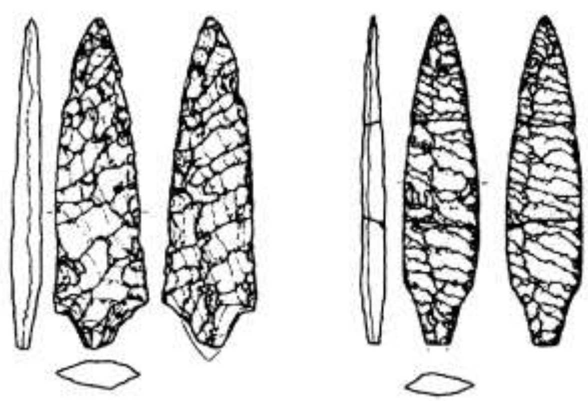

Figure 6. Oblique parallel pressure flaking patters on bifacial points (Nagai 2007)

Palaeolithic and Mesolithic Colonization of the European High Alps

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A striking feature of the end of the last ice age, with its major environmental changes, is the colonization of new lands. In particular, deglaciation uncovered large areas that became open to human occupation, and groups took advantage of these changes by relatively rapid expansion. In Europe, lowland areas on the North European Plain and moraine regions around the Alps were colonized and a new pattern especially focused on lakes emerged. High areas of the Alps also became attractive and saw expanded use once they became ice-free. The focus here is on the spreading occupation of the Alps, best known in their southern Italian flanks, but including scattered evidence in the northern Alps of Switzerland, Germany and Austria as well. Patterns of high elevation settlement and relationships between lowlands and highlands during the Late Palaeolithic and Early Mesolithic will be examined.

A notable feature of this colonization process is that it required adaptations to quite different environments across the continent. The initial late glacial movement into the north of the continent---the Netherlands, north Germany and Poland---took the form of the Hamburgian Culture during the Bølling warm interstadial (Bratlund 1996; Street et al. 2002). Characterized by shouldered points, these people moved into a tundra habitat and focused largely on the hunting of reindeer. Many sites were in narrow tunnel valleys created by glacial meltwater and often containing lakes.

In southern Germany and Switzerland, Magdalenian reindeer and horse hunters had spread into this region as tundra and steppe vegetation developed, but concentrated on hills and valleys that had been ice-free (Weniger 1982). Their penetration into the newly exposed lowland moraine areas was slight and archaeologically visible largely as isolated artifacts. Once forests of pine, birch and juniper developed, occupation spread southward and took the form of the Late Palaeolithic, characterized by arch-backed points and an economy focused on moose, red deer and other forest animals (Jochim 1998). Sites were concentrated on the newly formed lakes created by the retreating glaciers. Both southwestern Germany and north-central Switzerland show similar patterns.

Alpine Colonization

The Alps and their higher foothills are a very different environment than the moraine lowlands just discussed. As montane habitats, they share a number of features (Aldenderfer 1998), including:

- Environmental heterogeneity
- Extreme climatic conditions
- Low predictability of climate and resources
- Low primary productivity
- High travel costs

A move into such areas required considerable adjustments to their particular features.

The best studied region is northeastern Italy (Bagolini and Dalmeri 1992; Broglio 1992; Dalmeri and Pedrotti 1994; Fedele 1999; Figure 1). Pollen analyses have determined the variations in elevation of the treeline over the course of the late- and postglacial (Tinner and Vescovi 2005). During the Epigravettian of the Bølling/Alleröd warm period, sites begin to appear up to elevations of 2100 meters, although most are concentrated between 1000 and 1600 meters. These follow the treeline upslope, which varies between about 1000 and 1900 meters during this time. Many sites appear to concentrate in the higher parts of the forested zone, providing access to animals in the higher alpine grasslands. Although few faunal collections are available, it seems clear that the major focus of these sites was hunting in the open habitats. The site of Riparo Dalmeri, at 1240 meters elevation, had an assemblage that consisted of 90% ibex, together with red deer, roe deer, bear, beaver, marmot, fox, wolf, hare, and fish (Cassoli et al. 1999).

During the Early Mesolithic of the Preboreal and Boreal periods the treeline moved farther upslope, reaching 2400 meters, and sites appeared at higher elevations accordingly, concentrated between 1900 and 2300 meters (Figure 2). The site of Plan de Frea, at an elevation of 1930 meters, contained remains of ibex, red deer, alpine hare, boar, bear, birds and fish (Angelucci et al. 1999). Seasonal data are scarce, but it seems clear that the sites represent summer occupations, in light of the rigorous climate, with colder seasons spent in the lowlands.

Some of the sites, such as Plan de Frea, as well as Mondeval de Sora, at 2100 meters, are situated in the shelter of large boulders or stone outcrops (Angelucci et al. 1999; Fontana et al. 2012). Many are located near the numerous alpine lakes formed by glacial melting. Site functions can be inferred largely from lithic assemblages, which seem to represent two types of sites. Specialized hunting camps are dominated by microlithic armatures, whereas short-term residential camps contain a more balanced array of various tool types. For example, at the small Colbricon lakes, ten open-air sites have been discovered (Bagolini and Dalmeri 1992). Three of these sites are located near the lakeshores and have assemblages in which armatures are a relatively small part of the collections, which include a variety of other tool types. The other seven sites have assemblages dominated by armatures and are located on ridges and hills far from the lakes and possess good views of the countryside. Examples of such specialized hunting camps are three sites located on hills above the Buse lake, in which microlithic armatures make up between 65% and 82% of the tool assemblages (Dalmeri and Lanzinger, 1992).

At the site of Plan de Frea, such armatures constituted 70 – 79% of the tool assemblages of different levels.

Initial occupation of the Swiss Alps occurred in the Late Palaeolithic, but few sites are known and they are confined to elevations below 1500 meters. During the Early Mesolithic, however, a significant number of sites appear and extend in elevation up to 2550 meters (Cornelissen and Reitmaier 2016; Huber and Bullinger 2010). Most of these sites have very small assemblages and seem to represent brief residential camps with mixed assemblages. No sites with assemblages dominated by microlithic armatures have been found, suggesting that specialized logistical hunting camps are rare. A few sites have organic remains and indicate an important role for ibex, chamois, red deer, alpine hare, and bear in the economy.

Research in southwest Germany demonstrates that Late Palaeolithic groups began to move southward into the Alps, possibly during the Alleröd Period (Gulisano 1994; 1995). A number of sites have been found in the upper reaches of the Iller River and a tributary valley, the Kleinwalsertal. These sites are situated between 800 and 1100 meters elevation. During the Early Mesolithic the number of known sites increases and they now extend up to 2100 meters elevation. Most of the assemblages are small, and all appear to represent short-term residential camps.

In the Austrian Alps, relatively few sites have been reported (Leitner 1988-89; Schaefer 1998). Based on the available sample, groups moved into the higher elevations of this region during the Early Mesolithic, establishing most sites at elevations of 1800 – 2200 meters. These sites are small and are usually located on or near lakeshores. One site at an elevation of 2800 meters appears to be a quarry for extracting high quality quartz. The most extensive excavations have been carried out at the site of Ullafelsen, an open-air site at an elevation of 1869 meters, which appears to have been a repeatedly occupied small residential camp.

Adaptation to High Elevations

The archaeological record of Alpine colonization displays a number of characteristics indicating an adaptation to the particular environment of high elevations:

Environmental heterogeneity

Many of the sites are located near ecotones or boundaries between different habitats, providing access to both forest and grassland regions.

Extreme climatic conditions

Most sites appear to represent warm-weather camps, indicating the avoidance of harsh winter conditions.

Low predictability of climate and resources

The scant faunal evidence, mostly containing a variety of both large and small game, suggests a broad diet as a response to the low predictability of large game hunting.

Low primary productivity

The sites are almost uniformly quite small, reflecting the difficulty of supporting large groups.

High travel costs

Most sites are residential camps where a variety of activities took place, indicating the difficulty of trying to exploit the highlands with short-term logistical hunting camps. The few specialized camps known appear to represent hunting parties sent out from the highland residences. This is a contrast to the pattern observed in northern Europe, where initial occupation of empty areas took the form of brief, logistical hunting camps easily penetrating the new area from residential camps in previously occupied regions (Housley et al. 1997, pp. 44-45).

In light of the difficulty of traveling within the steep and broken topography of the Alps, it is surprising that contacts and some movement over considerable distances occurred during the Early Mesolithic. Raw material from lowland areas to the north and northwest reached sites deep into the northern regions of the Alps. For example, some

Swiss Alpine sites contain stone from outcrops up to 160 kilometers to the northwest (Cornelissen and Reitmaier 2016). Austrian sites in the Kleinwalsertal contain banded chert from sources almost 200 kilometers to the north (Gulisano 1995). More surprisingly, some materials from Italian sources in the south appear in the northern Austrian site of Ullafelsen, having traversed almost the entire width of the Alps (Schaefer 1998). Despite the high costs of travel in this high elevation environment, contact and transport of valued stone was maintained. The montane environment may have imposed severe constraints on people colonizing this region, but it is clear that these constraints were not insurmountable.

Conclusions

Despite the unique, and relatively unfavorable, conditions of high montane environments, hunter-gatherers of the late glacial and early postglacial periods made extensive use of these regions. The rigorous conditions required that this use was restricted to the warm seasons, implying a seasonal transhumance between lowlands and highlands. The difficulties of travel necessitated residential moves into the high elevations, rather than allowing brief, logistical use of these regions. The relatively low biomass was only able to support small groups. Although focused primarily on the hunting of ibex, chamois, and deer, the unpredictability of this habitat encouraged a broader diet that included small mammals and birds and guided the placement of camps near ecotones, allowing access to different vegetation patches.

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Figures

Figure 1: Alpine region of northeastern Italy.

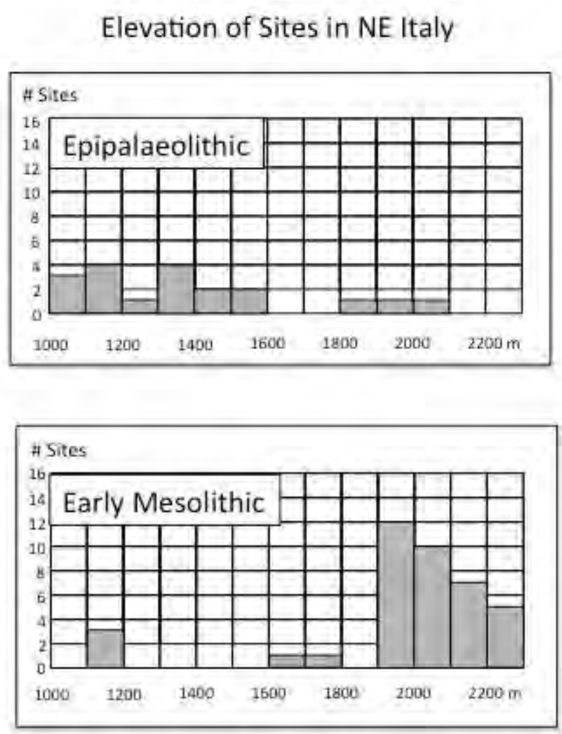

Figure 2: Elevations of Italian Epipalaeolithic and Early Mesolithic sites.

Landscape and Soil-Sedimentary Matrix-Forming Processes of Sorori Paleolithic Site in the Miho River since MIS 5, Korean Peninsula

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Along the mid-stream of Miho River (MiR), Pleistocene terraces are prevailed particularly near the confluent to the Musim River (MuR) in Chengju City (CC). The fluvial Low Terrace (LT) is located below 35 m (asl) and are mainly composed of subrounded gravels and channel sands with some intercalations of backswamp organic muds or peat layers (Kim, et al, 2000). The base level of LT gravels reaches at about 25~30 m in middle part of MR. It may be important that the Thalassostatic Terrace (TT) was formed up to near Cheongju City area in the Last Interglacial (LIg) period. Up to date the paleoshoreline in the west coast of the Korean Peninsula (KP) may reach maximally up to 26.5 m since the LIg, when the uplift rate of 0.14~0.21 m/ka is applied in terrestrial part of KP. Therefore it is commonly regarded the lower FT (or the 2nd terrace) in the Sorori Site (SS) was formed under the influence of the fluctuations of paleoshoreline since the Marine Isotope Stag (MIS) 5e. The Fluvial Sedimentary Sequences (FSS), however, prevailed along the MR, were mainly formed during the Last Glacial (LG) period rather than in the LIg. Cultural layers on the FSS are commonly associated with Geosols (frost-cracked paleosoils) (Kim et al, 2000, 2006). The Geosol in this paper is to be designated as soil solum having typical frost cracks (soil wedges) and/or desiccation cracks with fragipan textures, which may be indicative of dry climatic conditions, particularly during the LG period in KP, and some parts of Japan Island Arc (Cho et al, 2006). It is also pronounced that Geosols were formed in response to typical soil-sedimentary forming process reflected in the differences in soil color, micro-textures and compositions (Kim et al, 2015a, 2015b). The object of this paper is to review the Sorori Paleolithic site-forming process in viewpoints of the integration of pedo-sedimentary and geomorphic stratigraphy. The Paleolithic stone tools found in three excavation locations can be enumerated; 1) needle tools, bords, scrapers in the SS location A (CNU), 2) polyhedron, choppers and flakes scrapers in the SS location B (DU), and 3)scrapers in the SS location C (SCU) (Figure 1). The SS is mainly located at Namcheonri and Sorori, Oksan-myeon, Heungdeok-gu, CC area in the Chungbuk Province of Korea (Figure 1A). The three excavation locations in SS are situated at the foothills of the Jurassic Daebo Granite. In this research site-geomorphic and geological setting were reviewed in viewpoint of terrace stratigraphy and Soil-sedimentary stratigraphy in order to further integrate paleolithic meso-scale site-forming processes. AMS radiocarbon data was used to support the chronology of matrix-forming in the SS (Kim et al, 2000; Kim et al, 2012).

Fluvial Sedimentary Sequence

The Pleistocene terraces are distributed along the mid-stream of MiR basin below about 30 m (asl) and is assumed to be generated by geomorphic process by climatic change and/or sea-level change. The fluvial deposits are typified by two sequences, i.e., Old Fluvial Sequence (OFS) and the Young Fluvial Sequence (YFS) in the Sorori excavation locations (Figure 1B). The fluvial deposits in the OFS were typically developed along the whole MiR basin, where the low terrace system is prevailed at the level about 13 to 16 m above the bottom of MiR. Near the CC area the low TT may be shifted into the low FT along the boundary of foothill and Pleistocene alluvial plain in the MiR basin.

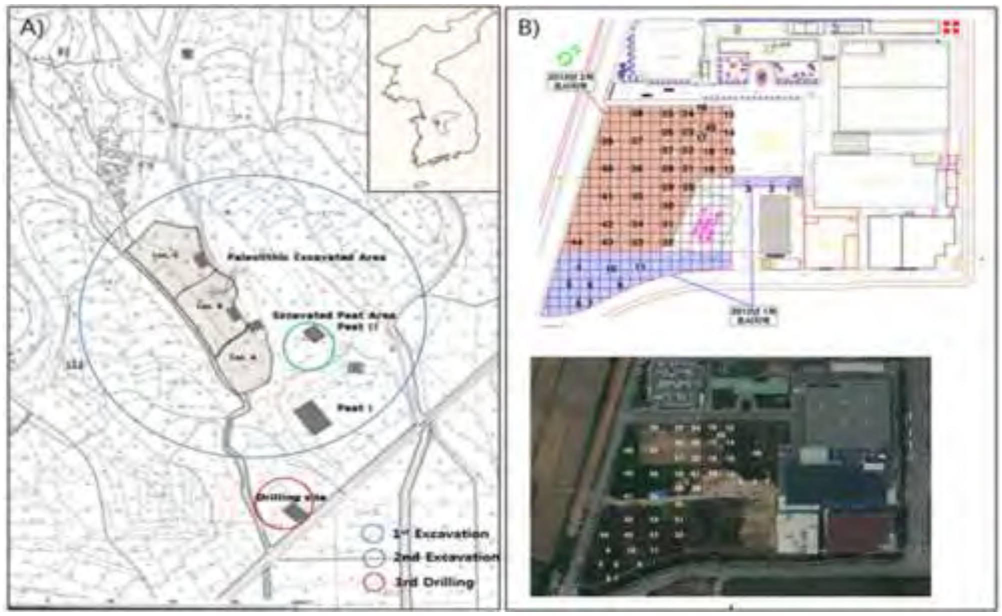

Figure 1. Locations (A, B, C) of Sorori paleolithic excavations; A) locations of excavations areas, B) Geological drilling locations in Sorori site.

Old Fluvial Sequence (OFS)

At the SS the low FT is located above the topographic level of 20-25 m (asl) and prevailed at the downstream part from the confluent of the MuR near CC area. It is mainly composed of subrounded gravels, channel sands with intercalations of backswamp organic muds or peat layers (Kim et al, 2000; Kim et al, 2015a, 2015b). The chronology of OFS can be interpreted by the AMS radiocarbon dates of organic muds (the 4th peaty soil) obtained from borehole BH-15 (Figure 1(B), and excavation trenches U24 and P38 (Figure 2). The ages of the OFS may indicate as old as 50 ka, when the interstadial periods were prevalent is the SS. Many stone artefacts are chronologically associated with the time intervals between ~LGM (ca 20 ka) and MIS 3 ~ (50 ka) in the OFS.

Young Fluvial Sequence (YFS)

The young fluvial deposits, composed of fluvial sand and gravels at the base and formed after about the LGM period, are superimposed by three organic muds and peats. The YFS are composed of three organic muds and peats formed at the ages between 17,000 yr BP and 11,500 yr BP. It is to be interpreted that after the LGM fluvial sands were associated with backswamp along the old MiR, particularly in Sorori~Namcheonri sites (Figure 1C). It is commonly accepted that the Latest Pleistocene fluvial deposits are mainly associated with the YFS in the KP, and prevailed along the major fluvial basins in the KP (Kim et al, 2008). In SS particularly the worldly well-known ancient rice seeds were found synchronously with the Bφlling and Allerōd interstadials, when several warm and wet periods were fluctuated in the MiR between YD (11.5 ka) and H1 (about 15 ka).

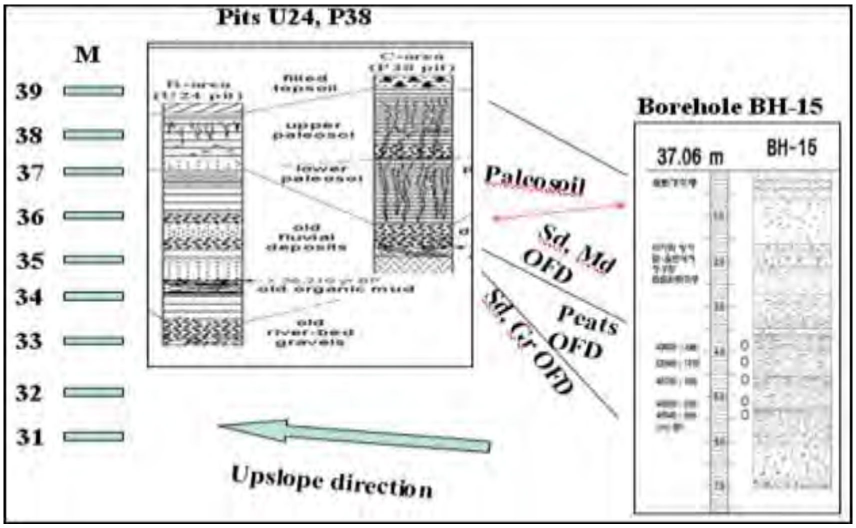

Figure 2. Soil-sedimentary stratigraphy of the Old Fluvial Sequence based on the lithological profiles of Pits (U24 and P38 of Location A) and drill cores(CH-15) in the Sorori paleolithic site (for Location A and CH15 see Figure 1).

The pollen production in the SS indicates the predominance of *Alnus-Quercus* in the organic muds and peats of middle peats (Figure 4) at the altitude of about 29.5 m~31 m (asl), which implies that the climate was relatively warm and humid to form backswamp muds and peats in the Sorori excavation areas along the MiR (Figure 1 (A)). It is especially true in the SS where particularly 3 peaty layers are characterized with the dominance of Gramineae (Poaceae), and associated with evergreen conifer (Betula-Abies-Piceas) with broad-leaved deciduous(*Alnus-Quercus). The* YFS includes the lowermost peats (about 17~17.5 ka), middle peats(12-15 ka), and humic Geosol in the transitional period (about 10 ka) of initial Holocene (~12 ka). (Figures 3 and 4).

Sorori Peaty clays was dated 12,920～17000 yr BP, indicating Post-LGM, during which a repetition of warm-humid and cool-dry prevailed in the SS in the MiR. The 2nd excavation works were carried out to find more rice seeds and some additional AMS carbon datings resulted 12,000 yr BP from the seeds found in Sorori excavation areas. The 3rd drilling survey was also aimed to unravel the extension of Sorori peats possibly containing rice seeds. From the 3rd survey any rice seed was not found from relatively small amount of the drilling core samples (black peaty clays) in comparison to 1st and 2nd surveys. The recent AMS dates for the peaty clays and wood fragments range also 12,920~16,320 yr BP, indicating fundamentally the same age range with those of the 1st and 2nd excavation works in the Sorori Peat II Location in 1999.

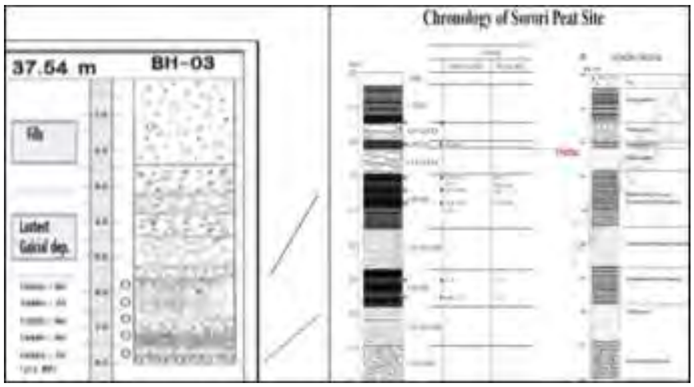

Figure 3. Young Fluvial Sequence (YFS) in excavation location 1 (Chungbuk Nat'l Univ. Loc.) in the Sorori Site (SS).

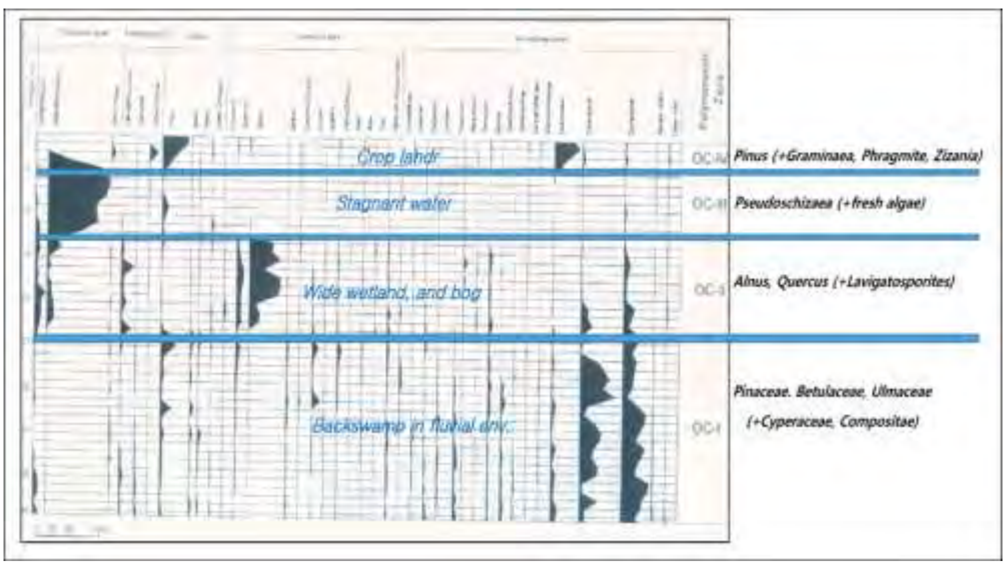

Figure 4. Palynological zones of the YFS in the pits of the Sorori Peat II location.

Geosols Occurrence in the Sorori Site (SS)

In SS Geosols are associated with vertical soil-wedges (frost cracking) and multiple horizontal laminations toward tail part of the soil-wedges (Kim, 2001; Figure 5). Geosols are characterized by such micro-scale textures as pronounced clay-fills, clay-capping’s, rubification, Fe-Mn nodules, and so on. Geosols on the low FT in the SS along the MiR are characterized by two different layers; The lower Geosol is conjugated by yellow or yellowish brown soils. The lower Geosol is prevalent with frost cracks overlying the Old Fluvial Sequence (OFS), which was formed since early Last Glacial(LG) period, as old as 60-65 ka in the KP (Figure 7). The lower Geosol has intercalations of rather reddish brown to dense brown Luvic Geosol, which may be intercalated as patches. The upper Geosol is rather pinkish dark brown Geosols with polygonal structures and fragipan textures. In SS the uppermost part of the YFS is characterized by a sort of Geosol, having desiccation cracks, or typified by anastomosing and relatively short vertical cracks with stiff soil solum, particularly marking age of the transitional period between the Pleistocene and the Holocene. The cultural layers in association with Geosols are typified by the heavy stone tools at lower part (lower Geosol), progressively changing into the flake culture and blade culture upper part (upper Geosol) in soil-sedimentary profiles.

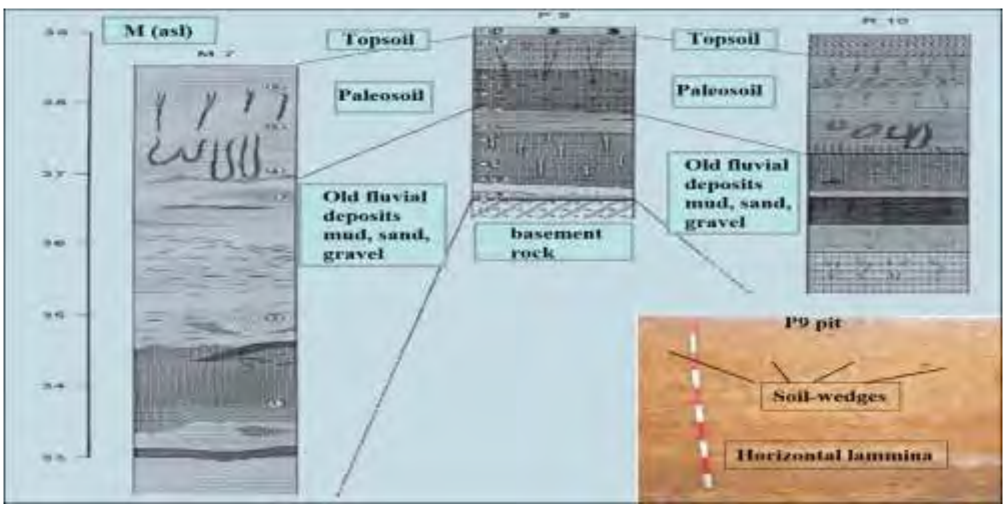

Figure 5. Soil-sedimentary matrix of the Old Fluvial Sequence (OFS) in the Sorori excavation location 1 (Chungbuk Nat'l Univ. Loc.) (Kim et al, 2015a).

Discussions

Terrace Formation and Paleolithic Site Matrix-forming Processes

At SP site the fluvial gravels are distributed generally at the level up to 35 m (asl), where the last interglacial Thalassostatic Terrace (TT) could not be reached up to the SS site; The paleoshoreline of MIS 5e in the western part of the KP may reach approximately up to 27 m (asl), when we apply the uplift rate of 0.14~0.21 m/ka (Kim, et al, 2008) in terrestrial KP. Paleoshoreline indications may not be reached out up to the SS, so it makes sense that the gravels on the low FT were formed after the highest stand of paleo sea-level during the MIS e5. In the KP during the MIS 4 (about 75~ ka), major drainage basins were progaded toward the Yellow Sea in western part of KP. Particularly the Yellow Sea was almost disappeared and became land since the earliest Last Glacial (70~65 ka) and particularly during the LGM (ca. 21~18 ka); The latter period the coastline dropped at the level of about ~120 m below the present mean sea - level and the majority of the Yellow Sea was subaerially emerged. After the LGM, however, the sea level abruptly rose up due to the rapid melting of polar ice, particularly since 17 ka. It is accepted up to date that the low Thalassostatic Terrace (TT), distributed in coastal area at the level of 10-20 m, is interpreted to be formed in the LIg (125~ ka, MIS 5e), while the low FT, distributed at the same level above the respective river-beds, is regarded to be formed since the early last glacial (75~60 ka, MIS 4).

The OFS are composed of and associated with fluvial sands and gravels overlain by Geosols of the LG period (Figure 6). Numerical dating, resulted from the 1st Sorori excavation area indicate that the soil-sedimentary layers on the low FT, indicate that Geosols and organic muds of OFS were formed at least as old as the MIS 3 (ca 50~ ka); It can be supported by the radiocarbon dating of the old backswamp organic muds (Figure 2 and Figure 6). After Geosol formation in the SS, it is noteworthy to explain that the Young Fluvial Sequence (YFS), associated with intercalations of backswamp organic muds or peaty clay layers, are prevailed at least 5 m below from the base-level of the OFS along the MiR.

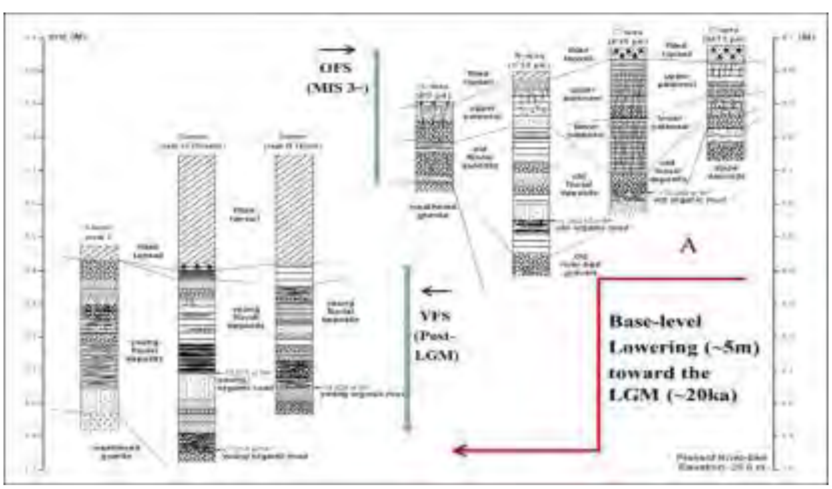

Figure 6. Base-level change of the low Fluvial Terrace (FT) since the MIS 4 period.

For the Geosols as site matrix-forming layers, the most typical one is pinkish and dark brown Geosol which is characterized by polygonal soil wedges prevalent with ice-lensing segregations and Fe-Mn nodules, as well as the aggregated forms of the matrix in the SS (Figure 5 and Figure 6).

Therefore it can be interpreted that after MIS 3, the base-level of Sorori FT was changed both vertically and laterally to the level of 26~28 m (asl) in SS up until the Last Glacial Maximum (LGM) period. The Upper Geosol (UGs) is pinkish dark brown, showing muddy loamy texture with relatively stiffer than lower Geosol below. The vertical length of cracks are ranged from several tens of decimeter up to several meters. The branching and patterning of cracking are more pronounced in the tangential direction from foothill to low FT. The filling materials into the cracks show the same with the matrix-forming materials. The curvilinear surfaces of cracks show glossy textures, vertically continuous, and light yellow to pale bluish gray as a whole in color. The microfabric texture is characterized by clay coatings and/or capping, patches of aggregates of Fe-Mn hydroxides and a number of clay-fills in the interstices of the soil-sedimentary matrix.

Chronology of Geosols and Implications to Paleolithic Cultural Layers

Generally Geosols in Korean peninsula are typified by the freezing and thawing cracking, and developed during the cold and dry climate condition. In particular during the Last Glacial period, landscape was degraded deeply so that the base level lowered up to more than –50 m (asl), which led to extreme and drastic freezing and thawing process under discontinuous periglacial condition in Korean Peninsula (Kim, 2001). In the Last Glacial Period winter monsoon was more activated than summer monsoon, which induced to a number of seasonally freezing and thawing grounds, The Geosols in the SS can be divided into 2 types; The Lower Geosol (LGs) is less pronounced and vertically discontinuous in some Pits. The LGs is short in length and designated to the interstadial of the LG period (possibly MIS 3, 50~35 ka) (Figure 6 and Figure 7). The Upper Geosol (UGs), however, is ubiquitously prevailed in SS and characterized by many polygonal structures in plan view, ground veins or frost cracks in the vertical view in many excavation Pits (R10, P9, M7). The bottom part of the UGs is commonly impregnated with Fe-Mn nodules or concentrated particles. The Paleolithic stone artefacts were found either at the boundary of the Upper and the Lower Geosols or the lower part of the UGs, where Fe-Mn hydroxides were often concentrated as 1~2 cm nodules in diameter. The LGs and UGs are both assumed to be formed under the different soil-and landscape-forming processes; the former favorably were formed during the interstadial (warm and dry/wet), but the latter was during the stadial (cold, dry/wet) of the LG period. Along the MiR post-LGM forestry changed from the fluvial stream and backswamp into wetland bogs, which may be favored for earliest grain grass (such as rice, barley, maize, buckwheat, etc.) growing in abundance during the B/A Interstadial. In SS pits, it may be supported by the production of some proto-type rice seeds (i.e., *Oryza proto-Sativa*), the appearance of which is synchronous with the Boelling and Allerod Interstadials (Figure 8).

In summary the UGs and LGs as site-matrix of the Upper Paleolithic (UP) cultures in the SS imply the informal pedo-stratigraphic keybeds during the LG period. It can be also suggested that the OFS in the SS may be assigned to the early Upper Paleolithic (eUP) ~ middle Upper Paleolithic (mUP), while the YFS may belong to the late Upper Paleolithic (lUP)~latest Upper Paleolithic(ltUP), which may provide a meaningful chronostratigraphic positions of the Sorori Paleolithic culture among the other Upper Paleolithic sites of the whole Miho-Keum River Basin. This Upper Geosol (UGs) may have a few fragments of AT tephras, which may be as old as 28~ka. Finally the Upper Geosol(UGs) may be conspicuously important in the sense that it is associated with culmination of the typical microblade and blade cultures in KP.

Conclusion

Upper Pleistocene fluvial environment change and Geosol developments in the MiR basin provide an important implication in the Upper Paleolithic cultures in the KP. Particularly the late Pleistocene terraces are developed in the mid-stream of MiR basin. The gravels lying on the low TT or FT below 30 m (asl) are assumed to be generated by surface processes derived from either climatic change or sea-level change along the MiR basin. Some typical geomorphological and soil-sedimentary sequences are well distributed on the low FT in the SS along the mid-stream of the MiR.

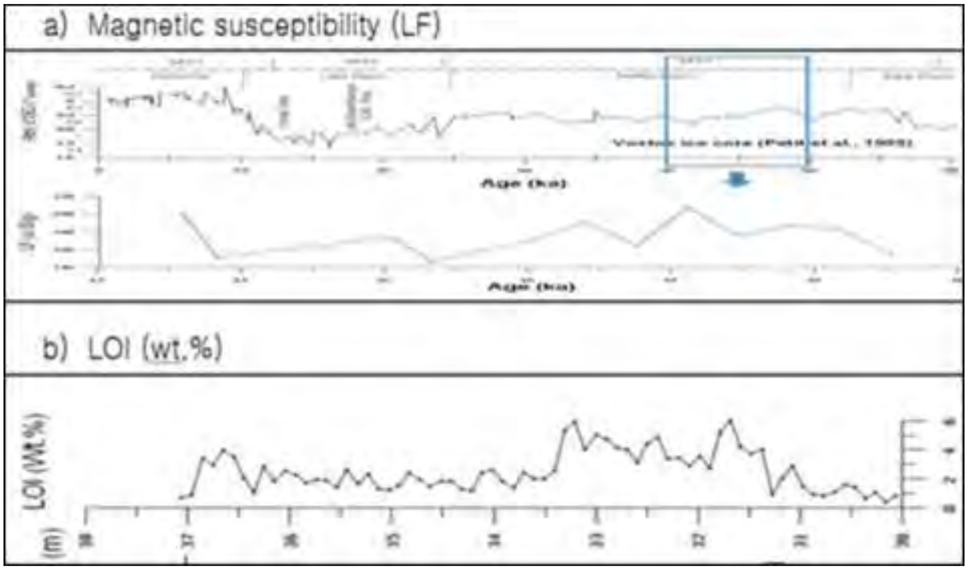

Figure 7 . Chronological implication of the OFS based on Magnetic Susceptibility (MS) and Loss of Ignition (LOI) profiles of the B-15 drilling cores in the Sorori Site (SS).

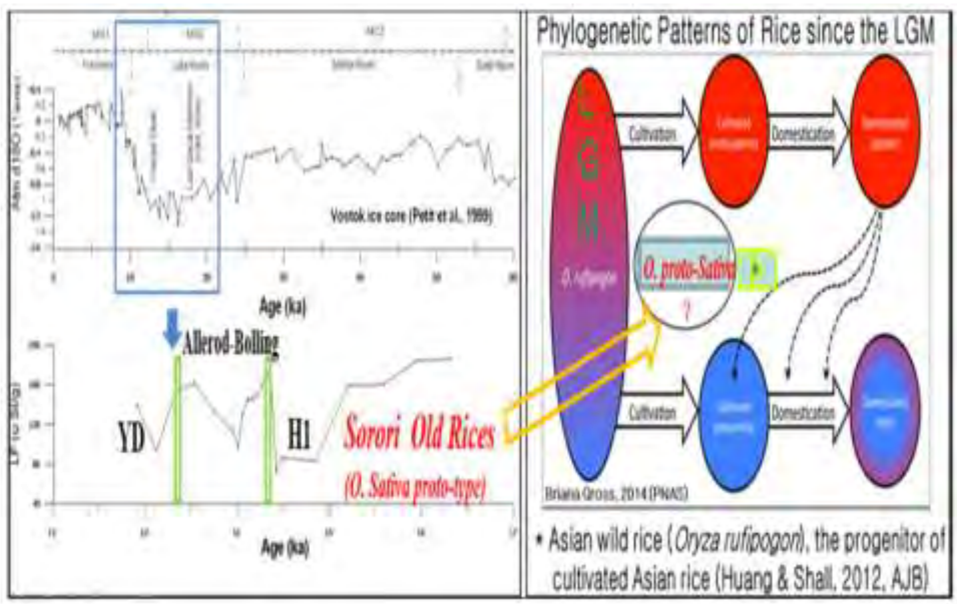

Figure 8. Sorori old rise (*Oryza proto-Sativa*) excavated at peaty clays and MS profile of the BH-3 cores in the Sorori Site(SS), indicative of B/A Interstadial periods (Kim et al., 2015a, 2015b).

From the representative excavation profiles in SS, the OFS composed of sand and gravels are at the bottom of low FT and Lower and Upper Geosols found in the middle and upper parts of the low FT. The Upper Geosol(UGs) is characterized by dark brown in color, while the Lower Geosol (LGs) just above the low FT is either reddish or yellowish brown in color. Geosols are often associated with vertical soil-wedges (frost cracking) and multiple horizontal laminations below the soil-wedges, micro-scale textures such as pronounced clay-fills, clay-cappings, rubification and Fe-Mn nodules.

The LGs is a typical cryoturbated Geosols either on low FT, or in the weathered zone of Jurassic Granites, or over the soil-landscape surfaces of an altitude below 28 m above the present MiR. The LGs is characterized by lots of short and narrow veins and cracks (desiccations) presumably originated from the dry climate in the early Last Glacial period. The UG is characterized by lots of veins and cracks presumably originated from the dry climate during the intensively cold episodes of the Last Glacial Maximum (LGM). It is believed in general that the UG in the KP, typified by the freezing and thawing cracks, were developed at the coldest and driest climatic condition and grass-covered steppe land in the discontinuous periglacial environment during the LGM period. After the formation of the UG, the YFS were associated with intercalations of backswamp organic muds or peat clays, prevailing below the base-level of the OFS in MiR.

Lastly the UGs and LGs are important soil-sedimentary matrix, producing Paleolithic stone tools such as polyhedron and choppers, flakes, bords, scrapers and needle tools, which were excavated from the SS location-A, -B and -C . In general the upper Paleolithic may progressively be changed from the relatively heavy and large stone tool culture into the small stone tool culture represented by flakes, blade, and micro-blade. These stone tools are interpreted to be representative of the middle to late Upper Paleolithic (35~22 ka, MIS 3~2) in the SS, when considering the association of Geosols and the formation ages of the LGs and UGs.

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Hell Gap Zooarchaeology: A Time to Reconsider

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Hell Gap is primarily known as a key site in the unravelling of Paleoindian chronology (Figure 1). Its stratified sequence became a virtual Rosetta Stone in the morass of known Paleoindian diagnostics of the early 1960. The site contains over 20 components with each component containing an unknown number of occupations, some single while others are likely palimpsests. In the history of Paleoindian studies, Hell Gap was also one of the rare camp sites known at the time of excavation in the 1960s and provided a contrast with the more typical bison kill sites of the Plains and Rocky Mountain regions. While the initial field studies and analysis focused on stone tools and specifically formal stone tools and stratigraphy, fauna fell by the wayside. The investigators analyzed the stone and easily identifiable bone, while shipping the rest of the bone to the University of Wisconsin for further analysis which never took place.

First Impressions

The first widely circulated publication on the stratified Hell Gap Paleoindian site in Wyoming (Irwin-Williams et al. 1973) contains only a few sentences describing the recovered fauna, we present several here. The authors state: “the small Goshen Complex camp at Locality I was at the base of geological Unit E, and yielded artifacts and workshop debris as well as faunal remains (principally bison)…” (pg. 44). The overlying Agate Basin component yielded “a good sample of artifacts, workshop debris, and large quantities of bone (principally bison). The materials are concentrated in the south end of Locality I, near the creek bed" (pg. 44). Even though that statement provides some provenience it is not of much use as far as any relationships or context for the bone and other material is concerned. For the uppermost Paleoindian component, Frederick the authors state that "Two separate Frederick living surfaces were defined, each yielding large quantities of artifacts, chipping debris and faunal remains. *Initial* field analyses indicate that the faunal remains are distinguished from those of earlier components by the relatively small proportion of bison bones and relatively large quantities of deer remains" (emphasis added, pg. 44). Similar statements follow for other localities. Finally the authors conclude that "The varied tool assemblage, like the varied faunal assemblage associated with the Frederic Complex, may reflect continuing readaptation towards a broad spectrum economy, more consistent with shifting climatic-environmental conditions" (pg. 52).

Results of analysis of 1960s sample

It took 35 years and the publication of a site monograph (Larson et al. 2009) before sophisticated analysis of the fauna was initiated leading to interpretations of animal utilization and their implications for Paleoindian lifeways. Three studies highlight 1000s of faunal specimens recovered at Hell Gap.

In their separate studies, Rapson and Niven (2009), Byers (2001, 2009), and Knell et al. (2009) discovered that the majority of the animals (predominantly bison) died over a range of seasons. In the lower components of Locality I, season-of-death data indicate remarkably consistent patterning with repeated fall-winter mortalities, occurring over the earliest period of Paleoindian times (2,000 to 3,000 years).

Patterning in the season of bison mortalities at Locality II, spanning a period of roughly 2,000 years, is considerably less clear-cut, with virtually all seasons of the year represented (with the exception of late fall). Although winter-spring mortalities predominate among the mandibular dentitions, these seasons are virtually absent among the maxillary data, which are primarily summer-fall deaths. The cause or causes of this unexpected patterning remains unclear.

The time span for Localities III and V are somewhat shorter (ca. <2,000 years) than for Localities I and II, and although sample sizes are again quite limited, patterning among these components is more consistent, with fall-winter mortalities predominating at Locality III (Hell Gap component) and late summer-fall deaths most common for the Cody component at Locality V. Patterning among the unprovenienced Locality X specimens from all localities is also fall-winter. There are no ageable maxillary dentitions from Locality III.

From the study of a series of 163 dentitions from various localities at Hell Gap, Rapson and Niven (2009:119) conclude that the Hell Gap dentitions represent multiple kill events, either of individuals or small groups, occurring over an unknown period of time, as opposed to a series of catastrophic kill events. Bison represent the most commonly identified faunal remains in the faunal assemblages. As the sample of dentition is rather small for any of the components an overall statement that Hell Gap valley was occupied at all times of the year is the safest inference at present.

The other major results of the three studies include butchering and consumption patterns, hunting strategies, and transportation choices. Butchering and consumption were documented in both size class 4 (bison) and size class 3 (deed/pronghorn) remains. The far larger assemblage of bison evidences significant quantities of cut marks detailing removal of meat cuts, dismemberment, and skinning processes. For size class 3 animals the evidence is more limited. Perhaps the most telling aspect of this activity is the high intensity of use of within bone nutrients as recorded by impact fractures. This added significantly to the small sample of Paleoindian sites, primarily camps, showing heavy butchering.

Not the least important, however, is the assemblage composition and its relation to utility indices). Representation of bison elements relative to several utility indices suggests that resource rich carcass portions were preferentially brought to the site, leaving low utility portions at kill locations. Together with other data this is one line of evidence demonstrating that Hell Gap valley functioned as a camp location for Paleoindian peoples.

All three studies, however, mention the collection bias and the problematic reliability of the results. Rapson and Niven (2009) are perhaps the most vociferous about the ambiguity introduced into the results as a consequence of not knowing the details of the excavation, collection, and subsequent curation, resulting in loss of specimens and records, biasing the assemblage and making inferences suspect. The extent to which the Hell Gap Locality I faunal assemblage reflects the original depositional assemblage remains unclear. Elements of the postcranial axial skeleton are undoubtedly underrepresented as a function of selective infield discard and other processes. However, the exact form of these and other modifications remains unknown.

Comparing 1960 and post-1990s Collections

Since 1993, we have been excavating the Hell Gap site, with systematic field (Figure 2), lab, collection, and curation protocols. Therefore, it should be possible to begin a preliminary evaluation of the bias presented in the 1960s faunal collection by comparing it to the post 1993 recovery. Only with such comparison can we evaluate the reliability of the results of the 1960s collection studies, which are still the largest assemblages available for analysis from the site.

Given the above caveats regarding interpretations from the 1960s collections, comparisons of 1960s to 1990s collections may provide some confidence about reliability of interpretations from the 1960 collections. We begin by asking how similar or different are the 1960s and 1990s collections? Specifically are the various assemblage measures such as NISP, MNE, %MAU, indexed NISP, and indexed %MAU similar or different between the two assemblages (Lyman 2001). Do these measures from the 1960s and

1990s collections correlate and is bone density a factor in the differences in the two collections?

To begin the comparison and in this paper we only compare 1960s Locality I fauna (n=572) with that from the 1990s (n=165). In addition, we only compare the bison or size class 4 and we further remove the ribs, and bone coded as flat bone, long bone, or various unidentifiable specimens from all following analysis as these make up more than 50 % of the assemblage and significantly skew the result of comparing elements.

We first ask: are the collections correlated? We find some correlations (Table 1) of NISP, MNE, and MAU and although the correlations are low, Pearson r is significant. And we find the same is true if we index NISP and MAU. What this suggests is that some elements occur in approximately similar proportions in the 1960s and the 1990s collections and we find no underrepresentation of post-cranial elements as suggested. To further explore these relationships we ask which elements are represented more than others and in which assemblages?

For this we subtract the 1990s NISP from the 1960 NISP (Figure 3a). The elements in the positive are overrepresented (> 1 sd) in the 1960s collections, while those in the negative (below) are overrepresented in the 1990s collection. The elements more than one standard deviation away from the mean are in the highlighted boxes. The same comparison for %MAU (Figure 3b) yields similar results, although with more elements 1 standard deviation away from the mean, likely a function of a less skewed distribution of this measure. The question arises what might the overrepresented elements have in common? Summarizing these deviations we find 21 elements more than one standard deviation away from the mean for each NISP or %MAU.

We might expect lower density elements to be less well represented in the 1960s assemblage, given the expected bone handling procedures of the field and lab. We first compare the bone density of all elements and find a significant difference between the two assemblages (Table 2a). However, the mean is the opposite of that predicted by density mediated attrition of the 1960s assemblage. In other words, the elements that are overall more common in the 1960s assemblage are lower density than those more common in the 1990s collection.

Furthermore elements that are overrepresented in both assemblages (Table 2b) are lower density bones than ones that are represented about the same. However, the difference of the mean density of the two assemblages is not significant. Several other comparison of bone density all show that bones form the 1960s collection are lower density than those of the 1990s, again the reverse of expected.

If we consider only overrepresented bones from both 1960s and 1990s assemblages (Table 2c), we find a significant difference between the two assemblages, but again with the 1960s being the assemblage with lower bone density.

Finally, we mention three aspects of the 1990s assemblage that are likely to have significant effects on future zooarchaeological analysis of Hell Gap: bone weathering, bone flakes, and carnivore modification. Bone weathering which generally appears to be more severe on the up sides will prove significant in demonstrating site integrity (Figure 4 left), something that has not yet been adequately investigated at Hell Gap. Two things appear forthcoming from bone surface condition: 1) bone was covered relatively quickly as the up and down sides often do not differ greatly; and 2) the small difference in weathering with the upper portion showing longer exposure to the elements is expected to demonstrate little post depositional movement of the bone and thus higher site integrity.

Although we have not yet compared bone flakes (See Figure 4 center) from the 1960s and the 1990s, we suspect that these will be underrepresented in the 1960s assemblage. The provenience of bone flakes recovered since the 1990s and their context will also provide a great deal of new information on butchering and consumption of animal products.

And third, carnivore modified bones (See Figure 4 right) are likewise expected to be more prevalent in the 1990s and subsequent collections. Again their detailed contextual information will add significantly to issues of site abandonment (i.e., carnivores coming into abandoned site) or possibly humans and their dogs. It is unlikely that carnivores would be that attracted to faunal remains at camps as these will not be particularly plentiful, with little food value remaining compared to kill sites.

Conclusion

To conclude, this is the first time since the 1960s and since the publication of the various Hell Gap site faunal analyses in various venues that we have an adequate sample of fauna to compare with the original collection. Presently we think that the 1960s assemblage and the biases introduced as the result of excavation and storage procedures has not resulted in catastrophic deletions of specimens and the substantive interpretations put forth in the works of Byers (2001, 2009), Rapson and Niven (2009), and Knell et al. (2009) may be more robust than originally thought. More to the point, however, further analysis of the 1960s collections, as well as the post-1990s collections, is likely to provide additional robust results from faunal specimens at this significant site.

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Figures

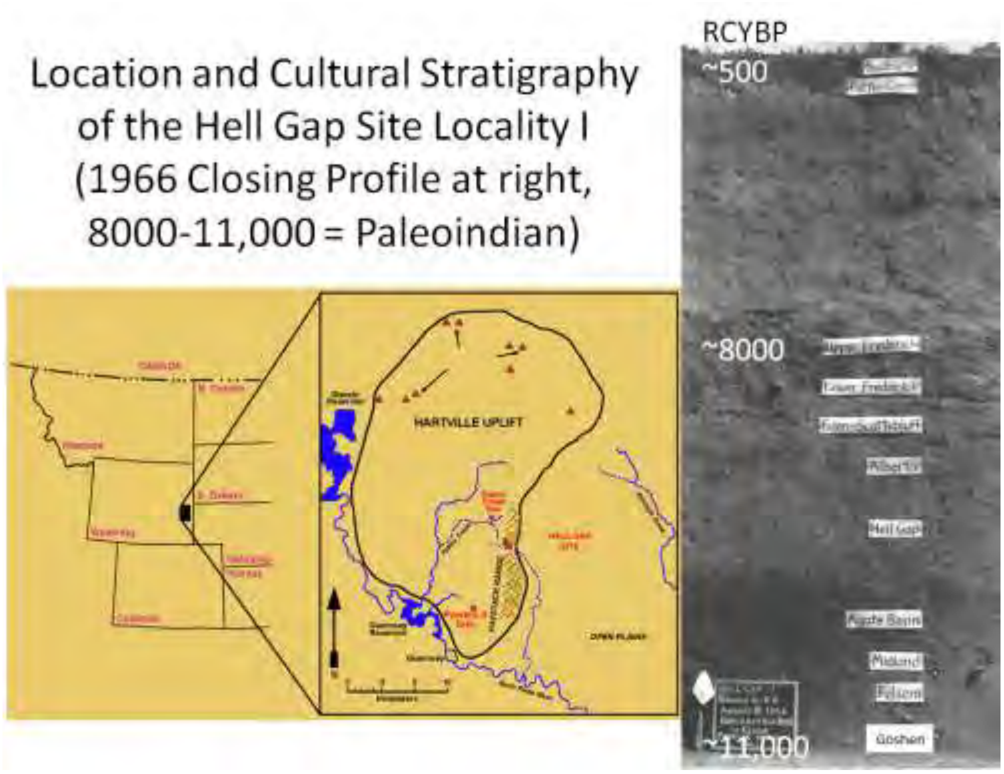

Figure 1. Location and stratigraphic section of Hell Gap

Figure 2. Post-1990s excavation and bone treatment

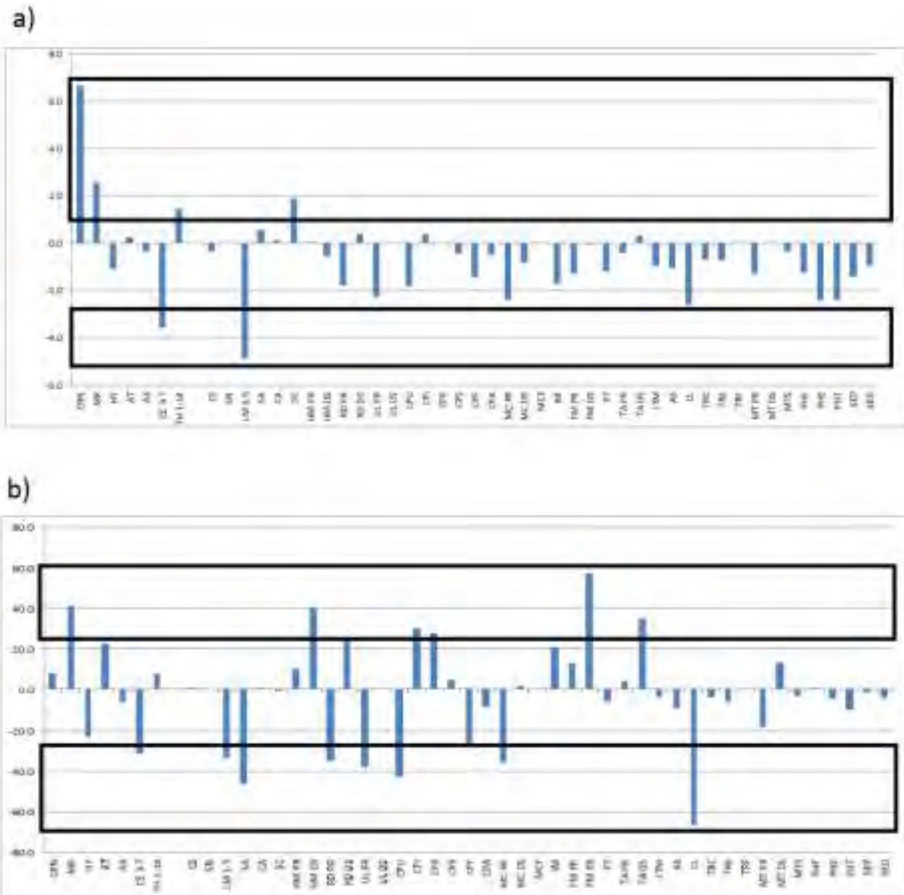

Figure 3. Difference between 1960s and 1990 element representation. a) NISP, b) %MAU.

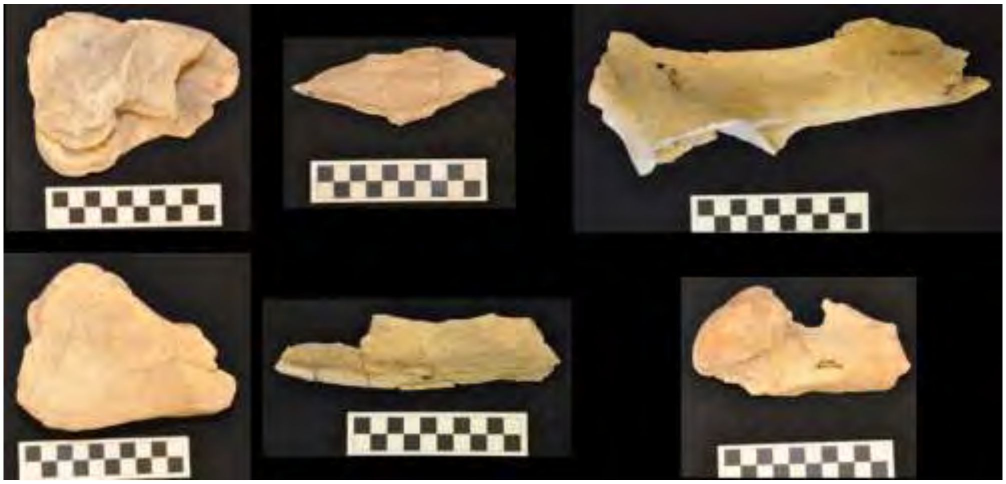

Figure 4. Examples of weathering (left), bone modification (flakes and impacts) (center), and carnivore modification on post-1990 Hell Gap faunal specimens (right).

Tables

Table 1. Correlation matrix of 1960s and post-1990 assemblages. Top-basic measures, bottom-standardized measures. **. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

		60s NISP	New NISP	60s MNE	New MNE	60s MAU	New MAU
60s NISP	Pearson Correlation	1	.501**	.598**	.240	.292*	.099
	Sig. (2-tailed)		.001	.000	.125	.044	.501
	N	48	42	48	42	48	48
New NISP	Pearson Correlation	.501**	1	.582**	.885**	.098	.416**
	Sig. (2-tailed)	.001		.000	.000	.539	.006
	N	42	42	42	41	42	42
60s MNE	Pearson Correlation	.598**	.582**	1	.537**	.640**	.291*
	Sig. (2-tailed)	.000	.000		.000	.000	.045
	N	48	42	48	42	48	48
New MNE	Pearson Correlation	.240	.885**	.537**	1	.024	.521**
	Sig. (2-tailed)	.125	.000	.000		.878	.000
	N	42	41	42	42	42	42
60s MAU	Pearson Correlation	.292*	.098	.640**	.024	1	.473**
	Sig. (2-tailed)	.044	.539	.000	.878		.001
	N	48	42	48	42	48	48
New MAU	Pearson Correlation	.099	.416**	.291*	.521**	.473**	1
	Sig. (2-tailed)	.501	.006	.045	.000	.001	
	N	48	42	48	42	48	48

Table 1. cont'd

		60s N%	New N%	60s %MAU	New %MAU
60s N%	Pearson Correlation	1	.563**	.293*	.099
	Sig. (2-tailed)		.000	.044	.501
	N	48	48	48	48
New N%	Pearson Correlation	.563**	1	.255	.543**
	Sig. (2-tailed)	.000		.081	.000
	N	48	48	48	48
60s %MAU	Pearson Correlation	.293*	.255	1	.473**
	Sig. (2-tailed)	.044	.081		.001
	N	48	48	48	48
New %MAU	Pearson Correlation	.099	.543**	.473**	1
	Sig. (2-tailed)	.501	.000	.001	
	N	48	48	48	48

Table 2. Bone density differences between 1960s and post-1990 assemblages.

a) all elements, >=.0 more common in post-1990s, <.0 more common in 1960.

	NISP (Old-New)	N	Mean	Std. Deviation	Std. Error Mean
VDa	>= .0	16	.4169	.18668	.04667

	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Equal variances assumed	.022	.884	-2.431	36	.020	-.13631	.05608	-.25003	-.02258
Equal variances not assumed			-2.367	29.098	.025	-.13631	.05759	-.25407	-.01854

b) elements overrepresented (>1sd) in both assemblages (O) versus those not (N).

	V21	N	Mean	Std. Deviation	Std. Error Mean
VDa	O	19	.4742	.19397	.04450
	N	19	.5174	.17091	.03921

	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Equal variances assumed	.365	.549	-.728	36	.472	-.04316	.05931	-.16344	.07713
Equal variances not assumed			-.728	35.438	.472	-.04316	.05931	-.16351	.07719

c) overrepresented elements only, >=.00 post 1990s assemblage, <.00 1960s assemblage

	%MAU (Old-New)	N	Mean	Std. Deviation	Std. Error Mean

	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Equal variances assumed	2.084	.167	-2.018	17	.060	-.14644	.07258	-.29957	.00668
Equal variances not assumed			-1.961	12.429	.073	-.14644	.07467	-.30851	.01562

Suyanggae, Why so Important (X)? With the Focus on Tanged-points from Cultural Layer 4 at SYG – 6

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Suyanggae Site, Danyang is one of the representative Upper Paleolithic sites having yielded various kinds of standardized lithic remains. Among 6 localities, there are 5 Paleolithic sites except Locality 2, where cultural phases have been identified from the Early to Late Upper Paleolithic Periods.

Through recent investigation from 2013 to 2015, there was excavated Locality 6 (SYG-6), 128° 17′ 54″ E, N 36° 56′ 09″ N, 3.5 km away from the Loc.1. From the SYG-6, all 4 cultural layers were found. While its CL 2 was dated around 18,000 BP identical to the SYG-1, the CLs 3 and 4 were formed from 34,000 to 40,000 BP. Especially, it is notable that there were unearthed the earliest blade assemblage in the Korean Peninsula from the CL 4, that is critical to study the blade technique of Northeast Asia in the Upper Paleolithic Age.

In addition to that, the CL 4 also revealed 56 tanged-points. It is the first case comprising such a large amount of the tool type in that early stage, except a few site with only 1 or 2 pieces. This paper will discuss the tanged-points excavated from the CL 4.

Geographical location and stratigraphy of SYG-6

Like SYG-1, the site is located on a wide and thick Paleosol deposited above the 2nd Terrace of the South Han River, where branch and main stream are united to form shallow waterflow (Figure 1). Sedimentation was formed with

Figure 1. Geographical Location of SYG-6

gentle slope from North to South. On fluvial sedimentation was deposited yellow brownish paleosol. Because of the complicated condition of sedimentation by slope and fluvial influence, composition and color come varied even in the same layer. Among the Paleolithic cultural layers, there are reddish brown sandy mud layers distributed, making clear separation among CLs (Figure 2).

Paleolithic cultural layers, yielding more than 40,000 pieces of artifacts. From the CL 2, 18~17 ka, there were excavated tool-making workshops, mainly utilizing shale as raw material.

The lithic assemblage appears identical to one of SYG-1, including blade, blade-core, microblade, microblade-core, and tanged points.

The composition of assemblage from the CL 3 are very similar with CL 2. What is important is that there were unearthed 'Suyanggae Stone Ruler', and 'Face-engrave sculpture' from the locality, showing the scientific and artistic development of the Paleolithic people. Below the layer, CL 4, 40~39 ka, shows very early laminar technology and tanged-

CL	Amount	%
1	581	1.4
2	21,775	53.5
3	7,439	18.3
4	10,882	26.8
Total	40,677	100

Table 1 Amount of Artifact Remains

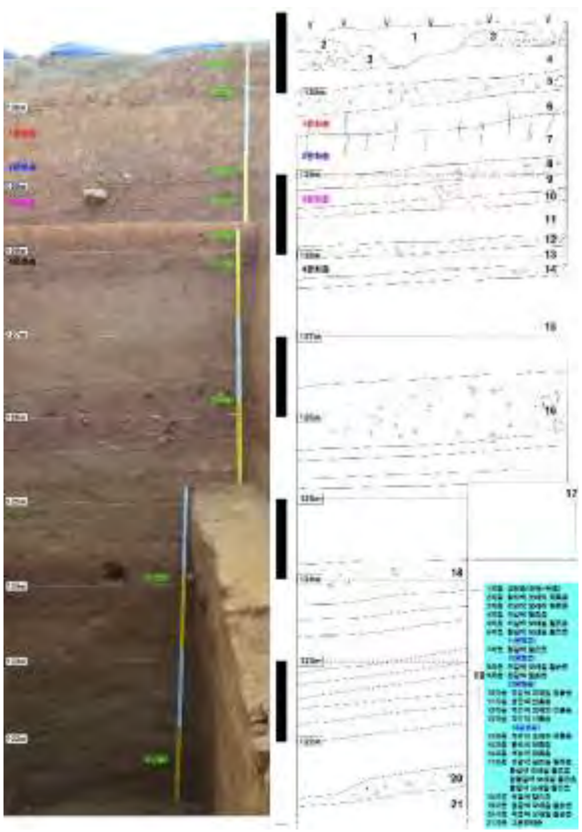

Figure 2 Stratigraphy of SYG-6

points mounting up to 56. Considering the early dates and typology, SYG-6 is thought to present us with critical date to understand the origin and diffusion of the blade and microlithic culture in the Northeast Asia.

Tanged-points of SYG-6

Tanged-point refers to a specific type of point, prepared with a tang, which is stem for hafting to a shaft. The tool is found distributed over the Eurasian Continent from the Middle to terminal Upper Paleolithic. In the Korean Peninsula, it has gained academic attention since excavation of SYG-1 (Lee, 1985). Basically, it is thought to have been manufactured for arrowhead, while the function can be varied.

So far, there were found 56 tanged-points from CL 4 at SYG-6, whose raw material is shale. Compared to assorted exploitation of raw material at SYG-1 using tuff, quartz, and porphyry as well as shale, it is very concentrated to a specific kind. Following is an analysis for 48 pieces including 39 in complete forms and 9 with broken tips.

Size

Position of tang is at the end of lower part of the tool. Size of 48 complete formed pieces are 44.76~93.76㎜ long, 14.14~35.17㎜ wide, and 4.45~11.18㎜ thick, whose average is 69.0×23.9×7.6㎜.

Ratio of length and width is 2.0 : 1~ 4.9 : 1, of which average comes 2.9 : 1. Compared to ones from SYG-1, whose average is 60×24×8.2㎜, and ratio of length and width is 2.63 : 1, the size and ratio is greater. It is thought to reflect difference of blank, that is, SYG-6 utilized blade in most of cases, while flake was used also with blade as blanks.

Size of tang is 7.7~31.5㎜ long, 2.98~17.4㎜ wide with 2.01~11.5 mm thickness, whose average is 15.8×8.2×5.8 mm. The ratio of length and width is 0.6 : 1~ 5.7 : 1, of which average is 2.1 : 1, while one of width and thickness ranges from 0.7 : 1 to 4.6 : 1, whose average is 1.6 : 1.

The ratio between whole length of tanged-point and tang ranges 2.4: 1~7.6 : 1, 4.6 : 1 in average, that is relatively short, only taking less than a quarter. This appears smaller compared to one from SYG-1, 2.9 : 1 (Lee and Kong, 2002).

Classification	Amount	%
Complete	39	69.6
Broken Upper Tip	9	16.1
Partially Broken	2	3.6
Damaged	6	10.7
Total	56	100

Table 2 Classification of Tanged-points

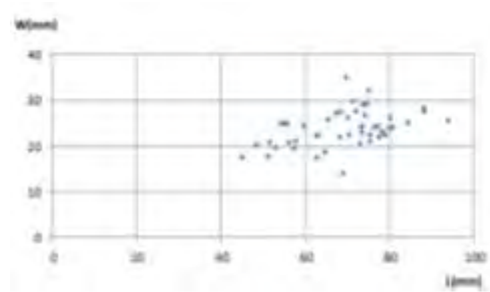

Table 3 Distribution of Sizes

Shape of edge and tang, and retouch on them

Every tanged-point was made from blank of blade. They can be classified by shape of cross section of edge, into 15 trapezoid, 32 triangle, and 1 polygon. Among them, trace flaked at basal surface was found in 44 pieces, which means that mostly 2 or 3 times of knapping had been performed for the tool-making.

Classification	Amount	%
Triangle	16	33.3
Trapezoid	14	29.2
Rectangle	13	27.1
Lozenge	4	8.3
Polygon	1	2.1
Total	48	100

Table 4 Classification of Cross-sections *Arrangement of tang and*

Table 5 Classification of Tang part

edge

Shape of Tang / Position of Edge		Ⅰ. Concave in both sides	Ⅱ. Concave in the left + oblique lines	Ⅲ. Concave in the right + oblique lines	Ⅳ. Oblique in both sides	Total
						
A. Unretouched		12	11	6	5	34
B. Right	a. Overall	1	6	1	1	9
	b. In the Middle					0
	c. Only at the End	1	1	2		4
C. Left	a. Overall			1		1
	b. In the Middle					0
	c. Only at the End					0
Total		14	18	10	6	48

Tang prepared by steep retouch can be classified into 4 types by Lee's classification (Lee 2011), while the edge can be divided into 3. Given the typology of tang, Type Ⅱ is largest with 18 pieces.

While many of position of edge were left not retouched, some was retouched in the right side. At SYG-1 where classification by shape of tang has not been attempted, it shows a similar statistics with SYG-6, with most of the edges unretouched.

Function of Tanged-point

Tanged-point can be classified by shape and working edge, into hunting tool as a point and household items like end-scrapper, denticulate, and borer. The symmetry is the most critical criterion to affect shooting range and precision (Lee and Jang, 2011).

So, to attest symmetry of the tanged-points, Flip Test v. 0.9 was chosen to have Index of Asymmetry (IA). As a result, 18 comes in symmetrical range from Class 1 to 4, while other 30, 62.5%, show low symmetry. Basically, the asymmetry appear because of inclined axis between tang and edge. Even cases with overall retouch, the degree of symmetry can be seen very low, because opposite edge of the retouched has a natural sharp edge, which can imply that there might have been other purpose other than a projectile point.

Future Research

It has been observed that some of the tang part still carry residue of adhesive to be fixed into shaft. With other cases found among end-scrapper, the analyses for adhesive will provide how the tool-maker utilized other elements more than lithic material, which has rarely been tried in the Korean Paleolithic. To understand the composite tool-types, it is critical to study how the Paleolithic people designed and maintained the purpose.

Conclusion

Suyanggae Site is a site of significance holding the developing phases in tool-making during the Upper Paleolithic. And recent investigation on SYG-6 revealed brand new dates from Cultural Layer 4 about laminar technology in the Korean Peninsula starting from 40 ka. With the technique, it is notable that tanged-points were excavated in a large amount with other blade tools.

As the tanged-point is typical tool type with microblade in the Upper Paleolithic, it is groundbreaking discovery that the dates around 40 ka is 20,000 years older than the famous tanged-points of SYG-1.

Given analyses, it is interesting that while the tanged-points of SYG-6 are bigger than ones of SYG-1, the portion of tang part is relatively small. This is thought to have reflected selection of blank according to specific purpose.

Class	Index of Asymmetry(IA)	Level of symmetry	Interpretation	N(=48)	%

1	1.0~1.49	Virtually perfect	Suggests an almost mathematical level of precision has been applied - unlikely on Acheulian items - could it be a modern replica?	0	0
2	1.5~2.99	Very high	An exceptionally skilled craftsman - special purpose?	4	8.3
3	3.0~3.99	High	Skilled work	4	8.3
4	4.0~4.99	Moderate		10	20.9
5	5.0~5.99	Low	Look for intractable material, or eccentric shape e.g. on butt.	7	14.6
6	6.0 & above	Very low	Look for intractable material, serious material defects, eccentric shape or a modern break in the item	23	47.9

Table 6 Degree of Symmetry

symmetry can be crucial criteria to check efficiency of projectile hunting tool, the great value of asymmetry of SYG-6 may show that the tool-type had a various function, not only as a hunting instrument.

Suyanggae Locality 6 is thought an important site showing that blade technique was already developed in the early stage of Upper Paleolithic before 40,000 BP. It is expected to provide us with valuable information about lithic technology and cultural features in the East Asian Region.

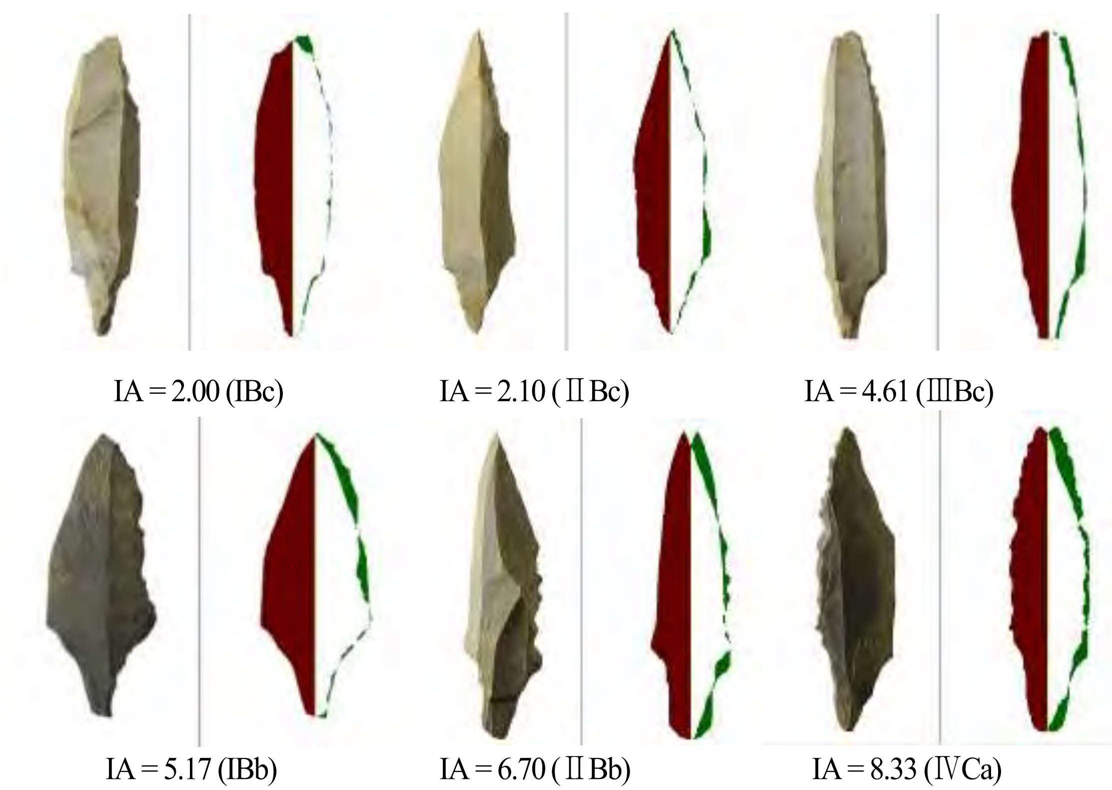

Figure 3 Index of Asymmetry(IA) of Tang part

Figures

Figure 4 Location of SYG-6

Figure 5 Unearthed Stone Artifact *in situ* from CL 4

Figure 6 Stone Artifact in situ from CL 4

Figure 7 Tanged-points in situ

Figure 8 Type 1 of tanged-points
from CL 4 of SYG-6

Figure 9 Type 2

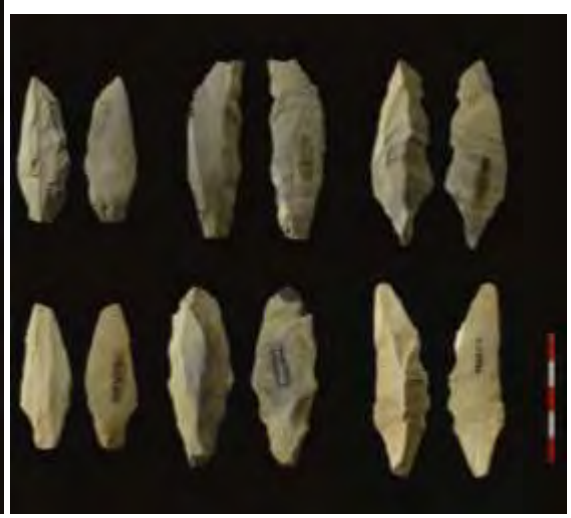

Figure 10 Type 3

Figure 11 Type 4

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The Akhziv Tsunami (?) Deposit

In memoriam Prof. Dan H. Yaalon

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Abstract
The Phoenician Tel Akhziv is located on the coastal sandstone ridge in northern Israel. In the southern cemetery of Akhziv rectangular discussed here chamber tombs (10th – 7th centuries BC) were cut into a hard sandstone. Above the tombs was deposited a surface layer of poorly consolidated sand 0.8 m thick, 3.5- 4.0 m above mean sea level. This sand layer is outstanding among all fossil dunes on the Israeli coastal plain by the intrusive objects it contains. There are angular debris of sandstone and limestone, limestone pebbles and numerous pottery fragments distributed throughout the layer's thickness. The potsherds, of types found in the underlying Phoenician tombs, do not show signs of erosion, wear or marine incrustations, suggesting a near-by terrestrial source, a short transport and a rapid burial. Both pottery assemblage and radiocarbon date the deposit to the 8th century BC. Sedimentological analyses currently on way will hopefully determine whether the deposit is tsunami-derived, as we believe.

The Phoenician city Tel Akhziv is located on the Mediterranean seashore of the Galilee in northern Israel about 5 kilometers south of the Israel/Lebanon border (Figures. 1 and 2). The city had three cemeteries located, respectively, north, east and south of the city.

The southern cemetery, subject of the present paper, is located on the south bank of the wide, sandy former outlet of the Shaal and Kziv rivers to the Mediterranean.

The Galilee seashore runs along a fossilized aeolianite sandstone (called 'kurkar') ridge. The southern cemetery is located on that shore ridge. It consists of 10th- 7th century BC rectangular Phoenician chamber tombs (Dayagi-Mendeles and Ben-Dor, 2012; Mazar 2012). The tombs were cut into the hard sandstone (Figure 3) of the Dor Formation dated 53-51 ky BP (Porat et al., 2004) and apparently reaching up to 38 ky BP (Engelmann et al., 2001; Frechen et al., 2002 and Neber, 2002).

The sandstone is covered by a thin (1-2 cm thick), strongly eroded or abraded layer of reddish loam (locally called Hamra) (Netanya Formation), composed of well sorted fine quartz grains (ca 80%) with clays, silts (10-40%), a small amount of heavy minerals (1.5%) and carbonates not exceeding 3% (Bakler et al., 1972). The clay particles thinly envelope the quartz grains and annex iron oxides that provide the soil's characteristic brick-reddish color. The Akhziv loam contains Epi-Palaeolithic, microlithic artifacts as in the Netanya Formation elsewhere along the Israeli coast (Bar-Yosef, 1970). This red loam is dated between 20.3±5.2 and 11.2±1.4 ky BP (Engelmann et al., 2001; Frechen et al., 2001; 2002), in good agreement with the date of the embedded archaeological remains, 20-12 ky BP (Ronen et al., 1975; Ronen, 1977; Saxon et al., 1978).

Above this soil a poorly cemented sand layer, the subject of our study, was deposited, 0.8 m thick, 3.5- 4.0 m above mean sea level (Figure 3). The deposit consists of medium and coarse sand grains with abundant tiny shell fragments of 1 – 2 mm. The upper 15-20 cm is gray (organic crust) with thick laminae (Figure 4), lightly consolidated and easily broken. The lower 50 - 60 cm of the deposit is yellowish unconsolidated sand with no visible bedding. The Akhziv sand bed is outstanding among all fossil sand dunes along the Israeli coastal plain, calcified or non-calcified, by containing geological and cultural objects. Sand and sandstone beds on the coastal plain are devoid of cultural remains (Ronen 1975). Cultural remains on the coastal plain occur only in red loams. Hence it appears that humans roamed the plain in periods of soil formation but were absent during sand transport and deposition, when sand storms must have rendered life unbearable. The encroaching sand also destroyed the vegetation and prevented the survival of animals as well as humans. The geological foreign elements in the Akhziv deposit include angular debris of ancient sandstone, angular limestone debris (Fig, 5a) and flat limestone pebbles 2-15 cm long (Figure 5b). The cultural contents include pottery fragments distributed throughout the entire depth of the deposit, always in a horizontal position (Figure 5c). The potsherds are of types found in the underlying Phoenician tombs, sometimes 20 cm in length. The potsherds do not show signs of erosion, wear or sea encrustations, suggesting a near-by terrestrial source, a short distance transport and a rapid burial. The pottery fragments incorporated in the Akhziv deposit could have originated in fragments left around during previous feasting parties. According to the pottery assemblage contained in the Akhziv deposit and to 14C dating (below) it probably dates to the 8th century BC.

Fossil sand dunes on the coastal plain are almost always strongly cemented by calcite originating in the shell fragments contained in the sand (Yaalon 1967). The cemented beds are of two major types: the most common is composed of Nile-derived quartz sand (=sandstone; locally "Kurkar") and the other type is composed of organogenic sand grains (=Calcarenite). Both forms were deposited by eolian transport. The Akhziv deposit is not eolian, as clearly indicated by the heavy objects it contains, nor is it strongly cemented. Hence it is neither sandstone nor calcarenite. These outstanding features generated the hypothesis (A.R.) that it was a man-made imitation of a natural sand bed aimed to cover the tombs and protect them from looting. Accordingly, the foreign objects would have been placed deliberately to help bind the sand deposit, similarly to the grits in the potter's clay.

The hypothesis of an artificial deposit raised two difficulties: first, no parallels are known of an anthropogenic imitation of a geological occurrence. Second, and the most serious, how was the upper part of the deposit artificially cemented, albeit slightly? What binder was used? The question was put to several geologists who visited the site but had no solution. One visitor, Dr. Dorit Korngreen of the Geological Survey of Israel, was the first to raise the possibility of a tsunami-derived deposit.

Later, mapping the Akhziv deposit with a total station 1 revealed that it could have covered originally an area ca. 22 x 15 m (Figure 6). Subsequently the deposit ended with a highly irregular contour which does not conform to natural erosion. Five deep bays were cut into the deposit with underlying tombs exposed in three of them (the eastern, northern and western) (Figure 6). The contour was seemingly man-made in order to expose the covered family tombs. It may be expected that additional tombs may hide beneath the two southern bays as well.

The non-eolian Akhziv deposit best resembles beachrock. Beachrocks are composed of sand rich in shells and shell fragments, arranged in thick bedding and cemented (Gavish and Friedman 1969). Beachrock forms slightly off-shore along the shoreline in the shallow sea, at the junction of salt and sweet water which allegedly triggers cementation (Hanor 1978). Large/heavy objects transported by the sea are sometimes incorporated in beachrocks. These characteristics closely match the Akhziv deposit, except that the latter is 4 m above sea level. Was the deposit tsunami-derived? A northern extension of the Akhziv deposit was found by E. Galili 5 km north of the southern cemetery (Figure 7). Hence the layer may have been deposited along the northern coast of Israel between Acco and Rosh Haniqra (Figure 8).

^{14}C Dating (S.Y.)

Radiocarbon dating of the upper and lower layers of the Akhziv sand deposit was conducted. After removing macroscopic contaminants and granules using tweezers and a sieve, the two samples were pretreated with HCl. Small shell fragments (less than 2 mm) contained in the sediments were dissolved in this process. The graphite samples produced after the pretreatment were measured against a standard of Oxalic acid (HOxII) provided by the National Institute of Standards and Technology (USA), using a 14C-AMS system based on the tandem accelerator, at the Institute of Accelerator Analysis Ltd. (Japan). The calendrical year calibration was conducted by OxCal v. 4.2 (Bronk 2009) based on IntCal 13 database (Reimer et al. 2013). The resulting radiocarbon age of the upper sand is 2570±30 BP, and 4070±30 for the lower sand. The calibrated calendrical age of the former is 800-769 cal BC for 1σ, and 808-571 cal BC for 2σ. For the latter, 2831-2499 cal BC for 1σ, and 2849-2488 cal BC for 2σ (Table 1).

The carbon recoveries after the pretreatment of the samples are 0.13% for the upper sand and 0.11% for the lower sand. The samples show low values of carbon recovery, and the interpretation of the obtained data requires some caution. However, the highest probability of the upper sand age is in the early 8th century BC, which is consistent with the archaeological observation.

Concluding Remarks

The Akhziv deposit is the only sand bed along the Israeli coastal plain that has consolidated (albeit lightly) in 2.500 years. The detailed history of this deposit remains an open question.

Needless to add that the apparent wish to expose the tombs underneath the Akhziv deposit refutes the hypothesized wish to hide them. Thus, the assumed human origin of the Akhziv deposit was erroneous. The 8th century BC deposit presented here was recognized 5 km northward, also 3-4 m amsl. The Akhziv deposit may have affected the shore of northern Israel between Akko and Rosh-Haniqra (Figure 8). Sedimentological analyses are presently being carried out to elucidate the origin and depositional process that led to the unusual Akhziv deposit and to compare it with known tsunami analogues.

Table 1 Radiocarbon age and calendrical age of the Akhziv deposit.

Lab number	Sample	Pretreatment	Radiocarbon age (yr BP)	Calibrated age (1σ)	Calibrated age (2σ)
IAAA-100712	Akhziv upper layer	HCl	2,570 ± 30	800 - 769 cal BC (68.2%)	808 - 750 cal BC (82.8%) 684 - 667 cal BC (4.4%) 638 – 590 ca lBC (7.6%) 576 – 571 cal BC (0.6%)
IAAA-100713	Akhziv lower layer	HCl	4,070 ± 30	2831 – 2821 cal BC (5.3%) 2631 - 2568 cal BC (50.9%) 2518 - 2499 cal BC (12.1%)	2849 – 2813 cal BC (9.8%) 2739 – 273 4 cal BC (0.4%) 2693 - 2688 cal BC (0.4%) 2680 - 2488 cal BC (84.9%)

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Figures

Figure 1: Location of Akhziv on the northern coastal plain of Israel**.**

Figure 2: Tel Akhziv seen from the southern cemetery. The white rocks on the horizon are on the Israel/Lebanon border.

Figure 3: The Akhziv deposit (foreground) and underlying Phoenician tombs in the southern cemetery.

Figure 4: The partly cemented upper part of the Akhziv deposit.

Figure 5a: Foreign objects in the Akhziv deposit: an angular limestone debris.

Figure 5b: Foreign objects in the Akhziv deposit: a flat limestone pebble.

Figure 5c: Foreign objects in the Akhziv deposit: pottery fragment.

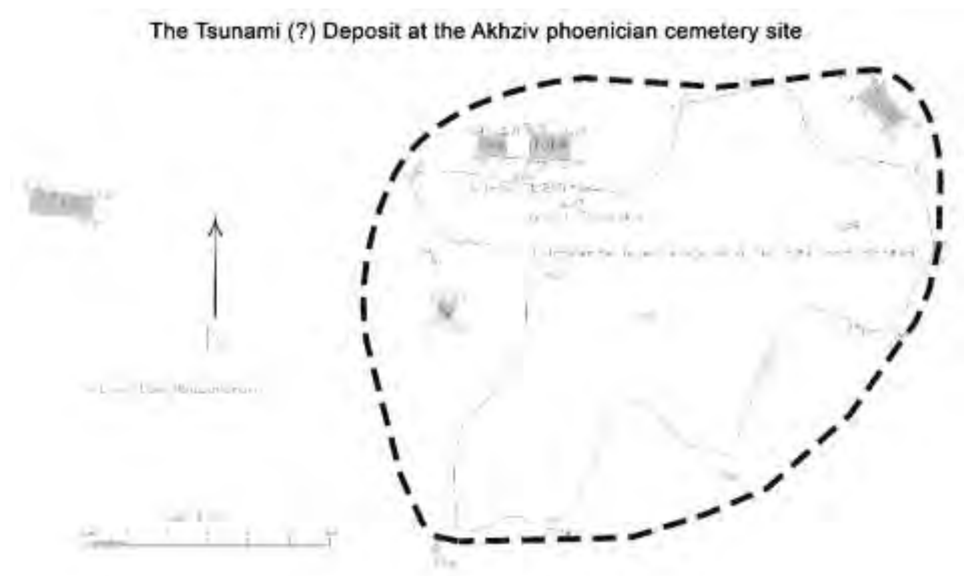

Figure 6: Probable original extension of the Akhziv deposit and present contour. Note tombs in the western and northern bays. Tombs may exist in the southern bays as well.

Figure 7: The northern extension of the Akhziv deposit. Note foreign intrusions.

Figure 8: The assumed range of the Akhziv tsunami on the northern coastal plain.

Pleistocene to Holocene archaeology in the Japanese Archipelago: an overview

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Abstract
In the Japanese Archipelago first pottery emerged just before Late Glacial (15 ～ 11.7 ka), and continued successively through Holocene and historical period till today. The Japanese LG corresponds to Incipient Jomon era archaeologically except Hokkaido, northernmost Japan. Paleoenvironmental settings changed greatly, but cultural changes are much different each area in the transition from Pleistocene to Holocene of Japan.

In the Late Upper Paleolithic of the Paleo-Honshu Island, mobile hunter-gatherers formed smaller regional territories in and after LGM, because the extinction of Pleistocene larger terrestrial mammals just before LGM led to middle-small animals for the main hunting target by hunter-gatherers. Main hunting stone tools, such as some kinds of backed point, bifacial point, microblade, each area interchanged one after another. Lastly, more sedentary subsistence activity of Jomon era started from 16 ka. While, in the Paleo-Hokkaido Peninsula, UP hunter-gatherers with microblade industries maintained large territories with wide mobile behavioral mode and continued through LG till the beginning of Holocene. Because, more warm and humid maritime condition, caused temperate forest and maritime stable resources, changed from the southern Kyushu to northern Hokkaido gradually during LG.

The transition from the Paleolithic to the Neolithic, Jomon era, in the Japanese archipelago, can be described as one of the largest historical epoch ever seen on both sides of the natural environment and human culture. This transition overlap with the global large scale climatic change of the Pleistocene / Holocene transition, the Late Glacial (LG), which eventually led to the later historical events such as emergence of cultivation, civilization and urban society. However, applying a simple development theory as the transition from mobile hunter-gatherers of Paleolithic to settled agricultural society of Neolithic is no longer efficient from a global perspective, and it has been widely accepted that there were diverse and unique "transition" for each area. Also, in the Japanese Archipelago, its own aspect has become increasingly evident according to the progress of recent researches.

Upper Paleolithic: 38,000 – 16,000 cal BP

Paleo-environmental settings

By sea level lowering of the ice age (-100~140 m), the Japanese Archipelago of the Paleolithic was in different geographical settings compared to the present. Sakhalin Island, Hokkaido and the southern Krile Islands were combined to form the Paleo-Hokkaido Peninsula and was connected to the Asian Continent, while Honshu, Shikoku and Kyushu formed a single landmass called the Paleo-Honshu Island, and in the Paleo-Ryukyu Islands land had expanded than it is today as a result of glacial eustasy (Figure 1). For these settings, historical genealogy of archaeological cultures between Hokkaido and Honshu is fundamentally different, and also the process to the Jomon (Jomonization) show significant dissimilarity between them (Sato, 2013).

Because the area of the Paleo-Sea of Japan reduced remarkably, and then full-scale ocean current could not flow into it by the sea level regression of the ice age, the Japanese Archipelago of the Upper Paleolithic had been dominated by cold, dry climate of the continental. Since in the ice age, the principal paleo-vegetation became cool temperate coniferous forest in the east half of the Archipelago and Pan-mixed forest with conifer and broad leaf trees in the western half, plant resources as the main food was very poor. In addition to the paucity of plant resources, climatic condition was unstable and fluctuated in a short period as Dansgaad Sycle. These led to the upset of resource structures and the low predictability of resource acquisition. Therefore, Paleolithic hunter-gatherers were the middle-sized and large animals, which are applied by moving to changes in the natural environment, in the major hunting target as the subject of food resources. This is well consistent with the fact that stone assemblages of Japanese Paleolithic had been mainly hunting tools (Sato, 2015).

Large and medium-size terrestrial mammals in the Japanese late Late Pleistocene comprised the two main faunal groups. The strait between the Korean Peninsula and Paleo-Honshu Island has not been connected after 120 ka, and the *Palaeoloxodon-Sinomegaceroides* complex, mainly composed of Naumann's elephant (*Paleoloxodon naumanni*), giant deer (*Sinomegaceros yabei*), is believed to have dispersed into the Japanese Archipelago across the Korean Peninsula by least 120 ka. The other group, the mammoth fauna, including woolly mammoth (*Mammuthus primogenius*), brown bear (*Ursus arctos*), and steppe bison (*Bison priscus*), derived from the northern cold zone as Siberia and spread across Paleo-Hokkaido Peninsula around 50 ka. Of both faunas, large animals such as elephant, cattle and large deer became extinct until the beginning of LGM (25-20 ka) in the Paleo-Honshu Island, and until the terminal LGM (20 ka) in the Paleo-Hokkaido Peninsula (Iwase et al, 2011).

Archaeological records and human behavior

In the latter part of Late Upper Paleolithic (29-18 ka) of the Paleo-Honshu Island, by rapid reduction or extinction of infested herbivory large animals moving a wide area, prehistoric hunter-gatherers changed the hunting target to small and middle-sized animals which have narrower habitat, so that they adopted the new behavioral strategy, moving round the reduced smaller area systematically. Therefore, the separation and alternation of regional lithic assemblages and the localization of regional communities made progress frequently. The main stone hunting tools such as various pointed tools with retouched back or base, Kiridashi-shaped tools, pyramid-shaped tools, and stemmed points, were changed one after another.

On the other hand, in the start of the Late Upper Paleolihtic (21 ka) of the Paleo-Hokkaido Peninsula, the microblade assemblages were introduced from the continent, and continued to be used until the beginning of the Jomon era. When the large animals began to extinct, the Sakkotsu (the stage of late Early Microblade Industry [19 – 16 ka]) type and Shirataki type microbalde assemblages (the beginning of the stage of Late Microblade Industry), which adapted to long distance movement and microcore producing made by Yubetsu Method, were gradually disappeared, and the stage was shifted to the Late Microblade Industry [16 – 10 ka], which performed the logistic subsistence behavior in the reduced activity area(Sato and Tsutsumi, 2007).

In the terminal Upper Paleolithic (18 – 16 ka) of the Paleo-Honshu Island, the bifacial projectile point assemblage emerged, and came to spread over the specific region. Immediately after that, the pyramidal microblade industry emerged in the east Paleo-Honshu Island under the influence of the microblade industry of Paleo-Hokkaido Peninsula, and then spread over the whole Paleo-Honshu Island. Significant separation of local lithic industries at this stage is latent, and it caused the upset in the local community network. Therefore, immediately after, beyond the cultural boundaries of the Tsugaru Strait, which had been firmly formed up to this time between the Paleo-Hokkaido and the Paleo-Honshu, the Sakkotsu and Shirataki type microblade assemblages, which adapted to a long distance movement as mentioned above, spread southward to the eastern Paleo-Honshu Island. Because large animals had been already extinct at the time of Paleo-Honshu Island, human groups with these two types of microblade assemblages could not maintain the advantage such as long distance movement, and came to adapt rapidly to the local environment through subsistence transformation such as a salmon fishing (Sato, 1993; Morisaki and Sato, 2014). These Yubetsu microblade assemblages of northern origin assimilated local bifacial assemblages in each regions of Paleo-Honshu Island, and gave birth to the Miko Shiba-Chojakubo assemblage, which is defined by large bifacial point, sophisticate axe, and blade end scraper. At this stage, some sites were already accompanied by first pottery.

Incipient Jomon (16 – 11.7 ka)

In 15 ka, immediately after the relative climate recovery phase of ice age, the global climate upheaval period called the LG (15 – 11.7 ka) begun. According to the Scandinavian pollen analysis, it is well known that three cold and two warm stages visited alternately in a short period of LG, but, because we cannot obtain high resolution in the environmental/paleo-climatic analysis of Japanese Archipelago, it is reasonable that LG of Japan roughly was divided into the first half of the warm period, LG-Warm, and the second half of significant cold period (LG-Cold, YD).

Since Odai-yamamoto 1 site of northern Honshu was reported to date to C14 calibration age 16,900-14,800 cal BP, which are oldest dates in Japan, by charred remains on earliest pottery, researches of this site insist that the oldest pottery was found in last stage of ice age beyond LG, in the vegetation zone with coniferous forest. Because the pottery continued to be used stably from the emergence period to the later in the Japanese Archipelago, the use of the term, the Incipient Jomon, for this phase, is reasonable.

Presently, areas where is the origin of the pottery in the East and North Asia reported to date back to the Pleistocene, are the Transbaikal, Russian Far East, China and Japan. In the East and South China, prior to 20 ka of the late LGM, world's oldest pottery emerged, while the earliest pottery appeared in the terminal LGM of the Japanese Archipelago later. In the early LG (LG-Warm), the first pottery emerged in the Russian Far East and the Transbaikal. In the Amur basin of the Russian Far East, the pottery making occurred first in the Gromatukha and the Novoprtrovka cultures of the middle Amur basin, and a little later in the Oshipovka culture of the lower Amur basin. The emergence of pottery in the Transbaikal was almost the same time as the middle Amur basin. In the late LG, the first pottery appeared in North and Northeast China. As earliest pottery emerged in all regions under the different natural and resource environments each other, it is difficult to explain that the beginning of pottery use by single or specific reason (Sato and Natsuki, in press; Table 1).

In the Japanese Archipelago, following the emergence period of pottery (16 – 15 ka), when the number of archaeological sites is a few, the period of linear relief and nail impressed pottery (15 – 13 ka) correspond to the warm period of early LG and in this stage the number of sites is increased in the entire Archipelago. However, since the vicissitudes of the number of sites is rise in the south and fall in the north, it is considered that hunter-gatherers adopted basically the semi-mobile residential subsistence behavior under the climate warming. Since livelihood activities seem to be quickly adapted corresponding to warming, the amount of pottery per single site greatly increased and pottery type differentiation occurred, and archaeological features such as trap-pits and fire pits actively built in the south Kyushu (Morisaki et al., in press).

According to the carbon/nitrogen isotopic analysis of charred remains on pottery for food habits, in the northern regions around the Sea of Japan such as the northern Japanese Archipelago and the Amur basin, use of aquatic resources was continued since the emergence of earliest pottery consistently (Kunikita et al., 2013). However, since the utilization of plant resources came to be active in the Incipient Jomon era of south Kyushu, where pottery use stabilized earlier, subsequently in the whole archipelago, the use of pottery was for processing the plant food such as nuts lying in the temperate broad leaf forest, which came to yield more nuts, and as a result, sedentary subsistence behavior came to be promoted.

However, the settlement consisting of multiplex pit dwellings first formed in the late LG, LG-Cold, that was the period of pottery with several cord marks (13 – 11.7 ka). That the formation of the first settlement carried out in the cold period of late LG is considered as one of the adaptive behaviors adopted in order to maintain the sedentary life way obtained in the warm period of the early LG even in the cold period. However, the assumption that the formation of the first settlement immediately led to established sedentary lifeway is premature. In the Jomon period, which is characterized by exclusively planned and efficient multilateral use of natural resources, though settlements and related facilities were maintained throughout the year, many of the population is thought to be carried out seasonal residential movement (Sato et al., 2011).

Earliest Jomon (11.7 – 7 ka)

When the LG was finished, the world reached a stable mild climate of the Holocene in reversal. In the Japanese Archipelago, the transitional process from the Pleistocene to the typical Jomon period, which lasted close to 5,000 years, completed and the Earliest Jomon began. In the Earliest Jomon, natural environment came to be nearly same to present. Vegetation of the Archipelago was almost divided into two parts, which were the west Japan with evergreen broad-leaved forest and the east Japan with temperate deciduous broad-leaved forest, nuts were one of major food in the resource environment. Because the large animals of the ice age had already disappeared, main terrestrial resources were small and middle-sized animals such as deer and wild boar, and therefore, bow and arrow hunting, which is more effective in the forest, became the major technique in the hunting method.

Because by rising sea levels due to global warming in the beginning of the Holocene, the continental shelf sunk below sea level and the shallow sea areas and tideland emerged. Large amount of marine resources, such as salmon and shellfish, became available. And as a result, fishing was adopted enthusiastically.

In contrast to the Asian continent where dry climate continued in the Holocene, because the Japanese Archipelago changed to the maritime warm and wet climate along with the expansion of sea area and the establishment of the Sea of Japan, the area of Jomon culture, which adopted seasonal and diversified forest economical system consisting hunting, fishing, and gathering, was supposed to be limited to approximately present range of the Archipelago, Hokkaido to northern Ryukyu.

However, since the progress of climate warming was delayed in the Hokkaido, Incipient Jomon pottery was not observed with the exception of a part of the Tokachi region, and mobile residential behavior was still continued. *Jomonization* was to be initiated from the southern part of Hokkaido. Spread of Jomon life way in whole Hokkaido, except for the northern part, had to wait till the middle Earliest Jomon (Morisaki et al., 2015; Morisaki et al., 2016).

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Figures

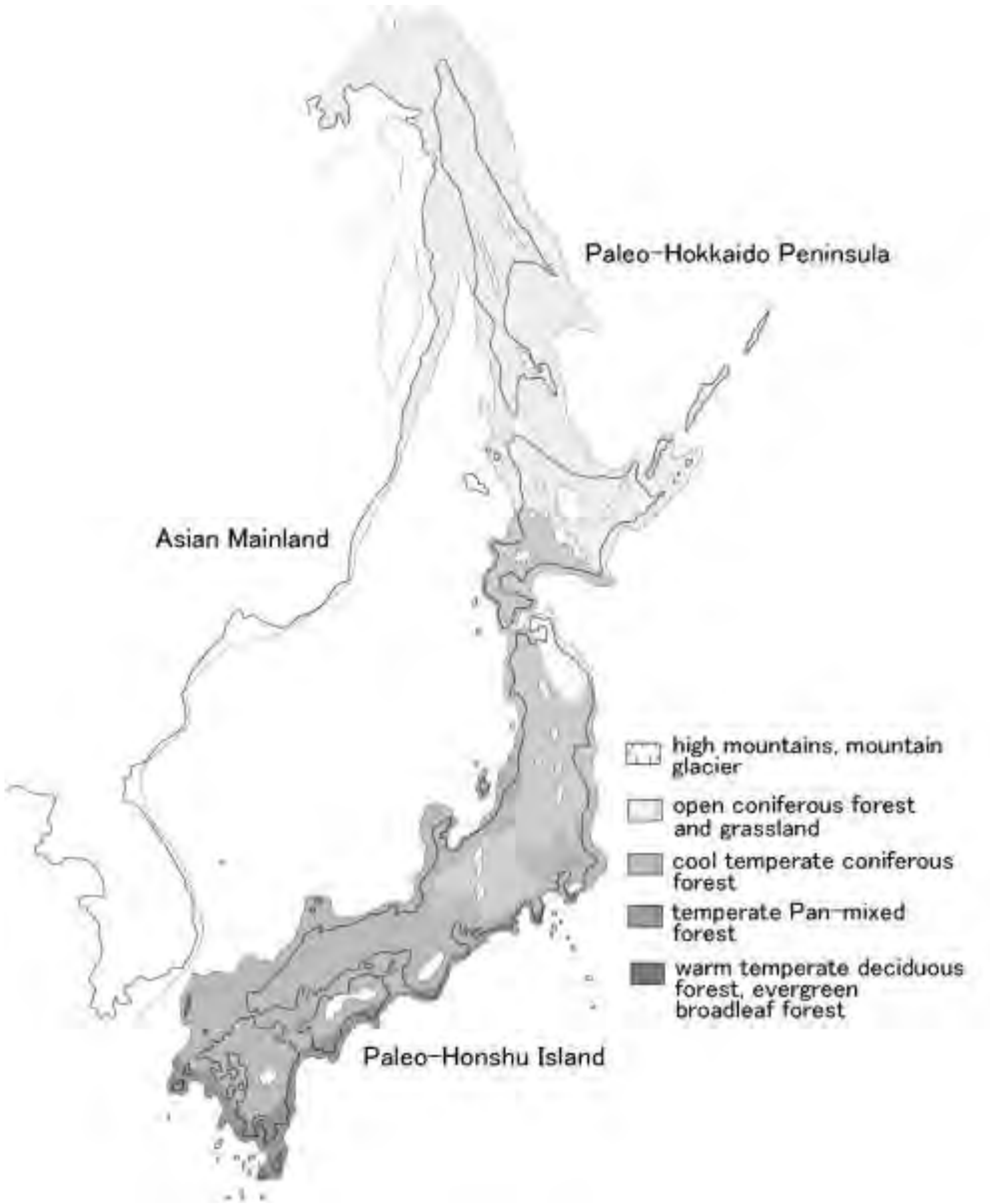

Figure 1: Topography and vegetation zones of the Japanese Archipelago and surrounding regions during the LGM (Iwase et al., 2012).

Region	Site	Layer	Calibrated Age	Estimated climate	Note
East China	Xianrendong west trench	3C1B	22,700～19,200	LGM Cold-2	
		3C1A	20,000～16,500	LGM Cold-2	
	Yuchanyan		18,200～13,500	LGM Cold-2/LG-Warm	
South China	Liyuzui	lower	27,900～12,000	LGM Cold-2/LG-Warm	
	Miaoyan	5L,6L	25,500～20,500	LGM Cold-2	
	Zhuwuyan		21,400～20,000	LGM Cold-2	
	Dushizi	lower	21,600～18,800	LGM Cold-2	
		middle of upper L	21,900～17,000	LGM Cold-2	
Japan	Odai-yamamoto 1		16,900～14,800	LGM Cold-2	Tohoku
	Akahira		16,800～16,400	LGM Cold-2	Tohoku
	Kitahara		15,800～15,400	LGM Cold-2	Kanto
	Gitoenyama 2N		16,400～15,700	LGM Cold-2	Kanto
	Fukui	2,3	16,200～15,700	LGM Cold-2	Kyushu
Far East	Gromatukha	lower or 3	14,800～14,000	LG-Warm	AMS, Gromatukha Culture
	Novopetrovka 2		15,600～10,800	LG-Warm/LG-Cold/PG	Novopetrovka Culture
	Goncharka 1	3B	13,300～12,100	LG-Warm/LG-Cold	AMS, Oshipovka Culture
	Novotroitskoe 10		13,500～12,900	LG-Warm	Oshipovka Culture
	Oshinovaya-rechika 16	3	13,300～12,700	LG-Warm	Oshipovka Culture
	Gasya	5	13,300～12,600	LG-Warm/LG-Cold	AMS, Oshipovka Culture
	Khummi	lower	16,200～11,700	LG-Warm/LG-Cold	Oshipovka Culture
Transbaikal	Ust'-Karenga 7	7	14,200～12,100	LG-Warm/LG-	

Region	Site	Layer	Calibrated Age	Estimated climate	Note
				Cold	
	Ust'-Kyahuta 3		13,500〜13,100	LG-Warm	
	Studenoe 1	8,9g	14,000〜13,300	LG-Warm	
	Ust'-Menza 1	8	13,500〜13,300	LG-Warm	
Japan	Taisho 3		14,700〜13,800	LG-Warm	Hokkaido
	Kiwada		14,500〜14,200	LG-Warm	Tohoku
	Seiko-sanso B		14,400〜13,700	LG-Warm	Chubu
	Kamiinoharu, Loc.5		13,600〜13,100	LG-Warm	Kyushu
North China	Nanzhuangtou	T1-6	12,700〜12,000	LG-Cold	
	Lingjing		12,800〜12,500	LG-Cold	
Japan	Takihata		12,100〜11,800	LG-Cold	Tohoku
	Kuzuharazawa 4		12,900〜12,700	LG-Cold	Chubu
	Torimama, 83 trench	85	12,800〜12,000	LG-Cold	Kinki
Far East	Oshinovaya-rechika 10	3	13,000〜12,200	LG-Cold	Oshipovka Culture

Table 1: Representative sites with Pleistocene pottery in the East and Northeast Asia (Sato and Natsuki, in press).

Useful Companions: Domestic Dog Use on the Northern Great Plains

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Abstract
Dogs were the earliest domesticated animal in the New World. They accompanied the original colonizers of the North American continent on their initial journey and remained important to indigenous groups even after the introduction of other domesticates such as the horse. On the Northern Great Plains, dogs were integral to the livelihood of many different groups. They were the original multipurpose tools, used as beasts of burden, hunting aides, sources of food and raw materials, alarm systems, camp custodians, and of course, companion animals. They also held ritual and symbolic significance for many groups. This paper presents some of the different ways that Plains Indian groups utilized dogs and integrated them into their societies. Accounts from European observers and ethnographic studies, along with scant archaeological evidence, are used to demonstrate the importance of dogs to the indigenous societies of the Great Plains.

There are many reasons why archaeologists and anthropologists should care about dog use, as it has the potential to impact several facets of human life, including subsistence, mobility, security, material procurement, and ceremonial life. Dog use affects subsistence in multiple ways. First, using dogs as hunting aides affects hunting behavior and outcomes, including investment in pursuit, success rates, and prey choices. Dogs can also affect subsistence directly as source of food. Mobility is enhanced by the use of dogs as beasts of burden, which is especially important to highly-nomadic groups such as most Plains Indian tribes. The role of a watchdog is important to the security of both people and their belongings. Dogs are materially important in multiple ways as well. They can be a source of raw materials such as bone and skin, and may also affect the material culture of group in their role as a traction animal. Dogs also have ritual and symbolic importance as well, showing up in creation stories and other oral and ceremonial traditions. Finally, dogs have a psychological impact on their keepers, even outside of contemporary Western ideas of pet-keeping. Dogs are companions and friends to people, in the present as well as in the past.

There are several sources of evidence for learning about dog use in the past on the Great Plains. First, diaries of travelers who spent time living with Indian societies on the Plains are rich sources of information on dog use, albeit from an outsider's perspective. Notable examples include Prince Maximillian, Henry Brackenridge, Paul Kane, and Rudolph Kurz, just to name a few. Several notable painters and artists who historically worked on the Plains often portrayed Indian dogs in their compositions, the most famous being George Catlin (Figure 1), Peter Rindisbacher, and Karl Bodmer. A few modern enthusiasts are experimenting with dog traction technology and their replication work is valuable to understanding this use. Archaeological information can be direct evidence, such as the skeletal remains of dogs or the material remains of technologies associated with dogs, or indirect evidence, such as rock art depictions and modifications to faunal assemblages that may be the work of dog scavenging. Finally, a few ethnohistoric accounts directly reporting on dog use are invaluable to the study of dogs on the Plains.

Gilbert Wilson's 1924 work "The Horse and Dog in Hidatsa Culture" is one such ethnohistoric account. Wilson's primary source of information on dog husbandry was Buffalo Bird Woman. She gave Wilson details about all aspects of dog husbandry in Hidatsa culture, including naming and training practices, descriptions of the dogs and how to build travois frames, discussions of how the dogs are fed and how they are used by different parts of Hidatsa society, and so on. This work is one of the richest sources of traditional dog use in the Great Plains.

Another excellent source, Glover Allen's 1920 work "Dogs of the American Aborigines" is a valuable overview of the types of dogs that used to be found among Native American groups. Three different "breeds," as Allen calls them, are important to this discussion. Plains-Indian dogs are described as medium in size, with large erect ears, drooping or slightly upcurved tails, and a rough coat that is "ochreous tawny", whitish tawny, or sometimes black and gray, mixed with white. The Sioux Indian dog is described as "a large, wolf-like dog, probably closely related to the Plains-Indian dog, but larger and gray rather than tawny in color." Finally, some dogs of the Plains groups probably fit best into the category of the common Indian dog, of which Allen says, "This was probably closely related to the Plains-Indian dog, but seems to have been usually solid black or black and white in patches instead of resembling the coyote in color." Naturally mummified dogs from the Basketmaker period cave site in Arizona demonstrate that different types of dogs were in use in the past; the larger one appears very similar to the description of Plains-Indian and Sioux dogs offered by Allen (Figure 2, from Colton 1970).

Perhaps the most important use of dogs on the Plains is as a traction animal or beast of burden, as dogs hauled people's goods during frequent residential moves. Some Plains Indian groups would move their encampments up to 30 times a year, following herds of bison and in search of fresh hunting grounds. Dogs also assisted on logistical forays, including hunting trips where they were responsible for hauling equipment and supplies on the way out as well as for transporting meat back to the residential base. Finally, dogs were especially useful to women on their daily excursions to collect firewood and haul water back to the camp. Multiple hauling strategies exist involving dogs. These include sled use in the winter, simple side packs, and the travois, which consists of two poles lashed together and secured near a dog's shoulders with various harness configurations (Figure 3, from Henderson 1994). Bundles of goods are then secured to the poles behind the dog. While dog sled use especially is a widespread phenomenon in Arctic and Subarctic regions around the world, dog travois technology appears to be unique to the Great Plains of North America.

Aside from ethnohistoric accounts, direct evidence of dog travois use in prehistory is known from a few examples of travois poles preserved in exceptional situations. Travois pole fragments are known from at least two cave sites in Wyoming, and a dog travois pole was found at an open-air site along the Bad Pass Trail in Montana in recent years. One of the issues with direct archaeological evidence of dog traction technology in prehistory is that poles, harnesses, and leads are made of perishable organic materials such as wood, sinew, and hide. These materials do not preserve well except in exceptional circumstances, such as caves and rockshelters in arid or protected contexts. However, direct archaeological evidence of dog traction may be found on the skeletons of prehistoric dogs as well. Long-term use of travois frames, harnesses, and packs can lead to skeletal changes that may be considered markers of occupational stress for dog traction. This includes deviated spinous processes on the thoracic vertebrae, deviations of the dorsal border of the scapula, and increases in the overall robusticity of the skeleton.

A fascinating attempt to understand dog traction was undertaken by Norman Henderson in the early 1990s. Henderson (1994) built a replica travois frame according to instructions given by Buffalo Bird Woman. He then hitched the travois to a borrowed Alaskan husky named Serge and set off across the Plains of Manitoba and Saskatchewan for an experiment in the efficacy of travois travel. Henderson found that Serge had difficulty pulling the travois through boggy wetlands or through thick brush, but the travois poles acted almost like sled runners over smooth grass and they were able to travel up to 27 kilometers a day with a load of about one half of Serge's body weight of 25 kilograms. Serge was able to haul his entire body weight and even a little more during shorter trial runs. Henderson found that the limiting factors to Serge's performance were overheating during the hot summer days and the amount of water the dog had to consume to remain active. More replication work in this vein would be both informative and exciting.

Somewhat surprisingly, it appears that dogs were not frequently used directly as hunting aides on the Great Plains, although the Cree, Assiniboine, Dakota, and Ponca are recorded to have used them. The Assiniboine in particular used dogs to harry and pursue wounded animals when hunting bison. Globally-speaking, dogs are more frequently used to hunt smaller game than larger game, and therefore Plains groups, who mostly focused on bison, may not have used dogs directly during hunting. However, dogs may have been more important as logistical support during hunting trips rather than as actual hunting aides. Buffalo Bird woman described the importance of dogs during hunting trips; the Hidatsa took several dogs with them whenever they left camp on hunting forays.

Dogs served a source of food for some Plains groups, and this could also be important during hunting trips, as there was always meat nearby if needed. Dogs serve as walking larders or meat on feet that do not spoil and are always nearby. Since dogs do a lot of scavenging and eating of food that is unfit for humans, they turn waste back into calories that are usable by humans. Not all Plains groups ate dog flesh on a regular basis, but the Sioux did, and a few groups of Athapaskan speakers ate dog so frequently they were called Chariticas or Dog-Eaters by their neighbors the Comanche (Thurman 1988). Many other groups ate dogs ceremonially or as a delicacy, including the Arikara, Dakota, and Blackfoot. Finally, some groups claimed to not eat dogs at all and had cultural sanctions against the consumption of dog flesh; this includes the Hidatsa and the Cheyenne groups.

Dogs can be very protective of their space and vicious towards strangers. The role of indigenous dogs as alarm and security systems is well-noted in ethnohistoric accounts (Pferd 1987). Paul Kane, in describing Cree dogs in the mid 19th century, noted that the dogs “were sometimes dangerous (especially) in times of scarcity. I have myself known them to attack the horses and eat them.” Kane, describing Indian dogs near Fort

Edmonton, stated that “Their ferocity is so great that they are often dangerous... Mr. Rundell was himself attacked one evening, while walking a short distance from the fort, by a band of these brutes, belonging to the establishment...” However, some travelers thought that the ferocity of Indian dogs was over-rated. Henry Brackenridge, writing during his 1811 stay with the Arikara along the upper Missouri River, said that “The dogs, of which each family has 20 to 30, pretended to make a great show of fierceness, but on the least threat, ran off.” In either case, it is clear that dogs fulfilled a role in the protection of the camp, people, and most importantly, the horses which were so important to Plains culture.

Perhaps one of the reasons dogs were described as so vicious is that they often led lives of hardship and had to fend for themselves and compete with each other when it came to food. Although accounts of dog feeding are rare in the ethnohistoric literature, most groups only gave dogs scraps and refuse such as bones that were inedible to humans. Buffalo Bird Woman reported that the Hidatsa did not feed their dogs once they were grown, but that puppies were often given extra bits of food to aid in their growth and development. Puppies were also occasionally suckled by human nursemaids as well. However, once dogs were mature, they were expected to fend for themselves by capturing small animals such as rodents and by scavenging in camp refuse. By being camp scavengers, dogs also served a function as camp custodians and contributed to the cleanliness of camp areas.

Depictions of dogs in rock art are an interesting source of information regarding their use and care. A panel from a Great Basin site shows two different types of dogs, some with short tails and some with long tails, pursuing big horn sheep (Figure 4, left, from Pferd 1987). This provides evidence of hunting strategies involving dogs which do not have archaeological signatures. A panel from the Dinwoody site in Wyoming appears to show a dog on a leash held by a person (Figure 4, right, from Pferd 1987). As mentioned earlier, much of the material culture associated with dog use is perishable and does not preserve at archaeological sites. Rock art panels such as this one depict aspects of dog husbandry, such as leashing, that may be difficult to learn about from other sources.

Dogs were more than just living tools to many Plains groups. The Sioux and other groups consumed dog flesh as parts of ceremonies and ritual feasts. Dogs figure in the creation stories, death stories, and general mythologies of several groups. For example, the Cheyenne told a story of a starving time early on in their history. A young man and his wife set off to find food, using their dogs to pull travois with their belongings on it. The man, his wife, and their dogs went to the Sacred Mountain and met a great Medicine Man. The Great Medicine Man told the young man to put on a cap of buffalo horns and leave the mountain. When the man, his wife, and their troop of dogs left, great herds of bison followed them back home and the Cheyenne people were saved from their hardships.

Finally, the origins of dogs are part of the oral traditions of these groups as well. The Hidatsa tell about a supernatural being named Yellow-Dog who taught their people about dogs and how to use them. Yellow-Dog told the Hidatsa that there were four kinds of dogs: a bad-tempered type named Forehead-Raised, one named Lodge-Digger that dug holes, one named High-Catcher that stole meat, and one named Four-Eyes that had two tan spots above its eyes and was kind and gentle. Yellow-Dog told the Hidatsa to kill the first three types of dogs, but to keep Four-Eyes, who was to be a friend and tool for the Hidatsa people.

Although the context of dog use on the Plains in very different from contemporary ideas of dogs as pets, the role of dogs as companions animals should not be overlooked. Dogs provide comfort and support from a psychological perspective and keeping dogs nearby can lend a sense of security and help keep the bed warm during cold Plains winter nights. A good hunting dog is a reflection of a worthy owner, and raising and training dogs can be a source of pride as well as economic worth. Finally, dogs may be simply be seen as a friend and constant companion in addition to other roles as a beast of burden, hunting aide, or any other specific use.

To summarize, many different groups of people on the Plains utilized multiple types of dogs for many different purposes. This is known from ethnohistoric evidence, period paintings and traveler diaries, rock art, and direct archaeological evidence including dog remains and associated technology such as travois frames. Most importantly for the Great Plains, dog traction complemented the high residential and logistical mobility necessary for migratory bison hunters. Even after the introduction of the horse, the dog remained an important tool as a beast of burden, hunting aide, watchdog, and food source. Dogs also figured into the ceremonial and personal lives of their keepers. To groups such as the Sioux, Cheyenne, Dakota, Comanche, Plains Cree, Arikara, Mandan, Hidatsa, Blackfoot, Piegan, and Assiniboine, as well as many others, dogs were multi-purpose tools, useful companions, and impacted the lifestyle and culture of their keepers in multiple and important ways.

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Figures

Figure 1. Comanche dog fight; print by George Catlin ca. 1834. Image courtesy of americanart.si.edu.

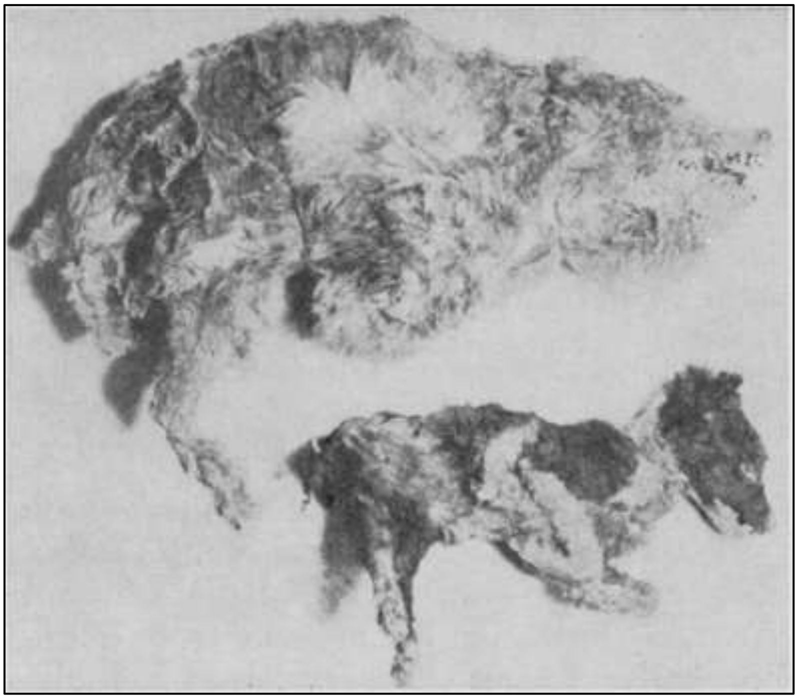

Figure 2. White Cave, Arizona: Basketmaker period mummified dogs of two different types. Image from Colton 1970.

Figure 3. Experimental dog travois recreated from Buffalo Bird Woman's instructions to Gilbert Wilson. Image from Henderson 1994.

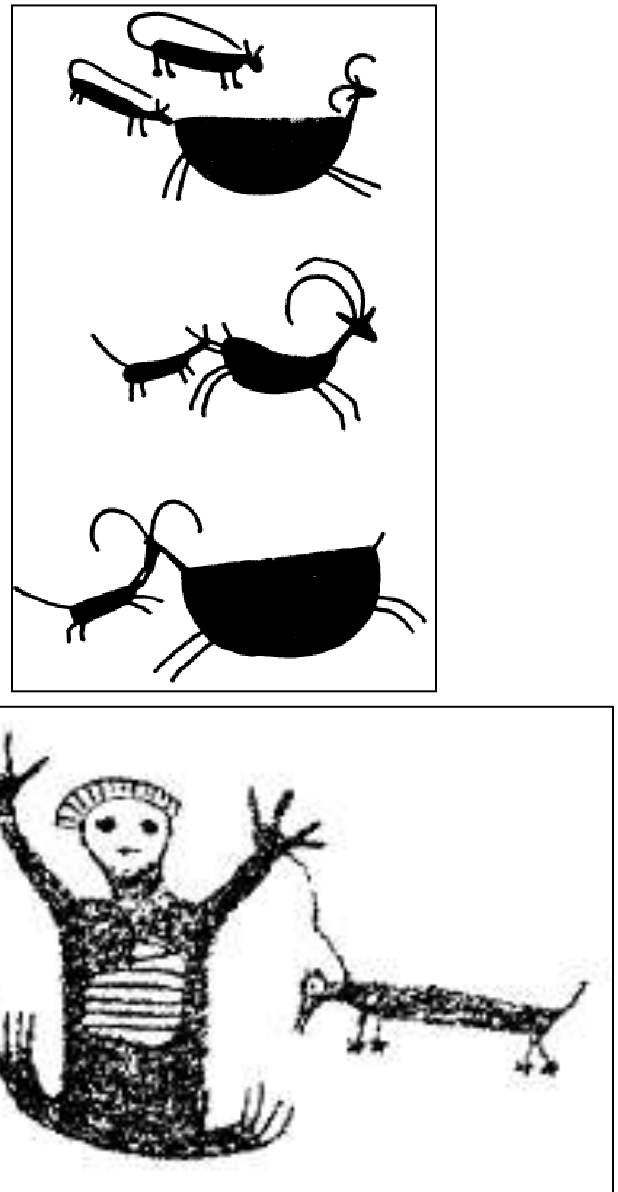

Figure 4. Rock art panels depicting dogs. Top: Great Basin. Bottom: Dinwoody, Wyoming. Images from Pferd 1987.

Hunting strategies in Late Pleistocene Landscapes. Case of the Middle Danube Basin

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Abstract
Landscape geomorphology, occurence of animal herds, and optimal hunting strategies are causaly related. This presentation combines patterns of the Late Pleistocene landscape in the Middle Danube basin (central Europe) with records of settlement archaeology and archaeozoology. Spatial distribution of various types of hunter´s sites (including the large mega-sites) and extensive mammoth bone deposits within the Dolní Věstonice-Pavlov area is correlated with the river valley geomorphology and used to address the hotly debated questions of Gravettian mammoth hunting and its efficiency. Location of a later site under the rock cliff at Stránská skála IV is presented as an example of Epigravettian horse hunting site. Finally, the paper examines some complex patterns engraved on mammoth tusks (Pavlov, Předmostí) as possible „field maps“, also related to optimal hunting strategies and planning.

Correlating settlement and hunting strategies

During the Würmian Interpleniglacial (MIS3), the „mammoth steppe“ of North Eurasia with large game herds offered abundant meat, fat, bone and skin resources to the early modern hunters, given that they were skilled, armed and organised enough to reach them. Specifically, the Gravettian sites of central Europe follow larger rivers and concentrate at narrow passages or bottlenecks („gates“), and at other places of strategic significance. Due to ongoing archaeological research, such strategy is documented at large sites within the Lower Austrian-Moravian geographic corridor (Willendorf, Krems, Dolní Věstonice-Pavlov, Předmostí, Petřkovice).

Later during the LGM, the central parts of Europe changed to a narrow belt between the Fennoscandinavian and Alpine glaciers. We generally observe a retreat of the arboreal and shrubb cover, related to a retreat of the large glacial megafauna and the hunting population density. The small Epigravettian hunting site Stránská skála IV is presented here as an example of the changed adaptive patterns.

The Gravettian/Pavlovian case

Within the Gravettian "mosaic" of various hunting orientations and strategies in the individual parts of Europe, the central parts of the continent represent a special case – the Pavlovian (30-25 ky uncal BP). The intensity of occupation layers and richness of artifacts, large hearths and related dwelling structures, variability in seasonal occupation over the year, and time-consuming and delicate technologies (microliths, fine ivory carvings, textiles...) suggest a relative sedentism, or, at least, tethered nomadism at these sites. As a paradox, the strong cultural relationship among the sites along the Austrian-Moravian-Polish geomorphological corridor, long-distance lithic material importations and following animals herds along the rivers, suggest a mobility of this population at the same time. All in all, we reconstruct a flexible resource exploitation system over a larger territory providing material and nutrition through the year.

The Pavlovian settlements are located regularly on elevations of the mountain slope, slightly above 200 m a.s.l., enabling cotroll of the floodplain about 30-40 m lower. Some of these sites also controll steep side-gullies which possibly served as „natural traps" (Figure 1). Extensive mammoth bone deposits, as a typical formative phenomenon at these Moravian sites, were accumulators either inside the settlements or separately, in the gullies or on the slopes below. Mammoth clearly played a major role in the Pavlovian economy (Svoboda et al. 2005; Musil 2010; Wojtal et al. 2012), accompanied by a relatively lower representation of the middle-sized herd animals such as reindeer and horse, but with numerous smaller fur-bearing mammals such as wolf and fox, and also by hares, fishes, birds (Bochenski et al. 2009; Wertz et al. 2015), and plants (Mason et al.

1994; Revedin et al. 2010). In the light of this evidence, various authors underline the different aspects and argue for mammoth hunting versus mammoth scavenging, reindeer hunting, small game hunting (using nets), and plant gathering (West 2001; Soffer 2003).

These debates have a long history beginning with the excavation of J. Wankel at the site of Předmostí in the 19th century. The authority of a visiting Danish scholar J. Steenstrup convinced Wankel that humans at this site were not contemporaneous with the mammoth. Finally, Wankel accepted Steenstrup's view that later hunters of the "reindeer age" would have come to the site to explore bones from natural mammoth bone deposits. However, as the larger and more systematic excavation was initiated by Absolon at Dolní Věstonice in 1924, doubts about man and mammoth interaction disappeared, and the idea of "mammoth hunters" was widely adopted in both scientific and popular literature. Still later, critical work of L. Binford concerning the pattern of human hunting in general, and reexamination of the Moravian mammoth hunting theory by Soffer (2003), raised further doubts about the human capacity to hunt animals as large as the mammoth.

Recent archaeozoological analyses of the mammoth bone deposits (Figures 2-3) show a certain preference for younger animals but no visible pattern in selecting a particular type of bone, and only few or no cutmarks directly on the deposited bones (Klíma 1969; West 2001; Svoboda et al. 2005; 2011; Oliva 2009; Musil 2010; Wojtal et al. 2012). In this situation, the arguments on intentional mammoth hunting are rather indirect in nature.

One of the arguments offers the spatial relationship of the archaeological sites to "elephantine environments" along the river valleys, especially to strategic locations controlling the valleys and to narrow side gorges which may have served as "natural traps".

Second, if we would exclude mammoths from the faunal prey composition, the classical horse-and-reindeer component will be too restricted and the remaining faunal spectrum formed by smaller animals (hares, foxes, wolves, birds) will be insufficient – given the size and complexity of the human settlements. Thus, the meat-and-fat content provided by the mammoth accumulations must be calculated into the food consumption.

We do not argue that mammoth were hunted systematically by all Upper Paleolithic populations who came to contact with these large animals on the steppes (similarly as not all coastal populations would automatically hunt whales). However, the complexity of the Pavlovian technology and related symbolism suggests that, if ever any Paleolithic society would systematically attack as large an animal as the mammoth, the Pavlovians would represent one well equipped in terms of material, knowledge, and psychology.

The Epigravettian case

Stránská skála (Figure 4) is a limestone cliff renomed especially as complex of EUP settlements and lithic workshops based on local chert exploitation (Bohunician and Aurignacian, 40-30 ky uncal BP) located on the upper plain, with poor organic preservation. In contrast, the Epigravettian site IV (18 ky uncal BP) at the foot of the cliff was not a regular settlement; rather, it was a hunting site. A large assemblage of horse bones was separated in two accumulations (Figure 5), together with limestone debris from the rock wall above, and rare lithics (mostly imported rocks in this case). Horse predominated in both accumulations, although one of them also provided a few other species. Following West (1996), eleven adult horses and one individual under theree and a half years were dispatched, probably (following dermestid life cycle) during summer seasons. It seems that the animals were extensively dismembered at the site, their heads were probably transported away (because of fat?) and various postcranial bones left at place. No cutmarks were observed.

It is clear that the rock wall of Stránská skála plaied a role in the hunting strategy, be it by driving the animals from the upper plain over the cliff (as at the Indian jump-sites) or, inversely, from the bottom valley upwards against the rock wall.

Hunting maps?

Ethnology provides us with a rich evidence of how recent hunters-gatherers produce simple but practical „maps“ and give names to geographic features in the landscape. Recent populations focus on practical landscape features that are directly related to resources and to modes of their exploitation – hunting, gathering, or fishing, and neglect other visible landmarks that are not related to such tasks. Among many examples, we refer here to Mallery´s (1886) documentation of a story transmitted into a two-dimensional representation: Lean-Wolf, a Hidatsa Indian, passed walking from his home village along the Missouri to a Dakota village to steel horses, and returns succesfuly back riding a stolen horse. Besides the narrative aspect of the story, the picture provides informations about the both villages, their internal structure, and on the riverine network between. The meaning of these patterns is both documentary and narrative.

At the site of Pavlov in South Moravia, Bohuslav Klíma (1988) discovered a complex geometric pattern engraved on a mammoth tusk, and interpreted it as a sorf of „map“. In his view, the pattern shows the meandering river, the mountain slopes behind and the living site represented by a small double circle in the center. At the first sight, this idea seams difficult either to defend or to opose, but it becomes more meaningful in context of other analogies from the Eurasian steppes. These were provided by a similar complex pattern engraved on ivory tusks at Kiev-Kirillevskaia street, Eliseevichi and Mezhirich (Ukraine), and by other, possibly spatial representation from western Europe (Svoboda 2007; Utrilla et al. 2009).

Předmostí is another mammoth site controlling the southern exist of the Moravian Gate as one of the important bottlenecks within the system of Lower Austrian-Moravian corridor. Two mammoth tusks from this site display complex geometric engravings. The first one originates from the 19th century excavations and it was interpreted as a simple female figure, possibly as a preparatory sketch for the second, more complex female engraving. The second case was discovered in 1895 and first interpreted as a geometric engraving, to be recognized later as a highly stylized female representation. Today, it is one of the best-known artifacts of the Pavlovian art.

When comparing the first simple drawing with the actual landscape (Figure 6), the two lines that Klíma interpreted previously as outlines of a female body may also correspond to the valley slopes and the short diagonal lines may provide additional information about their quality/accessibility. The two arches recalling female breasts refer to the bottleneck deeper inside the valley as an important point in hunting strategy. And, as at Pavlov and Kirillevskaia, the small rectangular object placed asymetrically below would corresponds to the location of the Předmostí site controlling the southwestern entrance to the valley.

A variety of linear symbols are being used and combined in the Pavlovian, and these were usualy considered simply as decorative patterns „to fill the space“. Given the analogies from recent hunters-gatherers, however, it is possible that the linear or zig-zag symbols, the curvature and hatching, display landscape features (tundra, water, slopes, or other natural barriers) and information about their accessibility to animals and humans. In the light of this, the Pavlov and Předmostí tusks may provides utilitary informations about how the river valley and the slopes may be used for driving animal herds and for planning the optimal hunting strategy.

Conclusion

Understanding the mammoth hunting as an integral part of the Gravettian/Pavlovian adaptation system become easier if one considers it in a context. The evidence of huge mammoth bone deposits as a result of *some* kind of man-and-mammoth relationship may be extended in the context of the adjacent hunter´s settlements, the sorrounding landscape, and its strategic potential. The complete change of settlement and hunting strategies after the LGM provides evidence of how strong the impact of climatic change on faunal exploitation systems may be. The earliest „maps“, „plans“, or „stories“, possibly created by hunters as functionally related and sophisticated artifacts, fit well into this complex record.

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Figures

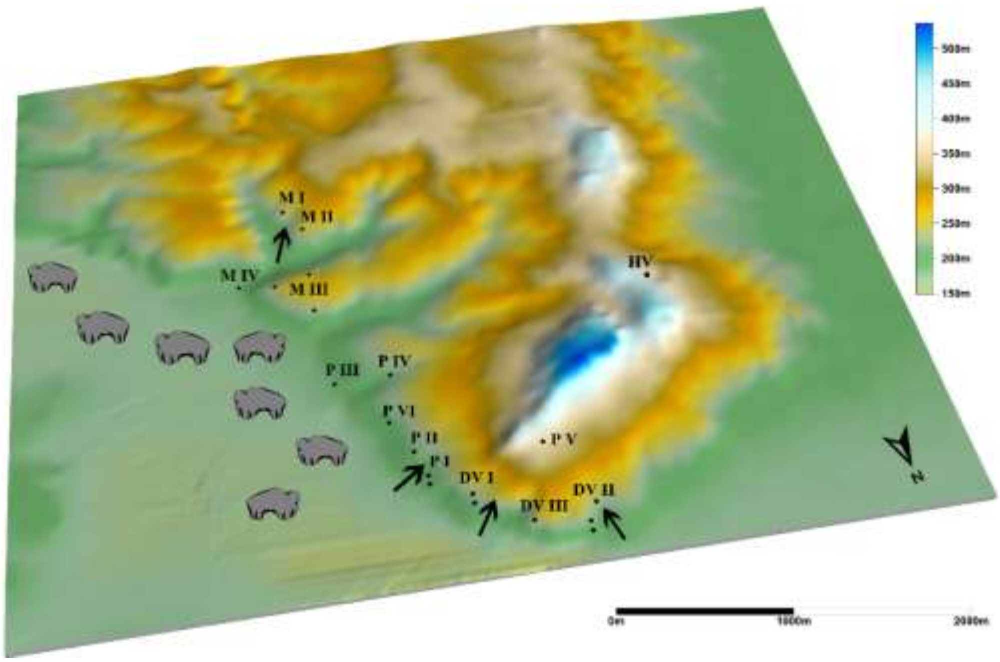

Figure 1: The Dolní Věstonice-Pavlov-Milovice area, distribution of sites in the landscape. Sites are located regularly on elevations of the mountain slope, slightly above 200 m a.s.l., enabling cotroll of the floodplain about 30-40 m lower. At the same time, the sites controll steep side-gorges which possibly served as „natural traps“. The arrows point to major mammoth bone deposits.

Figure 2: Dolní Věstonice II, example of a separate mammoth bone deposit, excavation 1986-1988.

Figure 3: Pavlov I, part of a mammoth bone deposit with a large mandible, excavation 2015.

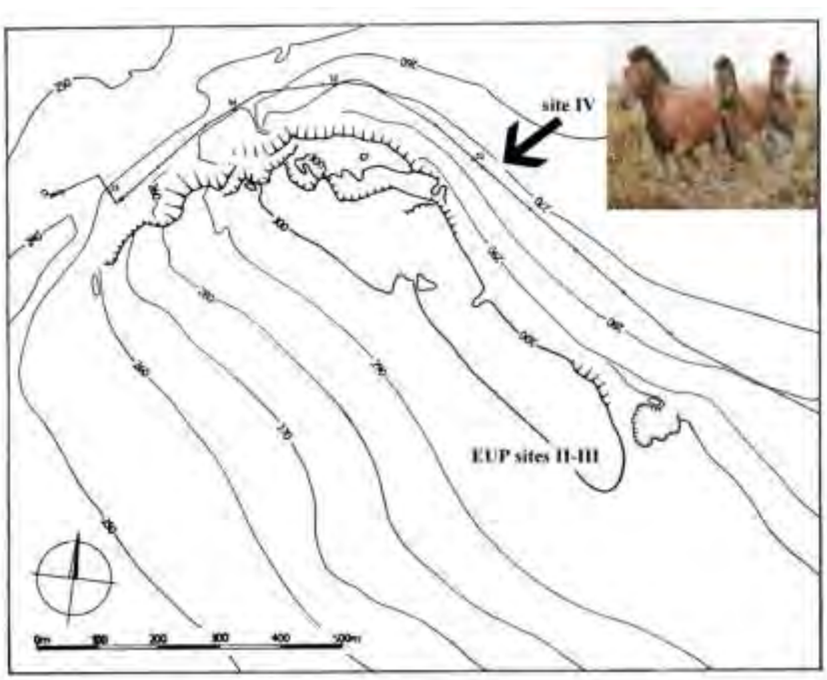

Figure 4: Stránská skála area, plan of the limestone cliff formation showing location of the Epigravettian site IV (arrow).

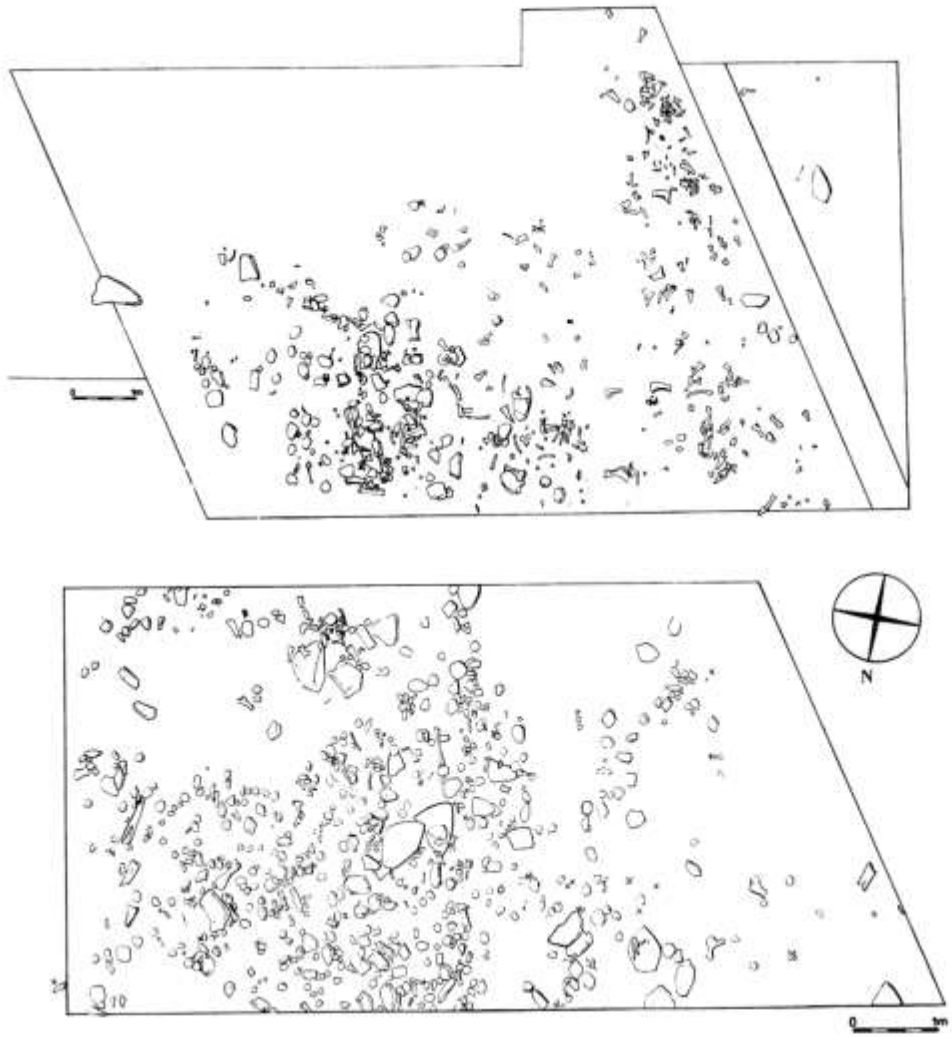

Figure 5: Stránská skála IV, detailed plan of the two horse bone deposits below the limestone cliff, excavation 1985-1986.

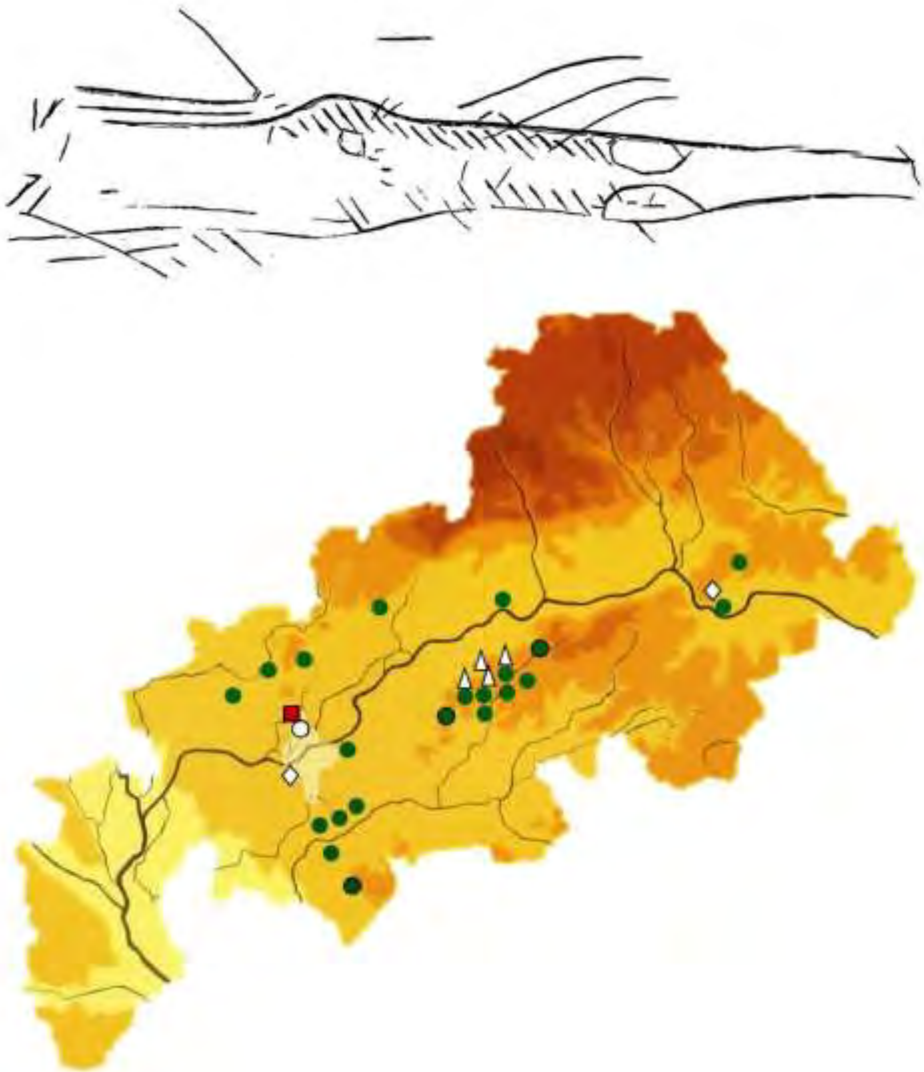

Figure 6: Předmostí, a linear pattern engraved on a mammoth tusk, interpreted as a „map“ of the Moravian Gate corridor, its slopes, a narrow passage deeper inside (right) and the site of Předmostí at the entrance (small square left). Below is the actual landscape geomorphology showing location of the site of Předmostí (red square) and other Paleolithic sites.

Middle Stone Age in the Horn of Africa: Research along Tributaries of the Blue Nile, Northwest Ethiopia

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For over a decade we have been investigating a series of open-air MSA sites situated along the trunk tributaries of the Blue Nile River in the lowlands of NW Ethiopia (Kappelman et al. 2013) under a general descriptive title of the "Blue Highways Project." These sites provide information about the behaviors of anatomically modern *Homo sapiens* in the Horn near the time of movement out of Africa (Armitage et al. 2011; Beyin, 2011; Rose 2004; Van Peer 1968) and are well positioned (Figure 1) to add data to help evaluate potential routes that *Homo sapiens* may have followed (e.g., Armitage et al. 2011; Groucutt et al. 2015a, 2015b) on their range expansion. In addition, the project area (Figure 1) is positioned in an area well suited to provide information on the relationships between more northern Nubia assemblages and the diverse East African MSA in the Rift (e.g., McBrearty and Brooks 2000; Shea 2008; Tyson and Faith 2013). The diverse fauna recovered from both surface and excavated contexts includes mammals, reptiles, birds, and fish from a wide range of body sizes. Stone raw materials include cryptocrystalline quartz and basalt cobbles, both found on the local gravel bars and in exposed basalt flows. Unlike other MSA sites in the Horn, our assemblage have no obsidian. Bifacial and Levallois core reduction were used to produce flakes and points (Figure 2a), prismatic blades, and extractive tools were recycled.

The NW Ethiopian region contains numerous MSA archaeological sites from this time interval that preserve the stone tools made and used by these ancient humans, the remains of the animals that they hunted, and a record of past climates. Understanding the behaviors of ancient modern humans is more complicated than simply finding and dating fossils or studying the genetics. Archaeological sites play a crucial role because stone tools are more readily preserved than fossil remains, and outnumber sites with only human fossils by several orders of magnitude. Undisturbed sites often preserve evidence of ancient behaviors that relate to how humans organized themselves at the site and across the landscape, how they collected raw materials and made and used tools, and the sorts of animals and in some cases plants that they collected, processed, and ate. The foraging behaviors practiced by these ancient humans facilitated our species' migration out of Africa.

At the heart of this broad question about early human evolution is understanding how our species adapted their particular behaviors so that they could live in different environments. This question is important not only for understanding these behaviors at a point in time but also through time because the modern humans that originated and evolved in Africa also migrated out of Africa at around ~70-50 Ka BP to begin populating the rest of the world. This migration is in itself one of the most remarkable events in the history of our planet and one that carried early humans into very diverse environments. Reconstructing these ancient environments provides us with the context for understanding early human behaviors, and this goal is one that combines the efforts of geologists, geochronologists, and geochemists. The question of how humans once adapted to their environments is perhaps even more relevant today in the face of growing populations, extreme climate events, and a diminishing resource base.

Much of our work has focused on excavations at a large, complex MSA site (designated SM1) along the terraces adjacent to the current Shinfa River channel (Figures2b, 2c), but we have also conducted limited test excavations at a series of other sites in a variety of other contexts (Figure 2d). The SM1 locality was discovered and first surface collected in 2002 (Figure 3a) with test excavations undertaken in 2003 (Figure 3b). Since 2010 excavations at SM1 have emphasized a combination of fine-scale excavation (Figure 3d) combined with 100% water screening of all excavated sediments (Figures 3e, 3f). At present, dating is still uncertain and we are working to make sense out a somewhat discordant series of dates using a variety of methods (OSL, ESR, AAR, radiocarbon, and U-series) that point to the earliest occupation occurring in the 70-80 Ka BP range for SM1.

One of the more striking aspects of the SM1 collections are the extremely small size ranges of all classes of materials. Figure 4a illustrates the range of sizes of chipped stone from surface collections mapped items from excavations, and from the screens with mean maximum lengths calculated at 27 mm, 22mm, and 7 mm respectively. In terms of spatial patterning of these materials, there seems to be some clear clusters of attributes indicating thermal alteration (i.e., crazing, thermal fractures, and pot-lidding) that may be indicative of hearth locations (Figure 4b) that may be the focal points for on-site extractive and maintenance activities (as indicated by microwear studies). The potential for examining what seem to be spatially distinct activity sets has also been indicated by our 2016 test excavations at the SM66 locality where at least one occupation surface is captured in fine-bedded sediments that preserve refitting cluster of basalt and fine-grained materials as well as heavily fractured large mammal bones. While we have no dates from these text excavations, the position of the site on higher terraces over 1 km from the Shinfa channel indicates that SM66 is older than SM1, and it is anticipated that further work at SM66 will expand the temporal range of our MSA paleoecological and archaeological data sets.

The Blue Highways project suggest that these MSA humans were well adapted to a riverine-based foraging lifestyle that exploited abundant food resources seasonally concentrated around isolated waterholes, and used raw materials found on river point bars exposed during the dry season. As local foods were depleted, longer distance foraging along the channel to new waterholes functioned as a dry season "pump" to siphon MSA populations up and down along the river systems. These highly seasonal riverine systems provided highly predictable food, raw materials, and water during an otherwise challenging dry season; movements from one waterhole to another would have effected population movements northward (Kappelman et al. 2013), and may lend some support for the northern migration route (Figure 1) being accessible during a wide range of climate conditions and not necessarily only during the moister phases.

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Figures

Figure 1. Location of Blue Highways Middle Stone Age project in NW Ethiopia with two general modeled routes of anatomically modern *Homo sapiens* out of Africa.

Figure 2. Overview of Blue Highways project a) MSA bifacial, unifacial (top two rows) and Levallois points from SM1; b) Shinfa River near SM1 at dry season low; c) 2016 excavations at SM1; and d) test excavations at SM66.

Figure 3. Investigations at SM1 2002-2016: a), initial surface collection, 2002; b) test excavations in 2003; c) beginning of block excavation 2010; d) excavation and mapping in 2011; e) pumping water from Shinfa River to screen site matrix; and f) screened matrix drying in preparation for sorting.

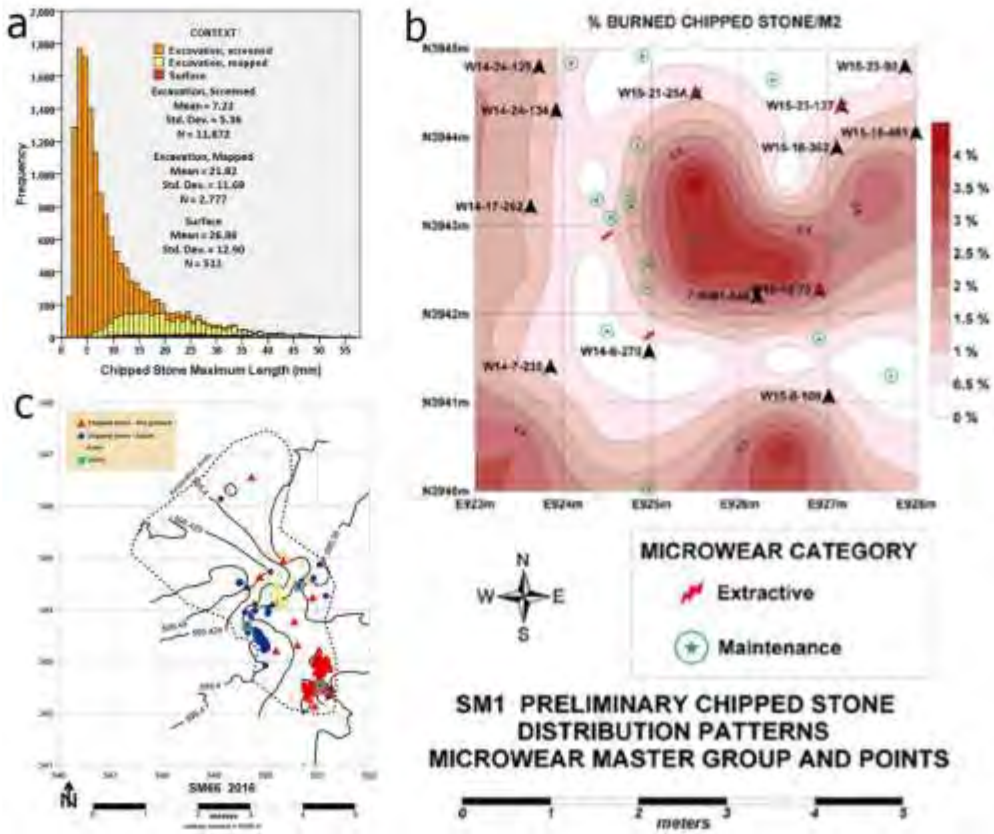

Figure 4. Excavation data from SM1 and SM66: a) size distribution of chipped stone from three recovery contexts (surface collection, excavation mapped, and screen matrix), this size distribution is strong indication that site has not been modified by flowing water; b) distribution of thermally altered chipped stone, MSA points (triangles), and tools with use wear traces at SM1; c) plan map of 2016 testing at SM66.

Chronology, Periodization, and the Main Features of Sony Culture (Early Middle Neolithic Sakhalin Island)

A.A. VASILEVSKY and V.A. GRISCHENKO

The report examines the most important sites of archaeological culture Sony, referred to the earlier phase of the Neolithic era middle of Sakhalin Island. The problems of its correlation, origin, periodization and chronology within the VI - V millennium BC. In 1937 - 1940 years. Ito Nobuo archaeologist from Tohoku University (Sendai), allocated to the most ancient type of pottery Sakhalin and called it by the name of Sony nearby river with the name of Ainu [Ito, 1942; Niioka, Utagawa, 1990, p. 66 - 69]. Culture first announced as a "Neolithic culture in South Sakhalin" and assigned to the stage of development of the Neolithic [Shubin, Shubina, Gorbunov, 1982]. Then VA Golubev called it "South Sakhalin Neolithic" [Golubev, 1985, 1986a, 1986B, 1987]. In later works [Vasilevski, Shubina, 2006; Vasilevski, 2008] complex of culture was described as a proof of the developed aquatic economy model existed in Sakhalin already as early, as the VI th mil.BC. The purpose of this report is the international introduction of new data about Sony culture obtained during the last several years.

Chronology and periodization

Radiocarbon age of Sony culture was determined as 7245±45 BP (6112±64 cal. BC.) - 5648±490 BP (4495±525 cal. BC.) These dates are the extreme points of the chronological scale of Sony culture, the basic number of dates group in the interval 6000 - 5300 cal. BC (Figure1), at the same date, received in 1980, and having a large sigma, lose relevance. To date, received on deposit from the ceramic, it is necessary to take into account the amendment of 400 BP in the marine / fresh water reservoir effect [Kunikita et al., 2007]. In this case, the most recently available dates of the sites of Sony grouped in chronological interval 5500 cal. BC - 5300 cal.

The distribution of the Sony culture

Geographically, the Sony culture covers the territory of the whole island of Sakhalin and of the island of Moneron. The twenty sites are in the list now (Figure 1). The most studied are the settlements of Sadovniky 2, Kuznetsovo 3-4 (Sony), Starodubskoye 3 (Otsunaoka), Slavnaya 4 and Chayvo 6. An indispensable feature of cultural arrangement of settlements - are confined to the coast - they are oriented to the sea and belong to the 5-25 m marine terraces. However, the hidden sites, such as the 73-meter sea cliff with steep slopes - site of the Cape of Vindis, on the border with the Early Jomon, was found not long ago. The most interesting less known site of Slavnaya 4, which is described below, excavated currently, is understood now as the most representative object of the early and middle Neolithic in Sakhalin.

Settlement of Slavnaya 4

The thick cultural layer and the houses of Sony culture were excavated in the Slavnaya 4 site. In the excavation grid 2 the Middle Neolithic layers covered the buried houses of the Early Neolithic, dated by the food crusts from the Akatsuki type pottery sheds as 8100±50 BP (cal.7172 ± 81 BC), 8135±50 BP (cal.7158 ±76 BC) [Grishchenko, 2011]. The radiocarbon dates on charcoals from a hearth as well as pottery food crusts place the Sony period of occupation in the range of both phases of the Culture. The series of those dates (Table 1, Figure 1) gives a chronological interval 6200 - 5100 cal. BC (taking into account marine / fresh water reservoir effect). Two types of Sony pottery, thick and thin, correspond to the early and late periods mentioned above.

A significant part of Sony cultural materials was published [Shubin Shubin, Gorbunov, 1982; Golubev, 1986; Golubev, Vasilevsky, 1986; Golubev, Kononenko, 1987; Golubev, Zhuschihovskaya 1987, Vasilevski, Shubina, 2006; Wasilewski, 2008].

So we may use them to reveal the main features of the Sony Culturetogether with the newly received data.

Dwellings

The dwellings - huts, always quadrangular, ranging in size from 4 x 4 to 8 x 10 meters, are placed into the ground to a depth of 0.15 to 0.5 m Unlike the Jomon stone circles-fireplaces, the Sony hearths have no stones. They are typically displaced aside from the geometric center of the house.

Ceramics

The production of pottery in the Sony Culture has the following features:

1) the shell tempered pottery was popular. But Irina Zhushihovskaya (Golubev, Zhuschihovskaya 1987) reported also the chopped grass as the admixture in pottery of Sony Culture.

2) The surface treatment methods in pottery making were rather primitive: the traces of the smoothing by the wet hand were recorded. The polishing and engobing were not known.

3) Sony pottery is characterized by the low temperature firing in the range of 400 - 500 ° C.

4) The types of ceramic vessels were not numerous: all of them were flat-bottomed, subrectangular in the horizontal cross section. The bottom of the tank also had a quadrangular shape.

5) The walls and the rims were mostly straight, they were slightly concave, not ornamented, decorated with vertical undulating ridges or narrow molded horizontal and vertical rollers, sometimes forming a simple relief composition.

6) The small size of the vessels predominated: height - 10 - 20 cm, bottoms' diameter 7 - 12 cm, diameter of mouth of 12 - 15 cm. The ceramic had fairly thick-walls - 6 - 8 mm up to 1 cm (Figure 2).

Comparative analysis of the ceramic complexes of settlements, allows us to trace the features of the temporal development of a single pottery tradition and raise the question of the periodization of culture. The early stage of Ceramics had the decor, with the exception of vertical ridges on the rim (Figure 3-1), while Kuznetsov-4 late period site found beaters with a narrow molded cornice on the outside, a few fragments of the walls, decorated with simple geometric compositions made of molded rollers (Figure 2; 3-1,2).

Lithic industry

The Sony Culture lithic technologies were typical for the Neolithic (Figure 4;. 5). The tools were mostly made of the local raw materials, including local shale, mudstone, jaspers, chalcedony and very rarely obsidian. The last was transported by the neighbors – Jomon people through the Soya-La Perrouse strait from Akaishiyama mountain near the Shirataki village in Hokkaido (... Volcanic glass, 2000, p. 99). Predominance of the local raw materials of lower quality can be explained as a result of the technological change. The obsidian from Hokkaido was not so necessary as before. The Sony people used any local stone, because they did not use microblades, but easily made flakes and polished axes. They used very amorphous pebbles to make the multiplatform or discoid cores of the radial splitting principle. The strategy of the subparallel and radial splitting to receive flakes was a very important step forward. It was a new efficient technology in the lithic industry. They also used the flat stones from riverside for manufacturing of bifaces and chopping tools. The secondary treatment of products included bifacial retouch techniques, polishing for axes and adzes.

The polished stone rods, length from 5 to 10 cm (Figure 3-3; 5-4,6,7) were the very typical Sony type tools. In Kolchem 3 site in Amur such tools were used as sinkers for nets [Kato, Shevkomud, 1998]. We distinguish such rods as the parts of the hooks and sinkers. In our opinion, we consider their presence in the archaeological complexes of the Early and Middle Neolithic, as the true evidence of a high level of maritime adaptation of the ancient population of Sakhalin. There is a miniature stone figure - sculpture of a whale, made of slate shingle. It was found on the floor of the Early Sony house on the settlement of Starodubskoye 3 in Southern Sakhalin. There are such features as clearly visible mouth, the eyes, the distinctive hump on the neck and a forked tail (Figure 8). This figurine makes us understand the significant role of the sea in the life of the Sony Culture communities.

The problems of correlation of Sony culture

The question of the origin of Sony Culture is still debatable. Judging by such archaic pottery items as shell or herb admixture in ceramic and as the very typical Jomon like triangular (wedge) shaped protrusions (lugs, wedges) on the rims of the vessels, one can decide that Sony Culture originated from the Jomon area. At the same time, Sony ceramics differs from Jomon pottery by some very important features that are almost nullify mentioned signs of kinship:

1) there is no ornamentation on the vessels except the simple clay molded rollers (fascia). No punching, no rope ornament, nothing like southern decor. It does not correspond to the fundamental traditions of the Jomon, according to which the rope impressions covered around the whole body of the vessel. Ceramics of Sony Culture distinguishes the extraordinary simplicity of design;

2) This stage of pottery making was characterized by ceramics fundamentally different from all known around the Far East. The shape of the vessels was almost unusual - quadrangular. Neither sharp nor flat-bottomed containers of circular cross section of the tank was found in the Sony Culture sites excavated in Sakhalin. Containers of quadrangular and, occasionally, of the oval shape, occur in the Incipient and Initial Jomon in Kyushu in the south of Japan. So maybe we just do not know some of their connecting links. But the type of Sony vessel was not known neither in the in earliest nor in the Middle or Late phases of Jomon in Hokkaido. However, the triangular ridges (lugs)

and molded rollers (fascia) characterizing Sony can be understood as the signs of cultural influence of Early Jomon to Sony.

It is noteworthy that no Early Jomon ceramics from the island of Hokkaido was found in any of the studied sites of Sony Culture in Sakhalin. In turn, there are no ceramics of Sony in any Jomon collection to the south of the La Perouse Strait. The border between two cultures – Early Jomon and Sony – had clearly passed along the geographical barrier of the strait betweeb Sakhalin and Hokkaido. Technologically the Sony Pottery looks more archaic comparing to the Condon, Rudninskaya, Boismanskaya and other Neolithic cultures of the Amur and the Maritime area. The fundamental difference is the basic approach of Sony people in the forming the shape of the container. Stone industry of Sony Culture can be characterized as a typical part of the regional Middle Neolithic traditions of the North East Asia without much difference. The obsidian exchange, in fact, was unexpectedly interrupted by the appearance of Sony Culture. The Early Neolithic sites in Sakhalin, with micro core technologies always include obsidian. In the Sony sites as proved above, obsidian is pretty rare and to our mind, usually originates from the older layers.

Sony is likely the Culture of the migrants, who came from the North, not South. It seems that the Early Jomon opposed Sony onto the natural geographical boundary on the La Perouse strait. There is no any sign of the transition from the local Early Neolithic cultures of the arrowheads on blades to the Culture of Sony. It seems that there was a change of culture by the sudden replacement, caused by migration.

Lifestyle and Economy of the Sony Culture people of the Middle Neolithic in Sakhalin

Sony - the culture of sea fishermen and possibly sea hunters and navigators, who had developed their adaptive skills and became the main cultural group in Sakhalin. No other culture existed during Sony period. A striking example of the level of adaptation of Sony people to the marin environment is one of the sites of this culture – the site in the bay of

Kologeras on the island of Moneron. To travel to the isle one have to go through the straits with three strong currents. They had to have the appropriate skills and craft to reach the Moneron in their boats. As it was evidenced by ethnographic data, for local people of the Middle Neolithic, Moneron could have been only a place of the sea hunting and deep sea fishing. (Samarin, 1996, 1993; Vasilevski, 1997). Land resources of the island are very limited. No salmon, no deer or any other beasts can be hunted in Moneron. It is clear that the Sony Culture people were attracted by the opportunity to kill the sea animals on the beach of the bay of Kologeras.

Economy and lifestyle of the Sony Culture people were determined by the opportunities provided by the Sea. The such features as the location of settlements in the lagoon shores, as well as the number of dwellings - their number varies from four to six – all for the coastal lifestyle and aquatic resources as the main opportunity to keep alive in the islands. The problem of the origin of the Sony Culture is still open open. It has nothing to do with Jomon cultural core and moreover, Sony was a culture that became a barrier for the spread of the influence of the Early Jomon to the North. Denying the influence of the Early Jomon Culture at Sony is not necessary, it has been a particularly noticeable in its second phase. And many questions still exist.

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Figures

Figure 1 The map of distribution of *Sony* culture sites on the Sakhalin and Moneron islands. 1.Kologerasa bay (Moneron isl.); 2-3.Kuznetsovo-3-4 (Sony kyodo-bokujyo); 4.Kovrizhka rock (Vindis); 5.Gornozavodskoe-3; 6.Slyda cape; 7-8.Mitsulevka-1,2; 9.Sadovniki-2; 10.Pioner-1; 11-12.Dolinsk-1,5; 13.Chekhov-1; 14.Starodubskoe-3 (Otsunaoka); 15.Novosibirskoe-1; 16-17.Penzenskoe-2,3; 18.Slavnaya-4,5; 19.Vzmorie-2 (Torii); 20.Ilinskoe-6; 21.Krasnogorsk-1 (Strelbishe); 22.Pil'vo-3 (Korsakovski cape-1); 23.Nyivo; 24.Venskoe-5;

25. Chayvo-6 (point 2)

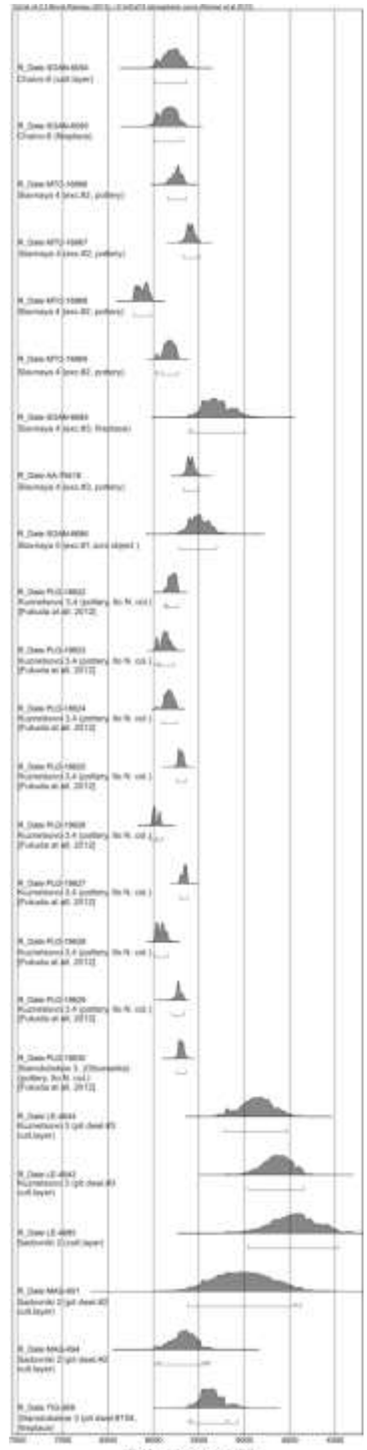

Figure 2 Chronology of *Sony* culture sites.

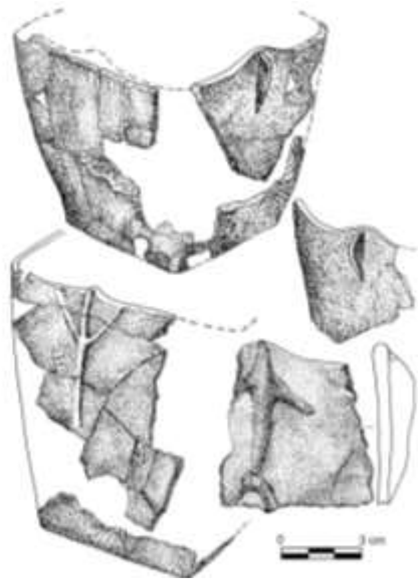

Figure 3 The pottery of *Sony* culture. Sadovniki 2 site. [Shubin at all, 1982].

Figure 4 The pottery of *Sony* type (1-2) from Kuznetsovo 3 site and stone polish sticks from Starodubskoe 3 site, (3).

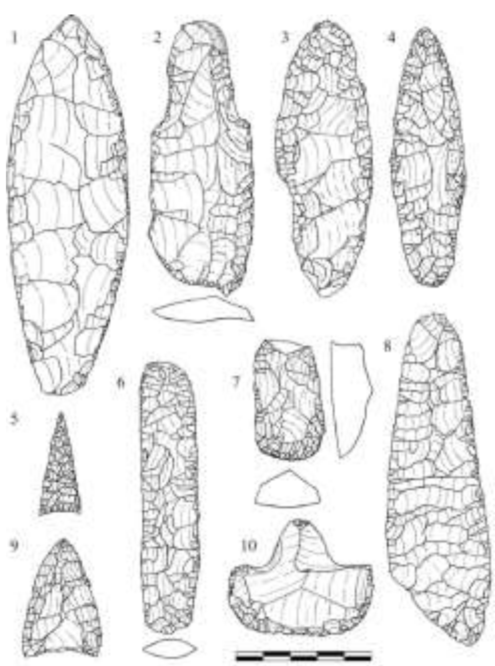

Figure 5 The stone tools of *Sony* culture. 1- Kuznetsovo 3 site, 2-9 - Sadovniki 2 site, [Shubin at all, 1982], 10-Starodubskoe 3 site.

Figure 6 The stone tools of *Sony* culture from Slavnaya 4 (exc.#3) site.

Figure 7 Pit dwelling (1), the stone tools (2-7) and vessels (8-9) from excavation area on the point 2 of Chayvo- 6 site.

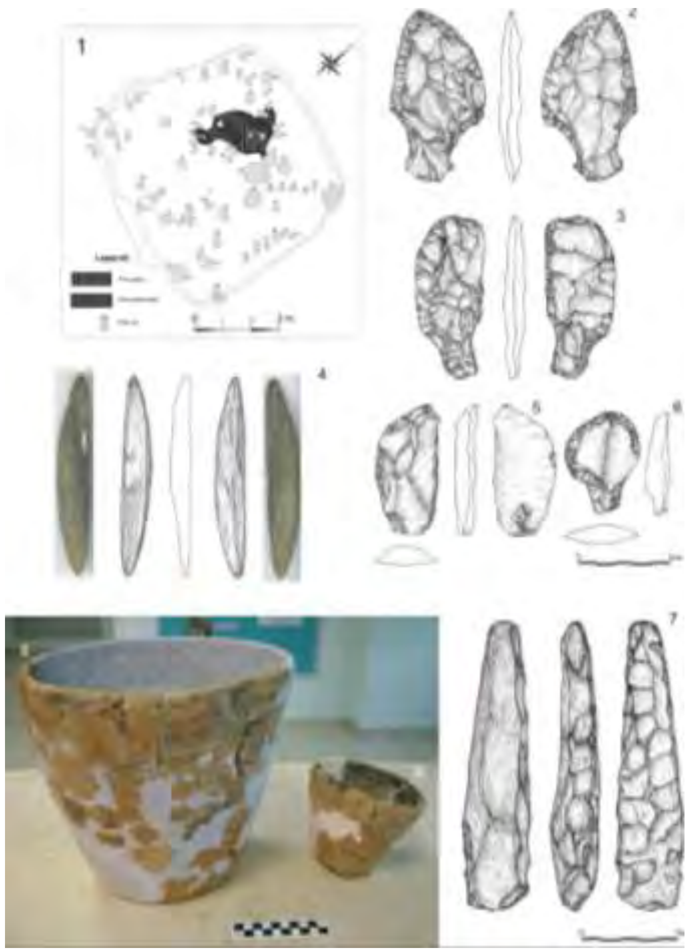

Figure 8 The figuring of the whale. Starodubskoye 3. Sakhalin. 1989. Sony Culture.

Epigraphic memorial stele 埋香碑 *Mehyangbi* («Incense Burial») as an Archaeological and

Cultural Heritage of Medieval Korea (Compared to Chinese and Japanese Traditions)

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Within the comparative study of literature, historical ethnographical, cultural, epigraphic, and partially archaeological aspect of the culture of incense in China, Korea, and Japan it seemed reasonable to attempt to analyze the phenomenon of traditional East Asian culture such as the «incense burial» 埋香 (Ch. *maixiang*, Kor. *maehyang*, Jap. *maikō*). Therefore the authors of this work not only have studied written memorials and artifacts gathered in the greatest museum collections and art galleries, in Chinese, Korean, and Japanese parks and temples, but also performed field studies in numerous large cities such as Beijing, Hong Kong, Seoul, Busan, Mokpo, Tokyo, Sendai, Kyoto as well as remote rural regions in China, Korea, and Japan.

At present, the term 埋香 («incense burial») is used in the East Asian culture of incense in the narrow meaning: as burning incense powder in a vessel followed by its burying in the ash. The essence of this procedure is that a master makes a pit in the specially prepared ash poured into a ceramic or bronze burner and then puts incense powder into the pit or channel and lights it, controlling the air access for qualitative combustion of the incense material. When all conditions are met, a wisp of incense smoke comes out from under the ash and its long-term action is considered to beneficially affect the physical and moral health of the ritual's participants.

The 埋香 ritual which originated in China proves to be related to the ancient funeral ceremony when a dead body was surrounded by incense wood pieces. Later the term "incense burial" was transformed, and since the Tang (7–10th cent.) and Song (10–13th cent.) dynasties, its connotation has been found in literature to be defined as "to bury a beauty", "to bury a beautiful young woman" (埋葬美女 *maixiang mei nü*).

Thus, based on the analysis of the written materials, it is possible to suppose that since the Tang dynasty (7–10th cent.) up until the end of the Qing dynasty (middle of the 19th cent.), during the full blossom of the culture of incense in China, writers and poets widely used the poetic metaphor 埋香 *maixiang* speaking about a prematurely dead beautiful woman. Later, starting from the late Qing (end of the 19th cent.), when Western aggression, social disturbances, and political crises negatively affected many spheres of the traditional lifestyle along with the decline of important functions of the culture of incense, numerous associations related to it have moved to the periphery of public conscience.

Taking into account stable traditions of using incense in Buddhist practices, it is quite logical that in the latest funeral culture of East Asian peoples, certain rituals associated with the importance of the role of incense burning and ascending to heaven together with prayers have retained. In this context, the unique epigraphic monuments that remained in continental China and the South Korean region prove to be very notable.

In China at present, there is virtually one single monument of such kind. It is a stone stele erected in the Taorangting park (陶然亭公园) in Beijing during the Xiangfeng years (1851–1861) of the rule of Emperor Wen-zong of the Manchu-led Qing dynasty. It was constructed on the grave mound of the Emperor's concubine and a sentimental poetic inscription was engraved on it. On the front of the plate the characters 香冢 *xiang zhong* (lit. "aromatic grave", "aromatic grave mound") were inscribed by the copperplate 篆書 *zhuan-shu*.

On the back side of the plate the 隶書 *li-shu* inscription was engraved[4]:

浩浩愁，茫茫劫。短歌终，明月缺。郁郁佳城,中有碧血。

碧亦有时尽，血亦有时灭，一缕烟痕无断绝。是耶非耶？化为蝴蝶。

Infinite sadness, eternal life of the universe.

The short song has been interrupted, the shining moonlight is no more.

There is blood in the splendid shrine, blood that has turned into jasper.

The time has come – and the Jasper has surrendered everything,

the time has come – and the crimson of the blood has dimmed.

No longer will the trace left by the wisp of the incense smoke be erased.

I don't know whether it's true or not but maybe it will turn into a butterfly …

(translated by E. Voytishek and I. Pertsovskaya)

Another name of this plate – 蝴蝶冢 *hudie zhong* (“grave of the butterfly”) –gives evidence of ancient folk ideas that souls of the dead become graceful butterflies and flutter above the flowers.

Indeed, no traces of this inscription on the stele as well as the stele itself have been revealed until this day. The results of diggings in the Taorangting park during the restoration performed after the cultural revolution

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4 *Xiang zhong* 香冢 [Aromatic grave] // Encyclopedia Baidu. URL: http://wapbaike.baidu.com/view/1404223.htm?adapt=1& (accessed 06.11.2015). (in Chin.)

Figure 1: The front and the back side of the stone engraved with the characters 香冢 *xiang zhong* erected in the Taorangting park (China, Beijing) (lit. “aromatic grave”), established in 18th cent.

have not shed light on this mystery – the “aromatic grave mound” remains an enigma. Now on its place there is a distinctly different monument to Communist Gao Junyu (高君宇 1896–1925), and his friend Shi Pingmei (石评梅 1902–1928), a revolutionist and a writer. Unfortunately, it seems impossible to reconstruct the 埋香 *maixiang* ritual itself: the assumptions derived only from poetic metaphors and hyperboles are too hypothetical.

There are two stone steles at the Izanagi-jinguu temple on Awaji island (Hyogo pref., Japan) established in October 1995 in memory of the legendary event, from which began the history of the use of aromatic wood[5] in the Japanese archipelago.

On one of the steles the character 香 (lit. “aroma”) is carved and another is engraved with the direct quote from the 22nd scroll of the mythological annual history

5 The official website of Izanagi-jinguu on Awaji Island http://awaji-kohshi.com/awaji_island.html (accessed 06.05.2016); The official website of the Incense Art Gallery KUNJUDO 薫寿堂. URL: http://www.kunjudo.co.jp/about01.html (accessed 06.05.2016). (in Jap.)

"Annals of Japan"[6]. The text fragment (in modern Japanese) carved on the stone plate describes the fact, that 1400 years ago in the year 595, a piece of agarwood about one meter long washed up to the shores of the Awaji island.

Except for the aforementioned medieval monuments dedicated to the "way of aroma", other memorial steles have not been revealed in Japan – just as no traces of the tradition of burying aromatic wood into the ground have been revealed [Ota Kiyoshi, 2001. Pp. 30–31].

Figure 2: Stone stele with the character 香 ("aroma") at the temple Izanagi-jinguu on Awaji island (Hyogo pref., Japan), established in October, 1995.

No less mysterious are stone steles 埋香碑 *maehyangbi* (Kor. "steles [on the place] of incense burial") which have been preserved so far in South Korea. Stone steles erected on the place of incense burial or transported from the burial places are practically untreated rocks. Hieroglyphic inscriptions are seen on them, and based on these engravings it is possible to some extent, to reconstruct the burial ritual of incense wood chips (as a rule, agarwood). The inscriptions usually contain information about the monument's installation date, names of the members of the village community who

6 Nihon shoki (日本書紀, 720).

carried out the ritual, their status, and so on. Part of characters cut on the unpolished stone surface is often indiscernible due to the long-term erosion processes.

According to the observations of South Korean scientists, about 15 of these epigraphic monuments have remained to the present day [Lee Jungon, 2005. P. 101]. The majority of them are in the South Eastern and South Western coasts, on the territory of modern Chungcheongnam-do, Gyeonsangnam-do, and Joeollanam-do provinces rather than in the central part of the Korean peninsula. Most of them belong to the end of the Koryo dynasty (918–1392); the period of the peak of Buddhism in the country. Some steles are dated to the beginning of the Joseon dynasty (1392–1910) when Buddhism was well established as a state religion, being developed in collaboration with the aristocratic upper crust.

In Korea the 埋香 *maehyang* ritual seems to have formed during the Koryo dynasty under the influence of the Chinese culture of incense, but with time it acquired specific features. It used to be the process of burying in earth aromatic wood pieces or their burning, after which a memorable stele *maehyangbi* was erected on the burial place and engraved characters on it about the date, purpose, and place of the ritual. Similar rituals were associated with the Maitreya Buddha cult in which it was believed that incense smoke provided the onset of the epoch of love and consent. The ritual "burial of incense" promoted the stabilization of community life and also gave hope for the long-awaited onset of the new world.

The analysis of the available data determines the following typology of steles: according to the geographical location of the monument, chronology, the appearance and shape of steles, and texts carved on the stone surface.

As for the ritual itself, it seems impossible to reconstruct it in its entirety, although the specific features of some of its elements can be understood from the text content.

The study of the specific features of the 埋香 "incense burial" ritual, and more generally, the whole culture of incense in East Asian countries provides the possibility to reconstruct the details of the ritual and everyday behavior of the peoples of this region and also to carry out comparative studies in various fields, including archaeology, history, literature, cultural anthropology, arts, and medicine.

Acknowledgments. This research has been supported by the Russian Scientific Foundation (project No. 14-28-00045)

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Human Behavioral Adaptation on Jinsitai Cave Site, Northern China

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Since 2000, Research Institute on Archaeology and relics of Inner Mongolia Autonomous Region, School of History in China Renmin University and Research Center of Chinese Frontier Archaeology of Jilin University have conducted a series of excavation at the Paleolithic sites of Inner Mongolia Autonomous Region and its surrounding areas. These sites provide valuable data on ancient human technology, adaptation and environmental changes in the region during the Pleistocene. Among these, the Jinsitai cave site is one of the most important Paleolithic sites, characterized by the larger excavated area, the longer excavation seasons, and the most abundant cultural remains recovered in the region.

Background

The Jinsitai cave site (45°13′ N, 115°22′ E) is located at Dong Wuzhumuqin County, Inner Mongolian Autonomous Region (Figure1). It was discovered in 2000, and was excavated from 2000 to 2001 for two successive seasons, exposing an area of about 80 m2 (Wei, et al, 2000). Large numbers of stone artifacts and fossil fragments were excavated from the site.

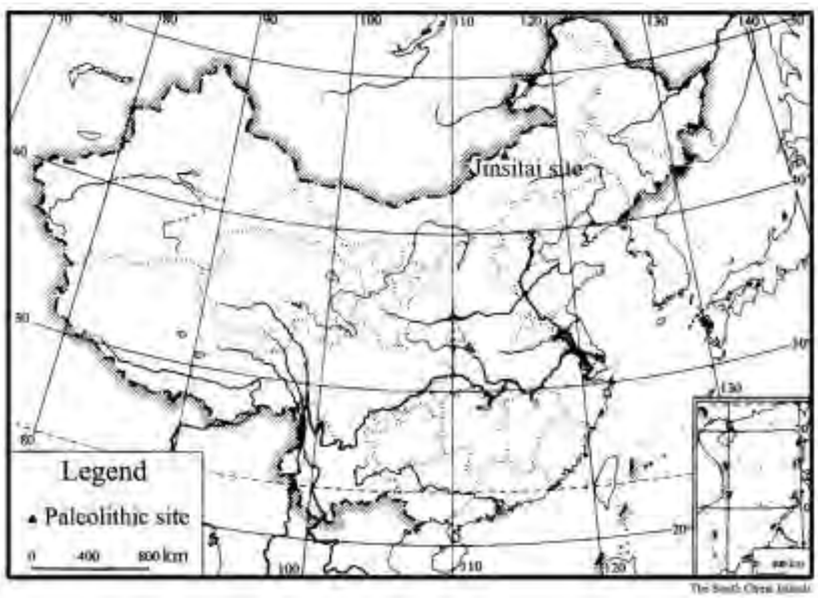

Figure 1 Geographic position of the Jinsitai cave site

Stratigraphy

Deposit of this site is interpreted as South Wall (T6) of excavation area. The stratigraphic sequence of the site (16 substrata with total thickness of more than 6 m) may be described from top to bottom.

Chronology

In order to get the independent ages of the cultural layer and the strata, systematic sampling and measurements were performed on the Jinsitai site. Radiocarbon dating was done in the radiocarbon dating lab in the Peking University. More than 10 animal bone samples were taken for age determination. The results show that the ages are mostly in the stratigraphic order, and the same stratigraphic units can produce consistent ages (Table 1). Table 1 presented all dating results from 36,285 ± 230 a B.P. to 6,380 ± 50 a B.P., calibrate date results from 39,916 cal. yr B.C. to 5,475 cal. yr B.C. indicating late Pleistocene to Early-Holocene in age.

Cultural remains and mammalian fossils

A total of 6585 remains, comprising 4212 lithic artifacts and 2373 mammalian fossils, were excavated during test excavation and two excavation seasons. Because of probable artificial action commonly encountered in Paleolithic cave sites, mammalian fossils from the site are mostly fragmented. Identified species include Rodentia Bowdich （*Myospalax aspala* an*, Marmota bobak*）, Perissodactyla（*Coelodonta antiquitatis*, *Equus przewalskyi* and *Equus hemionus*）, Artiodactyla（*Cervus elaphus*, *Gazella Przewalskyi*, *Pachygazella* sp., *Sus scrofa*, *Bison* sp. and *Spirocerus*）and Carnivora（*Ursus* cf.*spelaeus*, *Canis lupus*, *Gulo* sp. and *Crocuta ultima*）(Wang, 2005), characteristic of the Mammathas-Coelodonta fauna typically found in North China during the Middle and Late Pleistocene.

Lithic assemblage of Jinsitai cave site

Core reduction technology

At least two major core reduction technologies are recognized in cores and flakes from these sites. One is direct hard or soft hammer percussion, percussion flake and core are the most prominent character in stone tools assemblage, and the other is indirect percussion, microblade core, blade core, microblade and blade are the most prominent character in stone tools assemblage of Upper cultural layers. The characteristics of platform of microblade cores and flaking scars on the working face have direct relationships with core reduction technology and raw material economy. Primary reduction was mostly accomplished by flat parallel flaking. The process probably started with the partial removal of the cortex through the detachment of short spalls. Judging by the character and morphology of microblade core, all such microblades were struck from a selected and prepared platform, so the cores acquired the stable shape, such as wedge-shape, boat-shape, conical and cylindrical core. Microblade cores were exploited after the removal of one or two primary spalls aimed at shaping a crest, a character needed for the detachment of a blade blank. This is evidenced by products of flaking varying in size and proportions. According to the analyzing results, we can recognize microblade cores in the prepared stage and flaking stage, and there are some flaking scars (n=3~7) on the working surface of cores, platform angles of cores range from 72° to 96°. It indicates that hominids at sites have high cognitive ability on selecting raw materials and retouching tools.

The overwhelming majority of flakes are broken flakes, complete flakes are rare. Observing it from flake types, major platforms of flakes are striking-platform, followed by cortex-platform, it indicates that hominids at the sites often prepare platform of cores. Systematic striking-platform preparation can be recognized either on cores or on flakes. The dorsal surface of flakes exhibit well-controlled fine detaching, evidenced by regular and parallel scars. Flakes with scars bestrewed on the dorsal surface occupy 30.3% of all flakes. I2-2 and I2-3 type flakes (Wei, 2001) are predominant types; it indicates that these flakes are secondary flake removals. Direction of most flakes scars on the dorsal surface is consistent with core reduction. According to analyze the characteristics of edges of flakes, the edges of flakes are variety; mainly parallel and triangular, flakes with irregular edges are rare. Moreover, we can also recognize few bipolar fragments.

In the Upper cultural layers, the overwhelming majority of microblades and blades are middle parts, followed by proximal and distal part, complete microblades and blades are rare. The ridges of microblades and blades are variety, mainly single and double ridges, followed by crotched ridge. Pleistocene hominids are proficient in mastering truncation technique of microblades and blades; they choose straight middle part as the edge of composite tools. Debitage is defined as a detached piece that is discarded during the reduction process. It has recently become one of the most controversial and apparently least understood artifacts types. After being neglecting by researchers for decades as prehistoric trash or debris, debitage has gradually gained importance as an artifact that can help interpret aspects of prehistoric human technology, economy and organization. Debitage and chunks are by-products of retouching process or core reduction, they have a very important significance to study retouch technology and analyze human behaviors. As basalt, dacite and rhyolite are the predominant raw material used for producing stone artifacts at these sites, we can have some replicative experiments of core reduction and retouching process about raw materials, experiments are designed to determination which variables best distinguish between different techniques or technologies. We may apply principal components of experiments to archaeological assemblage, and analyze function (such as quarry, workshop or campsite) of sites through calculating percentage relationships between tools and debitage.

Retouch technology

Generally speaking, modified tools appear to be retouched by direct hard hammer percussion, followed by pressure technique. Most of tools were mainly retouched unifacially. Pieces made on flakes were modified overwhelmingly on the dorsal surfaces (66%), followed by the ventral surface (18%), multiple direction, alternating retouch and opposite retouch. Most of tools are small and regular. Most modification scars are parallel, sharp, shallow, regular, smooth or denticulate cutting edges and similar in size, indicating that modification of these pieces was normally well-controlled. Major blanks for tools fabrication are flakes (79%), followed by some microblades, blade, chunks and pebble.

The overwhelming majority of retouched tools are sidescrapers, followed by endscrapers. Sidescrapers are varied, such as concave, convex, round, straight scraper. They were retouched by direct hard hammer percussion, followed by pressure technique. Scrapers were mainly retouched unifacially. Pieces made on flakes were modified overwhelmingly on the dorsal surfaces, retouched part concentrate on a certain side of blank, not proximal or distal part. This indicates that such consistent edge can necessarily represent discrete functional types.

The utilization of raw materials

The quality and quantity of available raw material for chipping affects the choices made regarding material selection and conservation. Raw materials can be acquired by several means, including planned collection trips to quarries, opportunistic collecting, or trade. Raw materials collection strategies will condition the reduction strategies used to produce finished tools. According to the physical property of these raw materials, hominids prefer to choose them for making tools. The main sources of raw materials used by Paleolithic inhabitants of sites are exposed in the lower portion of the terrace and peddle beaches located in close proximity to the sites. Jinsitai site is located in the west margin of Dong Wuzhumuqin Basin, and it is close to Bayantuga lava volcano group. Eruptive activity of volcanic cluster gives birth to a lot of clastic materials. It makes hominids understand the advantage of basalt and obtain raw materials of high quality very easily during exercises.

Conclusion

According to the characteristics of these artifacts, the Jinsitai Cave site can be attributed to the main industry of Paleolithic tradition in North China. Three cultural layers come down in one continuous line. The Lower cultural stratum is dominated by the Small Tool Industry. A lot of cobble tools and Levallois tools are found in the Middle cultural stratum. The Microblade Industry in Upper cultural stratum is superior to the Small Tool Industry,

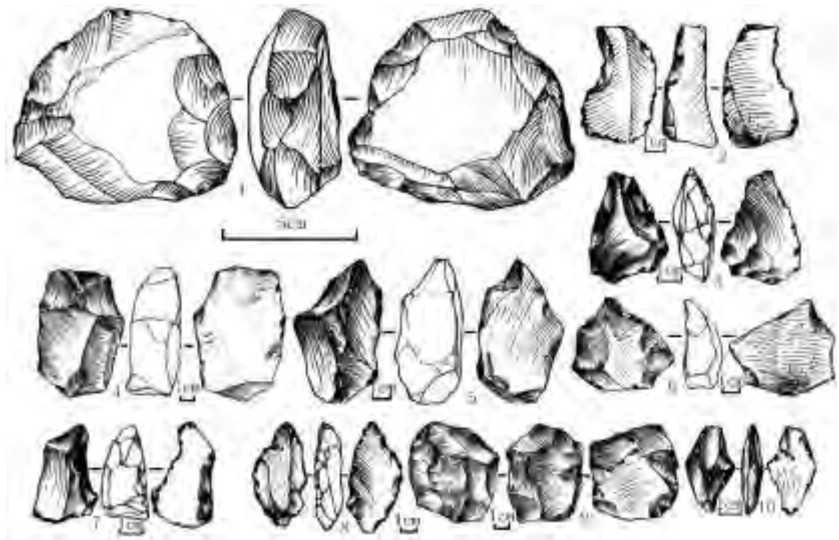

Figure 2 Stone artifacts from the lower cultural layer of the Jinsitai cave site
1.Chopping tool (T3.7D: 8); 2. Single concave scraper (T5.7A:31); 3.Double straight scraper (T3.7C:74); 4. Complete flake (T6.7A:1); 5. Broken flake (T6.7A:35); 6.Single straight scraper (T6.7A:28); 7. Core (T3.7C:93); 8. Point (T3.7C:307); 9.Spheroid (T3.7C:37); 10. Borer (T3.7B:86)

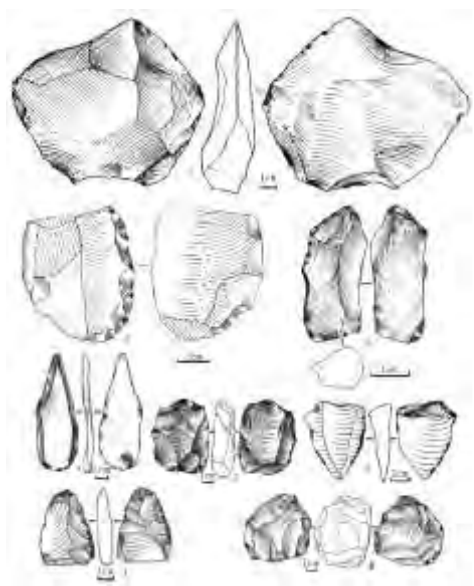

Figure 3 Some stone artifacts from the middle cultural layer of the Jinsitai cave site. 1.Chopping tool (T6.5A:52); 2. Cleaver (T6.5B:5) ; 3. Stone hammer (T3.5:20); 4. Complete flake (T6.5A:56); 5. Double straight scraper (T4.5A:112); 6.Used flake (T3.6:52); 7.Tongue-shaped tool (T6.6:1); 8.Spheroid (T3.5:201)

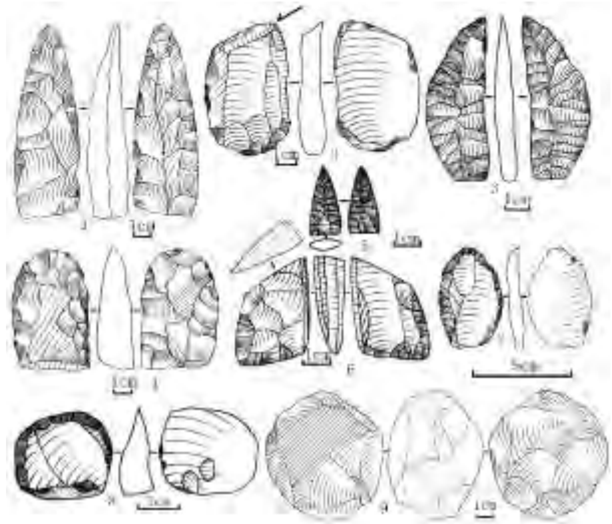

Figure 4 Some stone artifacts from the Upper cultural layer of the Jinsitai cave site. 1.Spear-like tool (T3.3:103); 2.Burin (T3.4:16); 3.Crescent-shaped tool (T3.3:161); 4.Tongue-like tool (T3.3:105); 5.Arrowhead (T3.3:301); 6. Wedge-shaped microblade core (T6.4:30); 7.Point (T3.4:43); 8.Round scraper (T5.3A:106); 9.Spheroid (T3.4:91)

according to the tool types, retouched technique and selected raw materials. Two Tool Industries are developed together. This site provides new data for studying distributing range and cultural connotation of the main industry; it has important significance for discussing intercommunion of Paleolithic cultures and appearance of the Microblade Industry.

Especially, the Jinsitai cave site is no longer an isolated case of the blade techno-complex in North China; it occurred along with some similar Paleolithic industries in North China, such as Shuidonggou site in Ningxia Autonomous Region, Shibazhan site in Heilongjiang Province, some Paleolithic sites (e.g. Luotuoshi site) in Xinjiang Province and Qinghai Province. However, it so far represents the south-most boundary of the migration of certain human groups with Levallois-alike and blade technology in East Asia. The root of the blade techno-complex in North China can be traced to earlier Levallois-alike remains and blade assemblages in Mongolia and Russian Siberia. We can obtain an indication: from west to east and from north to south (Derevianko A.P., 2001 and 2005), human migrations occurred during the last glacial period. The relationship between blade techno-tradition represented by many stone-tool industry and micro-blade industries in North China becomes clear more and more at the moment. It might be the key in resolving the issue of the origin of microblade complex in North China and greater East Asia.

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Recent Discovery of Paleolithic Sites in Bubing Basin, South China

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Abstract
The Bubing Basin, located at southeast Bose Basin of Guangxi, south China, preserves four fluvial terraces containing ubiquitous stone artifacts. These pebble-tools include bifacial technology in early Paleolithic period, and small flak technology in late Paleolithic Period. This finding provides important evidence for understanding Paleolithic human activities in Southeast Asia.

The Bubing Basin is a narrow karst depression, with 15 km in length and 1 km in width. Its margins formed by Paleozoic limestone and dolomite peak-forest karst in southwest, and Eocene fluvial – lacustrine sedimentary horsts in southeast. The horst separates the Bubing and adjacent Bose Basin. Tower karsts are commonly scattered inside the Bubing Basin (Figure 1). Ten layers of karst cave are broadly presented in karst realms, and four fluvial terraces are distributed inside the Bubing Basin (T4 through T1).

Figure 1 Landscape of the Bubing Basin

Since 1999, we carried out a long term of investigations, excavations and researches in cave deposits of the Bubing Basin, as a result, various of early Pleistocene to Holocene mammalian faunas have been recovered, including hominoid elements of *Homo erectus*, *Homo sapiens*, *Gigantopithecus* (Wang et al., 2005, 2007, 2015; Wang, 2009; Li et al., 2015).

Paleolithic stone artifacts were first found on surface of Ganxia Site when we surveyed in the basin in 1999. Up to 2008, we launched a systematic paleolithic investigation in the Bubing Basin, leading to discoveries of a dozen of Paleolithic - Neolithic sites and a large number of stone artifacts on surface. During 2009 to 2010, a test excavation was set at Dingmo Site, an area of 23 m^2 was exposed, yielding more than 1000 stone artifacts, dozens of mammal bones and some polished stone artifacts, including one piece of bark cloth stone beater (Li et al., 2005). During 2012 to 2013, we excavated at Aolingpo and Ganhuai Site in T3, resulted in numerous of stone artifacts unearthed (Wang, 2014)。

Here I briefly report general situation of Paleolithic and Neolithic sites, and features of stone artifacts in fluvial terraces in the Bubing Basin.

At present, there are nine openair sites have been found in the Bubing Basin, including Xincun-Beipo Site, Ganxia Site, Xinli Site, Ganhuai Site, Aolingpo Site, Kaikou Site, Baili Site, Pubu Site, and Dingmo Site. The Xincun-Beipo and Ganxia Site are distributed at T4 which is estimated to early Middle Pleistocene in age on basis of associated tektites, the Xinli, Ganhuai, Aolingpo and Kaikou Site are situated at T3 which is estimated to Middle to Late Pleistocene in age, the Baili Site located at T2 which is considered to late Pleistocene in age, and the Dingmo Site is distributed at rear edge of T1 which is dated roughly during 5 – 8 ka (Li et al., 2015). The stone artifacts of T4 to T2 are paleolithic assemblage, however that of T1 is Neolithic assemblage.

T4 Paleolithic sites

Xincun-Beipo Site (23°38′49.9″N, 106°56′23.4″; 184 m above the sea level (ASL)) is located at south slope of the horst. The sediment of the site is formed by lower gravel bed and upper laterite which yields stone artifacts and tektites. The Paleolithic assemblage contains five stone hammers, seven cores, eleven flakes, four scrapers, twelve choppers and six picks (Figure 2).

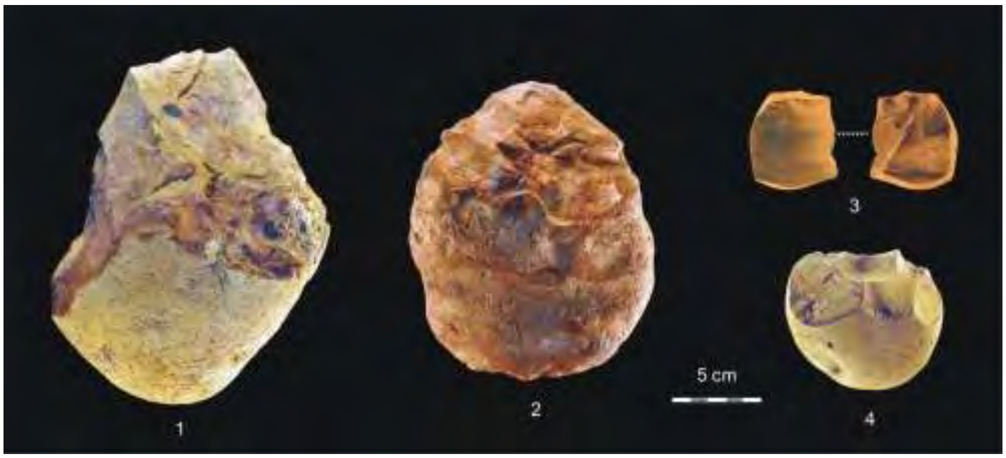

Figure 2 Surface collected stone artifacts at Xincun-Beipo Site in the Bubing Basin (1, pick (Z010218); 2, pick (Z010222); 3, flake (Z010242); 4, Chopper (Z010221).

Ganxia Site (23°38′17″N, 106°58′27″; 180 m ASL) is situated at a southern slope of the horst in central Bubing Basin. Stone artifacts exposed on surface at several locations, associated with a few tektites. The geomorphological features of this site are similar to above Xincun-Beipo Site. Collected stone artifacts include two stone hammers, two cores, fifty-two flakes, three scrapers, three choppers and two picks (Figure 3).

T3 Paleolithic sites

Kaikou Site (23°38′49.9″N, 106°56′23.4″; 145 m ASL) is located at northeast of the horst. It is a broad platform, eroded by some small ditches where stone artifacts are commonly exposed. T3 is formed by lower gravel bed and upper red-yellow sandy clay which preserves stone artifacts. Surface collected stone artifacts include one stone hammer, three cores, four flakes, two scrapers and one chopper (Figure 4).

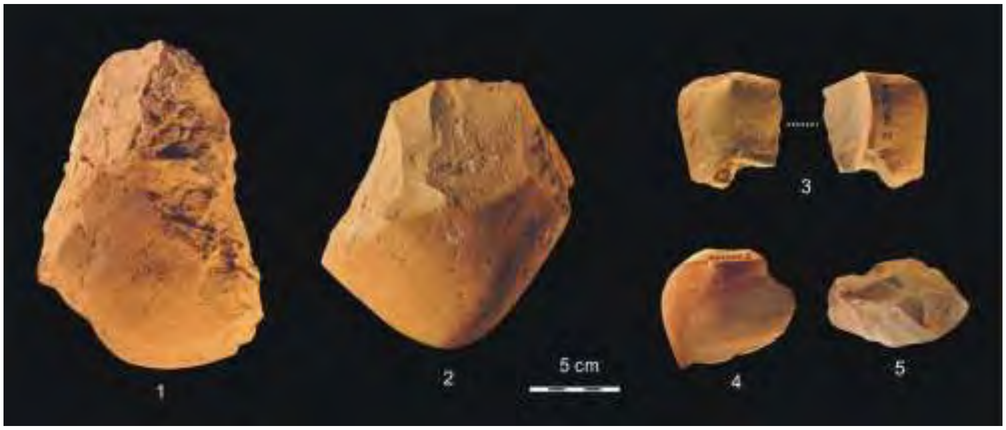

Figure 3 Stone artifacts collected from Ganxia Site in the Bubing Basin (1, pick (Z008364); 2, chopper (Z008367); 3, flake (Z008384); 4, flake (Z008387); 5, core (Z008380))

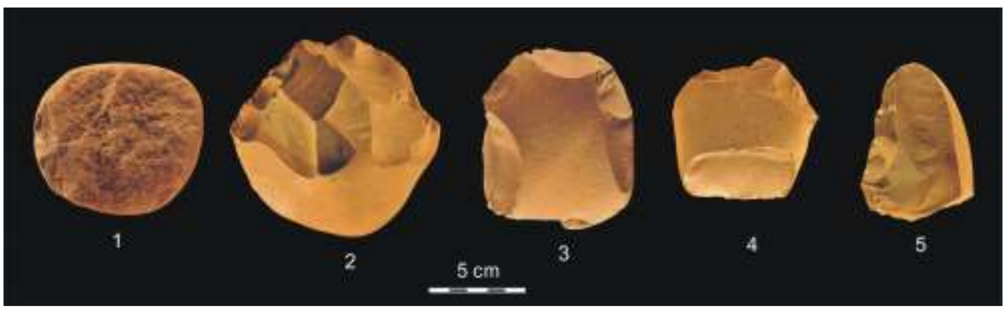

Figure 4 Stone artifacts collected from Kaikou Site (1, stone hammer (Z010298); 2, core (Z010302); 3, core (Z010303), 4, scraper (Z010305); 5, scraper (Z010308))

Aolingpo Site (23°38′59.5″N, 106°56′58″; 130 - 150 m ASL) is located at northwest Bubing Basin. This site is a long slope, extending from horst to central basin. Sediment of the site is thick red-yellow sandy clay, with about 10 m in thickness. When we surveyed in this site in 2012, dozens of stone artifacts have been collected, including one handax from newly exposed profile (Figure 5). This is the only handax found in the Bubing Basin, made of a sandstone cobble, triangle in shape. It is simply flaked on dorsal side, however, ventral side was well manufactured and refined.

Figure 5 Natural exposed profile and handax from Aolingpo Site in the Bubing Basin

T2 Paleolithic sites

Baili Site (23°35′56″ N, 107°0′21″ E; 130 m ASL), situated at southeast the Bubing Basin, is a platform formed by red-yellow sandy clay, with 2 – 3 m in thickness. There is no gravel bed underlying. In 1999, we carried out a test excavation, resulting in discoveries of two cores, twenty-one flakes, one scrapers and four choppers (Figure 6).

Figure 6 Stone artifacts collected from Baili Site in the Bubing Basin (1, core (Z008352); 2, chopper (Z010281); 3, scraper (Z008353); 4, chopper (Z010283))

T1 Neolithic site

Dingmo Site (23°26′38″ N, 106°59′04″ E; 138.3 m ASL) is located at central basin. We conducted an excavation at this site during 2009 to 2010, an area of 23 m2 has been exposed and thousand of stone artifacts and animal bones and teeth have been unearthed. This site is dated to 4734±76～7898±34 B.P. applying AMS. A total of 2433 stone artifacts were recovered during the excavations. The artifact assemblage is comprised of cobbles, hammer stones, anvils, whetstones, choppers, and debitage. The majority of the artifacts were discovered in Layer 3, along with the bark cloth beater. Both chipped and ground stone tools are presentin Layer 3. In addition to the bark cloth beater, other ground stone tools include stone adzes (Figure 7). Most of the artifacts were primarily produced on locally available sandstone (Li et al., 2015).

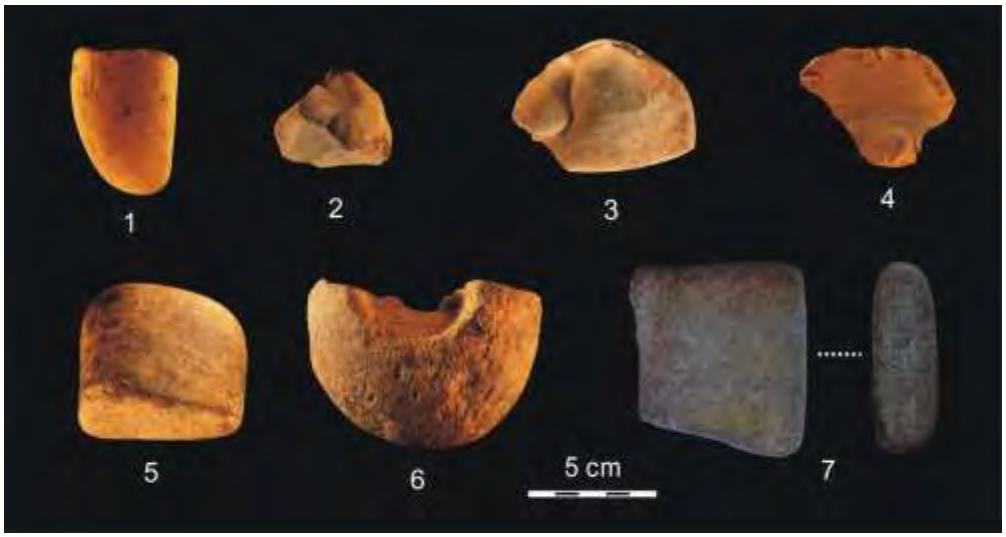

Figure 7 Stone artifacts excavated from Dingmo Site in the Bubing Basin (1, stone hammer; 2, core; 3, flake; 4, scraper; 5, grinding stone; 6, perforated stone, 7, stone bark-cloth beater)

Discussion

To date, the paleolithic sites are mostly concentrated in the Bose Basin in south China. There are 115 sites have been found in the basin which were dated to around 800 ka B.P. (Hou et al., 2000; Wang et al., 2014; Huang et al., 2015). Except the Bose Basin, there are only a few paleolihic sites have been found in this area, such as Qilinshan Site at Laibin in Guangxi, dated to 44～112 ka B.P. (Jia and Wu, 1959; Shen et al., 2007), Baojiyan Site at Guilin in Guangxi, estimated to late Pleistocence according to associated mammal fauna (Wang et al., 1982), Bailiandong Site at Liuzhou in Guangxi, dated to 36 – 7 ka B.P. (Jia and Qiu, 1960; Shen et al., 2001), Maba site in Guangdong, dated to 120 to 237 ka B.P. (Gao et al., 2007), Luosha-yandong Site at Kaifeng in Guangdong, dated to 22～48 ka B.P. (Zhang et al., 1994), and five newly found sites in Hainan Province, estimated to 20 ka in age (Li et al., 2008).

Althoug the fluvial terraces are broadly distrbuted along the Pear River system, the paleolithic remains in openair sites are not rich in this area. Based on the known discoveries, we can find a huge time interval within paleolithic age in south China, from early Middle Pleistocene to terminal Late Pleistocene. Therefore, this situation restricts discussion of regional human evolution.

Dense contemporaneous paleolithic sites in Bose Basin implies early human had ever been prosperous and extremely active. However, there is few evidence of where this *Homo erectus* community had come from or gone? Thus, our new findings in Bubing Basin provide an oppotunity to resolve this scientific question.

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A Study on the Neolithic Chipped Stone Tools from Lingnan (South China)

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Abstract
In Lingnan region, chipped stone implements are not only present throughout the Neolithic age, but also make up a large proportion of the lithic assemblage and become an important part of the Neolithic cultural relics. This paper focuses on the chipped stone implements excavated from sites dating to the early and middle Neolithic in Lingnan region, South China, their cultural characteristics, and then comparing them with site of the Upper Paleolithic to investigate the relationship between stone implements and finally discussing the reasons for the large number and long-term existence of chipped stone tools in the Neolithic of this region.

Lingnan is defined here as an area in the south of the Five Ridges, mainly including the provinces of Guangxi, Guangdong and Hainan (Figure 1). It shares the border with Vietnam and faces the South China Sea. It is characterized by a karst landscape, especially in Guangxi and western Guangdong, where karst mountains contain many caves and rock shelters. Most of the main rivers flow from northwest to southeast, and converge into the Pearl River. There are many basins, big and small, and most of them are distributed along the main river channels. This region has a tropical and subtropical moist monsoon climate. Flora and fauna are rich and diverse.

The study of the Neolithic in Lingnan can be traced back 80 years to the 1930s, when de Chardin and Per Wenzhong conducted archaeological surveys in Guangxi that led to the discovery of several cave sites. More extensive archaeological work has been completed since 1949, especially in the 1970s

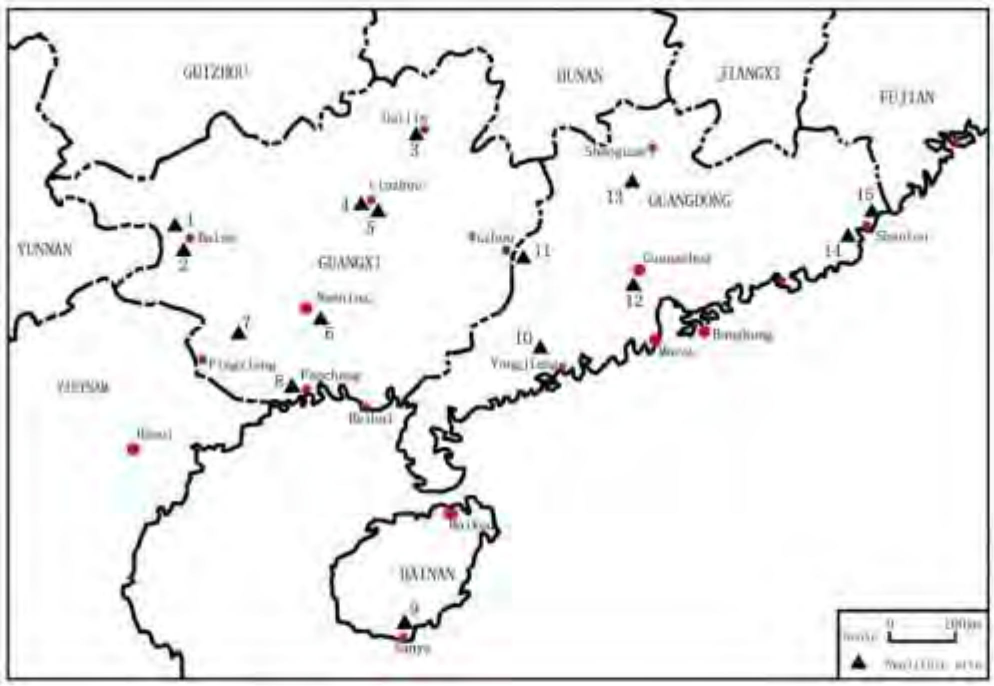

Figure 1: Distribution of the mentioned Neolithic sites in Lingnan（1. Baida; 2. Gexinqiao; 3. Zengpiyan; 4. Liyuzui; 5. Bailiandong; 6. Dingshishan; 7. Chongtang; 8. Yapushan; 9. Luobidong; 10. Dushizai; 11. Huangyandong; 12. Xiqiaoshan; 13. Niulandong; 14. Nan’ao; 15. Chenqiao）

and 1980s. Hundreds of sites have been discovered, dating to the early, middle and late Neolithic, and nearly 100 sites have been excavated.

Chipped stone tools made by knapping are the major artifacts of Paleolithic age. In the Neolithic, although ground stone tools appeared, chipped stone tools still existed. This is more the case in the Lingnan region where chipped stone tools are common and persist throughout the Neolithic. In most of the early and middle Neolithic (12000-6000BP) sites, a large number of chipped stone tools were excavated and they dominate the assemblages from these sites.

Characteristics of the Neolithic chipped stone tools from Lingnan

Raw materials

The Neolithic chipped stone implements from Lingnan are mostly made of sandstone cobbles. In addition, other rock types such as quartzite, quartz, diabase, siliceous rock, flint and tektite also have been identified. Apart from tektite, nearly all of them are cobbles. Raw materials change with sites, especially those in different areas. For example, at Zengpiyan cave site (Fu et al, 2003) in Northern Guangxi, raw materials are almost all cobbles of sandstone, while at the Dingshishan midden site（Fu et al, 1998） in southern Guangxi, raw materials for chipped lithic implements are nearly all tektites. At the sites of Bailiandong（Xie et al, 1987）and Liyuzui (He et al, 1983) in Guangxi and Xiqiaoshan site (microlithic assemblages) in Guangdong（Yang, 1985）, however, flint dominates as a raw material. Cobbles for tool making are often medium size with a diameter of 10 cm and cortex is present on one or both sides. However, those of higher quality, such as siliceous rock, flint, tektite, are much smaller in size.

Manufacture technology

Methods for flake detachment include direct hard hammer percussion, anvil techniques, R*uilengzaji*-line-platform techniques but rarely bipolar reduction. In the early Neolithic, flakes are detached mainly by direct hard hammer percussion and by the R*uilengzaji*-line-platform technique. For example, most of flakes from the Baida site（Xie et al, 2006）and Gexinqiao sites (Xie et al, 2012)were made by direct hard hammer percussion, and those by R*uilengzaji* technique are also abundant. But flakes made by the anvil technique and bipolar reduction were more rare at these two sites. A special technique for making micro-cores and micro-flakes was found at the Xiqiaoshan site (Yang, 1985). With the exception of Xiqiaoshan site, the methods for flake manufacture during the Neolithic in Lingnan, on the whole, are nearly the same as those of the Palaeolithic in this region, especially the Upper Palaeolithic.

Stone tools are made by direct hard hammer percussion, anvil technique and bipolar reduction with direct hard hammer percussion dominating. Pebble tools are often made by direct hard hammer percussion and anvil technique, and most of flake tools are made by direct hard hammer percussion. Flake tools made by anvil technique were not found at Neolithic sites. The indirect technique is rare and was only found at the Bailiandong cave site （Jiang et al, 2009 ） where a great number of flint small flake implements were recovered. Most of the tools are unifacially made, though those bifacially made also occur. In most of the pebble tools, the flaking is characterized by large flakes and fairly regular stepped scars extending along one edge of the tool in such way as to produce a straight or scalloped outline. On the tools, there are large unflaked surfaces, which exhibit the original cortex of the cobble. The tools made unifacially on cobbles often have a flat surface that is left unflaked. As to the flake tools, most of them are retouched unifacially along one side. They are simply worked, and nearly unchanged from the original form of the flake.

Typology of implements

Neolithic chipped stone tools from Lingnan include choppers, scrapers, picks, points, handaxe-like tools and cutters. Choppers comprise the maximum number in the tool assemblage, especially at the sites of Zengpiyan in Guangxi, Huangyandong（Song et al, 1983）, Dushizai （Qiu et al. 1982）and Niulandong in Guangdong，and Luobidong （Hao, 1997）in Hainan. Nearly all of them are made on cobbles that are usually of flattish oval, elongated oval, or circular shape. Both unifacial and bifacial types were found. The former are much more in number than the later. There are a few retouched scars on the edges, but few traces of use-wear can be observed. Based on edge number and shape, choppers can be divided into several subtypes (Figure2, 1-5). Picks comprise a considerable number in the tool assemblage. They are flaked unifacially. Nearly all of them are made on cobbles, and in most cases are worked on the upper surface only. The tips have a plano-convex or triangular cross section, and the butt-end normally exhibits large areas of cortex (Figure2, 6). Scrapers are made on both cobbles and flakes. The raw material type for scrapers is considerably different from those of the heavy-duty tools such as choppers and picks. Scrapers are mainly made on fine-grained sandstone or flint. Those made on cobbles often have a flat base which is left unflaked. In many cases, use-wear traces can be observed on the edges. Those made on flakes are often smaller in size and the raw materials are mainly flint and silicified rock, these were identified at a few sites such as Bailiandong（Zhou et al, 1987）, Nan’ao（Qiu, 2008） etc. Subtypes are side scraper, end scraper and notched scraper, but the side scraper is the common (Figure2, 7-10). Handaxe-like tools are nearly identical to Palaeolithic handaxes in terms of technology and typology. They are made on cobbles. Presence of the cortical surface near the thick butt is common. The tips are often in tongue shape. In general, the handaxe-like tools are very similar to those of the Bose industry in western Guangxi. They were only found at the midden sites such as Yapushan （Mo et al, 1961）, Chenqiao（Mo, 1961） etc, which are distributed along the coast(Figure2, 12). Points are small in number and were found only at a few sites. They are made mostly on flakes of flint and silicified rock（Figure 2, 11）. Cutters are small in size, often made on flakes of flint and tektite. They were only found at a few sites such as Dingshishan（Fu et al, 1998）and Chongtang（He, 2008）(Figure3).

Comparison with Paleolithic chipped stone tools

The comparison of the Neolithic chipped stone tools from Lingnan with those of the Palaeolithic in the same region indicates that there are many common characteristics between them. These are as follows:

1) They mainly belong to the pebble-tool tradition, and pebble tools are the majority in assemblages.
2) The tools are large and heavy, and most of them are heavy-duty tools.
3) Tools are simply made, nearly all of the pebble tools exhibit the original cortex.
4) Although there are several tool types in the assemblage, choppers inevitably dominate.

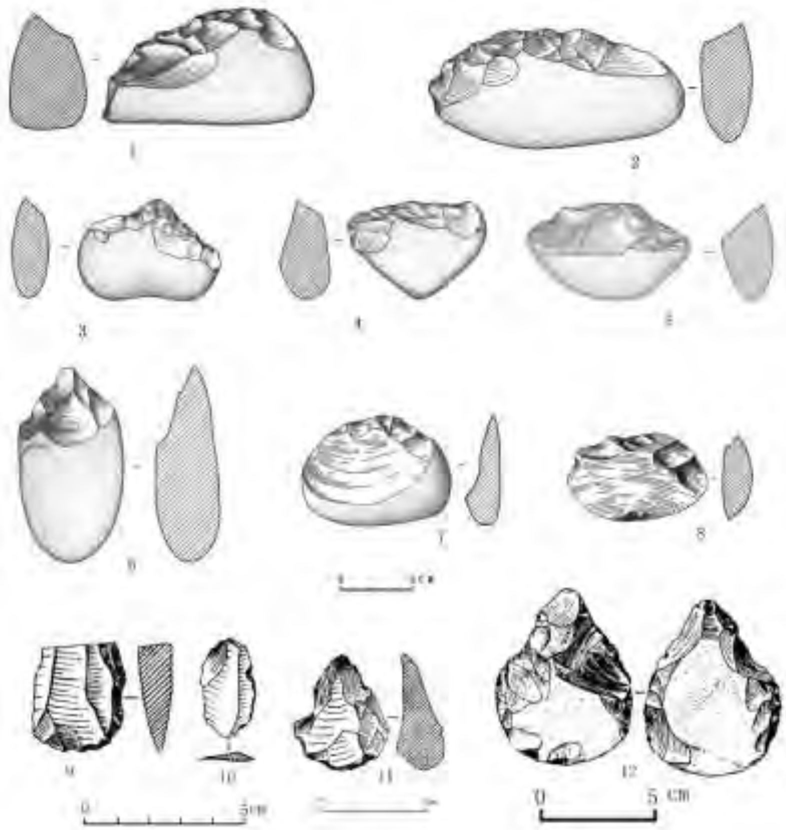

Figure2 Neolithic chipped stone implements from Lingnan （1-5 Choppers; 6 Pick; 7-8 Scrapers; 9-10 Flint scrapers; 11 Point; Handaxe-like tool）

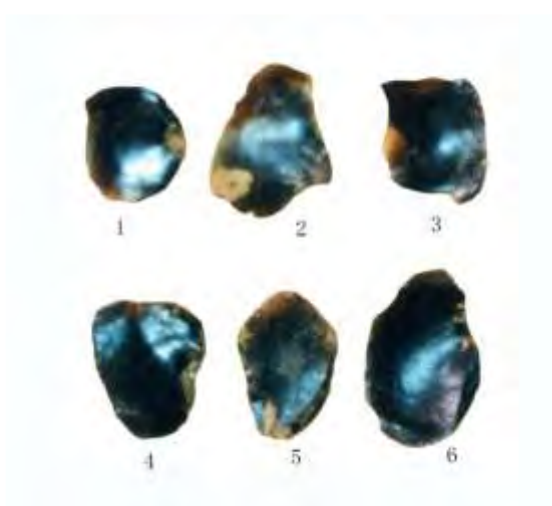

Figure 3 Chipped implements made of tektites

However, differences between them are also obvious. Firstly, in the Palaeolithic age, raw materials for tool making were mainly sandstone, quartzite and quartz, while in the Neolithic age, sandstone is the main raw material type for the pebble tools, and flint, tektite and siliceous rock for flake stone implements. Secondly, there are some changes in tool type and percentage in the assemblage. In the Palaeolithic age, tools include choppers, picks, scrapers, handaxes and cleavers, but apart from choppers, picks and handaxes are the main types. In the Neolithic age, however, scrapers increase, and picks and handaxes（handaxe-like tools） decrease dramatically. Thirdly, the Palaeolithic pebble tools are larger than those of the Neolithic.

Discussion and Conclusions

Tradition of the Neolithic chipped stone implements

The Neolithic chipped stone implements were inherited from the Paleolithic stone implements, and they both belong to the same technological tradition. In Lingnan region, the Palaeolithic implements belong to pebble-tool tradition. Up to the Neolithic age, chipped stone implements, on the whole, still belong to this tradition. Despite of different stages (early, middle and later stages), chipped stone implements unearthed from most of the sites are made on cobbles, only at a few sites were chipped stone implements found that are mostly made on flakes. Technologically, in the Palaeolithic age, direct hard hammer percussion is the main method for flake manufacture and for tool retouching. Most of the tools were simply made and flaked unifacially, leaving a large area of cortex on the tool surface. These characteristics continue to exist in the Neolithic. In addition, types of the Neolithic tools are nearly the same as those of the Upper Paeolithic.

New developments of the Neolithic chipped stone implements

Apart from the inheritance of the Palaeolithic, some innovation and development in the Neolithic chipped stone implements can be seen. The *Ruilengzaji* technique, which occurred in the Palaeolithic, was also prevalent in the early and middle Neolithic. Flake tools, not common in the Palaeolithic, now increased in the Neolithic. New assemblages occurred. At the sites of Bailiandong, Liyuzui in Guangxi and Nan'ao in Guangdong, small flake implements made of flint were abundantly found, and those made of tektite were unearthed in great number at the Dingshishan midden site near Nanning.

Some new cultural elements due to the cultural exchange

Microliths from the Xiqiaoshan site are very special, for it is unique in Linnan during the Neolithic. Apart from microliths, painted pottery, which originated in central China, also appeared in Linnan during this period. But they are distributed in limited time and space. They were found almost only in Guangdong, especially in the Pearl River Delta. These new cultural elements may be a result of cultural exchange.

Reasons for the long-term existence of the Neolithic chipped stone implements

In most parts of China, chipped stone implements decreased gradually in the post-Palaeolithic period, and along with the increase of ground stone implements in the Neolithic, they were quickly replaced by the later. In Lingnan, however, chipped stone implements continued to exist for a long time and did not disappear until the late Neolithic. In the early and middle Neolithic, they played an important cultural role. The reasons for this may be as follows:

Lingnan is located in tropical and subtropical region. There had been a good and stable environment with a rich and diverse plant and animal ecosystem during the late Pleistocene to Holocene. This provided the prehistoric people in this region with favorable living conditions. Mammalian fauna of late Pleistocene continued to exist in Holocene. Like their ancestors in the Palaeolithic, the Neolithic people must have got an abundance of meat from these animal species by hunting. In addition, people of this period also exploited various plants. This is confirmed not only by the unearthed plant food remains from Neolithic sites, but also by the plant food processing stone tools. Because of the rich natural food resources in this region, agriculture did not appear until late Neolithic age (after 6000 BP). For these reasons, there was little change of the economic pattern from late Palaeolithic age to Neolithic age, and, if any, the Palaeolithic people lived on hunting and gathering associated with fishing, while the Neolithic people lived on hunting, gathering and fishing. Because the prehistoric economics of this period in Lingnan was a broad-spectrum strategy of hunting, fishing and gathering, the chipped stone implements, which were adapted to this economic pattern, continued to exist throughout the Neolithic period, and were an important part of their culture in the early and middle Neolithic age.

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The First Floating Farmers: Tempo and Mode of the Neolithic Transition in Taiwan

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Encounters between Upper Paleolithic Taiwanese foragers and seafaring Chinese farmers about 6,000 years ago ushered in a Neolithic lifeway that ultimately extended far into the Pacific (Bellwood 2009, 2007, 2005; Diamond and Bellwood 2003, Lu 2010; Pawley 2002; Rolett et al. 2000). Many agricultural origins have involved forager adoption of exogenous crops (Bellwood 2005, Diamond and Bellwood 2003, Winterhalder and Goland 1997), so the dramatic introduction of farming to Taiwan is an ideal forum for exploring the evolutionary implications of crop transfers (Hung and Carson 2014, Kennett et al. 2006).

Data from both sides of the Taiwan Strait (Chang, K. C., 1969, 1989; Chang and Goodenough 1996; Jiao 2007) indicate that the first immigrations occurred as early as 6,000 B.P. but most evidence centers at 5,000 – 4,500 B.P. The current consensus is that millet, rice, and possibly taro were introduced from the Southeast China coast, along with red cord-marked ceramics and polished stone technology (termed Dapenkeng Culture; Chang, K. C., 1969). Yet the transition from foraging to agriculture in ancient Taiwan is not well known (Jiao 2007, Liu 2009): securely dated archaeological sites from this period are rare due to marine transgressions and dynamic geophysical landscapes (Chen,

M. L. 2015, personal communication; Liu 2015, personal communication, Jiao 2007, Zong 2004). We do not yet know if Upper Paleolithic foragers adopted crops immediately or gradually, as a package or separately, or if the process was (at least for a time), reversible.

To maximize limited archaeological data and help focus the search for new materials, related independent bodies of information can aid in hypothesis development (Binford 2000, 2001; Lupo 2007; Yu 2014). Human behavioral ecology (HBE) offers models germane to labor effort, costs to mobility, and decision-making that apply at the boundary between foraging and food production (Cohen 2009; Gremillion 1996, 1998, 2004; Gremillion and Piperno 2009; Piperno and Pearsall 1998; Winterhalder and

Kennett 2006;

Figure 1. Important Neolithic-era crops in Island SE Asia. Upper left taro (Colocasia spp), upper right Ginger (Alpinia spp), lower left Millet (Panicum, Setaria spp), lower right Rice (Oryza spp).

Kramer and Greaves 2014).Improving our understanding of the costs of cultivation can help to identify measurable characteristics of crops that would have influenced forager decisions to adopt agriculture. HBE models quantify costs and benefits in a way that can be assessed in a framework of evolutionary decision-making at the level of groups and individuals (Kennett et al. 2006, Lupo 2007, Winterhalder and Smith 2000).

Making the leap to archaeological inference from such small scales is, of course, a major challenge. Ethnoarchaeology uses real-time observations of dynamic relationships between humans and the material world from an archaeological stance that accounts for the effects of post-depositional phenomena on the material record (Binford 2001, David and Cramer 2001, Gifford-Gonzales 2010, Yu 2014). Interviews with modern foragers under pressure to adopt agriculture (Binford 1983; Kaplan et al. 1990; Kelly 2014; O'Connell and Hawkes 1981; Yu 1997, 2015) indicate that opportunity cost (Winterhalder 1983, Winterhalder and Kennett 2009), future discounting (Cohen 2009, Winterhalder and Kennett 2009), and risk avoidance (Winterhalder and Golan 1997) HBE models apply to this question. Lewis Binford's Hunter-Gatherer Database (Binford and Johnson 2014) allows for projections of foraging habitats, resources, mobility, and subsistence in areas where foragers no longer reside. In this paper, I use Binford's database to frame hypothetical expectations for Upper Paleolithic Taiwanese foraging and the tempo and mode of agricultural adoption. I begin with a brief summary of the state of Neolithic Taiwanese archaeology today.

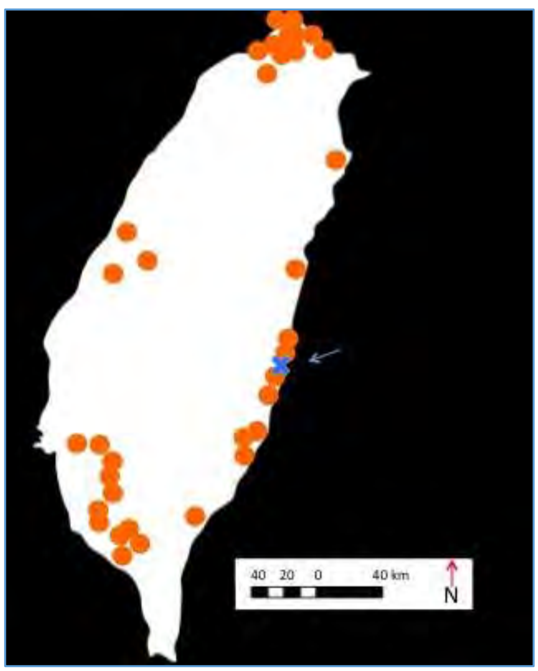


Figure 2. Selected archaeological sites in Taiwan (after Hung and Carson 2014).

Incipient Neolithic sites do not show strong geographic patterning. The Dapenkeng type site is located in northeast Taiwan, with other very early sites (Nan-kuan-li, O-luan-pi, and others) near the southern tip. From footholds at the north and south of the island, the 'Neolithicization' of Taiwan proceeded rapidly. New excavations at Nan-kuan-li in the south (Tsang 2005) and Taichung in the west-center of the island (Drake and Chung 2016, Chu, W. L. personal communication 2016) are exposing Dapenkeng cultural remains of extensive scope and complexity including large settlements, burial grounds, ceramics, architecture, and 5,000 year old millet grains.

Unfortunately little is known about the preceding foraging lifeway, most of it from the type site for the Taiwanese Paleolithic Changbin Culture, Baxiandong (Sung 1969; Tsang et al. 2009). For at least 30,000 years throughout the Pleistocene and into the early Holocene Taiwan was inhabited by fisher-foragers who favored sea caves and used pebble tools as well as bone technology. Securely dated archaeological sites dating to the late Pleistocene to early Holocene transition are relatively scarce (Jiao 2007, Liu 2009) due to early Holocene sea level rise and another major marine transgression at about 4,500 BP (Chen, M. L. 2015, personal communication; Liu 2015, personal communication, Jiao 2007). Although the subsidence of a stable Paleolithic foraging lifeway based on marine aquatic productivity to imported agriculture may seem inevitable, the archaeological record suggests variability in adoption depending on island habitats.

Figure 3. Typical Asian Pebble Tool chopper, Baxiandong Paleolithic Site, E. Taiwan.

A Foraging Frame of Reference

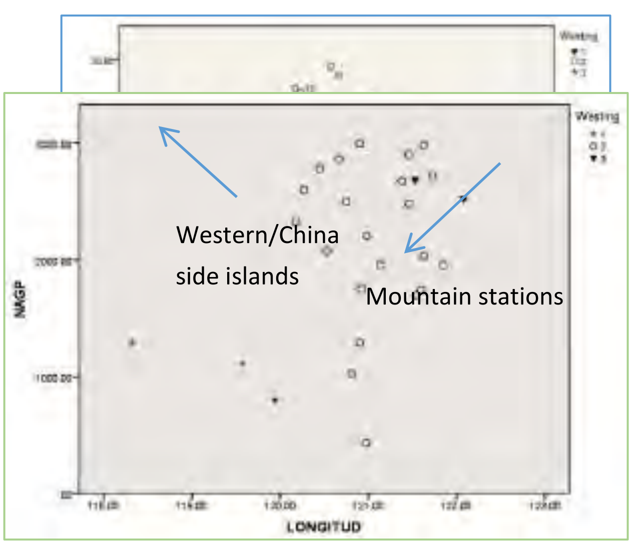
Until more archaeological data surface, a useful means for developing hypotheses about the earliest food production is to employ a foraging frame of reference. Lewis Binford's hunter-gatherer database (Johnson and Binford 2014) allows for projections of foraging adaptations based on properties of habitats and what is known about more than 400 ethnographically documented foraging groups. I collected weather station, soil, and vegetation data and calculated Binford's foraging projections for Taiwan and some of its offshore islands, which were certainly within the realm of influence of seafaring Paleolithic foragers. The idea is to formulate expectations about Taiwanese foraging that would help inform testable hypotheses about the adoption of exogenous Neolithic crops. I begin with climate and habitat projections to provide the backdrop for the

ethnographically derived projections.

Figure 4. Lewis R. Binford.

Figure 5. Effective Temperature (ambient warmth) and Calculated Real Rainfall (mm) for Taiwan, with ordinal longitudinal category of weather station.

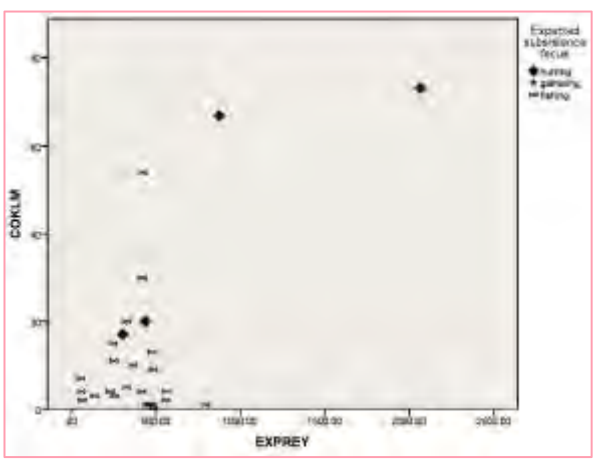
Rainfall/growing season: The climate for Taiwan is sub-tropical in the north and



tropical in the south, with 12 month growing seasons, high temperatures, and tremendous rainfall (up to 5 m per year in some areas). Yet there is dramatic variability driven by the two major mountain chains with peaks that soar to more than 13,000 feet/3,900 m. and capped with cooler, drier alpine habitats. Summer winds associated with the East Asian monsoon are southerly, bringing typhoon related moisture. Winter rains are harder to predict, with northwesterly winter winds blowing from China's cool interior and bringing moisture that falls as rain on the leeward side of the Central Mountain range. Most winter moisture falls in lower elevations. The NE quadrant of Taiwan with the lowest amount of flat land receives the highest rainfall and the western or mainland facing side of the island gets the least.

Figure 6. Net Above Ground (plant) Productivity and Longitude, with ordinal longitudinal category of weather station.

Net above ground (primary) productivity and longitude. Lowest wild plant productivity is on the China side of the island, particularly the small islands there.

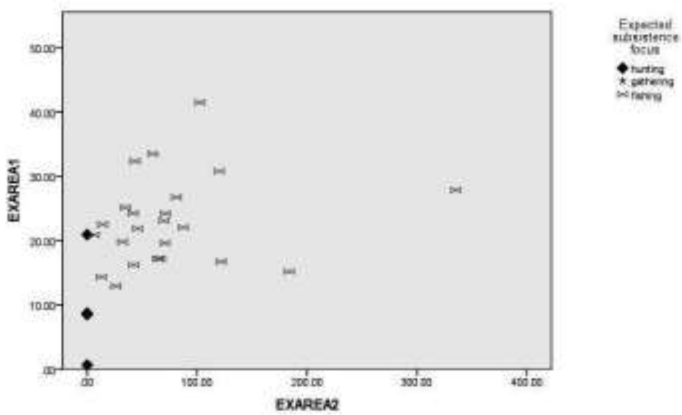


Otherwise plant productivity is high everywhere except for high cool mountains. Much tropical vegetation is foliage and not easily consumed by humans.

Figure 7. Expected (large mammal) Prey and Distance from Coast (a proxy for mountainous topography), with Projected Foraging Emphasis.

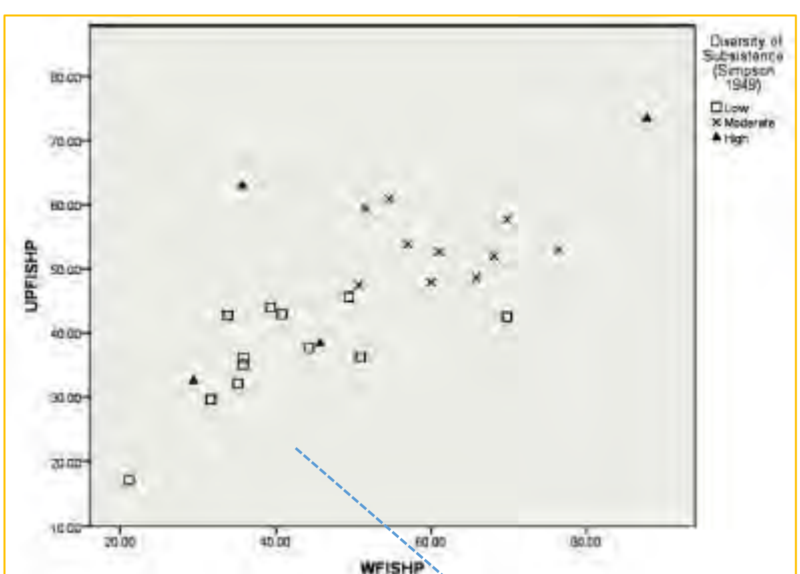
Prey, topography, and projected foraging emphasis. Mammal prey is projected as low overall; 'Formosan' sub species were isolated by flooding of Taiwan strait around 11,000 years ago. Large body size animals (bear, deer, boar) favor mountain habitats. Of 27 stations, only three show hunting emphasis. The remainder are expected to specialize in aquatic resources due to proximity of the coast. Although Binford's database does not project specifically for aquatic prey productivity, Taiwan is situated along the edge of the Eurasia plate at the junction of three Large Marine Ecosystems or Ecoregions: the East China Sea, South China Sea and the Philippines. Nearly two-thirds of Taiwan's surrounding marine ecosystems are expected to hold a rich diversity of deep-sea fish.

Figure 8. Projected Fishing Dependence for Un-packed and Packed Foragers, with



Projected Subsistence Diversity.

Area used by foraging task groups versus residential base camps. Generally, as the projected foraging area used per year increases, so does the area used by residential



base camps. The warm waters of Taiwan condition for residential and catadromous fish in continuous rather than patchy distribution that dis-allows concentrated specialization on fish like that seen with anadromous species in cooler temperate waters. Thus despite Taiwan's aquatic productivity, the degree of foraging mobility is high compared to semi-sedentary fishing specialists.

Figure 9. Expected Area Used Per Year of Foraging Task Groups and Area Used by Base Camps, with Projected Foraging Emphasis.

Packing and intensification. Binford projects that 'unpacked' Taiwanese foragers (those who are not affected by proximity of neighbors) are at least 20% dependent on aquatic resources, with values approaching 75% at one extreme. Packed foraging populations (e.g., more than 9.1 persons/km^2; Binford 2001) show higher dependence on fishing/shellfish, indicating this is an intensification tactic that added diversity to subsistence through niche expansion.

Discussion

According to Binford's projections for Taiwan, Paleolithic foragers are expected to be fishing specialists who made hunting forays into the mountains. With the isolation of the island by rising sea levels of the early Holocene, human populations became isolated and growing density and competition would have required intensification tactics. The warm waters of Taiwan's coasts and her short rivers probably conditioned for evenly distributed aquatic prey in time and space, thus foragers practiced a higher level of mobility than seen in cooler climate fishing specialists.

If fishing allowed for denser but still-mobile foraging populations, any curtailment of that mobility would result in rapid subsistence pressure. This pattern has been seen in other warm habitats where long sequences intensification on aquatic resources allowed for populations to grow but plant domestication was not necessary (Johnson et al. 2015, Yu 2015). The arrival of newcomers from China 6,000 years ago could have been a tipping point through added pressure on wild resources, occupation of lands with sedentary villages and fields, or both. Yet immediate adoption of a farming lifestyle is not guaranteed. Case studies of ethnographically known foragers show strong selective pressure to maintain enough mobility to access wild foods, retain influence over territory and resources, and gather environmental and social information (Binford 1983; Kelly 2014; Yu 2015). Certainly, ancient Taiwanese foragers encountering new crops would have assessed costs and benefits, thus the 'opportunity cost' model in behavioral ecology is useful for predicting variability in the transition to Neolithic farming.

The opportunity cost model predicts that specific obstacles would need to have been surmounted before Neolithic crops were adopted. We know that domesticated crops can expand forager diet breadth -- but at a severe cost to mobility (Winterhalder and Golan 2006, Yu 2015). Field preparation, fertilizing, watering, weeding, and pest control require constant presence, and seed crops are especially demanding. In certain environments however, *vegeculture* (e.g., proto-domestication of local wild species such as trees and geophytes to maintain adaptive characteristics), expands diet breadth while offsetting costs to mobility (Yu 2015, Winterhalder and Goland 1997). Vegeculture cultivation tactics include dispersed field placement, shade cultivation, multi-species permaculture, fallow intervals, and supplemental continued use of wild resources (Ibid; Fogg 1983). Today, traditional Taiwanese indigenous farming includes a mix of vegeculture and seed crops (although millet has largely been replaced by rice mono-cropping). From these considerations I offer two hypotheses regarding the transition to agriculture in Taiwan.

Hypothesis Statement 1. The evolutionary process.

Taiwan's projected foraging intensification strategy combines high dependence on aquatic prey with high mobility, and would have been susceptible to stress when mobility is curtailed. Adding people and/or subtracting foraging territory as occurred with Neolithic immigration could have pressured foragers to the point that they were willing to adopt certain crop species. Earliest adoption is expected to be vegeculture crops such as taro, with seed crops like millet and rice adopted later.

Below (Table 1) is a schematic of intensification of agriculture by crop species, diet breadth and mobility cost.

The above schematic points to a likely sequence for adoption of Neolithic crops by ancient Taiwanese foragers. We expect that resiliency of crops and their transferability to new island habitats would be inversely proportional to mobility costs and risk: thus vegeculture would be preferred for long-distance transplanting. This in turn has implications for the Ideal Free Distribution model of Austronesian expansion to Pacific island ecosystems (see Kennett and Winterhalder 2006), expanding the range of suitable habitats for colonization.

Hypothesis Statement 2. The archaeology.

2a. If adoption of crops was rapid, it will be challenging to distinguish earliest Neolithic sites from the latest Paleolithic. Architecture, features, and the presence of cord-marked ceramics could serve as Neolithic markers, whereas Terminal Paleolithic or transitional forager sites would contain roasting and grinding equipment but otherwise still appear like foraging camps.

2b. If adoption of crops was slow, I expect that at terminal Paleolithic sites vegeculture species will pre-date millet and rice, persist alongside them, and eventually

serve as the ‘canoe crops’ of choice for Austronesian colonists due to versatility, resiliency, and low labor costs. Finally, fishing for freshwater and littoral species is expected to have decreased – at least temporarily – with the advent of seed crop agriculture.

Figure 10. Edge of Amis indigenous field, south of Baxiandong Cave, Taiwan. Note use of megaliths at field boundary.

Conclusion

Characterizing Taiwan’s Neolithic transition in an evolutionary perspective contributes to global understanding of human migrations, adaptation of horticulture to island ecosystems, persistence of foraging lifeways in mixed economies, and implications for resiliency to climate change and other stressors. Specifically, vegeculture may have offered Taiwanese foragers under subsistence and land tenure pressure from Neolithic immigration an option to expand diet breadth at a low impact to mobility due to low risk and labor costs. We would expect that vegeculture preceded seed crops (Fogg 1983; Winterhalder and Goland 1997), persisted alongside, and could be reverted to when conditions necessary for agriculture dropped below a critical threshold (e.g., loss of the labor force [Lau 2008, Yu 2015]). Resiliency of vegeculture to environmental stressors would also facilitate transfer to new settings (e.g., the Austronesian expansion) and ensure maintenance of techniques through Local Ecological Knowledge.

	Low productivity →→→→→→	Moderate productivity →→→→→→	High productivity
Crop	**Taro (C. esculenta)**	**Millet (Setaria and Panicum spp.)**	**Rice (O. sativa)**
Planting	Simple vegetative propagation	Seed preparation and broadcast sowing/hoes or sticks	Seed preparation and hand sowing in paddies
	Year round	January/Feb.	Late March
Field requirements	Shade tolerant/mixed crop	Requires sunny, open fields/swidden clearing	Requires paddy preparation and water management
Harvest/Storage	Roots self-storing underground;	Harvest when ripe, July/August	Harvest when ripe, October
	Sealed storage after harvest	Sealed storage required	Sealed storage required
Vulnerability to predation	Predator resistant/slightly toxic in raw state	Subject to predation, requires some pest control	Subject to predation, requires major pest control
Soil requirements	Tolerant of range of soils	Less tolerant of range of soils	Picky about soil and moisture conditions

Mixed/Vegeculture →→ →→ →→ Intensive/Agriculture
Low Mobility Cost →→→→→→ Medium cost →→→→→→ High cost
Expected adoption sequence/addition to the forager diet early →→ →→ →→ →→ →→ →→ middle →→ →→ →→ →→ →→ late

Table 1. Characteristics and predicted adoption sequence for Neolithic crops by Paleolithic Taiwanese foragers.

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Zheng, Meng (University of New Mexico). 2016. Microblade-based Societies: A new perspective on roles of the microblade technology in northern China after the Last Glacial Maximum

Stone Artifacts Analysis from Re-Deposited Sediments in Seochon Paleolithic sites, Cheongju, Korea.

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Institute of Korean Prehistory

The Seochon Paleolithic sites are located on the western part of Cheongju nearby Miho-stream which a tributary of the Geum River. This site has been discovered through the surface survey by Institute of Korean Prehistory in April 2013, and many Paleolithic artifacts were found with debris of hard earthenware and ceramic belong to the ancient or Joseon Dynasty period

The Seochon Paleolithic sites are consisted of 3 areas divided by topographical locations. After the surface survey, through the test-pit excavation, there were unearthed Paleolithic artifacts concentrated in end of slope and around summit in northern part, which where the locality B and C. As a result, the Paleolithic cultural layer was found with households of the Bronze Age and tombs belong to the Joseon dynasty (modern age) in Jan-Feb 2014. Finally, locality A has been discovered during investigation of the modern age's tombs at the southeastern slope in May 2014.

From The 3 localities at Seochon Paleolithic sites, there were excavated 870 pieces of artifacts including 701 pieces of tool-making artifacts, 121 pieces of heavy duty tools and 48 pieces of light duty tools. More than 91% of the Paleolithic artifacts were manufactured with quartz that is easily acquirable near the site from river flows gravels(65%) or sedimentary rock breccia (30%).

Seochon Paleolithic sites have the typical form of the mid-Paleolithic in Korea which mainly use heavy duty tool including Picks, handaxes, chopper and chopping tools, polyhedrons made by quartz or quartzite.

Table 1. Artifacts assemblages from Seochon Paleolithic site

Locality	Cultural Layers	Debitages	Heavy duty tools	Light duty tools	sum
Loc. A	CL. 1	35	4	3	42
	CL. 2	30	11		41
	CL. 3	1		1	2
	surface	3	1		4
	Sum	**69**	**16**	**4**	**89**
Loc. B	CL. 1	5			5
	CL. 2	228	46	14	288
	CL. 3	85	22	11	118
	Sum	**318**	**68**	**25**	**411**
Loc. C	CL. 1	78	1	1	80
	CL. 2	11	2		13
	CL. 3	27	8	2	37
	CL. 4	194	26	14	234
	surface	4		2	6
	Sum	**314**	**37**	**19**	**370**
Total		**701**	**121**	**48**	**870**

The sedimentation layers are classified into 7 by cause of formation and particle composition in a wide view excluding color and shade which is surface - clay layer with soil-wedge - clay layer with end or without soil-wedge - soil with clay layer - clay with superior soil layer - soil layer - weathered bedrock layer. But the dating of sedimentation layers are very different from each locality with AMS dating. For example, clay layer with soil-wedge observed locality B and C except locality A. Each cultural layer with AMS dating is as follow Table 3. As a result the sedimentary aspect of the site each localities are not same conditions. So, we have rearranged the cultural layer with AMS datings stage by stages.

The most importantly, the classified Paleolithic stages are not able to divide by stone artifacts cultural dating, but can be divided by sedimentation dating. It means the Seochon Paleolithic sites stone artifacts and sedimentation

Table 2. Raw material assemblages

Locality	Cultural Layers	Gravel	Breccia	unknown	sum
Loc. A	1	24	15	3	42
	2	29	9	3	41
	3	2			2
	surface	4			4
	sum	59	24	6	89
Loc. B	1	2	2	1	5
	2	186	84	18	288
	3	84	28	6	118
	sum	272	114	25	411
Loc. C	1	41	33	6	80
	2	7	6		13
	3	25	11	2	38
	4	155	77	1	233
	surface	5		1	6
	sum	233	127	10	370
Total		564	265	41	870

cultural layers are re-deposited under a different environmental condition depending on location or dating stages. As the results of the excavation, we have found that stage 1 is excavated with Middle Paleolithic artifacts and Upper Paleolithic stone tools which dating are from up to 12,000BP, but these are maybe including heavy duty tools from before 45,000BP.

We hope to know the dating results of re-deposited clue excluding. So we have been display stone artifacts weight distribution map, and found that heavy-weight stone artifacts are rearrangement to lowest. It is caused by accumulation due to frequent flooding, landslide along the river.

As a result, The Seochon Paleolithic sites have several cultural layers of the Upper and Middle Paleolithic era. And these layers are re-deposited under a different environment, and Middle to Upper Paleolithic artifacts have been found from same sedimentation layers which confirmed by AMS dating results and artifacts weight distribution. It is great significant to study the re-deposition of the Mid Paleolithic the Korean Peninsula.

Table 3. Sedimentation layer with AMS

Sedimentation	Loc. A	Loc. B	Loc. C
Surface			
clay layer with soil-wedge		1 CL (12,300±50 BP)	1 CL
clay layer with end or without soil-wedge	1 CL (7,940±40 BP)	2 CL (12,400±60 BP)	2 CL
soil with clay layer	2 CL (28,570±220 BP)	3 CL (12,350±50 BP)	3 CL
clay with superior soil layer	3 CL		
soil layer			4 CL (before 45,840±660 BP)
weathered bedrock layer			

Table 4. Stages with AMS and Cultural layer

	Loc. A	Loc. B	Loc. C
Stage 1 (up to 12,000BP)	1 CL	1,2,3 CL	1,2 CL
Stage 2 (up to 30,000BP)	2,3 CL		3 CL
Stage 3 (before 45,000BP)			4 CL

Figures

Figure 1. The Sechon Paleolithic sites in 1968

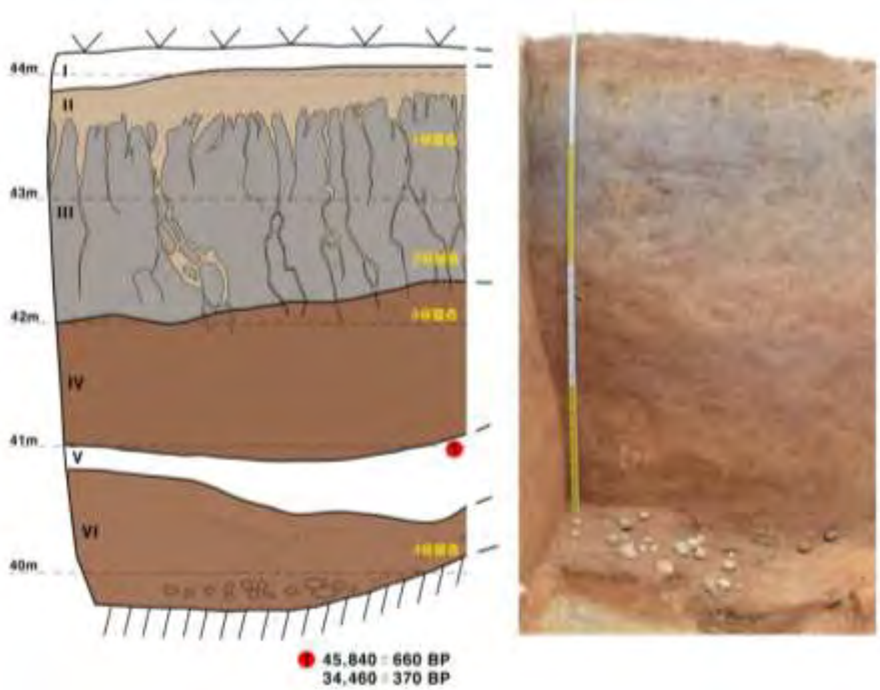

Figure 2. Sedimentation section (Locality C)

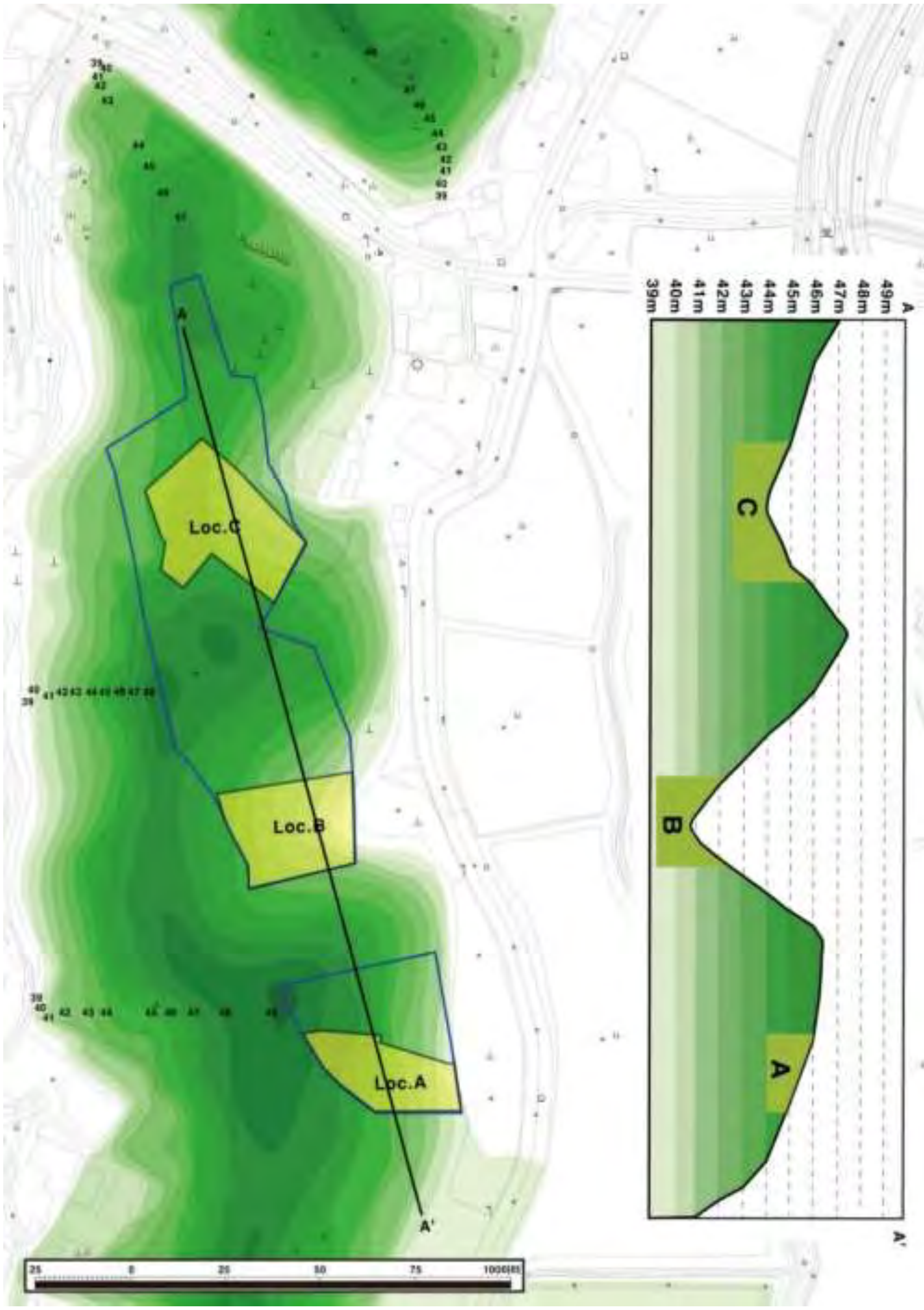

Figure 3. Sechon Paleolithic sites map

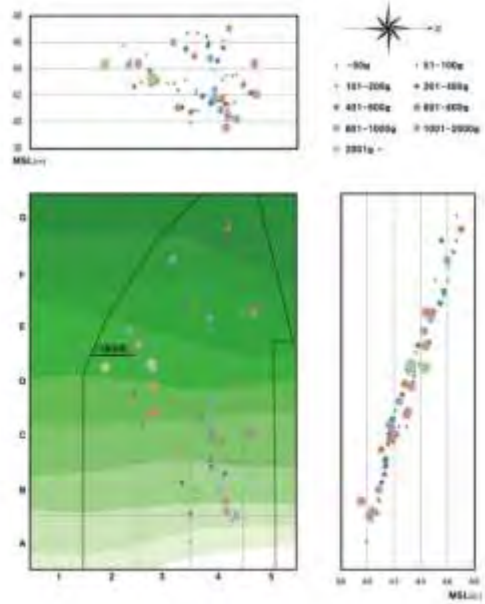

Figure 4. Artifacts weight distribution Map of Loc. A

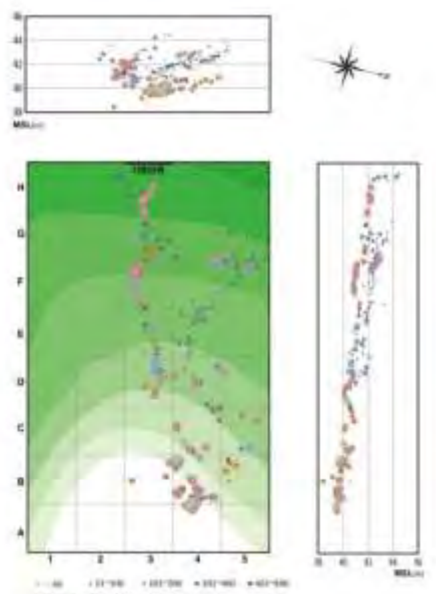

Figure 5. Artifacts weight distribution Map of Loc. B

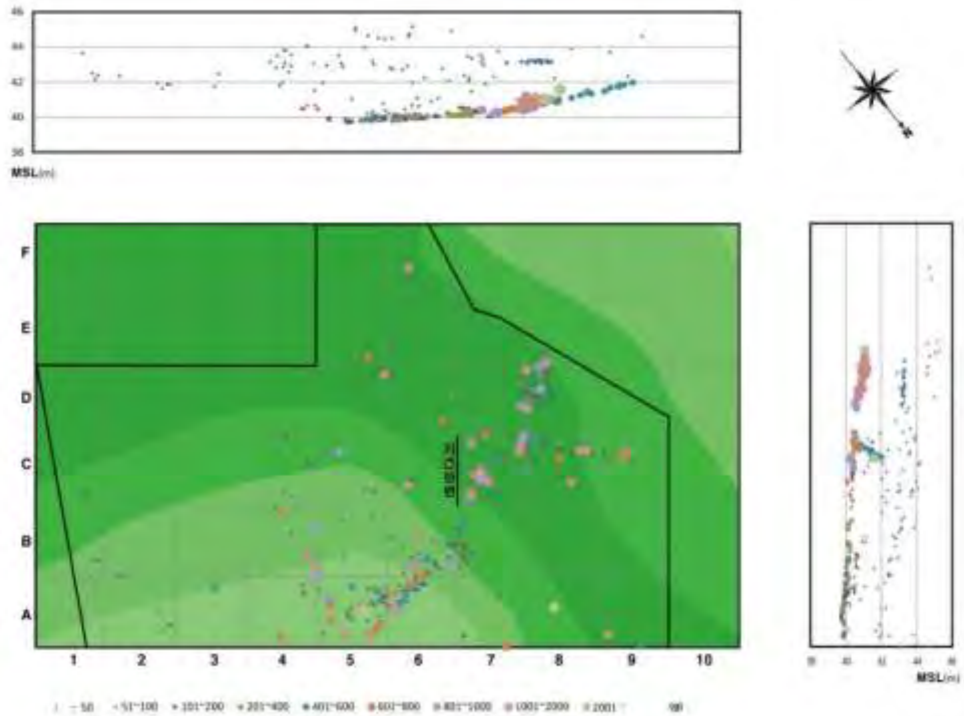

Figure 6. Artifacts weight distribution Map of Loc.C

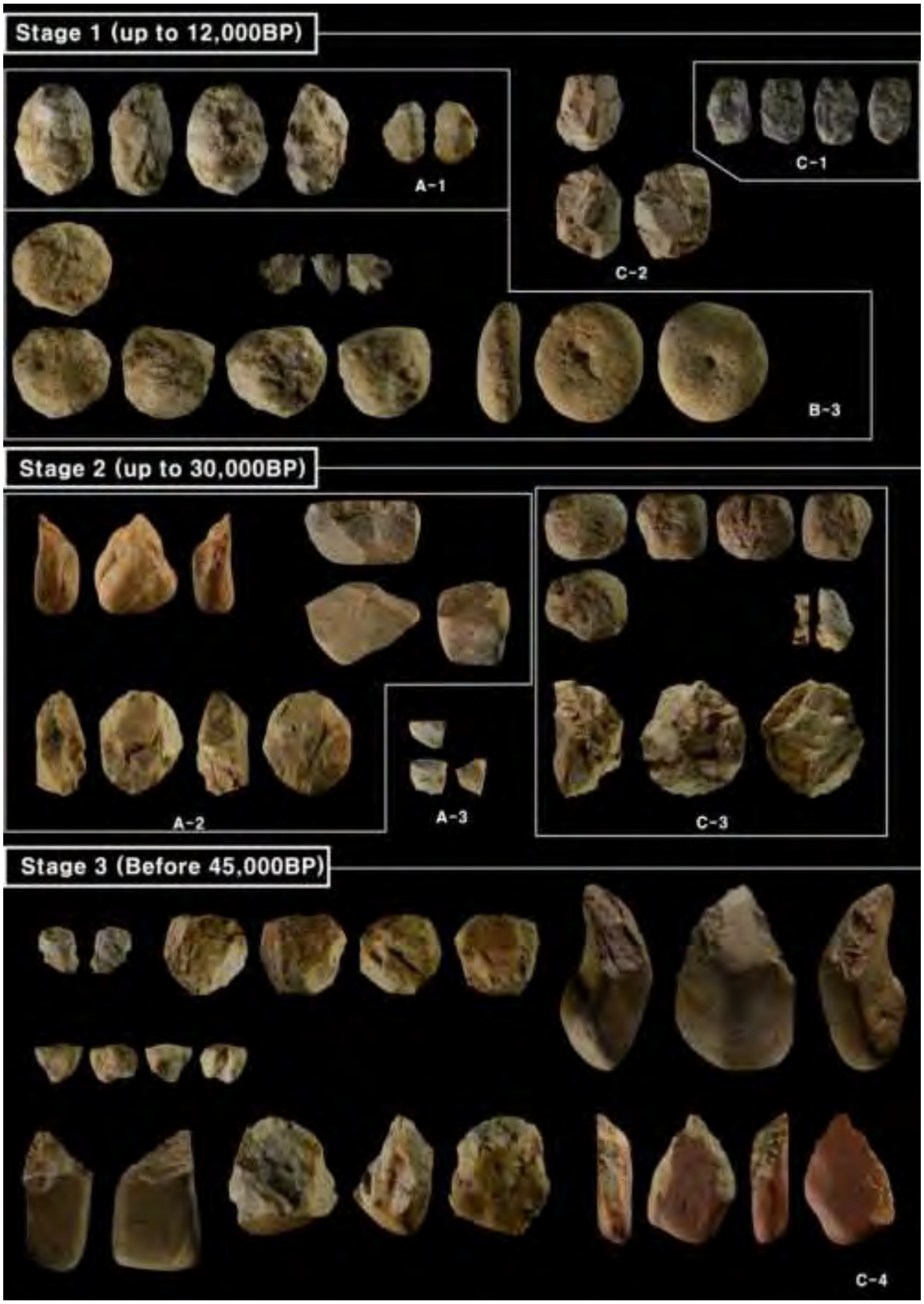

Figure 7. Sechon Paleolithic sites artifacts

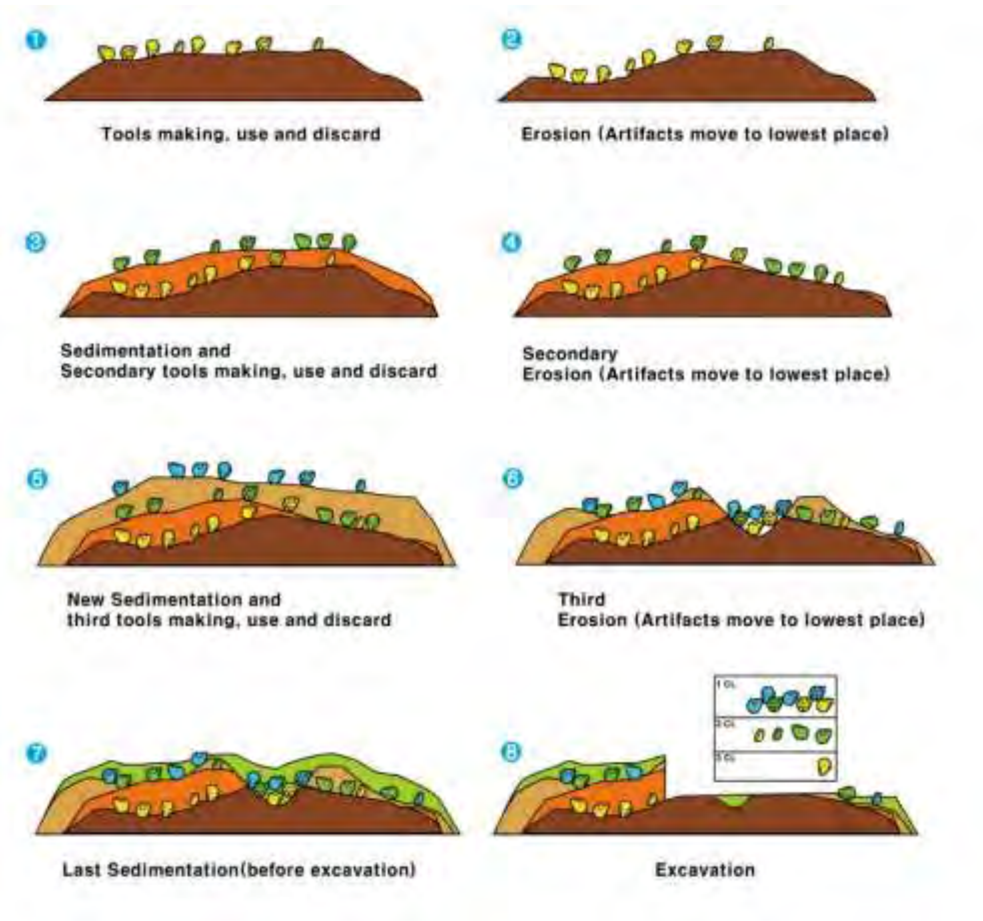

Figure 8. Sedimentation and erosion with artifacts

Microblade-based Societies: A New Perspective on Roles of the Microblade Technology in Northern China after the Last Glacial Maximum[7]

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The microblade technology, or microblade technique, is a concept defined by the methods used to produce microblade products in northeastern Asia, Beringia, and northwestern North America during the late Pleistocene (S.Q. Chen 2008). The bladelets detached from the microblade cores are used to create continuous cutting edges in-set in slots gouged from the sides of projectile point shafts from organic materials and other tools, such as knives and sickles (S.Q. Chen 2008; Dixon 2012). The microblade assemblages are those dominated by microblade products, including microblade cores and microblades, as well as tools to make microblade-based tools, especially burins. In recent decades almost all research has focused on the origin and spread of microblade technologies (C. Chen 1992; Kuzmin et al. 2007). Several researchers have also adopted processual standpoints to understand the appearance and spread of microblade technology, considering factors such as climate change (Barton et al. 2007), high

7 Zhang, Meng (2016). Microblade-based Societies: A new perspective on roles of the microblade technology in northern China after the Last Glacial Maximum. Paper prepared for the 21st International Symposium on Suyanggae and Her Neighbors, University of Wyoming, Laramie, Wyoming, July 26-31, 2016.

mobility of foragers during the last glacial (S.Q. Chen 2008), seasonality and raw material availability (Dixon 2012), and risk-minimizing strategies (Elston and Brantingham 2002). Almost all of the previous studies focus on microblade technology itself, and technological organization of hunter-gatherers in the frameworks of cultural ecology and human behavioral ecology. A broader perspective of social organization has not been adopted. However, investigating social organization has several advantages, including overcoming the disadvantage of explanation in the cultural-historical approach, expanding archaeological studies to reconstruct prehistoric societies associated with microblade technologies, and using other sources to explore the social networks and human adaptations in different temporal and spatial circumstances.

In this research, I propose a concept of “the microblade-based societies” to explore socio-technological variations in different circumstances in the societies in which microblade technology was adopted in the northern China. Combining Horn’s model on resource-demography relationships and its updated version (Horn 1968; Winterhalder 1981; E.A. Smith 1981; Heffley 1981; Kelly 1995;Whallon 2006), settlement systems (Binford 1980, 1983), information exchange (Whallon et al. 2011), risk-reduction model (Wiessner 1982), and social network of prehistoric foragers (Gamble 1999), this research aims to build a holistic framework to discuss the role of microblade technology in the societies of hunter-gatherers after the Last Glacial Maximum (LGM). Chinese microblade assemblages will be analyzed in this framework to explore the variation of microblade-based societies.

“Microblade-based societies”, as a new concept proposed here, is a synthesis of the lifeways of the hunter-gatherers who widely shared microblade technologies in northern circum-Pacific regions. These societies can be combined with the culture-history paradigm and the functional approach to answer questions about microblade technology from broader anthropological view. It is not an ethnic term, but rather a term used to generalize a socio-technologically adaptive radiation (i.e., people used similar technological assemblages to organize their social lives in their territory depending on local resources) after the LGM in NE Asia and into NW North America, in which people had adopted microblade technology as a source of composite tool/weapon elements. The research questions are not directly related to the origin of microblade technology and its routes of spread, but rather are linked to the establishment and development of microblade-based societies, as well as the operation of socio-technological systems facing harsh environments during MIS2. The research questions are anthropological, including: Why did foragers quickly adopt microblade technology in a huge area during the late Pleistocene and abandon a millions of years old flake-and-core technology? What kind of role did microblade technology play in these societies, especially beyond subsistence strategies? How can different regional forms of microblade cores be interpreted? How were foragers organized in terms of resource-demographic relations and risk reduction? Is there any correlation between the effective temperature and organization of microblade-based societies? Is there any variation because of local circumstance?

Reconstruction of microblade-based societies: social networks in hunter-gatherer societies

In the foraging societies, no matter prehistoric or historic, social networks have been explored by archaeologists and anthropologists. Since the "Man the Hunter" conference in 1966, social networks have been discussed in the context of information exchange (Webb 1974; Morre 1981; Wissner 1986; Wiessner and Schweitzer 1998; Whallon 2006) and food sharing (Wenzel et al. 2000). Gamble (1999) evaluated Paleolithic societies in Europe and identified three kinds of networks, intimate, effective and extended, which are principally defined by the resources – emotional, material and symbolic. Intimate networks are built on significant others, effective on colleagues and friends, and extended on friends of friends (Gamble 1999: Table 2.8). According to Gamble's research, social networks expanded from the lower Paleolithic to the Upper Paleolithic, and extended networks mark the Middle to Upper Paleolithic transition, which show higher degree of planning depth (see Binford 1979). Behaviors related to social network building and maintenance include sharing, visiting, aggregating, and information exchanging. Comparing to allowing strangers to access some resources, social networks based on genes and friendship can secure the sharing. They can also provide hunter-gatherers two advantages. First, is short-term in which hunter-gatherers use social network as a buffer during resource crises. Second, is long-term in which hunter-gatherers employ social networks to increase their fitness, providing them adaptive benefits.

Reconstruction of the microblade-based societies: based on the archaeological record

Magdalenian Europe can become a meaningful comparison to reconstruct microblade-based societies with northern China due to similar chronological periods but also because of following reasons: (1) the warming during the post-LGM period, people moved northward; (2) humans developed an open-land adaptation, hunting both mid-size mammals such as deer and horse as major prey and other species according to the local biomass (Jochim 2010). In sum, if we assume that the societies in the late Upper Paleolithic northern China share some characteristics as same as those in Magdalenian Europe, and that the foragers in the microblade-societies fully adopted the innovations by their ancestors, several basic elements of microblade societies can be generalized: (1) effective hunting; (2) highly diversified subsistence; (3) diversified settlement system; (4) widely spread non-utilized exchange; (5) widely distribution of portable artwork, ornaments, and rock art; (6) seasonal aggregation; (7) rituals and ceremonies; (8) exploitations to new regions.

Based on Horn’s model (1968) on demography-resource distribution relationships and its updated versions linked to hunter-gatherers (Winterhalder 1981; E.A. Smith 1981; Heffley 1981; Kelly 1995), as well as Binford’s (1980) forager-collector dichotomy, Whallon (2006:Fig.1) illustrates a figure showing the expected hunter-gatherer mobility strategies in relation to selected resource distribution characteristics. Wiessner (1982) criticizes the forager-collector dichotomy and argues that archaeological data are products of both of the strategies. She insists that risk theory – strategies to reduce risk or to reduce the variance in social and nature resources – is better at explaining differences in social organization of hunter-gatherers. She also notices that most hunter-gatherers used a combination of strategies for reducing risk, and show a continuum of organization. However, there is no significant conflict among the models above, all of which can be generalized into the synthetic model of resource, mobility, and risk-reduction (Fig.1). This model shows four patterns: A, B, C, and D.

According to archaeological record in the post-LGM northern China, four patterns are expected to be found linked with hunter-gatherer mobility. Pattern A is assumed in the valley or lake region during the late Pleistocene, Pattern B in the plateau regions during the late Pleistocene, Pattern C in Northeast China Plain during the Holocene, and Pattern D in the plateau regions during the Holocene (assuming Pattern B corresponding to the late Pleistocene).

Post-LGM northern China: four settings

Based on the modeling method of Binford (2001), S.Q. Chen (2006) constructs the habitat and subsistence variables of the assumed hunter-gatherers, relying on 431 weather station data from China. From maps showing the southward movement of the forest-steppe ecotone (S.Q. Chen 2008), four research regions can be constructed, including the Nihewan Basin, Northeastern China Plain, Inner Mongolian Plateau, and Tibetan Plateau. The sites in the case studies are chosen because of relatively well studied archaeological record associated with microblade technology. In Binford's four thresholds based on the effective temperature (ET) associated to adaptation of hunter-gatherers, 11.43, 12.75, 15.25, and 18.00 are subpolar bottleneck, terrestrial plant threshold, storage threshold, and growing season threshold. In the Nihewan Basin, the Taoerhe alluvial fan where Shuanta site is located, and sites on the Inner Mongolian Plateau, the ET are between 11.43 and 12.75, meaning if depending on hunter-gathering on the terrace resources, the foragers required to heavily rely on hunting and storage. The ET on the Tibetan Plateau is

	A	**B**	**Reference**
Unpredictable ↑	Clumped, mobile, and unpredictable		Kelly 1995
	Logistical procurement	(unlikely to support a hunter-gatherer population)	Whallon 2006
	Collectors		Binford 1980
	Substantial household stores		Wiessner 1982
	C	**D**	
	Clumped and predictable	Evenly distributed, stable and predictable	Kelly 1995
	Focused residential positioning	Residential mobility	Whallon 2006
		Foragers	Binford 1980
Predictable ↓	Storage in combination with centralized pooling of risk	Primarily on risk sharing	Wiessner 1982
	← Concentrated	Scattered →	

Figure 1: expected hunter-gatherer mobility and risk reduction strategies in relation to selected resource distribution characteristics (modified from Whallon 2006:Fig.1)

lower than 11.43 (the subpolar bottleneck), suggesting that if depending on hunting-gathering, they had to heavily rely on big-sized herd hunting or fishing, similar to the Indians on the Great Plains and Eskimos who are marine fishers.

The four case studies which I conducted support the four patterns built in this paper (Fig. 1 and Table 1), though more evidence is required to support these conclusions. Microblade-based societies show variations, not only in terms of their geography and ET, but also in terms of percentage of microblade assemblages in their tools used for subsistence. The microblade technologies were used in huge areas, and the assemblages in northern China are only a portion of those in the northern circum-Pacific. However, the variation in northern China during the post-LGM Pleistocene and Holocene also provides several intriguing topics to discuss the development of microblade technology in different circumstances.

Patterns	Regions	Time	Case studies	ET
A	valley or lake	the late Pleistocene	Nihewan Basin	11.43-12.75ºC
B	plateau regions	Holocene	Sites on the Tibetan Plateau	<11.43 ºC
C	Northeast China Plain	Holocene	Shuangta Site	11.43-12.75 ºC
D	plateau regions	Holocene	Sites on the Inner Mongolian Plateau	11.43-12.75 ºC

Table 1: the tempo-spatial information of the sites in the case studies and their effective temperatures (ETs)

Conclusion and Suggestions

This paper aims to build a new paradigm to explain the wide-spread microblade assemblage in the northern China during the post-LGM. The cultural-historical paradigm provides archaeologists a database about the chronology of different microblade technologies and illustrates a dynamic

Notes: 1. Assume the ET during the Holocene is as same as recent years (1951-1980). 2. Assume that the southward movement of temperature zone made the Nihewan Basin in the range of 11.45-12.75.

picture of the advance and retreat of microblade assemblages during the late Pleistocene, but it ignores those during the Holocene, their association with other artifacts, their behavioral system (including social networks), and their connections with spread of food production. In short, the older understanding of microblade technology has limited archaeological research in a self-evident closed circle. The new paradigm using the concept of "microblade-based societies" can overcome these difficulties in the cultural-historical approach. To explore the development and variation of microblade-based societies, three kinds of resources need to be studied, including (1) global microlithization trends, especially comparison between the microblade societies with the Magdalenian and Mesolithic, as well as the LSA in the southern Africa; (2) ethnographic documents, which help archaeologists recover a possible living system in the microblade-based societies; (3) and variation of microblade-based societies, in which microblade assemblages need to be connected with other artifacts and ecofacts in the technological organization framework.

This paper is an early version of further research to explore the roles of microblade technology in the Last Glacial and Interglacial adaptations of northern circum-Pacific foraging societies. In this paper, social network analyses have not been robustly built, which will be systematically studied by combining raw materials in microblade assemblages in every sites and using spatial analyses in ArcGIS. In addition, how to interpret the role of microblade assemblages in terms of need, including social meaning, raw material availability, and hunting efficiency, needs to be further studied in which model-building would be essential.

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