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Biological Relationships among Siberians: Craniometric, Serological, and Dermatoglyphic Approaches

Miyo Yokota
University of Tennessee, Knoxville

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I am submitting herewith a dissertation written by Miyo Yokota entitled "Biological Relationships among Siberians: Craniometric, Serological, and Dermatoglyphic Approaches." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Anthropology.

Richard L. Jantz, Major Professor

We have read this dissertation and recommend its acceptance:

William M. Bass, Lyle M. Konigsberg, Christine R. Boake, Murray K. Marks

Accepted for the Council:

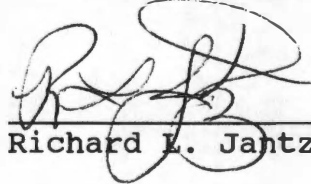
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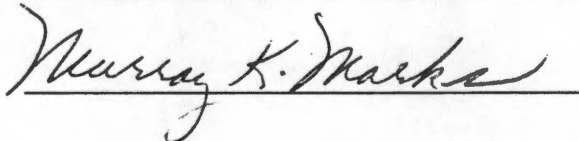
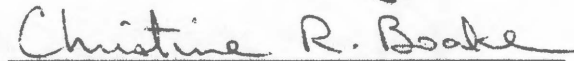
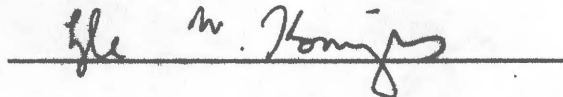
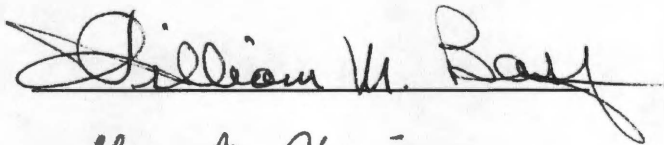
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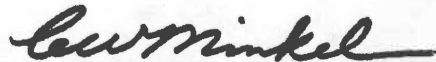


Richard L. Jantz, Major Professor

We have read this dissertation
and recommend its acceptance:



Accepted for the Council:



Associate Vice Chancellor and
Dean of The Graduate School

**Biological Relationships Among Siberians:
Cranimetric, Serological, and Dermatoglyphic Approaches**

**A Dissertation
Presented for the
Doctor of Philosophy
Degree
The University of Tennessee, Knoxville**

**Miyo Yokota
August 1997**

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DEDICATION

This dissertation is dedicated to my parents

Mr. Tadao Yokota

and

Mrs. Kazuko Yokota

who have given me opportunities to see the world

ACKNOWLEDGEMENTS

I would like to thank my advisor, Dr. Richard Jantz, for his support, guidance, and patience. I learned a lot from him: research, wisdom, bicycling, and most of all, just "keep going" when obstacles are encountered.

I would also like to thank other committee members in the Anthropology Department, Dr. William Bass, who would always talk to me in the hallway to see how I am doing; Dr. Murray Marks, who was patient and kind enough to go over the revisions of this dissertation with me; and Dr. Lyle Konigsberg, who "nicely" gave me critical comments on my papers including this dissertation and taught me the whole shebang of American slang and idioms.

My appreciation goes to Dr. Christine Boake in Ecology and Evolutionary Biology, who kindly agreed to be one of my committee members.

This dissertation would not have been not completed without the generosity and assistance of the following people: Dr. Michael Crawford at the University of Kansas, Drs. Hajime Ishida, Kunihiro Morita, and Ei Ikeda at the Sapporo Medical School, Japan, and Dr. W.W. Howells at the Harvard University. I am extremely grateful to them.

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Lastly, I like to thank my parents and all my friends who are always there for me with their love, support, and encouragement throughout the long journey of graduate schools.

ABSTRACT

Siberian people, residing in the wide range bounded by the Urals to the West, Beringia to the East, Mongolia to the South, and Arctic to the North, form an important link between Asia, Europe and people in the New World. However, biological contribution of Siberians to Asians, Europeans and people in the New World were not sufficiently studied until recently.

Previous extensive Siberian studies were mainly conducted by Russians and Japanese researchers, most of whom agreed that Siberians were clearly classified by typology. However, their typology is problematic when explaining tribes i.e., Evenks and Evens, who are exchanging genes and culture with their neighbors. Previous studies also contain problems such as methodology and lack of data especially for westerners because of political barriers between the U.S. and Russia.

This study attempts to reveal biological relationships among Siberians. The extensive data, including 647 crania, more than 3000 fingerprints, and over 340 blood samples, are available from the wide Siberian regions. Biological variation is evaluated with Fst, and biological patterning is summarized with UPGMA clusters and contour maps. Furthermore, matrix comparisons between geography and biological data sets are investigated with Mantel t-test.

Siberian biological variation in this study shows low variation except for crania. High cranial variation may have resulted from the selection of measurements, environmental

influences, selection and genetic drift. Low variation in dermatolyphics and blood may have been related to less environmental effects, and nature or function of blood and dermatoglyphic systems which are used in this study.

Siberian biological relationships are patterned primarily regionally and linguistically. Southern Siberian Altaic speakers, for instance, are biologically close to one another. Such regional and linguistic patterning matches Russian typology. However, this study also showed three forces of Siberian population structure, reflecting Siberian history: a north-south connection reflecting dispersions of occupants through prehistory, a west-east connection indicating the migration and diffusion of Bronze cultures, and east and west influences in the Baikal regions reflecting cultural and political influences. Such distributions and migration patterns were insufficiently demonstrated by previous typological studies. Significant correlations between geography and finger ridge counts, fingers and blood, crania and blood, as well as crania and finger ridge counts indicate a common N-S connection.

Today, the investigation of origins and divergence of Siberians are more difficult due to heavy admixture with Russians and decrease of "pure" indigenous tribes. This study provides useful biological information of Siberian indigenous populations and their history.

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CHAPTER I

INTRODUCTION

Background and Statement of Problem

With the collapse of the USSR, scientists have been given the opportunity to study the genetic structure of Siberian human populations. Siberian people form an important link between Asia and North America. The analysis of the genetic structure is critical for understanding not only their origins and divergence but also the possible connection with other populations. To date, our information on this genetic structure comes mainly from limited craniometric (skeletal measurements) and anthropometric (body measurements of living people) data taken by Russian (Debets, 1951; Levin, 1963) and Japanese (Ishida, 1990; 1993; Ishida and Dodo, 1990) researchers who published their studies in local journals. Because of this, the origin of the Siberian peoples and their divergence have not been widely debated.

In this study, I utilized dermatoglyphic (finger and palm prints), serological, and craniometric data in the analyses of the genetic structure of these populations. The study entails assemblage of dermatoglyphic data from the Brehme Data Bank, the University of Tennessee, serological data including data collected by Dr. M. Crawford from the University of Kansas and from other studies, and original craniometric measurements

taken separately by Dr. W.W. Howells, from Harvard University and Dr. H. Ishida, from Sapporo Medical College, Japan. The ultimate goal of this dissertation is to obtain some general understanding of the origin of the Siberian people as well as of their connections with other populations.

New World-Siberian-Asia Connection

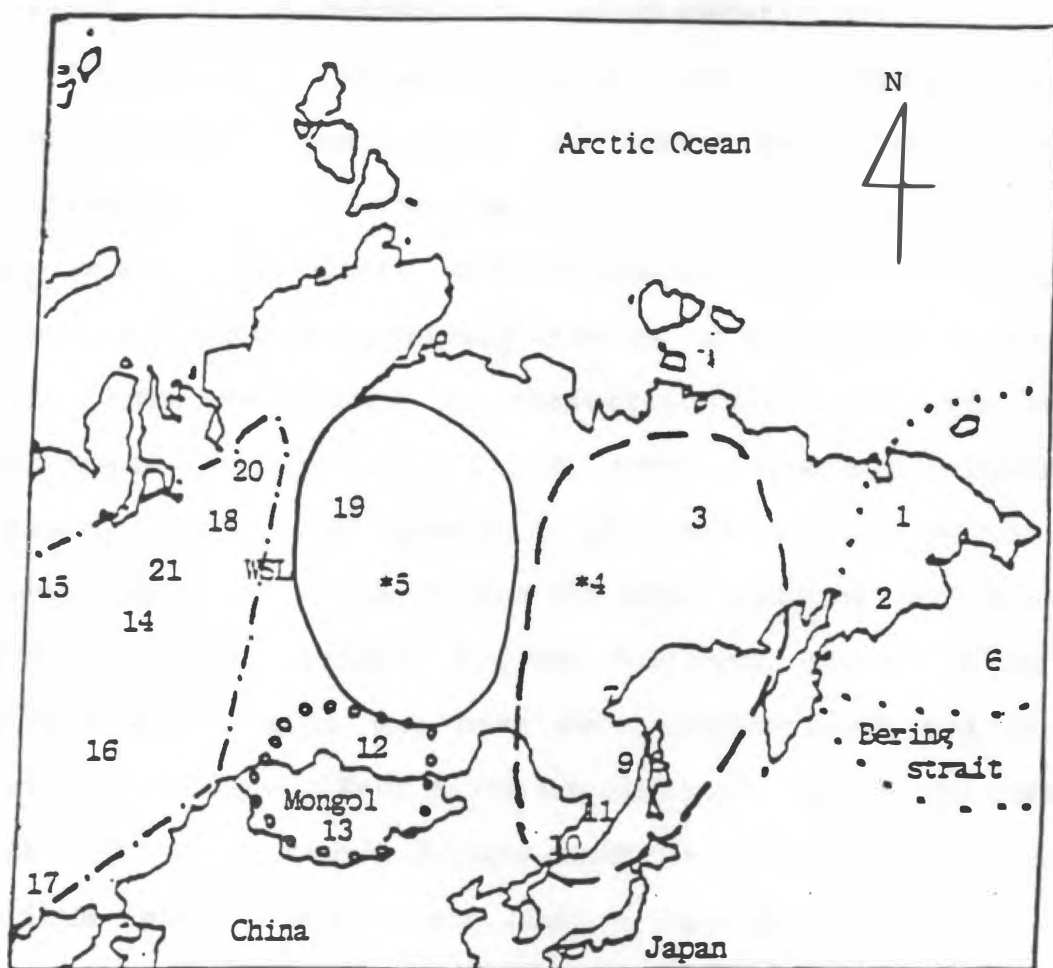
Scientists have been investigating the origin and migration patterns of the people in the New World since early in the 20th century (Boas, 1910; Hrdlicka, 1932; Szathmary, 1981; Turner, 1983; Wallace and Torroni, 1992 among others). Various types of biological evidence indicate that the Siberian people represent the important connection between Asia and North America. For instance, Wallace and Torroni (1992), using mtDNA analysis, found that Native Americans have rare Asiatic genetic markers. They observed that a particular rare Asiatic marker, Hinc II morph 6, which is not seen in Europeans and Africans, is seen in Native Americans, indicating that American Indians were derived from Asia. Szathmary (1981) demonstrated that the Asian blood markers such as Di^a in Diego system of red blood cells and Tf^{Doh1} in the Transferrin system of serum protein also exist in Siberian populations, suggesting the connections between Asia and Siberia. Furthermore, using nonmetric dental traits, Turner (1983) found that North Amerindians, Asians, and Siberians have similar morphologies that deviate from those exhibited by

Micronesians, Europeans, and Africans.

Despite the interest in Siberian-American genetic relationships, it is impossible to understand them without determining relationships among the Siberian populations themselves. Boas (1910) collected anthropometric data on Native Americans and Siberians. Unfortunately, he merely referred to the existence of the Siberian data in his publications. The origins of the Siberians and their divergence were also largely neglected in New World studies, and the genetic relationships of Siberians has not been widely discussed in Western countries.

The Locations and Typologies of Siberian Populations

Siberians, the indigenous peoples who inhabit Chukchi and Kamchatka in Russia and Northern Japan (East), Central region covering Steppe Desert and Tundra areas (Central), the Arctic region (North) and Mongolian borders (South), consist of numerous ethnic groups (Figure 1.1). Much of what we know about the Siberian peoples comes from contributions made by Russian and Japanese scientists. Most of the serological data collected by several Russians were analyzed with no consideration for the genetic relationships in wide geographical regions in Siberia. For instance, Sukernik et al. (1981), collected various allele frequencies from ABO, MNS, Kell, Rh, and Diego blood categories in Chukchi and Eskimo populations located geographically proximate to one



- 1) Eskimos 2) Chukchis 3) Yakuts 4) Evens 5) Evenks
 6) Aleuts 7) Amur Nivkhis 8) Sakhalin Nivkhis and Ainus
 9) Nanays 10) Orochis 11) Ulchis 12) Buryats 13) Mongols
 14) Selkups 15) Komis 16) Kets 17) Kazakhs 18) Dolgans
 19) Yakuts 20) Nganasans 21) Nentsy 22) Entsys

WSL = Western Siberian Lowlands

..... = Arctic

----- = Eastern

oooo = Southern

———— = Central

- - - - = Western

Numbers reflect centers of distribution

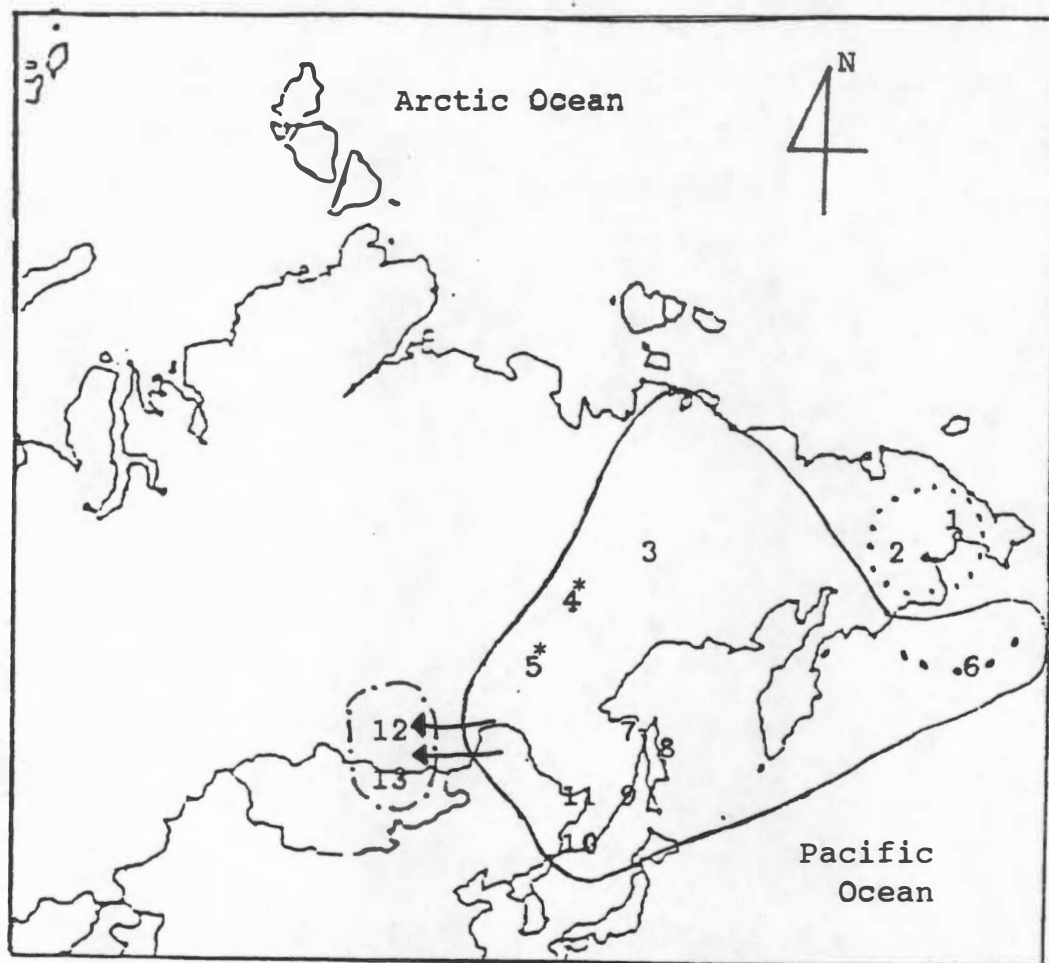
* groups exhibiting wide-spread distributions

Figure 1.1. Distributions of Siberian Ethnic Groups

another. They found the two populations dissimilar and attributed the differences to random genetic drift.

Craniometric and anthropometric data are available for a wide geographic sampling of the Siberians. Debets (1951) observed phenotypic variation in such morphological traits as hair color, eye color, craniometrics, and facial flatness among the groups collectively comprising the Siberian people. Using these characters, he classified Siberians into three main types (Figure 1.2): 1) the Arctic type represented by Eskimos, Aleuts, and Chukchis, who have a heavy epicanthus (inner corner of eye covered with upper eyelids) and a well-developed nasal ridge; 2) the southern/central group of Buryats and Mongols who have dark pigmentation and facial flatness similar to East Asian populations; and 3) the eastern type such as the Evens, Evenks, Orochis, and Nanays, who have maximum facial flatness and lighter colored hair.

In another study, Levin (1963) used cranial measurements from both North and East Siberian peoples of prehistoric and modern periods. He also used a combination of qualitative and quantitative traits in Siberians to link craniometric variation with ethnohistorical background. Ethnic groups such as the Evens and Evenks, who are geographically widespread, showed more cranial variation than an ethnic group like the Nivkhis, whose language and culture were isolated from other Siberian groups. Classifying Evenks and Evens into three subgroups of the eastern type, Levin concluded that these



- 1) Eskimos 2) Chukchis 3) Yakuts 4) Evens 5) Evenks
 6) Aleuts 7) Amur Nivkh 8) Sakhalin Nivkh and Ainus
 10) Orochis 11) Ulchis 12) Buryats 13) Mongols

..... = Arctic type
 ————— = Eastern type
 - - - - - = Central/southern type

Numbers reflect centers of distribution
 * groups reflect wide spread distributions
 Arrows represent a migration pattern

Figure 1.2. Main Siberian Types Suggested by
 Russian and Japanese Scientists

subgroups had diverged through prehistory. Alexseev (1979) also examined historic crania from the eastern, Arctic, and southern Siberian populations. His results agreed with Debets's conclusion (1951).

Ishida and Dodo (1990) analyzed a single facial complex: degree of facial flatness, which they estimated as the triangular distance made between the eye orbits and nose. Based on the measurements from 31 populations including prehistoric and contemporary Siberians, Ainus, Japanese, Russians, and Indians, their analysis clustered the Siberian people into Arctic, Northeastern Siberian, and Central Asian types, which is similar to that of Debets (1951). In addition, Ishida (1990) suggested that migration and divergence must have occurred from East Asia to Central Siberia (Figure 1.2). This is because 1) a prehistoric group in the Baikal area was more similar to people from East Siberia than to contemporary Baikal groups, and 2) the central Siberians clustered with the East Asians in his cluster analyses.

Recent Siberian Studies

Recently, intensive studies of certain Siberian regions were conducted using serological data. McComb et al. (1995) investigated the genetic structures of one Ket tribe and two Evenk tribes. Comparing variable number of tandem repeats in DNA analyses, they discovered that the distinction between

Kets and Evenks existed. In addition, the Kets showed higher admixture with Russians than the Evenks did. Novoradovsky and coworkers (1993) succeeded in demonstrating the associations of Buryats with their neighboring tribes of Mongols and Yakuts based on the blood analyses of 5 different Buryat sub-populations. Despite many Siberian studies dealing with small regions, few scientists investigated the population structures of large Siberian regions using blood data. For instance, Crawford and Enciso (1982), examining the variation of Siberian populations in circumpolar regions, discovered that the population structure was patterned with geography, history, and culture. Cavalli-Sforza et al. (1994) summarized the population structure of Asia showing that the Siberian groups with the same linguistic phyla are, in general, biologically close to one another. Some of their results indicated genetic differentiation among populations of Eskimos and Lapps in Arctic regions due to genetic drift. They also demonstrated distribution maps of blood groups in Asia, although some of the biological patterns in Siberia are hard to interpret on a historical or cultural basis.

Problems of the Siberian Studies Completed to Date

Although previous studies have provided some insights into the genetic relationships existing among Siberian peoples, there are a number of problems with these studies including typology, small sample sizes, inconsistent methods,

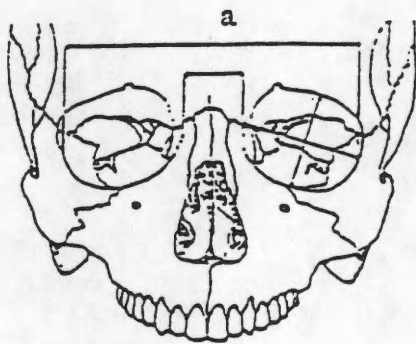
and errors in both anthropological measurements and statistical analysis (Bendyshe, 1973; Hrdlicka, 1910; 1932; Ishida and Dodo, 1990). Russian and Japanese scientists classified the Siberians into three types. However, populations of different types living in close geographic proximity constitute a problem for this typology. For example, the Evens of the eastern type are clearly different from Buryats of the Central type. Yet, at the edges of their inhabited ranges, these groups are in close geographic proximity to one another and gene flow has possibly occurred between them (Levin and Potapov, 1956).

Between the late 19th century and the early 20th century, various researchers proposed that the Siberians were genetically close to Asians and/or Native Americans on the basis of measurements taken on a few crania (Blumenback, 1865, republished in Bendyshe, 1973; Hrdlicka, 1910, 1932). Today, more anthropological data are available through larger sample sizes, particularly crania, but are still small for some populations (Table 1.1). Larger sample sizes may allow us to properly differentiate the genetic relationships among Siberian groups.

Another problem is inconsistent methods of measurement. In some studies, cranial measurements were based on the German method developed by Martin (1957) (Figure 1.3a) who established many landmarks in the measurement procedures for cranial studies. Alexseev (1979) collected cranial

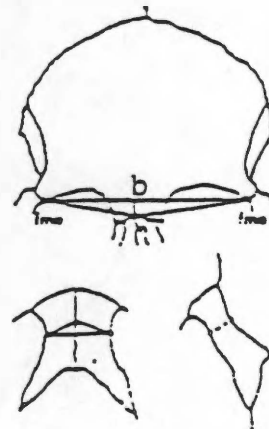
Table 1.1. Examples of Small Population Samples

Population	Sample Number	References
Nivkhi	8	Alexseev (1979)
Nanay	7	Alexseev (1979)
Orochi	9	Ishida (1990)
Okhotsk	5 8	Ishida and Dodo (1990) Ishida (1988)
Eskimo	9	Levin (1963)



Martin (1957) method

a. Biorbital distance



Woo and Mourant (1934) method

b. Distance between frontomale orbital (= fmo)

Figure 1.3. Measurement Methods

measurements using Martin's methods (Figure 1.3a), while Ishida and Dodo (1990) measured facial flatness based on a method provided by Woo and Mourant (1934) (Figure 1.3b). Alexseev measured orbital breadth and nasal breadth to examine cranial morphology (Figure 1.3a), while facial flatness in the latter study was measured with orbital distances and the internal suture of nasal bone (Figure 1.3b). The two sets of results are not comparable. Future studies should utilize either Martin's method, as it is the more widely accepted method, or Howells' method (1973), as it includes most measurements of Martin's method with subtense and radial measurements.

The methods of analysis also could be improved. While Hrdlicka (1942) collected large sample sizes of Siberian crania, his comparison of Amerindian and Asian crania was strictly qualitative. He did not apply any statistical analyses to the data. On the other hand, Levin (1963) as well as Alexseev (1979) applied too many univariate analyses to conclude that these populations belong to only three types. Although Ishida and Dodo (1990) applied multivariate analysis to their data, the reliance on only eye orbital and nasal areas to investigate genetic relationships does not permit strong conclusions. These studies, while enticing, are incomplete and further study is needed.

This Study

Using different biological analyses is important to reveal the origin, divergence and historical status of populations. Froehlich and Giles (1981) compared anthropometric, dermatoglyphic, and blood data in investigating historical and genetic relationships between nine villages representing three language phyla in Papua New Guinea. They found that dermatoglyphics corresponded to linguistic separations among these villages, while other data did not. Froehlich and Giles thought that, compared to other quantitative data, dermatoglyphics involved more genes and were more genetically stabilized in environmental influences and changes. On the other hand, blood and anthropometric data showed unclear genetic relations among these populations because blood tends to reflect recent gene flow or selection, while anthropometrics are confounded by environmental influences.

Some serological and craniometric studies also successfully revealed population structures and histories. Menozzi et al. (1978), using principal component analysis of gene frequencies from 10 loci and transforming the results onto the map, reconstructed the demic expansion of agriculturalists in the early history of Europe. They indicated that northwest-southeast clinal distributions of the blood frequencies matched actual migrations of European farmers. Jantz (1973) collected cranial measurements from 5

archaeological sites dated from 1600 A.D to 1800 A.D in the Arikara populations in the North American plains. Based on the canonical and discriminant analyses, he demonstrated that morphological differences between groups were associated with temporal sequences and tribal contact with other populations in Arikara history.

In this dissertation, I have accessed adequate samples sizes in dermatoglyphic, serological and craniometric data of wide Siberian regions. Different systems provide different pieces of a population's history. Considering problems including typology, sample size, measurement methods, and statistical approach, syntheses of these 3 types of data, available for the entire geographical range of the Siberian peoples, should provide insight into both their origins and subsequent divergence.

CHAPTER II

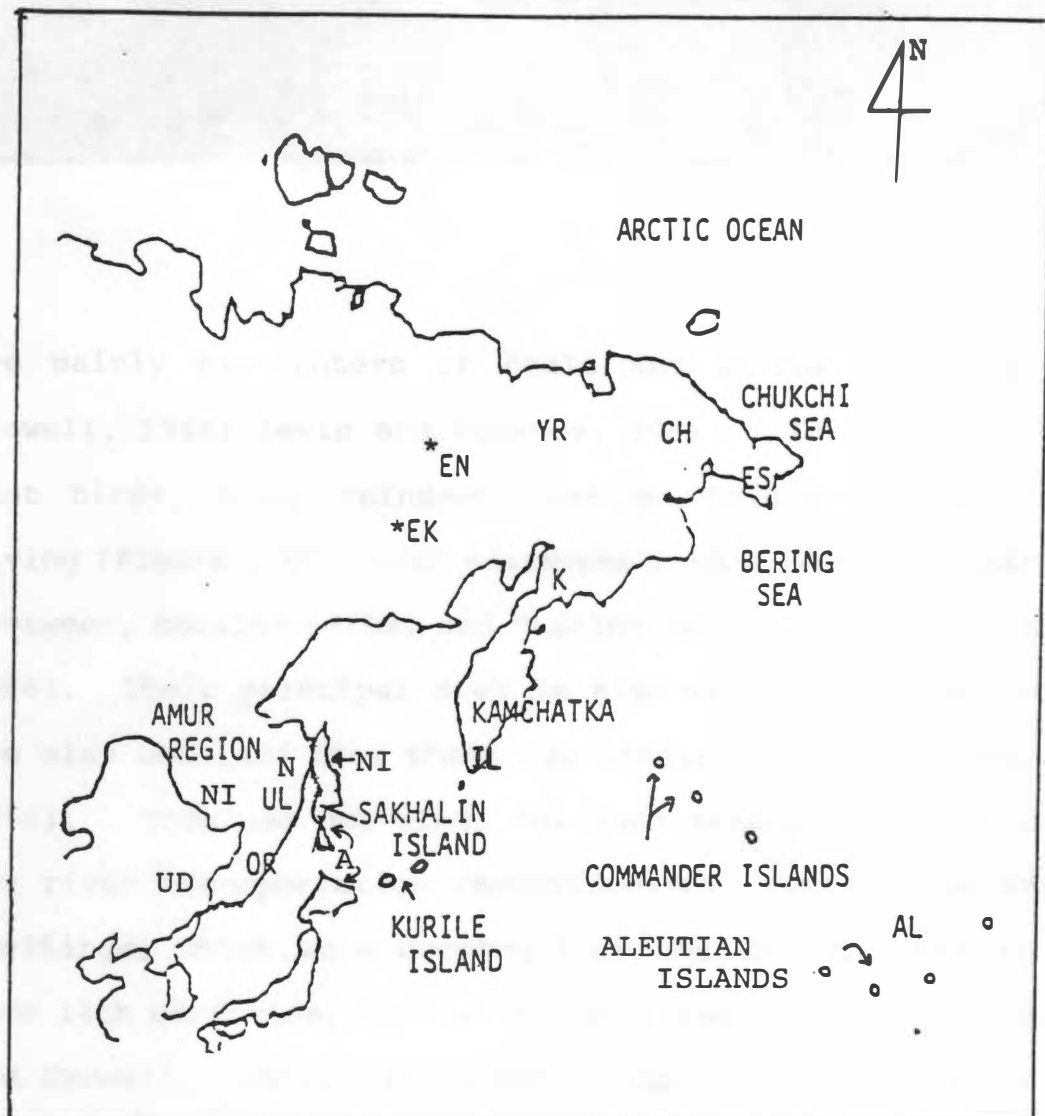
SUBSISTENCE PATTERNS AND CULTURES IN SIBERIA

Siberian Populations

Today, a wide region of Siberia is inhabited by indigenous people (Figure 1.1). The population size of ethnic groups varies, with groups like Aleuts consisting of fewer than 1,000 people while ethnic groups such as the Yakuts and Buryats contain more than 200,000 people (Levin and Potapov, 1956). However, since the Russians started settling in Siberia around the 16th century, Russian populations have exceeded indigenous populations (Levin and Potapov, 1956). Today, the number of "pure" indigenous populations has decreased due to the assimilation with Russians (Levin and Potapov, 1956). Numerous indigenous ethnic groups more or less share their cultures among themselves (Jochelson, 1928; Levin and Potapov, 1956). In this chapter, traditional lifestyles, cultures, and languages of the main Siberian groups are summarized according to their geography.

Subsistence Patterns and Cultures of Siberia

a. Arctic Siberian Region: Groups such as Eskimos, Chukchis, and Aleuts are found around the peripheral coastal areas of the Bering and Chukchi Sea (Figure 2.1). The Asiatic and the Bering Eskimos, living on the Bering Strait Coasts,



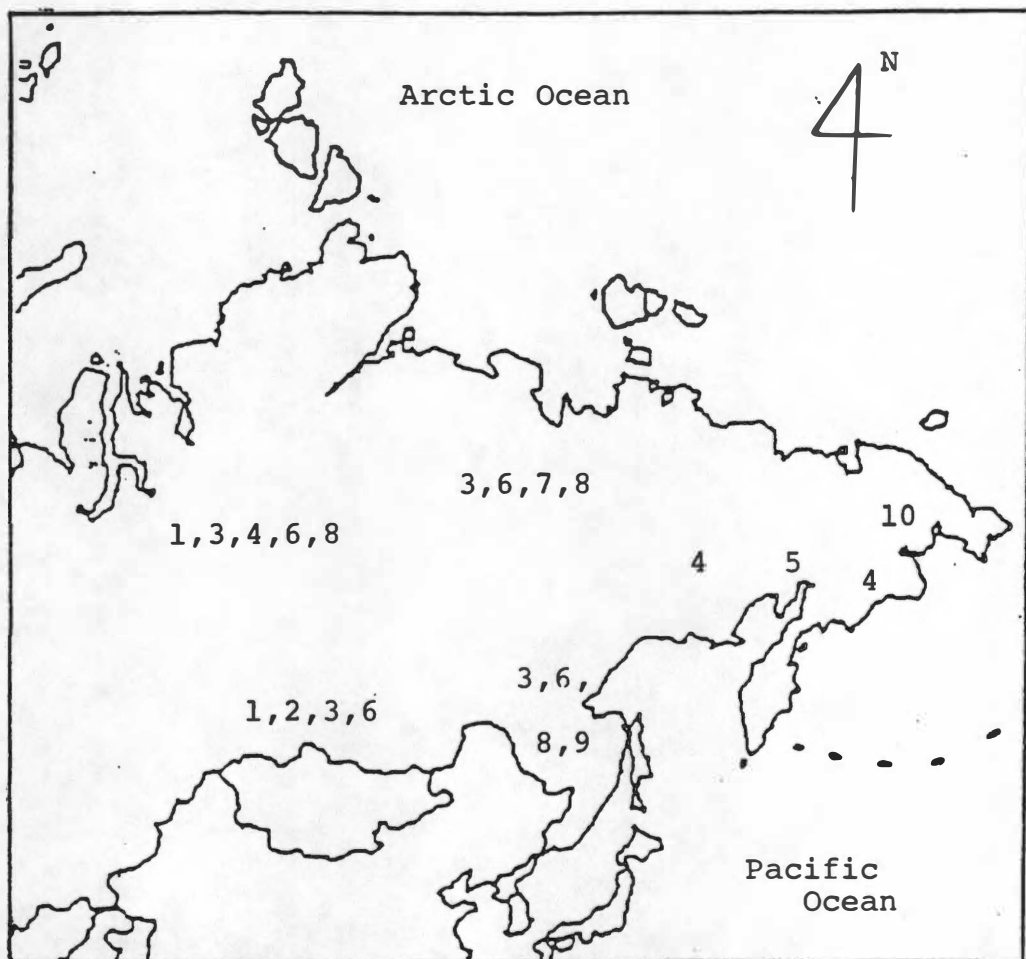
EN=Evens EK=Evenks YR=Yukagirs CH=Chukchis ES=Eskimos
 K=Koryaks IL=Itelmens AL=Aleuts NI=Nivkhis A=Ainus
 UL=Ulchis OR=Orochis N= Nanays UD=Udegeys

* groups exhibiting wide-spread distributions

Figure 2.1. Arctic and East Siberia

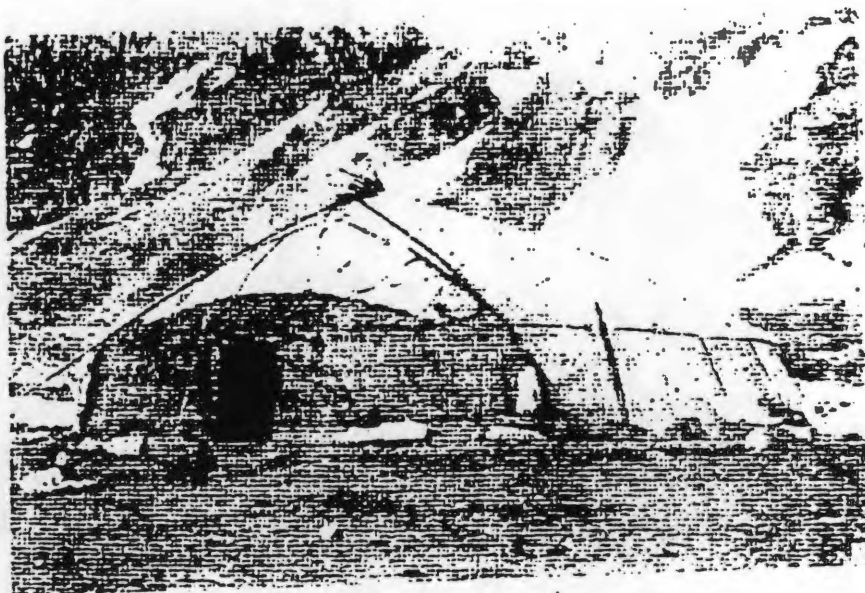
are mainly sea-hunters of seals and walrus (Fitzhugh and Crowell, 1988; Levin and Potapov, 1956). In addition, they hunt birds, fish, reindeer, and mountain sheep for their living (Figure 2.2). Such sea-mammals were used for clothing, footwear, housing parts, and hunting gear (Levin and Potapov, 1956). Their principal diet is high-protein and fat, which are also obtained from these sea-mammals (Levin and Potapov, 1956). They use dog-sleds for land transporting and boats for river transportation (Menovshchikov, 1956). The Eskimo dwellings, which were adopted from the Chukchi tent in the late 19th centuries, consist of two types by season (Fitzhugh and Crowell, 1988). In winter, people live in tents built with turf, stones, and tarpaulin (Figure 2.3a). The summer dwelling is structured with a wood or bone covered with walrus skins and tarpaulin (Figure 2.3b). The Asiatic Eskimos are culturally and biologically very close to the Chukchis through social contacts and intermarriage (Levin and Potapov, 1956). In the early 1900s, some of the Asiatic Eskimos in Russia as well as Alaskan and Kodiak Eskimos in the U.S. were influenced by Russians cultures, while Bering Sea Eskimos maintained their traditional lifestyles by isolating themselves from other Eskimos (Fitzhugh and Crowell, 1988).

On the coasts along the Chukchi Sea and Bering Sea, the Chukchis share their cultures with the Koryaks and Eskimos (Figure 2.2). For example, common ornamentations made from reindeer hair are used among these three groups. Chukchi



- 1) Nomad 2) Semi-nomads 3) Hunting animals
- 4) Reindeer-breeding 5) Reindeer-hunting
- 6) Agriculture 7) Horse-breeding
- 8) Fishing 9) Metallurgy 10) Sea-mammal hunting

Figure 2.2. Main Lifestyles in Siberia



a. Winter Dwelling



b. Summer Dwelling

Figure 2.3. The Eskimo Dwellings (Levin and Potapov, 1956)

origins are considered to be linked with Eskimo origins based on the cultural similarities and archaeological evidence (Antropova and Kuznetsova, 1956; Jochelson, 1928). Chukchi folklore indicates that there were frequent contacts between the Chukchis and Eskimos (Antropova and Kuznetsova, 1956). The Chukchi hunting of sea-mammals was in fact adopted from the Eskimos. An archaeological site dated around 0 A.D. indicates that the Eskimos initially lived in the interior Chukotka and were later driven to the coastal area by the ancestors of the Chukchis and Itelmens who were migrating from the west (Fitzhugh and Crowell, 1988; Jochelson, 1928).

Subsistence and languages of Chukchis and Koryaks also show some affinities. Both groups include two types of hunters, such as reindeer-breeding tundra residents and reindeer hunters (Figure 2.2) (Antropova and Kuznetsova, 1956). The counting system in both groups is based on twenty, consisting of the fingers and toes. In languages, both Chukchis and Koryaks call themselves "seaside resident." Their original word, "enemy," is the same between these two languages (Antropova and Kuznetsova, 1956). Economic and cultural contact between Chukchis and Russians started in the 17th century (Antropova and Kuznetsova, 1956). Coal mining, for example, was developed by Russians on the Chukchi Peninsula.

Aleuts, who used to live in the area ranging from the Alaska Peninsula to Kamchatka, relocated to the Commander and

Aleutian Islands of the Bering Sea due to Russian and American influences during the 18th century (Figure 2.1) (Fitzhugh and Crowell, 1988). The Aleuts also have cultures similar to Eskimos in terms of hunting, river and land transportation, and languages (Fitzhugh and Crowell, 1988; Levin and Potapov, 1956). However, the major difference between Aleuts and Eskimos is that Eskimos kept their traditional lifestyles, while Aleuts adopted more European cultures. Gender dichotomy is strongly seen in the Aleut culture (Fitzhugh and Crowell, 1988). Males are woodworkers and ivory sculptors, while females work mainly on fibers and animal skins. Males wear valuable cormorant skins, while females wear sea mammal skins. Men are hunters of birds and fish, while women are gathers of berries and seamstress for clothing (Antropova, 1956a). Therefore, Aleut lifestyles and cultures are diverse and practical as a result of division of labor and the adoption of Russian, American, and Eskimo cultures.

b. East Siberian Region: Ethnic groups such as Evens, Nivkhis, Udegeys, Orochis, Ulchis, Nanays, Itelmens, Koryaks, and Yukagirs, inhabit wide areas covering the Amur regions, the Sakhalin island, the Kamchatka Island, and some Central Siberian areas (Figure 2.1). Subsistence around these regions includes fishing, sea-hunting, reindeer breeding, and hunting animals such as bears, fox, and raccoons (Figure 2.2) (Levin and Potapov, 1956; Jochelson, 1928; Fitzhugh and Crowell,

1988). Their diets are varied including meat from deer, bears, rabbits, fox, birds, and fish, as well as vegetables, sea weeds, and buckwheat. Their clothing includes cottons and furs made of deer, bears, fox, rabbits, and sea animal skins. Furthermore, some ethnic groups such as the Ainu also practice agriculture.

Primarily, many people in this region assimilated into their neighbors due to cultural contact. In the 19th century, the Evens, who used to be considered as a part of the Evenks, separated from the Evenks by sharing cultures and languages with Yukagirs and Yakuts. The Evens, later became assimilated into Yukagirs and Yakuts. Traditionally, Koryaks and Itelmens in the Kamchatka Peninsula share the similar cultures with the Chukchis from the Northern Arctic Region (Antropova, 1956b). For instance, mythologies in the Koryaks and Itelmens show similar characters and contents to the Chukchis. Various tribes such as the Evens, Nanays, Orochis, and Ulchis are strongly associated with the widely distributed Evenks in their cultures, languages, and origins (Ivanov, et al., 1956a and 1956b; Levin and Potapov, 1956; Levin and Vasil'yev, 1956). For example, the hide covered conical structures found throughout the Evens' habitations are also seen in the Evenks (Figure 2.4).

The Nivkhis, living in the Amur region and on the northern part of Sakhalin island are metal workers, whale hunters, and dog breeders. In addition, they conduct trade

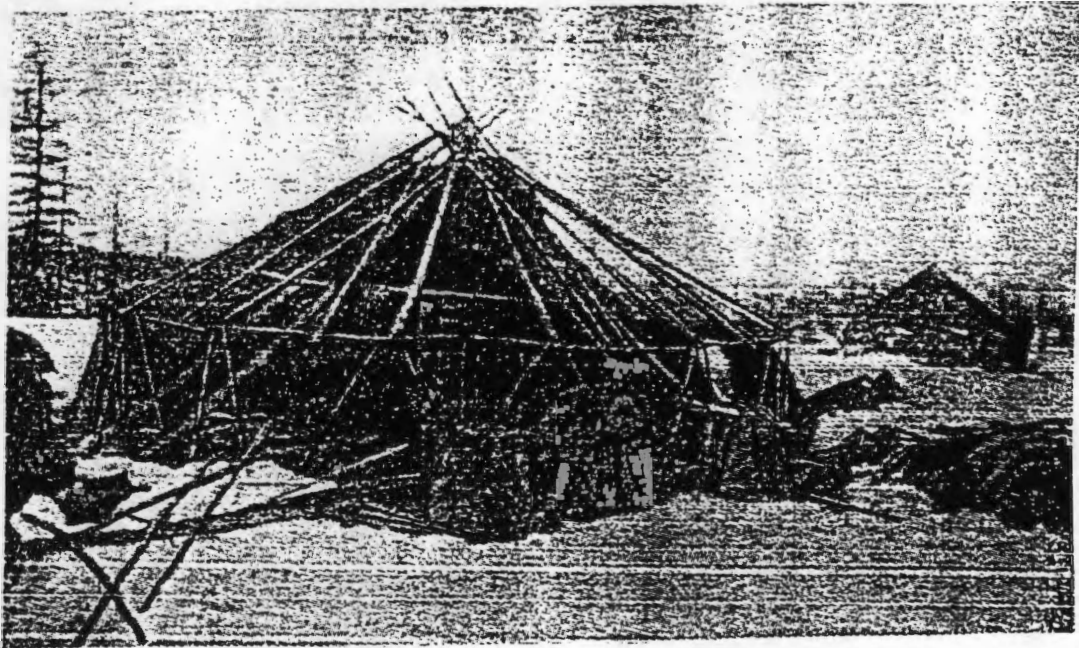
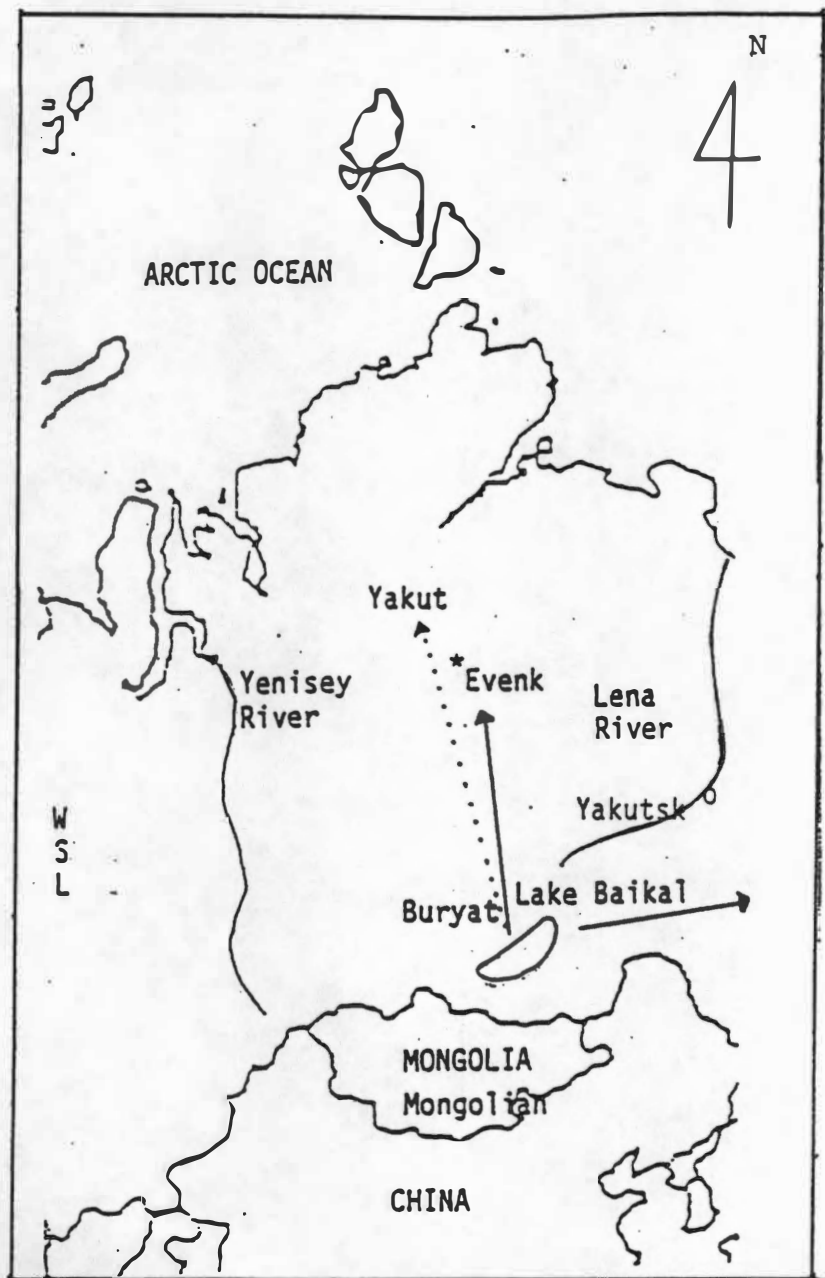


Figure 2.4. The Evenk and Even House Structure
(Levin and Potapov, 1956)

with Chinese, Ainu, and Tungus people (Levin and Potapov, 1956). The Ainu, who used to live on Kurile Island, on the south part of Sakhalin Island, and in the southern part of the Kamchatka peninsula until right after World War II, are heavily assimilated into Japanese society by intermarriage. Such assimilation caused a tremendous decrease of the pure Ainu today (Shibatani, 1990). Due to geographical proximity, cultural exchange and trade between the Nivkhi and the Ainu, they have affinities in some words, the design of harpoons, clay vessels, and stone objects (Ivanov et al., 1956c; Levin, 1963). Also, bear cults known as protection from bad luck and evil have been known to practice in both Nivkhi and Ainu cultures (Ivanov et al., 1956c).

c. Southern Siberian Region: Main ethnic groups such as the Buryats and Mongols live around the Lake Baikal and Mongolia areas (Figure 2.5). The origins of the Buryat people is suggested to be in the Lake Baikal and Mongolia regions based on evidence of their language similarities with Mongolians (Vyatkina, 1956). By the 17th century, the Buryats linguistically and ethnically separated from the Mongol populations and settled in the current habitations. The Buryats and Mongols are traditionally either nomadic or semi-nomadic in lifestyle and are animal breeders (Figure 2.2) (Jochelson, 1928). In the 19th century, under the Russians'



WSL=Western Siberian Lowland

* a group exhibiting wide-spread distributions

Arrows indicate the migration of Evenks suggested by Levin and Potapov (1956)

A dotted arrow indicates the migration of Yakuts suggested by Levin and Potapov (1956)

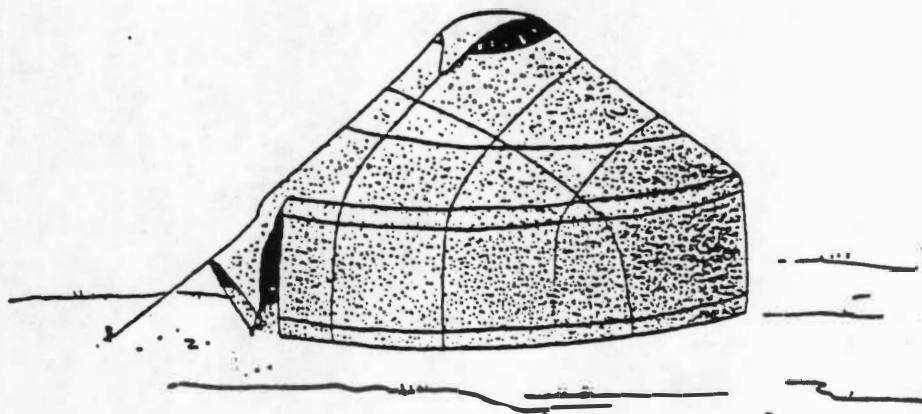
Figure 2.5. South and Central Siberia

influence, farming of crops such as rye, wheat, and oats started in the Buryat populations. The Buryats consume various foods including dairy products, meats, and vegetables. They practice hunting deer, bears, fox, wolves, lynxes, seals, and otters. The hunted animals were used for food, clothing, saddle-making, and trading. Later, Russians introduced their farming methods, educational systems, and culture into Buryat society.

The Buryat's dwellings are different by seasons (Vyatkina, 1956). In general, wooden huts are built near river for pasture during summer and the winter camps are felt yurts located near farming places (Figure 2.6).

The Mongols, who are settled in Mongolia today, had widely intruded from Southern China and the Black Sea to Iran in the past. As a result of political intrusion, they assimilated with Turkish tribes, Russians, and Chinese (Kirby, 1971). Under the conditions of historical intrusion and the Steppe desert environment in Mongolia, the people's lifestyle has been nomadic and involved the herding of horses, sheep, and camels (Kirby, 1971).

d. Central Siberian Region: The Evenks and Yakuts are widely spread through the Western Siberian Lowland to the Lena river and Yakutsk regions (Figure 2.5). Some Evenks also live in the Amur region of Eastern Siberia, Northern China, and Mongolia. Based on anthropological and archaeological

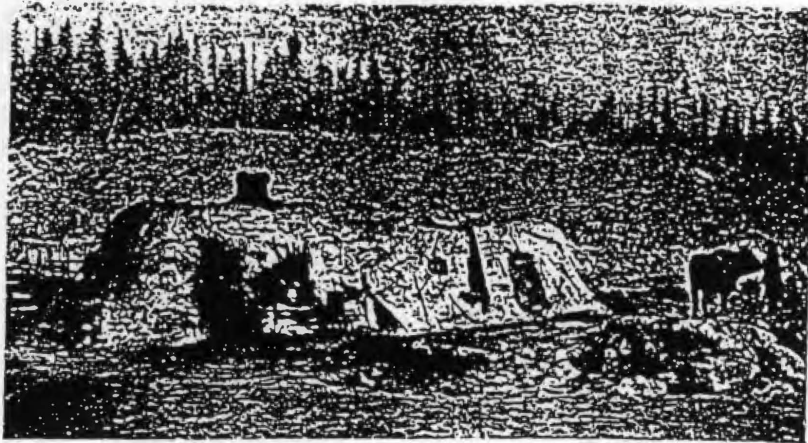


A Felt-Covered Cylindro-Conical Tent used chiefly by Mongoloid Tribes and usually known as the Kalmuck Tent. This type is used by the Kalmuck, Buryat, and other Mongoloid tribes.

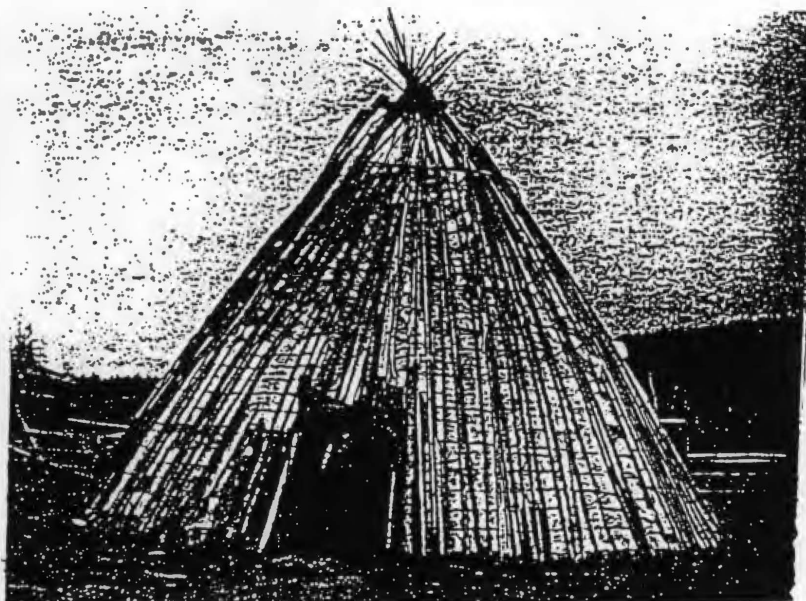
Figure 2.6. The Buryat Winter Dwelling
(Jochelson, 1928)

evidence, the origin of the Evenks has been speculated to be in the Baikal area (Figure 2.5)(Levin and Potapov, 1956). For instance, some aspects of the Tungus cultures such as conical tents, bone tools, transportation (i.e., birch-bark boats), and clothing are strikingly identical to the Neolithic Baikal cultures (Levin and Potapov, 1956). Some Evenks are reindeer-breeders and hunters, while some of them are pastoralists and farmers (Figure 2.2). They exchanged furs, skins, and meat for iron tools from the Buryats and for fabrics and grains from Mongolia and China (Vyatkina, 1956). They also had relations with farmers in the Amur regions and assimilated with the Yakuts and Russians (Vyatkina, 1956; Tokarev and Gurvich, 1956).

The Yakut's lifestyle is primarily pastoralism, based on horse-breeding. They also practice hunting, fishing, and agriculture for their living. Because of various lifestyles, their diets, including dairy products, fish, meat, and vegetables, are various and rich. The Yakut's dwelling is known as a Yurt (Figure 2.7a). It is built with four main columns surrounded with beams and bark on the roof, and the walls are coated with clay with cow dung. Their traditional summer dwelling is a conical tent covered with birch bark (Figure 2.7b). After the 19th century, the Yakut adopted a Russian-type house structure such as log huts onto their Yurt. Some ethnographers and scholars believe that the origin of the Yakuts is in the south around the Baikal region based on their



a. A Yakut Dwelling. A double structure is shown, a dwelling with chimney, and a cattle stable, adjoining. Inside the dwelling a door leads to the stable. New-born calves are kept in the dwelling behind the chimney.



b.. Summer Dwelling of the Ancient Yakut.

Figure 2.7. The Yakut Dwellings (Jochelson, 1928)

common cultures including pastoralism, dress style, and their diet (Figure 2.5)(Tokarev and Gurvich, 1956).

e. West Siberian Region: Populations such as the Komis, Kets, Khants, Mansis, Nentsys, Dolgans, Entsys, Nganasans, Selkups, and Kazakhs live around Urals, Kazakhstan and Western Russia (Figure 2.8). In general, Western Siberians are nomadic and hunting, fishing, and reindeer-herding people, although their hunting methods and animals they caught for game are slightly different among the tribes. Kets, Mansis, and Khants do not use dog-sleds for hunting, while Selkups sometimes utilized dog-sleds. A few groups like Kets, Nentsys, and Selkups are also familiar with agriculture (Jochelson, 1928; Levin and Potapov, 1956). The dwellings in West Siberia generally consist of two seasons: temporary camps/tent for summer, and winter huts/houses covered with animal skins (Levin and Potapov, 1956).

Cultural exchange also varies by populations. The Entsys, living in the Western Siberian lowland, are assimilating with their neighbors such as the Nentsys and Nganasans. As a result of cultural contacts, the geometrical designs, for instance, are seen in both Entsys' and Nganasans' clothing (Dolgikh, 1956). The Selkups, living together with the Nentsys and the Kets in some forest and tundra regions, are similar cultures and subsistence as Nentsys and Kets (Prokof'yeva et al., 1956). The Khants and the Mansis also



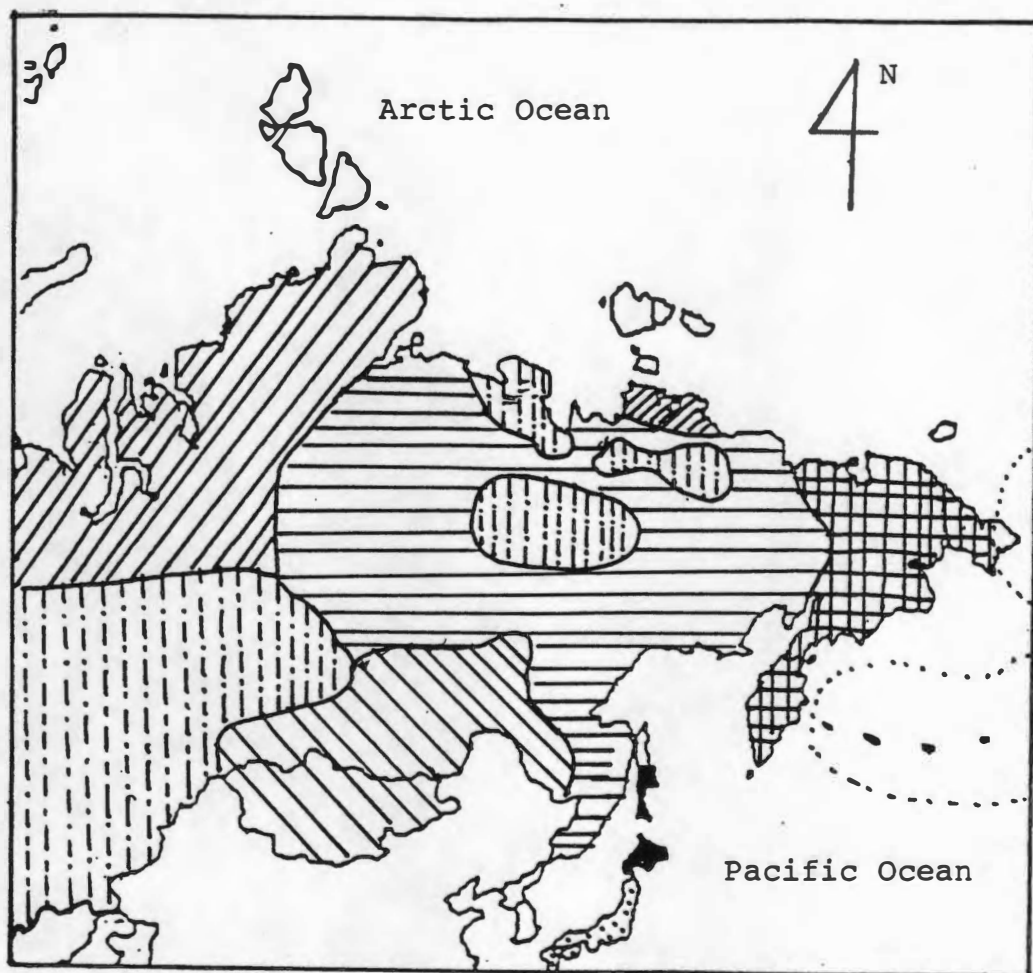
Figure 2.8. West Siberia

have much in common between these two groups in language and culture. Both groups have customs to wear short footwear made from soft smoked elk or deer with fur outside. The designs of shirts and outer clothing for men in the Khants and Mansis are also very similar (Prokof'yeva et al., 1956). Linguistically, Khants and Mansis, who speak the same Finno-Ugric language (Ruhlen, 1987), have similar vocabulary and structure.

The Dolgans started moving in the 17th century to the northwest where the Yakuts also began settling at the same time (Popov, 1956). The Yakuts were later assimilated into the Tungus groups such as the Evenks and Evens. Due to assimilation, the Yakuts separated from the Dolgan cultures (Popov, 1956). The assimilation and migrations of the Dolgans and Yakuts also reflect clinal patterns in their languages. Although Dolgan is a dialect of the Yakut language, their language affinities with the Yakut language decrease from east to west (Popov, 1956).

The Languages of Siberia

The languages spoken by indigenous populations of Siberia are diverse. According to Ruhlen (1987), there are four main language phyla including Altaic, Uralic-Yukagir, Chukchi-Kamchatkan and Eskimo-Aleuts families, and unclassified languages. Figure 2.9 and Table 2.1 summarize the language map and classification of Siberia, respectively. Ruhlen introduced his world-language classification systems by 1)



- ▨ = Uralic-Yukagir language
 ▤ = Eskimo-Aleut language
 ▩ = Chukchi-Kamchatkan language
 Altaic language = Turkic (= ▧) + Tungus (= ▨) +
 Ainu (= ▣) + Japanese (= ▤) +
 Nivkhi (= N) + Mongolian (= ▩)

Figure 2.9. Ruhlen's (1987) Language Classification in Siberia

Table 2.1. Summary of Siberian Languages
Based on Ruhlen (1987)

I. Altaic

1. Altaic Proper

A. Turkic: Turkish, Altai, Azerbaijani, Uzbek, Kazakh, Yakut, Kirgiz, Dolgan, etc.

B. Mongolian-Tungus:

a. Mongolian: Khalkha, Khorchin, Mongol, Buryat, etc.

b. Tungus: Evenk, Manchu, Even, Nanay, Ulchi, Orochi, etc.

2. Korean-Japanese: Korean, Ainu, Japanese

II. Chukchi-Kamchatkan

1. Northern: Chukchi, Koryak

2. Southern: Kamchadal

III. Uralic-Yukagir

1. Yukagir: Yukagir

2. Uralic:

A. Samoyed: Nenets, Selkup, Nganasan, Entsy

B. Finno-Ugric:

a. Ugric: Hungarian, Mansi, Khanty

b. Finnic: Komi, Udmurt, Mari, Mordvin, Saami

IV. Eskimo-Aleuts

1. Aleut

2. Eskimo:

A. Inuit: Greenlandic

B. Yupik: Central Yupik

V. Others: Unclassified languages
Ket, Nivkhi

summarizing the work done by more than 100 linguists, 2) considering the historical context of linguistic phylogeny, 3) incorporating various language classifications, and 4) adopting strengths of different classification systems. His language classification has been widely accepted with corroborating scientific research (Barbujani and Sokal, 1990; Cavalli-Sforza et al. 1994; 1988). A majority of Siberians, approximately 250 million people, speak an Altaic family language consisting of three subfamilies of Turkic, Mongolian, and Tungus, and three independent languages of Korea, Japanese and Ainu languages (Table 2.1)(Ruhlen, 1987). The Altaic family is spoken in Turkey, Russia, Mongolia, northwestern China, Korean, and Japan. One-third of the Altaic family speakers use Turkic languages including Altai, Turkish, Kazakh, Kirgiz, Dolgan, and Yakut (Table 2.1). Approximately 3 million speak a Mongolian language such as the Buryats and Mongolians. Tungus languages are spoken by 80,000 native Siberians from Northern, Southern, and Eastern areas including Evenks, Evens, Nanays, Ulchis, Oroks, Orochis, and Udegeys (Ruhlen, 1987). Japanese is mainly used in Japan and spoken by 115 million people. Ainu is spoken in northern Japan and on the southern part of Sakhalin Island. Approximately 16,500 Ainu people speak this language (Ruhlen, 1987). Ruhlen (1987) classifies the Ainu language as a Korean-Japanese language (Table 2.1). In the past, Japanese linguists tended to separate the Ainu language from the Japanese (Umehara and

Hanihara, 1994). However, Ruhlen's classification of the Ainu language is recently supported by Umehara and Hanihara (1994) based on the common words and syntax between the Japanese and the Ainu. The Nivkhi, spoken on the northern part of the Sakhalin Island and the Amur regions on the continent, is classified as an isolated language because it does not contain commonalities with any other Tungus and East Asian languages (Ruhlen, 1987). Both Ainu and Nivkhi languages are almost extinct.

The Chukchi-Kamchatkan language is spoken by 23,000 Siberians including Chukchis, Koryaks and Kamchadals in northeastern Siberia, mainly on the Chukchi and Kamchatkan peninsulas (Figure 2.9) (Ruhlen, 1987).

The Uralic-Yukagir family of Samoyedic and Ugric languages is used by Northwest Siberians such as the Mansis, Khantys, Nentsys, Nganasans, Entsys and Selkups (Figure 2.9). These languages were spoken by less than 3% of the total Siberian populations (Levin and Potapov, 1956; Ruhlen, 1987). The language of Kets, one of the western Siberian groups with unknown genetic affiliations, is classified into an isolated language (Ruhlen, 1987).

Languages in Northeastern Arctic regions, Alaska, Greenland, Commander Islands and Aleutian Islands in Siberia are known as the Eska-Aleuts family including Aleut and Eskimo languages (Figure 2.9). Approximately 85,000 speakers use these languages (Ruhlen, 1987). However, the number of people

who speak Eska-Aleuts languages in the Russian Siberian side is only around 2,500 (Ruhlen, 1987).

CHAPTER III

HISTORY OF SIBERIA

The Emergence and Settlement of Siberians

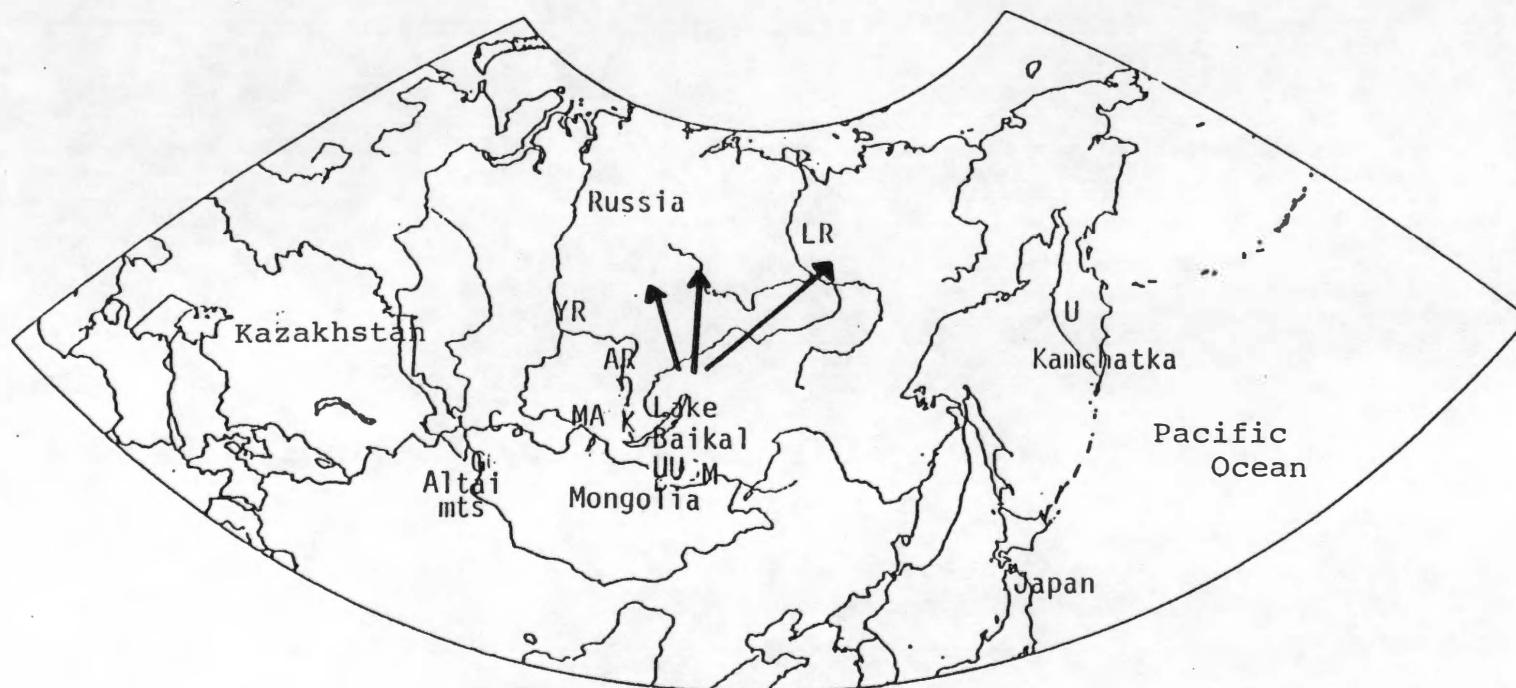
Although the timing of the first appearance of Siberians is still under investigation, researchers suggest that, based on archaeological and skeletal evidence, Siberia was settled by the Paleolithic period with people migrating from either Europe and/or Asia (Levin and Potapov, 1956). Later, Siberia's occupants spread from south to north, east, and west.

In this chapter, the emergence, divergence, and history of Siberians are chronologically introduced.

Paleolithic Period (around 21,000 BP -)

To date, one of the oldest pieces of archaeological evidence for the time and place of the first Siberians is the Mal'ta site, near Lake Baikal, dated around 21,000 BP (Figure 3.1) (Chard, 1974; Levin and Potapov, 1956). This site, containing artifacts and skeletal materials, provides two hypotheses about the first Siberians: One is that the first Siberians were of European origin; the other is that they originated in Asia.

Turner (1983, 1986) suggested that the Upper Paleolithic people were more associated with Europeans than Asians based



K: Krasnoyarsk; UU: Ulan-Ude MA: Mal'ta
G: Gornoaltaisk; M: Malyi kot; U: Usiki

AR: Angara River; YR: Yenisey River; LR: Lena River

Arrows indicate the spreading inhabitants in late
Paleolithic period (suggested by Levin and Potapov, 1956)

Figure 3.1. Paleolithic Settlements in Siberia

on absence of shoveled incisors in Mal'ta skeletal materials. Archaeological remains, i.e., sculptures, lithic artifacts including discoid cores and blades and dwelling structures, and the reconstructions of lifestyles based on the remains also show a resemblance between the Mal'ta and the Upper Paleolithic European sites, indicating similar lifestyles between Europeans and Siberians during this period (Dolitsky, 1985; Gerasimov, 1964; Okladnikov, 1961).

However, based on stone tools, faunal and skeletal remains, and ecology, many researchers believe that the first Siberians settled in southeast Siberia, around Mongolia, rather than in other regions (Alexseev and Goghman, 1996; Chard, 1974; Dolitsky, 1985; Larichev, et al., 1987; Levin and Potapov, 1956). Ecologically, researchers believe that Paleolithic people were more adaptable to southern climates than to northern climates because southern Siberia was warmer and more humid than the northern regions (Chard, 1974).

Alexseev and Goghman (1996) suggested the classification of the Upper Paleolithic people into the Asiatic type because they observed that the Mal'ta skeletal sample appeared to have shoveled traits on its teeth, which is a typical Asiatic feature. The Afontova, an Upper Paleolithic site near Krasnoyarsk, showed clear shoveled incisors in skeletal materials (Alexseev and Goghman, 1996). In addition, despite few discoveries of skeletal remains in this period, many stone tools and faunal remains were spread in the southern

Paleolithic sites along their Asian sides rather than European sides (Chard, 1974; Larichev, et al., 1987). Larichev et al. (1987) showed that the transformation of Mousterian stone tool cultures into Upper Paleolithic cultures is focused in southern Siberia and northern Asia. Sites such as Gornoaltaisk, near the Altai mountains, and Malyi Kot, near Irkutsk, on the southern Baikal Lake contain crude artifacts, mammoth teeth, and choppers (Figure 3.1) (Chard, 1974). Another site near the Angara river, west of Lake Baikal, contains houses made of interwoven reindeer horns with hearths and elevated sites with corridors. Such house structures are similar to the later Chukchi-Eskimo maritime settlements (Levin and Potapov, 1956). Bones were useful materials due to the absence of wood in those days, and are still used as tools by contemporary Arctic people (Levin and Potapov, 1956). Furthermore, Okladnikov (1961), examining artifacts (i.e. pebbles and adzes) in Transbaikal Paleolithic sites, indicated that the techniques for making such tools were similar to those in the China and Baikal areas.

By the late Paleolithic period, inhabitants were spread through the Lake Baikal regions, the Yenisey River basin of Central west Siberia, Northern Siberia of Lena River to Eastern Siberia (Figure 3.1) (Levin and Potapov, 1956; Okladnikov, 1964). Archaeological evidence showed that the Kamchatka peninsula was occupied by this time as well. At Usiki sites in the Kamchatka Peninsula, leaf-shaped knives and

human burial sites with stone pendants were found which date around 14,000 B.P (Fitzhugh and Crowell, 1988). Other various types of animal bones and advanced tools, such as bifacial tools, arrowheads, and axe-shaped tools, were found in Late Paleolithic sites. Such artifacts indicate advanced hunting techniques, domestication of animals, and longer survivorship in Late Paleolithic Siberians (Chard, 1974; Levin and Potapov, 1956).

Neolithic Period (Around 7000 B.P -)

Unlike in Asia and Europe, the term "Neolithic" in Siberia refers to the concept of utilizing ceramics and time prior to adopting metal cultures, rather than the domesticating of plants and animals (Chard, 1974). Therefore, the lengths of Neolithic periods vary by Siberian regions: Far northern regions, the Neolithic did not end until Russian conquest in the late 1700s, while the Neolithic ended around 3600 years ago in the Lake Baikal regions (Chard, 1974).

Neolithic cultures are found in vast areas, ranging from the southern Mongolian regions to the Arctic regions, and from the western Siberia of Kazakhstan to the eastern Siberia of the Amur regions (Chard, 1974; Fitzhugh and Crowell, 1988). Neolithic Transbaikal sites, containing single shouldered arrow points and denticulate tools, indicate the presence of small bands of hunters and the influences of microlithic cultures from the steppes (Chard, 1974; Okladnikov, 1964).

The earliest burial sites are found in Zhigansk, near the Lena River of Northern Siberia. There, the skeletons decorated with red mineral ocher lay in round holes in the ground. The burins, arrowheads, and knives from these regions, known as Ymyiakhtakh culture in the Arctic regions, suggest an ancestral connection to the Eskimo culture (Figure 3.2) (Levin and Potapov, 1956).

During Neolithic periods, more sophisticated tools such as polished stone tools, flakes, foliated flints and arrowheads, and pottery appeared in the Lake Baikal and Angara region of Central Siberia, the Upper Lena, Yakutiya, and Arctic areas of Northern Siberia, and the Eastern Siberia regions (Figure, 3.2)(Bobrov, 1988; Chard, 1974; Levin and Potapov, 1956; Okladnikov, 1964). These settlements grew in size and became permanent due to preservation of foods with pottery, advanced tool technology, and various lifestyles including hunting, fishing, and nomadic (Levin and Potapov, 1956). Such advanced lifestyles led Siberians to adapt to inhabiting forest and tundra regions.

Artifacts and skeletal morphology suggest cultural diffusion and migration between the west and east of Siberia, Asia, and Europe (Bobrov, 1988; Levin and Potapov, 1956; Okladnikov, 1964). The zigzag type designs of pottery in the Amur region show similarities to those from Chinese, Japanese and Manchurian neolithic cultures (Levin and Potapov, 1956). The custom of comb ornamentations was spread from the Ural



TRB: TransBaikal; SK: Shilka; LR: Lena River
 YR: Yenisey River; AR: Angara River

○ represents cultures

Figure 3.2. Neolithic Inhabitants and Cultures in Siberia

regions toward the east (Bobrov, 1988). The burial remains and chronologies of the upper Ob and Transbaikal sites indicate that late Neolithic people possibly migrated from the upper Ob River basin into the west (Bobrov, 1988).

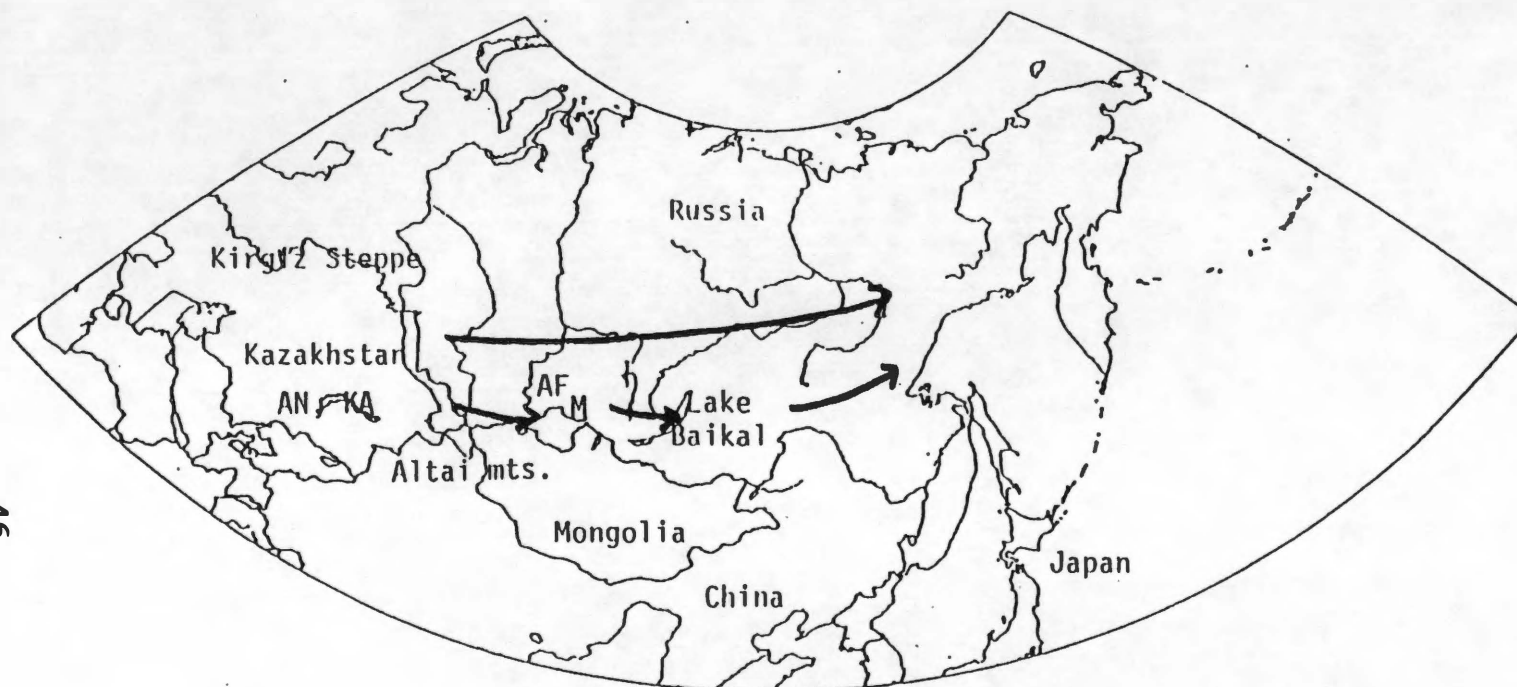
The Neolithic crania also show the European and/or Asiatic influences by localities. However, the cranial analyses are simply descriptive and researchers hardly indicate the definitions of European and Asian typology, which may provide bias toward their studies (Bobrov, 1988; Levin and Potapov, 1956; Okladnikov, 1964). The skeletal materials around the Transbaikal region, i.e., Ulan-Ude, the Fofanovo grave, show more association with Asians and Neolithic population than Western Siberian populations (Levin and Potapov, 1956). Some Russian anthropologists theorize that ancient Baikal people were related to the ancestors of Tungus and Yukagirs (Levin and Potapov, 1956). In addition, a cranium discovered from Shilka Cave, in the Amur regions, showed similarity to contemporary Tungus (Levin and Potapov, 1956; Okladnikov, 1964). Okladnikov (1964) describes Shilka skulls as classified into "the Baikal type," a southern/central Siberian type representing Tungus, Evens, and Evenks. However, based on the observation of skeletal remains, Bobrov (1988) reported that the skeletal materials from the Levedi cemeteries, Eastern Kazakhstan, are of the European type, possibly with Asiatic admixtures.

Bronze Age (around the 2nd Millennium B.C -)

During this period, the Bronze cultures were introduced into the steppe desert of Kazakhstan and Western Siberia (Figure 3.3). In the beginning of this time, three main cultures inhabited Western Siberian regions: Afanasievo, Andronov, and Karasuk cultures. Also, people's lifestyles demonstrated how they adapted to the region's various climates.

a. **Afanasievo culture:** Artifacts including bronze metallurgy, animal bones, and stones are found at a Minusinsk site (Figure 3.3) (Chard, 1974). Afanasievo people were hunters and stock breeders of sheep, cattle, and horses. They were the first bronze users as well as users of stone and bone technologies (Chard, 1974; Levin and Potapov, 1956). Skeletal remains around this region showed tall stature and strong projecting nasal bones, suggesting the European type, ancestors of Indo-European speakers and European influences (Chard, 1974; Levin and Potapov, 1956).

b. **Andronov culture:** This culture was developed in the Altai mountain and Kirgiz areas (Figure 3.3). Like Afanasievo culture, the Andronov culture also contains western influences based on the evidence of metallurgy and European type skeletal features including a high cranial index, straight forehead, and low face. However, unlike Afanasievo, they were sedentary farmers of millet and wheat, and animal breeders (Chard, 1974; Levin and Potapov, 1956).



AF = Afanasievo Culture; AN = Andronov Culture
 KA = Karasuk Culture
 M = Minusinsk

Arrows indicate the directions of spreading
 Bronze cultures

Figure 3.3. Bronze Cultures

c. Karasuk culture: Around the 13th century B.C., the Karasuk culture was developed in the same area of Andronov culture (Figure 3.3). Based on the large cemeteries and animal bone remains (i.e. sheep, cows, horses, and camels), the Karasuk people started longer lasting settlements with larger semi-nomad bands, the horse-riding inhabitants, and the specialization of sheep (Chard, 1974; Levin and Potapov, 1956). In addition, massive metal artifacts and woolen textiles discovered in the sites reflect the Karasuk lifestyle and bartering with their neighboring tribes. The Karasuk vessels and metal objects support cultural contacts between the Karasuk and Yin Dynasty of Northern China. Human skeletal remains around this region show the similarity to the European type with the high cranial index and low face like the Afanasievo and Andronov, compared to Asiatic skulls (Levin and Potapov, 1956). Based on the skeletal features between Andronov, Afanasievo, and Karasuk sites, Levin and Potapov (1956) thought that the Andronovian people migrated into Southern Siberia from Kazakhstan (Figure 3.3). Andronov and Karasuk cultures were later spread into Yenisey, Northern, and Arctic regions (Figure 3.3).

The metal culture was also later introduced into the Baikal, Transbaikial, Yakutsk, and Arctic regions (Figure 3.3)(Chard, 1974; Chernykh, 1992; Levin and Potapov, 1956; Levin and Servegyev, 1964; Rudenko, 1964). Metallurgy was introduced in the Lake Baikal, Transbaikial, and Mongolia

regions around the first Millennium B.C. (Chernykh, 1992; Levin and Potapov, 1956). Levin and Potapov (1956) describe bronze mirrors found in the Transbaikal sites. Although many researchers describe Neolithic skeletal remains in the Baikal regions, the Baikal/Mongolian skeletal remains from the Bronze Age periods were hardly described (Tokarev, 1962). In the Kamchatka peninsula and Arctic regions, individuals started using metals after Russians arrived there around the early 17th century (Levin and Servegyev, 1964; Rudenko, 1964).

Thus, nomadic lifestyles and metals were major cultural influences in Siberia from the West during the Bronze age, and skeletal remains from western Siberia indicate more European influences than Asiatic influences.

Around the First Millennium B.C.

Southwestern Siberia during this period contained two main cultures: the Tagarian and Pazyrik cultures (Figure 3.4). The Tagarian culture appeared at the Karasuk site and replaced the Karasuk culture, while the Pazyrik culture developed in the Altai region. The large Tagarian sites, containing metals including coppers, irons, animal figurines, and glass ornaments, indicated that the Tagarians were permanent settlers, agriculturalists, iron users, and artists (Levin and Potapov, 1956). The Pazyrik sites show human and horse skeletal remains, as well as different fabrics including wool, silk, fur, and felt, which indicate that they were traders and

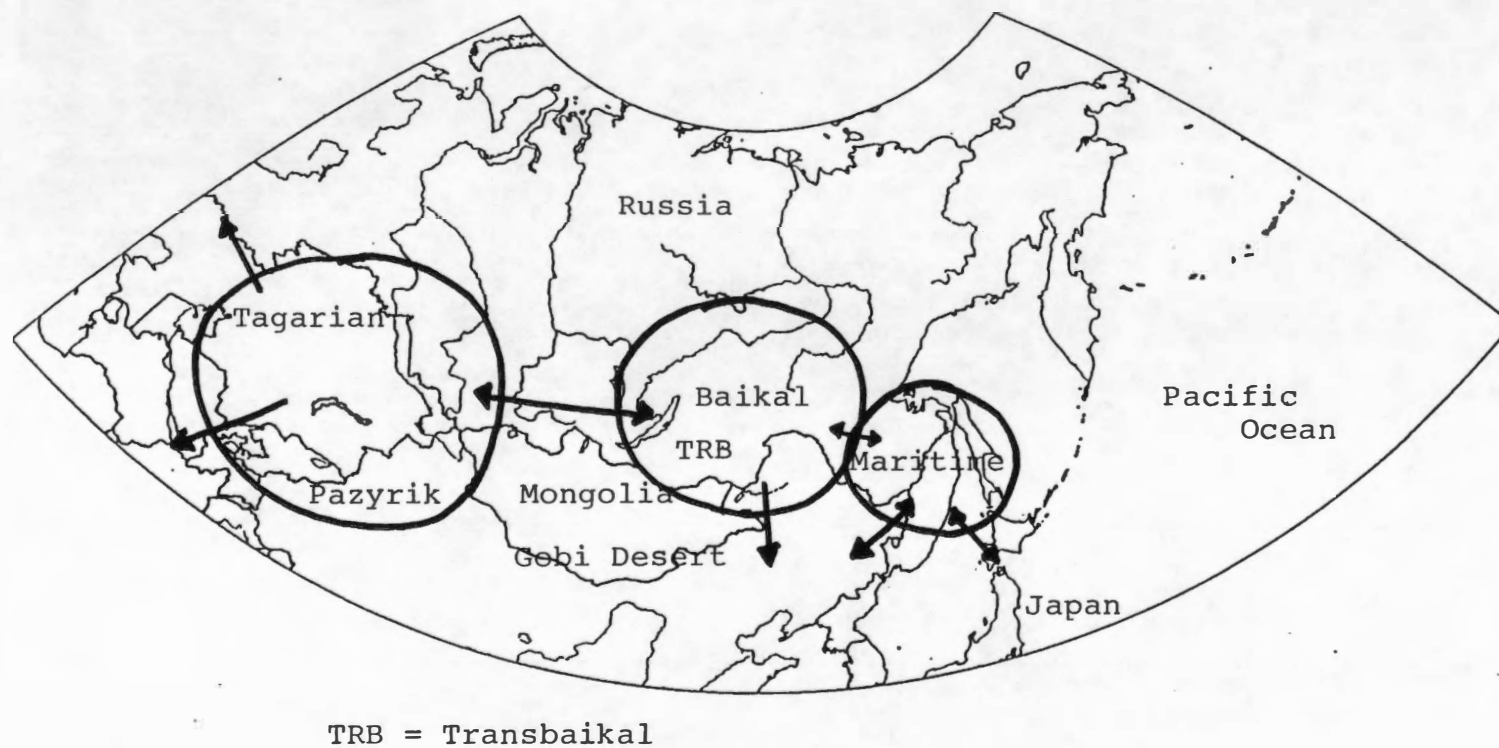


Figure 3.4. Major Cultural Contacts in the First Millennium B.C.

pastoralists (Levin and Potapov, 1956). The practice of embalming the cadavers in both Pazyrik and Tagarian cultures reveals that the people were ritual believers. The silk, animal figurines, and practices of embalming in the Tagarian and Pazyrik cultures were influenced by European, Central Asian, Mediterranean as well as East Asian cultures (Levin and Potapov, 1956). In addition, beginning in 99 B.C, the Han dynasty from China started spreading their political powers in the wide range of Turkmenistan, Southern Siberia, Transbaikial region, Upper Yenisey river basin, and lower East Siberia. These contacts linked contacts between China, Siberia, and Europe (Levin and Potapov, 1956; McNeill, 1979). According to Russian researchers, such interactions between the Southern Siberians, Europeans, and Asians also reflect the skeletal morphology by localities around this time. Levin and Potapov (1956) stated that Debets analyzed a skull from a Tagarian burial site, that was similar to the European type, found in Afanasievo and Andronovian sites. On the other hand, Levin and Potapov also argued a skull buried in Pazyrik Barrows is similar to the Asiatic type seen from the Yenisey and Altai regions. However, such skeletal analyses are problematic because the definition of Asiatic and European types are poorly mentioned and unclear.

The Transbaikial populations were spread to inhabit in the steppe areas like Gobi deserts (Levin and Potapov, 1956). They were nomads, metal users, and animal breeders of horses,

cows, sheep, and goats. Levin and Potapov (1956) further indicated that their houses were portable felt yurts which are similar to the contemporary nomads' felt yurts. The Transbaikal culture in the first Millennium B.C. is associated with other steppe tribes and China (Chard, 1974). The knives and daggers decorated with steppe animal heads were also found at the An-yang site near South China (Levin and Potapov, 1956). Iron artifacts and clay tripods from China, which were found in the Transbaikal areas, link the cultural contacts between Chinese, Baikal, and East Siberia (Chard, 1974).

The Maritime tribes, living along the Pacific, the Japan Sea, and the Okhotsk Sea during this period, were fishermen and hunters like the contemporary Eskimos, and farmers like the ancient and contemporary East and Central Asians (Fitzhugh and Crowell, 1988; Levin and Potapov, 1956). The use of harpoons for fishing that occurred during this period is practiced even now by contemporary Eskimos (Fitzhugh and Crowell, 1988). Maritime people had "shell midden culture," in which they consumed shells, mollusk, and fish for a part of their diets. Later, the stone tools and slate arrowhead were slowly replaced by metal objects influenced from the steppe neighbors. The design and shape of Maritime round-bottomed clay vessels and ceramics are related to the Baikal regions in the early Bronze Age, as well as to East Asia, i.e., China, Korea and Japan, indicating the connections between these regions (Chard, 1974; Levin and Potapov, 1956). The

subsistence of Transbaikal and Maritime populations around the 1st millennium B.C. are reconstructed mainly based on literature and archaeological artifacts, rather than analyses of skeletal remains.

Around the First Millennium A.D.

During this time, different ethnic groups arose and separated from one another by politics and languages. Metal industry from the West had diffused to East/North Siberia and the Far East.

Turkic-speaking steppe people in Siberia spread their power by uniting various tribes from Middle Asia, Central Asia, and Altai regions, to Persia. However, around the 6th century, the Turks were divided into east and west, and by the 7th century, they were controlled by China (Levin and Potapov, 1956; McNeill, 1979). After 50 years of Chinese domination, the Turks were freed and rebuilt their own state around the Yenisey river, known as the Orkhon. The Orkhon state was later inhabited by ancestors of the Kirgiz (Figure 3.5), who had more European traits than Asiatic traits in the skeletal morphology (Levin and Potapov, 1956). The Kirgiz were farmers of wheat and millet, metal workers and barterers with the Chinese, the Arabs, and the forest tribes in Siberia. The Orkhon's neighbors, who were non-Turkic speaking people, engaged in hunting, fishing, and pastoralism. Debets (1972) chronologically examined skeletal morphology, i.e., facial

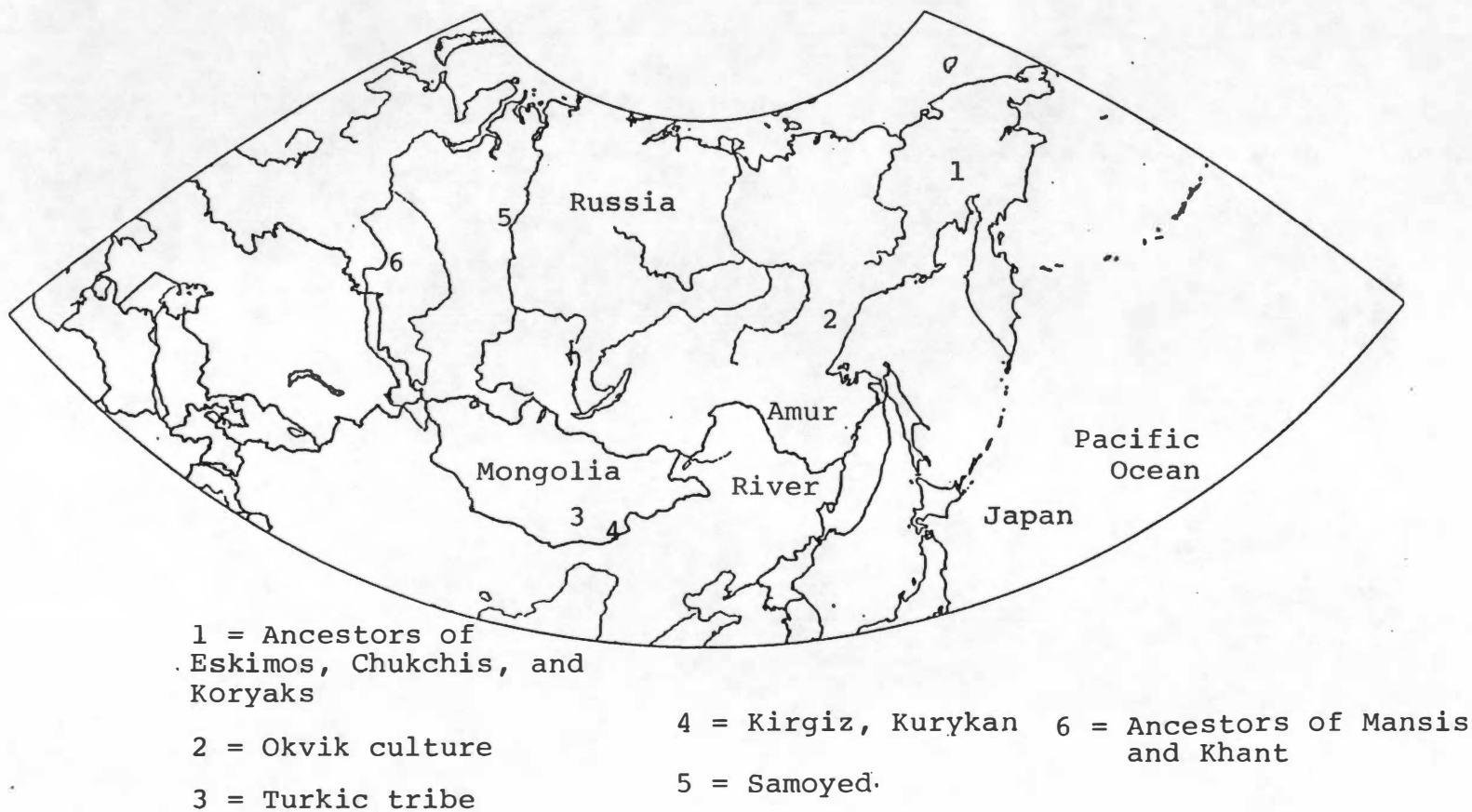


Figure 3.5. The Distributions of Ethnic Groups and Cultures in the First Millennium A.D.

flatness, in the Kirgiz populations. He found that the physical type of the Kirgiz people around the 1st century A.D. was the European type with high nasal heights, while skeletal feature after the 1st century A.D. indicated stronger Asiatic admixtures as time went by. After the 1st Millennium A.D., the Mongol tribes spread their powers and assimilated themselves into the Turkic speaking people. Thus, southwestern Siberian history matches Debets's skeletal results.

The main Turkic tribe beside the Kirgiz around this period was the Kurykans, living through the Baikal to the Lena river of Northern Siberia (Figure 3.5). The Kurykans were also pastoralists, animal breeders of horses, cows and camels, and farmers (Levin and Potapov, 1956). They had rich literary and artistic drawings, which reflected their subsistence in those days. Although their art designs such as horse riding and battles are similar to the Kirgiz, the Kurykans were politically hostile to the Kirgiz. They are considered as the ancestors of contemporary Yakuts because the ancestors of Yakuts were forced to move from the Kurykan territory to Yakutsk region by Mongol settlers (Levin and Potapov, 1956).

By the end of this period, new populations appeared (Levin and Potapov, 1956). Ancestors of the Mansi and Khanti appeared in the western Siberia. Spreading through the Ob and Yenisey rivers of Central and West Siberia, they established a new ethnic group known as Samoyeds. In the Lowland Siberia,

the ancestors of the contemporary Selkups appeared as results of admixtures between the Samoyeds, Kets, Ugrians, and Tungus (Levin and Potapov, 1956).

The maritime culture during this time is called the Okvik culture. Ornamented harpoons known in this culture are similar to those from northern Japan and Kurile Islands, where the ancestors of the Ainu lived in the Neolithic time (Levin and Potapov, 1956). Their lifestyles included hunting sea-mammals and fishing. By the 5th century, the Northeast Asia and Arctic regions were settled by the ancestors of the Eskimos, Chukchis, Koryaks, and Itelmens (Figure 3.5) (Fitzhugh and Crowell, 1988; Levin and Potapov, 1956). Iron was used by the Northeastern Siberians as a result of trading with the lower Lena tribes and the Amur people, but the Stone age technologies were still dominant in their cultures (Levin and Potapov, 1956).

Archaeologically, the people of the Amur and Maritime regions during this period have been poorly explored. Reconstruction of their history during this period was based mainly on literature. The people in the Amur regions had a great deal of contact and bartered with two main groups: One is technologically advanced places such as China, Korea, and Pacific shores, and the other is people around Arctic Ocean who still relied on Stone Age technologies. The Amur/Maritime lifestyles were based on the use of iron and stone tools, as well as agriculture and pastoralism (Levin and Potapov, 1956).

The Tungus people, who settled around the Maritime district and the Amur Basins during the first millennium A.D., became mixed with their neighbors' tribes, established their own states and spread their powers. The ancestors of Tungus-Manchurian people were farmers, pastoralists, and animal breeders. Their lifestyles, cultures, and politics, which are strongly influenced by China and Korea, were flourished (Levin and Potapov, 1956).

After the First Millennium A.D.

In the late 12th century, for approximately 200 years, the Mongols of the Khan spread their power over Northern China, Central Asia, Western Siberia, and Northern Persia (McNeill, 1979; Spuler, 1972). They also assimilated themselves into the Turkic speaking people. Artifacts such as gold and pearl ornaments, clay pots, bronze mirrors, and lacquered artifacts, that were found in the graves near north Mongolia, i.e., Kabansk, Zaburino and Krasnoyarsk, reflect the Mongols' rich culture. Such artifacts were originated from ancient Mongols, China, and Persia (Levin and Potapov, 1956). Around the 14th century, the Mongol's power became reduced to maintain the contemporary Mongolian regions because the Chinese were against the diffusion of Lama Buddhism driven by Mongolians (Leinwand, 1968; McNeill, 1979). When the Mongol incursion fell, Russians started intruding into Siberia (Spuler, 1972).

During the 16th century, seeking furs and minerals, Russia spread its colonies from the Ob river and Ural mountains to Yenisey regions (Figure 3.6; Forsyth, 1992). In addition, migrating into these regions, the Russian peasants introduced agriculture, tribute systems (= "yasak" in Russian), and fine metal objects including iron axes, cooking pots, knives, and ornaments. While the tribes such as the Khanti, Mansi, Selkup, and Nentsy were culturally and politically assimilated into the Russians, other Siberians including Yakuts and Tungus resisted the Russian government, (Forsyth, 1992; Levin and Potapov, 1956). During the 17th century, for similar reasons, Russian invasions expanded from Central Asia, Northern Siberia to Northeast Siberia (Figure 3.6; Forsyth, 1992). The Russians became mediators for trades among Middle Easterns, Siberians, and Europeans. At the same time, their invasion lead some indigenous groups like Yakuts to relocate their settlements. Furthermore, Russian intrusions caused the warfare not only between Russians and Siberians but also among Siberians such as between Koryaks and Yukagirs. The warfare and epidemic diseases drastically decreased the numbers of indigenous Siberian populations such as Kets and Yukagirs (Forsyth, 1992).

By the early 19th centuries, Russians reached the East and Arctic Siberia to seek grains. They brought their cultures including their agricultural methods, guns, forts, the yasak systems, and mines into E. Siberia (Forsyth, 1992).

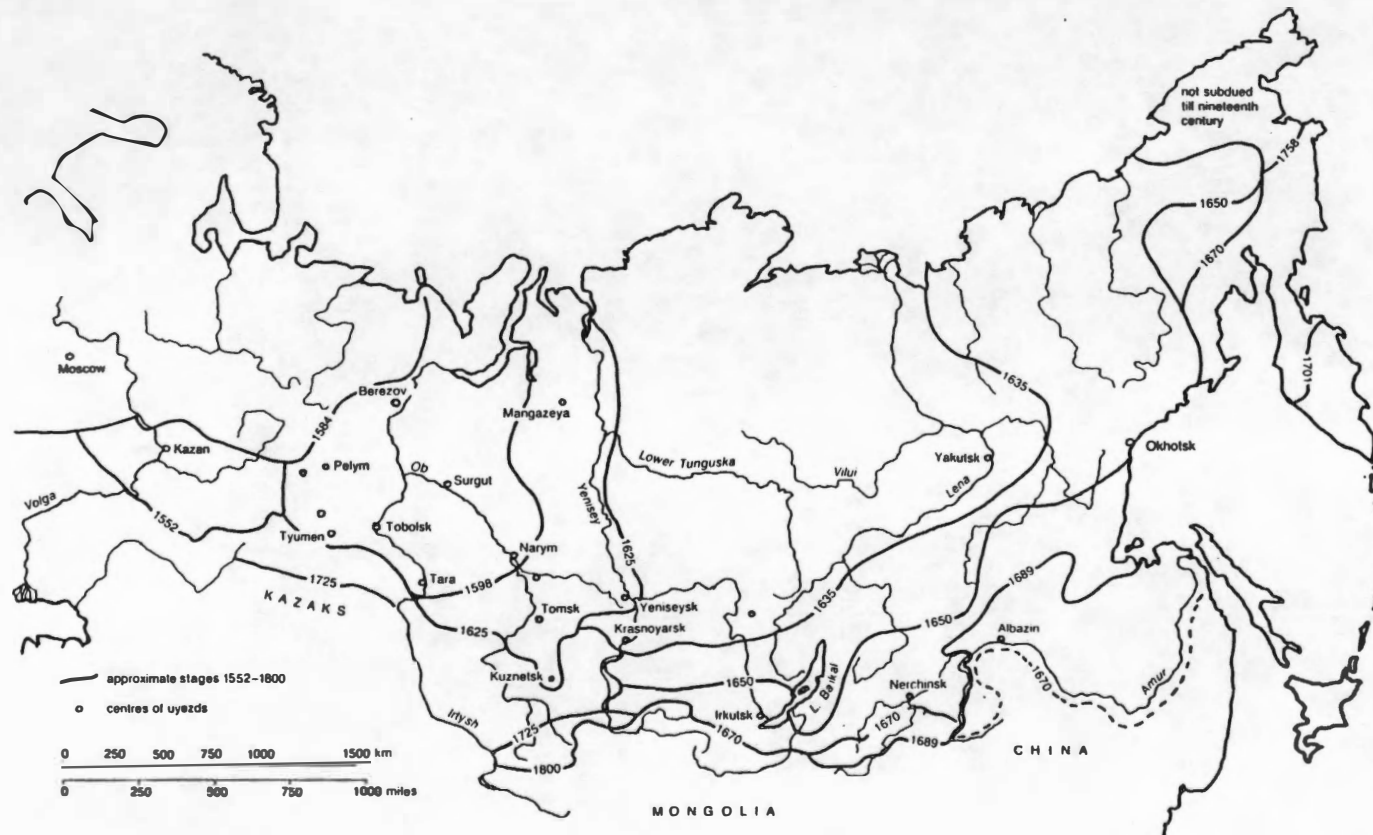


Figure 3.6. The Russian Conquest of Siberia (Forsyth, 1992)

However, the Russian diffusion was not as successful as it used to be because 1) the Amur regions had been inhabited by a large number of Mongol or Tungus-language speaking people; and 2) they had been politically and culturally influenced by Chinese (Forsyth, 1992). On the other hand, the Aleuts, an Eastern Siberian group, easily adopted Russian cultures and politics (Fitzhugh and Crowell, 1988). Systematic division of labors as well as mediating trades between the U.S. and Russia resulted in rich material culture in the Aleuts compared to other Siberians. Despite the geographical proximity and some similar traditional cultures between the Aleuts and Eskimos, the Eskimos, even today, kept their own traditional lifestyles.

CHAPTER IV

MATERIALS AND METHODS

Considering cultures and history of Siberia shown in Chapter II and III, the main goal of this study is to reveal the origins and divergence of Siberian populations using biological data sets. In addition, whether or not Siberian biological relationships reflect their cultures and history are also examined. The following materials and methods are utilized for the investigation.

Sampling Method

Because these three separate data sets (serology, crania, and dermatoglyphics) contain the same as well as different populations, I adopted the grid procedure described by Derish and Sokal (1988) in selecting localities to be included. Using this method, each map quadrat (or grid zone) is defined by a certain longitude and latitude, and data are compared among quadrats instead of emphasizing comparisons among specific ethnic groups (Figure 4.1). This quadrat procedure has an advantage because if a particular population is not available for certain biological data, other populations in the same geographical grid will allow comparison. In addition, map quadrats may provide larger sample sizes by pooling several samples in a grid zone because larger sample

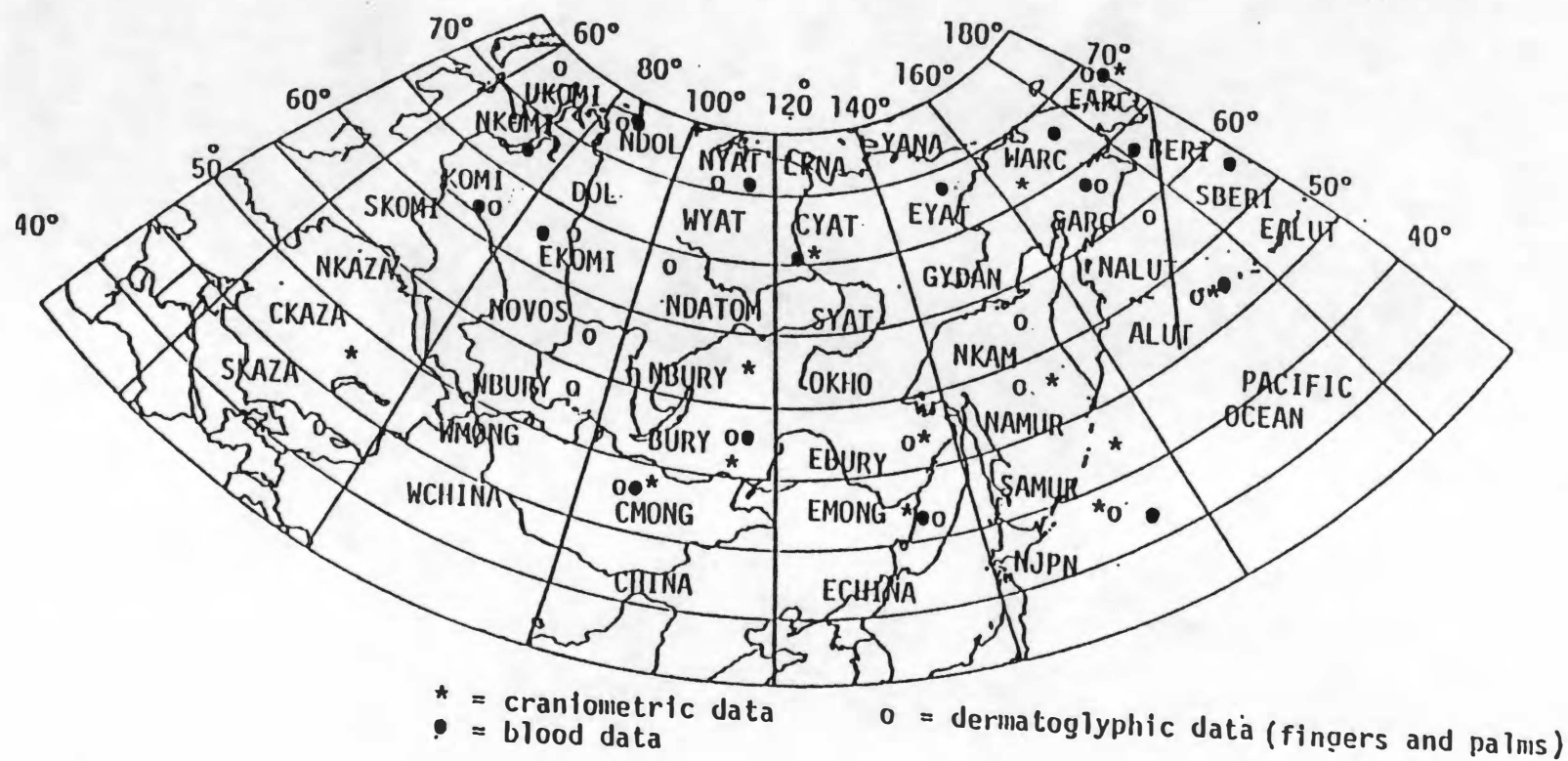


Figure 4.1. Map Quadrats and Data Distributions

sizes are less likely to provide chance errors (Freedman, et al., 1980).

Figure 4.1 shows map grid zones defined by 5 degree latitudes and 20 degree longitudes in Siberia. I have given a grid zone the abbreviated name of a geographical location. Table 4.1 is the summary of grid zones. For example, NAMUR represents northern Amur region. WMONG stands for western Mongolian region (Table 4.1).

Samples

a. Cranial Samples: Alexseev (1979) and Levin (1963) collected varying cranial samples that were unevenly distributed among populations. Ishida, Sapporo Medical College in Japan, collected measurements on a large sample of Siberian crania, which were used in this study. These data contain only males. In addition, the Ainu craniometrics collected by Howells of Harvard University are available at the Anthropology Department in the University of Tennessee. To be consistent with Ishida's data, I used the male samples in this study. In addition, these samples are separated from prehistoric collections by labeling prehistoric samples with "0" because secular/time change has been concerned. Sites from OEARC (Iron Age Ekvens), OEBURY (Troitskoes), OCMONG (Neolithic Baikal), and ONBURY (Iron Age Tagars) are prehistoric materials. Table 4.2 provides a summary of populations and the number of crania available for this study,

Table 4.1. Data Distributions and the Abbreviations

Abbreviation: Name	Abbreviation: Name
ALUT: Aleutian Islands	CKAZA: Central Kazakh
EALUT: East Aleutian Islands	NKAZA: North Kazakh
NALUT: North Aleutian Islands	SKAZA: South Kazakh
NAMUR: North Amur	KOMI: Komi
SAMUR: South Amur	EKOMI: East Komi
EARC: East Arctic	NKOMI: North Komi
SARC: West Arctic	UKOMI: Upper Komi
SARC: South Arctic	SKOMI: South Komi
BERI: Bering Strait	GYDAN: Gydan
SBERI: South Bering Strait	NJPN: North Japan
BURY: Buryat	LENA: Lena
EBURY: East Buryat	CMONG: Central Mongolia
NBURY: North Buryat	EMONG: East Mongolia
WBURY: West Buryat	WMONG: West Mongolia
CNINA: China	NOVOS: Novosibirsk
ECHINA: East China	OKHO: Okhotsk
WCHINA: West China	CYAT: Central Yakutsk
NDAT: North Datom	EYAT: East Yakutsk
DOL: Dolgan	SYAT: South Yakutsk
NDOL: North Dolgan	WYAT: West Yakutsk
NKAM: North Kamchatka	YANA: Yana

Table 4.2. Cranial Samples

Grid	Ethnic groups	Data Source	N
ALUT	Aleuts	Ishida	25
BURY	Buryats	Howells	67
CKAZA	Kazakhs	Ishida	75
CMONG	Mongols	Ishida	71
CYAT	Yakuts	Ishida	36
EARC	Eskimos, Chukchis, Evenks	Ishida	113
EBURY	Nanays, Negidals	Ishida	26
EMONG	Ulchis, Orochis	Ishida	35
NAMUR	Nivkhis	Ishida	12
NJPN	Ainus	Howells	48
OCMONG	Neolithic Baikals	Ishida	39
OEARC	Iron Age Ekvens	Ishida	34
OĒBURY	Troitskoes	Ishida	5
ONBURY	Iron Age Tagars	Ishida	48
SAMUR	Sakhalin Ainus	Ishida	28
WARC	Yukagirs	Ishida	11

and asterisks in grids in Figure 4.1 indicate available populations for craniometrics.

b. Serological Data: Because Siberian serological studies deal with different blood types by particular regions, consistent blood data in the entire Siberian region available for this study were limited to ABO, Haptoglobin, MN, and Rhesus groups. Frequencies of ABO blood types are calculated using an E-M algorithm because alleles A and B are dominant to the O allele (Hartl and Clark, 1989). Assuming Hardy-Weinberg equilibrium, the E-M algorithm provides expected allele frequencies based on maximum likelihood estimates. Frequencies of alleles within the serological systems ABO, Haptoglobin, MN, and Rhesus groups were taken from Crawford, the University of Kansas, while others were taken from the literature (Cavalli-Sforza et al., 1994; Eriksson, et al., 1979; Karaphet et al., 1981; Mourant et al, 1976; Novoradonsky et al., 1993; Roychoudhury and Nei, 1988; Szathmary, 1979a, 1981; Saha and Tay, 1992 and among others).

Dark circles seen in the grids denote the locations of serological samples available, as given in Figure 4.1. Although the exact sample sizes collected from Crawford were uncertain, each population in his data contains at least 20 individuals (personal communication). Based on the sample sizes available in the literature and the ethnic groups in the Crawford data duplicated by locations in certain grids, the

sample sizes contain at least 20 individuals each sampled grid. Table 4.3 shows references for serological data.

c. Dermatoglyphic Samples: Dermatoglyphic prints were collected during the 1960s and 1970s by H. Heet, Institute of Ethnography in Russia. The ridge count data are stored in the Brehme Data Bank, at the University of Tennessee. White circles from the map show the places where dermatoglyphic data are available (Figure 4.1). Table 4.4 shows the sample names and the number of individuals available for finger and palm prints, respectively.

Data Sources

a. Cranial measurements: Eleven skull measurements were available from Ishida's data and his measurements were based on Martin's (1957) definitions. Therefore, to be consistent, I also used the same 11 measurements from Howells' (1989) data, which were also based on Martin's definitions. Figure 4.2 shows skull measurements and the landmarks on which skull measurements were based.

b. Blood data: Blood frequencies of four genetic loci (ABO, Haptoglobin, MN, Rhesus groups) were used for the analyses.

c. Dermatoglyphic data: The late H. Brehme, University

Table 4.3. Blood Data and Their Sources

Type	Alleles	Grid	Reference
ABO	A, B, O	ALUT	Mourant et al., 1976
		BERI	Crawford
		BURY	Mourant et al., 1976; Novoradovsky et al., 1993
		CMONG	Mourant et al., 1976; Saha and Tay, 1992
		CYAT	Mourant et al., 1976; Szathmary, 1979a
		EARC	Crawford
		EKOMI	Crawford
		EMONG	Cavalli-Sforza et al., 1994; Mourant et al., 1976
		EYAT	Crawford
		KOMI	Mourant et al., 1976
		NDOL	Crawford
		NJPN	Cavalli-Sforza et al., 1994; Mourant et al., 1976
		NKOMI	Crawford
		NYAT	Karaphet et al., 1981; Sukernik et al., 1978
		SARC	Crawford
		SBERI	Crawford
		WARC	Mourant et al., 1976; Szathmary, 1979a
MN	M, N	ALUT	Mourant et al., 1976
		BERI	Crawford
		BURY	Mourant et al., 1976; Novoradovsky et al., 1993
		CMONG	Cavalli-Sforza et al., 1994; Saha and Tay, 1992
		CYAT	Mourant et al., 1976; Szathmary, 1979a
		EARC	Eriksson et al., 1977; Roychoudhury and Nei, 1988
		EKOMI	Crawford
		EMONG	Cavalli-Sforza et al., 1994
		EYAT	Crawford; Mourant et al., 1976
		KOMI	Crawford; Mourant et al., 1976
		NDOL	Crawford
		NJPN	Cavalli-Sforza et al., 1994; Mourant et al., 1976
		NKOMI	Crawford
		NYAT	Karaphet et al., 1981; Sukernik, 1978
		SARC	Crawford
		SBERI	Crawford
		WARC	Roychoudhury and Nei, 1988; Szathmary, 1979a

Table 4.3. (Cont.)

RH	d	ALUT	Crawford
		BERI	Crawford
		BURY	Crawford
		CMONG	Cavalli-Sforza et al., 1994; Crawford
		CYAT	Mourant et al., 1976
		EARC	Cavalli-Sforza et al., 1994; Crawford
		EKOMI	Crawford
		EMONG	Cavalli-Sforza et al., 1994
		EYAT	Crawford
		KOMI	Crawford; Mourant et al., 1976
		NDOL	Crawford
		NJPN	Mourant et al., 1976
		NKOMI	Crawford
		NYAT	Mourant et al., 1976
		SARC	Crawford
		SBERI	Crawford
		WARC	Crawford
Hp	Hp1, Hp2	ALUT	Crawford; Mourant et al., 1976
		BERI	Crawford
		BURY	Mourant et al., 1976
		CMONG	Cavalli-Sforza et al., 1994
		CYAT	Crawford; Posukh et al., 1990
		EARC	Crawford; Szathmary, 1981
		EKOMI	Crawford; Rychov et al., 1984
		EMONG	Cavalli-Sforza et al., 1994; Szathmary, 1981
		EYAT	Crawford
		KOMI	Crawford
		NDOL	Crawford
		NJPN	Cavalli-Sforza et al., 1994
		NKOMI	Crawford, Spitsyn et al., 1976
		NYAT	Karaphet et al., 1981
		SARC	Spitsyn et al., 1976
		SBERI	Crawford
		WARC	Roychoudhury and Nei, 1988

Table 4.4. Finger and Palmprint Samples

Grid	Ethnic Groups	F(N)	P(N)
ALUT	Aleuts	44	45
BURY	Buryats	200	207
CMONG	Mongols	56	60
EARC	Chukchis, Eskimos	306	330
EBURY	Evenks, Nanays, Ulchis	390	411
EKOMI	Selkups, Kets	140	147
EMONG	Orochis, Amur Nivkhis, Udegeys	216	227
KOMI	Khants, Forest Nentsys, Mansis	224	227
NALUT	Evens	136	268
NAMUR	Sakhalin Nivkhis	228	242
NDATOM	Evenks	192	201
NDOL	Dolgans, Entsys	133	167
NJPN	Ainus	250	85
NKAM	Itelmen	107	96
NOVOS	Tatars	139	139
NYAT	Nganasans	91	94
SARC	Evens, Koryaks	319	331
SKAZ	Kazachs, Kirgiz	99	280
UKOMI	Tundra Nentsys	120	134
WBURY	Chelkans, Altai-Kizi, Sagayans	352	357

F(N) = Fingerprint sample size

P(N) = Palmprint samples size

1. Maximum Cranial Length (GOL): The straight line between Glabella (g) and Opisthocranium (op)
2. Basion-Bregma Height (BBH): The distance between the lowest point on the anterior margin of the foramen magnum, basion (ba), and bregma (b)
3. Cranial Base Length (BNL): The direct distance from nasion (n) to basion (ba)
4. Maximum Cranial Breadth (XCB): The maximum width of the skull
5. Maximum Frontal Breadth (XFB): The maximum cranial breadth at the coronal suture perpendicular to the median plane
6. Bizygomatic Breadth (ZyB): The direct distance between both zygia (zy)

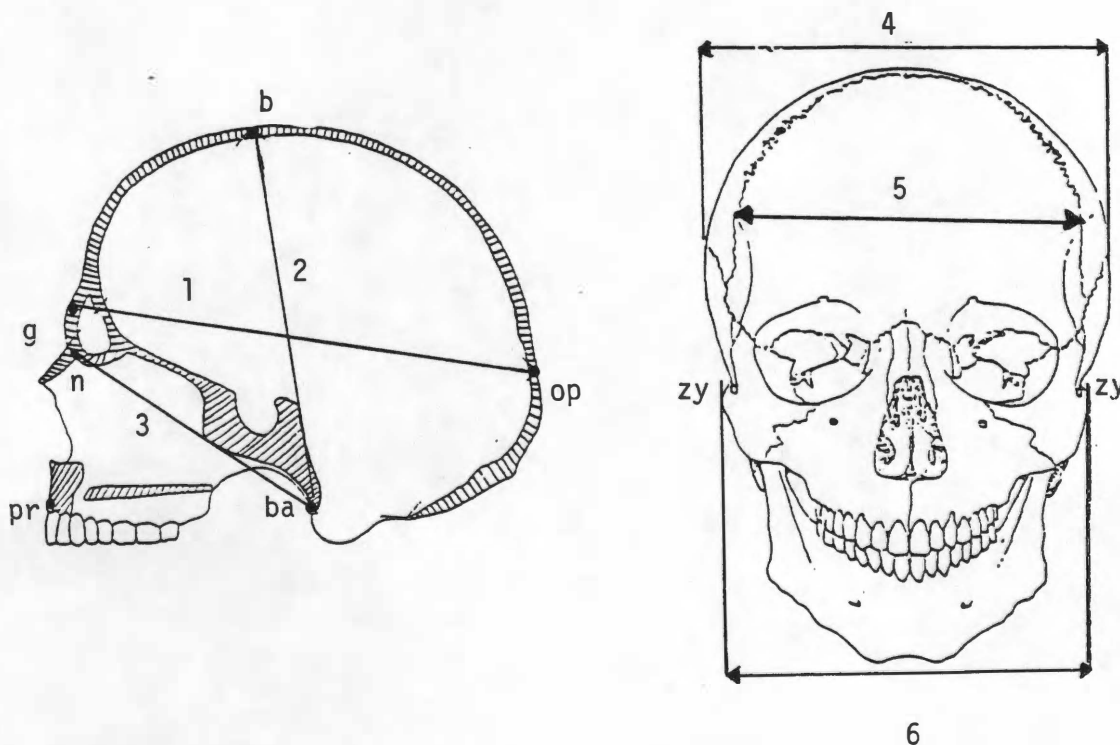


Figure 4.2. Martin's Skull Measurements (Moore-Jansen and Jantz, 1989; Howells, 1989)

7. Nasal Height (NLH):

The direct distance between nasion (n) and nasospinale (ns)

8. Nasal Breadth (NLB):

The maximum breadth of the nasal aperture (al)

9. Orbital Breadth (OBB):

The laterally sloping distance from maxillofrontale (mf) to ectoconchion (ec)

10. Orbital Height (OBH):

The direct distance between superior and inferior orbital margins

11. Simotic Chord (WNB):

The minimum transverse breadth across the two nasal bones, or chord between the naso-maxillary sutures at their closest approach.

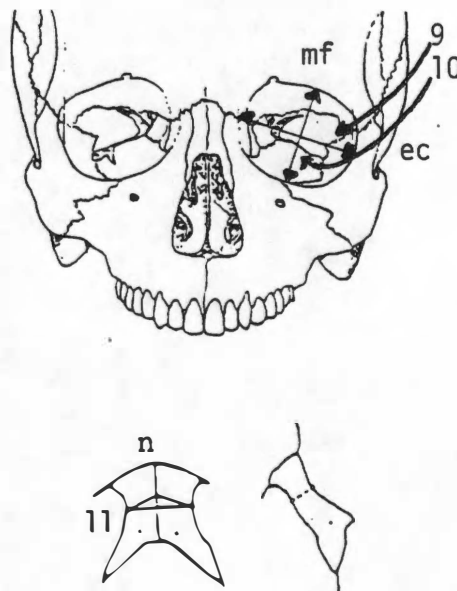
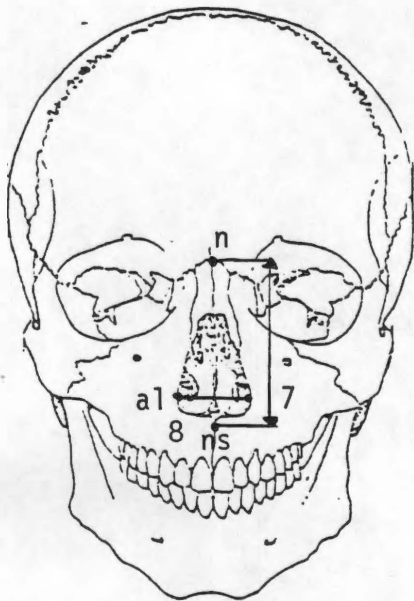


Figure 4.2. Martin's Skull Measurements (cont.)

of Freiburg, Germany, analyzed all but one Ainu sample which was analyzed by Yokota. Brehme used the work of Brodhage and Wendt (1951) as a methodological guide for finger ridge counts and this study followed Brehme's method for consistency. Finger ridges were counted based on the distances between a core and triradius (Figure 4.3). Cores were determined at the center where they started forming the finger pattern, while triradii were the place where three ridges created a triangle. In palm ridge counts, Brehme adopted Baitsch and Schwarzfischer's (1959) method, which I also used (Figure 4.4). Palm ridge counts were made based on the distance of a-b, b-c, and c-d. Points of a, b, c, and d were determined by digital triradii, which were located around distal sides of II, III, IV, and V metacarpals (Figure 4.4).

Statistical Method

a. Fst Estimation: Fst is the index expressing the variation within sub-populations relative to the variation among total groups (Wright, 1978; Hartl, 1988). It is useful for summarizing overall biological distance or variation between populations. Although other variation index such as Rst and Gst are identical to Fst (Crawford and Enciso, 1982; Jorde, 1980), in this study, Relethford and Blangero's Fst (1990) is used because their Fst is designed for genetic and quantitative data, while Rst and Gst are more suitable for serological data (Nei and Chakravarti, 1977).

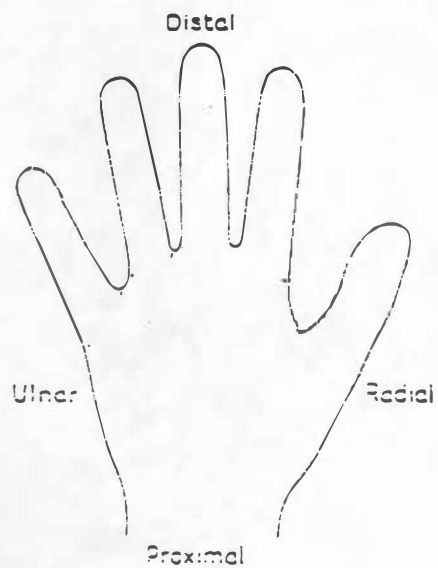
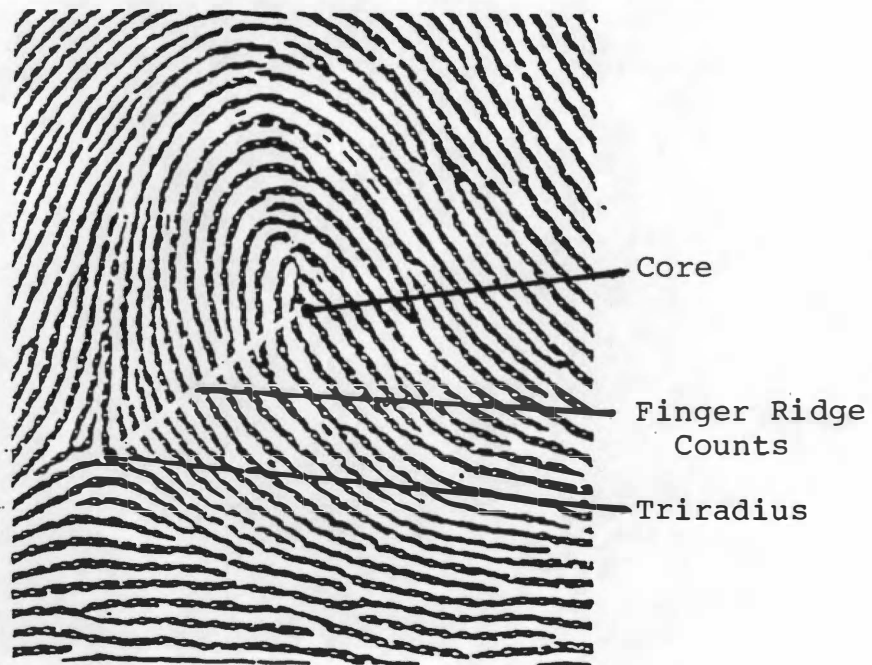
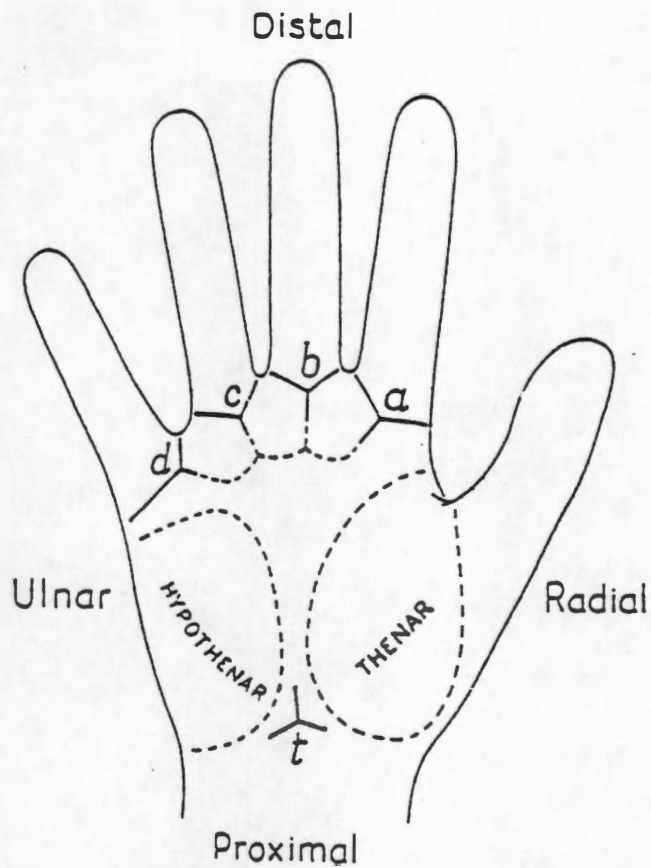


Figure 4.3. Finger Ridge Counts (Holt, 1968)



a, b, c and d are the digital triradii

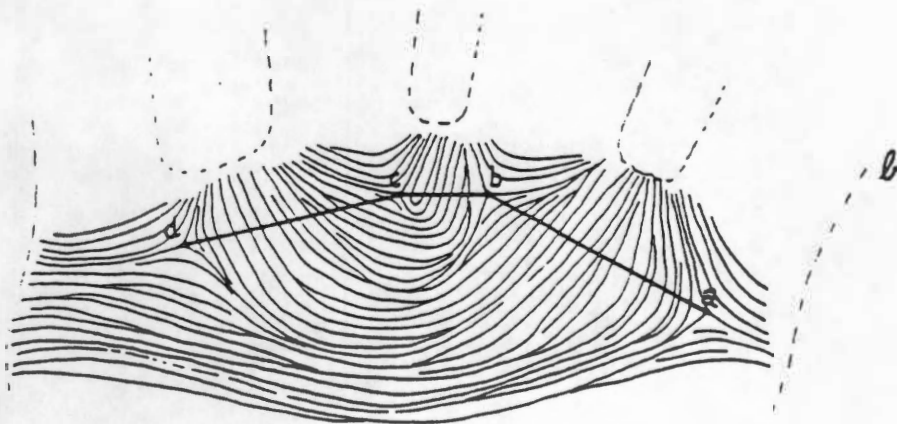


Figure 4.4. Palm Ridge Counts (Holt, 1968)

Relethford and Blangero (1990) define F_{st} as follows:

$$F_{st} = \left(\sum_{i=1}^g w_i c_{ii} \right) / \left(2 + \sum_{i=1}^g w_i c_{ii} \right)$$

where

$$c_{ii} = (x_i - \bar{x})^2 / g_w$$

and x_i is the mean for group i . \bar{x} represents the total mean and g_w is the pooled within group genetic variance. w_i is relative population size weight. F_{st} is minimum when phenotypic variance is used instead of genetic variance ($= g_w$).

F_{st} in finger and palm ridge counts was conducted with True Basic programs, while craniometrics excluding prehistoric samples were calculated by the Rmet program (Relethford and Blangero, 1990). F_{st} in blood data was conducted based on the kinship analysis, using the program Kship (Harpending and Jenkins, 1973).

b) Generalized Distance Analyses: Distance analyses were applied to the dermatoglyphic, craniometric, and serological data for further examinations of biological divergence. In addition, geographical distance was provided for comparison with three types of biological data. Generalized distance (or Mahalanobis distance) was used in dermatoglyphic and craniometric data because it is suitable for investigating the phenotypic distance of morphometric data. In this analysis,

pairwise distances were made between all pairs of populations. For instance, because dermatoglyphics contain 20 grid zones, $(20 \times 19)/2 = 190$ pairwise distances were calculated. Distances are calculated by:

$$D^2_{ij} = d W^{-1} d'$$

where d is the difference between the means of the two groups, i and j . W^{-1} is the inverse of the variance-covariance matrix, which contributes the discriminant function between these two groups (Blackith and Reyment, 1971).

Genetic distance for blood frequencies is estimated with a Kinship program (Kship), which is designed by Harpending and Jenkins (1973). As in the distances for morphometries, Kship provides a Euclidean distance. However, the genetic distance is made by maximizing differences among groups based on gene frequency covariance divided by the scaling factor $\{P(1 - P)\}$, known as an effect of genetic drift (also see Contour line section). Therefore, genetic distances for blood frequencies are estimated as:

$$d_{ij} = r_{ii} + r_{jj} - 2r_{ij}$$

where $r_{ij} = \{(P_i - P)(P_j - P)\}/\{P(1 - P)\}$, known as sample coefficients of kinship. P is the mean gene frequency among all groups, and P_i and P_j are gene frequencies in groups i and j . The kinship matrix is calculated for each allele and then

all matrices are averaged to provide an overall matrix of kinship coefficients.

Additionally, a geographic matrix was made from the distance between locations (longitude, latitude) based on the left lower corner of the map quadrat (Figure 4.1). Geographic distance is estimated by Spuhler (1972) based on:

$$\cos(D) = \sin(\text{lat}_i) \sin(\text{lat}_j) + \cos(\text{lat}_i) \cos(\text{lat}_j) \cos(\text{long}_i - \text{long}_j)$$

where

sin = sine, cos = cosine, lat = latitude, and long = longitude; and i and j stand for two separate geographical locations. Geographical distance is calculated from D multiplied by 60 nautical (or geographical) miles = 1° of great circle distance.

Generalized distances in dermatoglyphics, blood, and geography are estimated by the True Basic programs, while generalized distances from craniometrics are estimated using SAS programs (1990).

In addition, UPGMA (unweighted pair-group method using arithmetic averages) cluster analyses, which summarize the relationships among populations in tree grams, were utilized for a better understanding of the relationships among many groups. The UPGMA clusters are constructed by connecting clusters, averaging similarities and dissimilarities of distances among groups. The analyses were conducted by the

NTSYS programs (Rohlf, 1993).

c) Contour lines: Synthetic variables were created by linear combinations of each set of traits in each population. In order to obtain synthetic variables, canonical discriminant analyses were performed on morphometric (dermatoglyphics and cranial) data sets, while principal component analyses were applied to blood data. Overall, both canonical discriminant and principal component analyses perform the same function on quantitative and blood data, respectively. The canonical discriminant analysis separates groups by maximizing variations among groups. Then the relationships among groups are expressed with axes called canonical variates.

The principal component analysis for blood frequencies is conducted based on Kship analysis (Harpending and Jenkins, 1973). In general, the principal component analysis on morphometries seeks eigenvalues and eigenvectors of a correlation matrix (or R matrix) between groups. However, because the unit of blood frequencies is usually smaller than that of morphometric data, principal components differentiate less relationships among groups in blood. Like a Kship distance matrix, the Kship program also provides principal components by maximizing different relationships among groups based on gene frequency covariance divided by $\{p(1-p)\}$.

Synthetic variables obtained from canonical discriminant and/or kship analyses were transferred to SURFER interpolation

computer programs (Sokal, 1990) to create contour maps. SURFER requires three points of x, y, z (in this case, longitude, latitude, and canonical/principal axis), then connects the closest z point between grid zones consisting of x and y. Contour analyses have been helpful to reconstruct divergence and origins of certain populations. Menozzi et al. (1978) succeeded in reconstructing the direction of migrations of farmers in European history based on the clinal distributions of blood frequencies using this method.

d) Correlation of distance matrices: A distance matrix contains quadrats (=N) x N pairs of distances for each biological and geographical data set as mentioned earlier.

Then, those matrices were examined with the Mantel Z test (Mantel, 1967) to determine if any correlations among matrices reflect similar distances. Correlation analyses of distance matrices only take consistent groups in biological and/or geographical data sets. For example, for testing a correlation between craniometrics and fingerprints, 8 common groups (ALUT, BURY, CMONG, EARC, EBURY, EMONG, NAMUR, NJPN) were found between the distance matrices. Then 8 x 8 matrices of craniometrics and fingerprints were tested by a Mantel Z test as:

$$Z = \sum X_{1j} Y_{1j}$$

where X_{1j} and Y_{1j} are non-diagonal elements of craniometric

matrix, X, and dermatoglyphic matrix, Y. One thousand randomizations were performed to obtain the sampling distribution of Z. A Z value is high when the correlation between X and Y are high. Correlation analyses were also conducted by the NTSYS programs (Rohlf, 1993).

CHAPTER V

RESULTS

In this chapter, population variations among different biological data sets are reviewed. Then, population structures are summarized by biological data sets and matrix comparisons among geography and biological data are evaluated.

Inter-population Variation

Table 5.1 is the summary of F_{st} for each biological data set. The minimum F_{st} of craniometrics, with the assumption of 100% heritability, was 0.101. The value indicates that 10.1% of the variation exists between Siberians tribes (without prehistoric samples) and that the remaining 89.9% results from variation within them. Heritability of human quantitative traits has been estimated by several researchers (Cheverud, 1988; Devor, 1986, 1987; Konigsberg and Ousley, 1995; Paganini-Hill, et al., 1981; Raposo-Do-Amaral, et al., 1989; Relethford, 1994). F_{st} of Siberian crania is 0.179 when the heritability as 0.55 is used based on craniofacial traits on human populations (Devor, 1986, 1987; Relethford, 1994). F_{st} of Siberian crania is 0.243 when the heritability as 0.35 is considered based on anthropometric and skeletal traits (Cheverud, 1988; Konigsberg and Ousley, 1995). The minimum F_{st} of Siberian craniometrics shows more differentiation than

Table 5.1. Craniometric, Blood and Dermatoglyphic Fst in Siberia

Biological data	Minimum Fst	Heritability	Fst
Craniometrics	0.101 (U)	0.55 - 0.35	0.179 - 0.243 (U)
Blood	0.040 (B)	1.00	0.040 (B)
Fingerprints	0.010 (U)	0.6 - 0.35	0.016 - 0.028 (U)
Palmprints	0.012 (U)	0.6 - 0.35	0.020 - 0.055 (U)

(U) indicates Unbiased: Fst is estimated based on census size

(B) indicates Biased: Fst is estimated based on sample size

the cranial minimum F_{st} ($= 0.085$) of worldwide regions (Africa, Europe, Australasia, Polynesia, Far East, and America) provided by Relethford (1994). However, high Siberian differentiation has also been demonstrated in an anthropometric study (the minimum $F_{st} = 0.12$) using heritability of 0.42 (Ousley, 1995).

The blood F_{st} in this study is 0.040 (Table 5.1). Crawford and Enciso (1982) calculated blood R_{st} in Siberian tribes and found similar variation ($R_{st} = 0.047$) to this study. R_{st} , which is estimated based on the mean genetic heterogeneity among total populations, is equivalent to F_{st} . In addition, F_{sts} in other regional populations such as Australian aborigines, Africans, and New Guineans also demonstrate similar variations ($F_{st} = 0.040$) (Jorde, 1980; Wiesenfeld and Gajdusek, 1976).

The minimum F_{sts} of finger and palm ridge counts are 0.010 and 0.012, respectively. As in anthropometrics and craniometrics, various heritabilities were also observed in dermatoglyphic studies (Arrieta et al., 1991; Holt, 1968; Malhotra, et al., 1981; Ousley, 1997). When the heritabilities of finger and palm ridge counts were chosen as 0.6 based on the average of all ridge count heritabilities from family and twin studies (Holt, 1968; Arrieta et al., 1981), F_{sts} in finger and palm ridge counts in this study are 0.016 and 0.020, respectively. When the heritabilities of dermatoglyphics are chosen as 0.35 based on a pedigree study

in German populations conducted by Ousley (1997), F_{st} s in finger and palm ridge counts in this study increase to 0.028 and 0.055, respectively. However, overall, the low dermatoglyphic variations are consistently shown among the Siberian groups and are similar to the results among Lapp and European groups (minimum F_{st} = 0.012-0.020) found by Jantz et al. (1993) and Jantz (1997).

Thus, variations among Siberian populations in blood and dermatoglyphic data are low, while craniometrics indicate more differentiation among the Siberian populations.

Population Relationships

a. Craniometrics: Table 5.2 is the generalized distance matrix of craniometrics, and Figure 5.1 shows the dendrogram based on the distance matrix. In general, the cranial similarities reflect regional and linguistic relationships. Southern Siberians who are Altaic speakers such as the CMONG, CKAZA, and BURY cluster together. East Siberians from the EBURY, EMONG, and NAMUR assemble together. The NJPN and SAMUR, which contain the Ainu groups, cluster together.

The second craniometric feature is that some distant Siberians have closer relationships with southern Siberians than with their neighbors. For instance, the EARC from Northeast Siberia is closer to southern Siberians of the EBURY and EMONG than to their neighbor groups of the WARC and ALUT. The western Siberian group of the CKAZA and the northern

Table 5.2. Distance Matrix from Cranial Measurements

ALOT	BURY	CRAZA	CMONG	CYAT	EARC	EBURY	EMONG	KOMI	NAMUR	NJPN	SAMUR	WARC
0												
8.95979	0											
5.69002	1.40179	0										
6.81106	1.66255	2.17170	0									
11.78913	4.35782	4.00810	2.96458	0								
6.33471	7.24022	4.81986	3.40396	3.75687	0							
8.38522	5.25960	3.96327	2.13343	4.26441	2.66647	0						
5.42119	5.91394	3.77779	2.32336	4.62852	1.20763	0.90347	0					
11.30773	9.93091	6.82983	10.51047	12.72510	9.64778	10.60345	8.85551	0				
7.45835	5.58134	2.63197	4.11157	4.75394	3.34525	2.27496	2.09630	10.80615	0			
14.35319	15.27824	12.87563	12.26794	14.16198	12.14084	8.36347	8.71013	10.92380	11.93864	0		
8.19132	15.26747	10.17127	10.61855	12.18764	5.74681	6.44037	4.93096	8.54878	8.02901	4.30557	0	
8.03940	5.23992	3.28338	2.35844	4.35070	2.96341	2.29481	2.51425	9.73145	3.66745	10.93726	7.65802	0

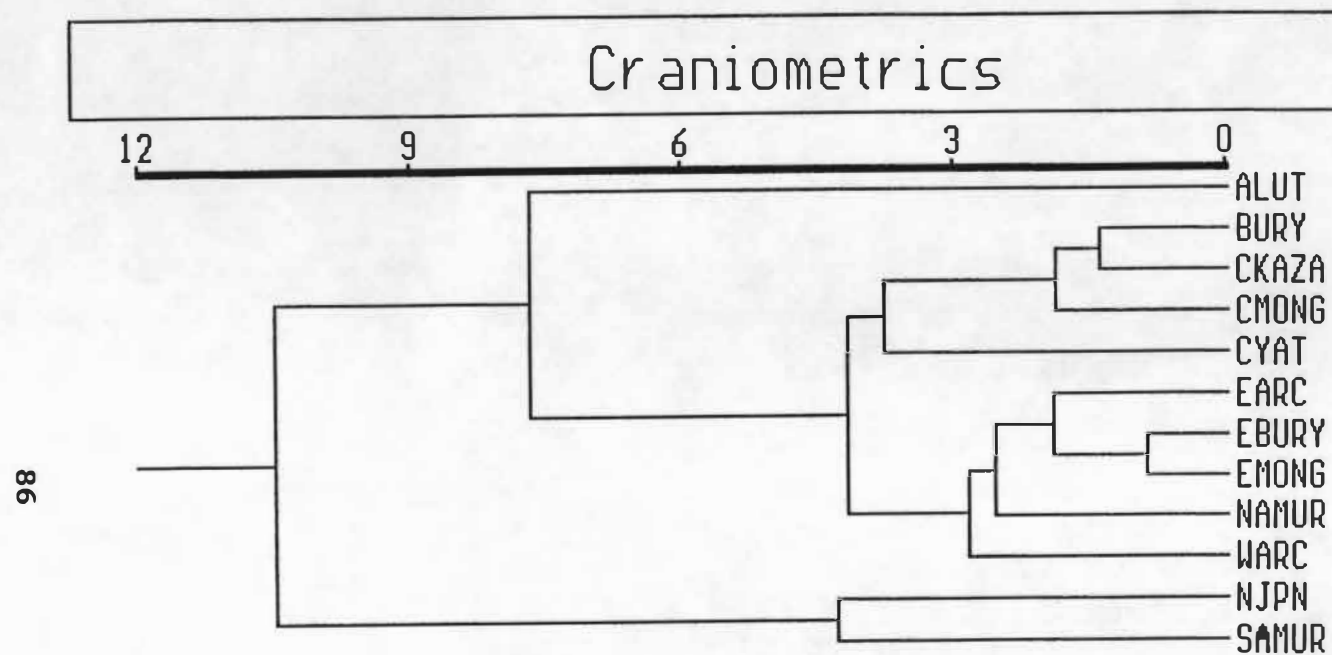


Figure 5.1. Dendrogram obtained from Craniometrics

Siberian group of the CYAT are also similar to southern Siberians of the BURY and CMONG. Finally, the distance matrix shows that the groups including NJPN, SAMUR, and ALUT are distant from all other groups in Siberia (see Table 5.2) because 1) the Ainu (NJPN, SAMUR) origins have been speculated with various ethnic groups (Bannai, et al., 1996; Brace and Nagai, 1982; Hanihara, 1992; Kimura, 1962; Matsumoto, 1988; Matsumoto and Miyazaki, 1972; Omoto, 1972; Simmons et al., 1953) and 2) Aleuts (ALUT) have been heavily assimilated with Russians (Fitzhugh and Crowell, 1988; Levin and Potapov, 1956).

The contour maps based on a canonical discriminant function analysis are shown in Figure 5.2 and Figure 5.3. Figure 5.2 is the contour map of craniometrics based on the first canonical variate (= CV1) from the canonical analysis. With 39% among group variation in the first canonical variate, Figure 5.2 shows that the peaks of gradients are in Mongolia (50N°, 100E°) and Central Yakutsk (60N°, 120E°), and fall gradually towards the west and southeast. Table 5.3 is the total canonical structure and class means of canonical variates of cranial data. The high concentrated contours indicate greater maximum cranial breadth (XCB) and nasal height (NLH), which agree with some of the results provided by Alexseev (1979), and Ishida and Dodo (1990). Therefore, Siberians from the Baikal, Mongolia, and Yakutsk regions have wider cranial breadths and greater nasal heights than eastern

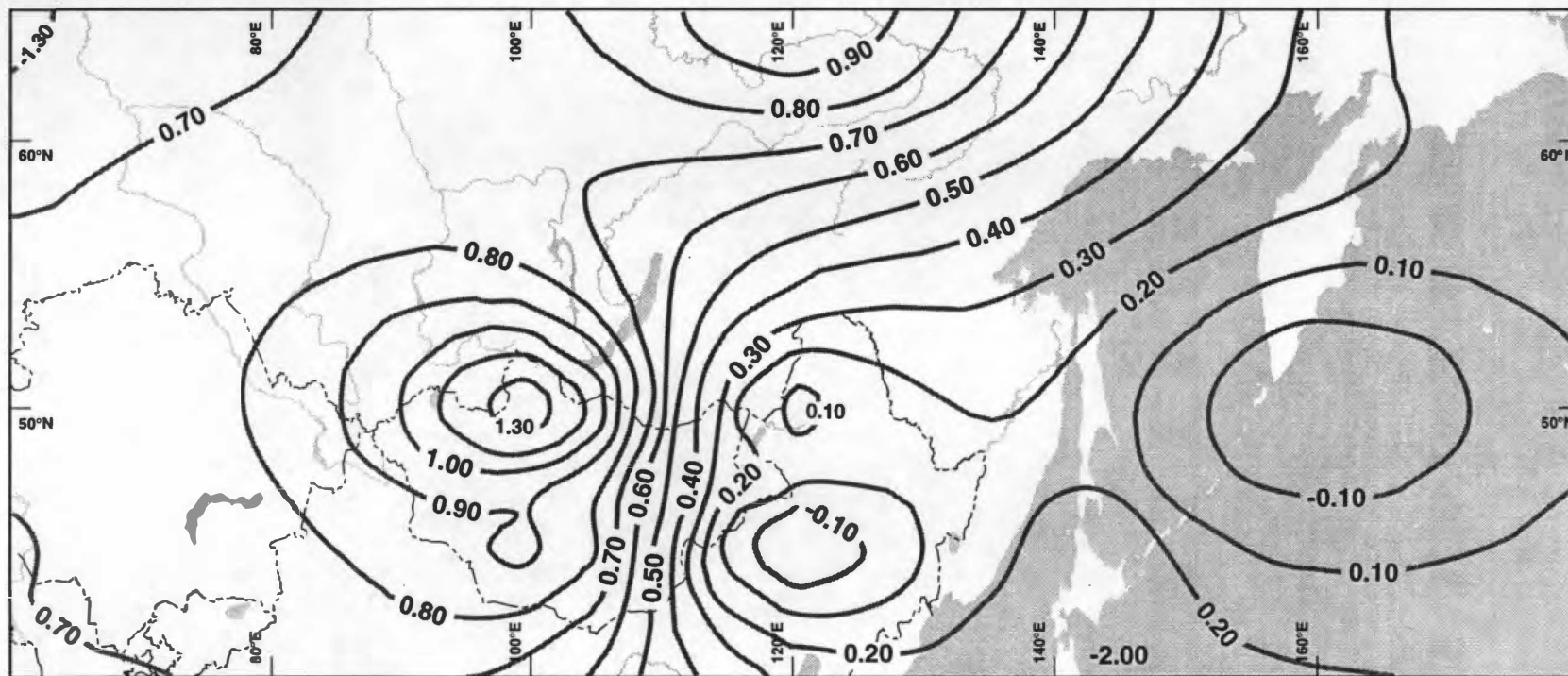


Figure 5.2. Contour Map of Craniometrics Based on the First Canonical Variate

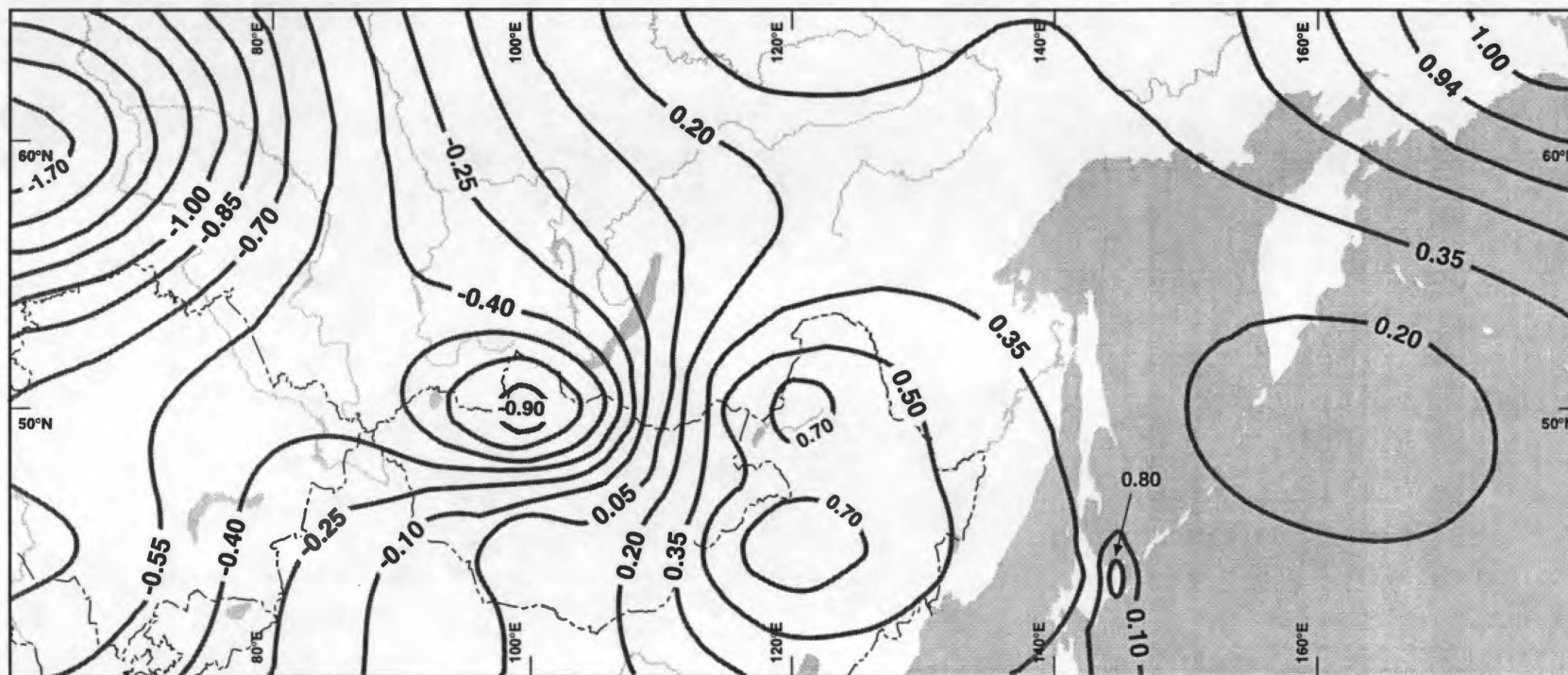


Figure 5.3. Contour Map of Craniometrics Based on the Second Canonical Variate

Table 5.3. Total Canonical Structure and Class Means of Canonical Variates in Crania

VAR	CAN1	CAN2	CAN3	CAN4
GOL	-.277826	0.310265	0.457199	0.162926
BNL	-.185153	0.253856	0.451029	0.325965
XCB	0.584879	-.538000	0.262464	-.143351
XFB	0.341902	-.617186	0.262153	0.216168
BBH	-.376433	0.136643	0.159250	0.474378
ZYB	0.497162	0.194654	0.405996	-.160765
OBH	0.385761	0.386487	-.134068	-.076444
OBH	0.442081	0.464728	0.202230	-.310131
NLB	0.215181	-.066134	0.786525	0.003802
NLH	0.754112	0.298892	0.181055	0.423149
WNB	-.282862	-.526287	0.065781	-.093479

POP	CAN1	CAN2	CAN3	CAN4
ALUT	-0.095879300	0.134008969	-0.688446081	-2.015902315
BURY	1.285045090	-0.949451865	0.570862933	-0.065174594
CKAZA	0.699182724	-0.735124199	-0.017340645	-0.28707313
CMONG	0.919960592	0.103665765	0.442827411	-0.073255153
CYAT	0.969697681	0.442493554	0.334239523	1.013828067
EARC	0.098534950	1.052549742	-0.731927609	0.241754279
EBURY	0.074060016	0.717026873	0.526216870	0.141572244
EMONG	-0.105216506	0.774718845	-0.088422939	-0.141314059
NAMUR	0.346718321	0.452181709	-0.010491954	-0.153842040
NJPN	-2.328847320	0.105937432	1.561805805	0.005658350
SAMUR	-2.036146068	0.799624114	-0.185915431	-0.345494625
WARC	0.280673737	0.407190478	0.098179823	0.139938412

Siberian groups. A biological picture based on CV1 matches the dispersion of Siberians from south to north and east, suggested by Russian researchers (Levin, 1963; Levin and Potapov, 1956). Figure 5.3 is the map of the second canonical variate (= CV2), accounting for 26% of among group variation. A peak is in the west, and a clinal distribution is roughly shown from west to east. The canonical structure indicates that western Siberians have greater simotic chord (WNB) and frontal (XFB) and maximum cranial (XCB) breadths than eastern groups (Table 5.3). Such an east-west relationship in cranial breadth matches the cultural diffusion of bronze between the west and east historically (Levin and Potapov, 1956; Levin, 1963).

Further analyses were performed using Siberian craniometrics with archaeological samples. Figure 5.4 shows the dendrogram and table 5.4 is the distance matrix based on the cranial data with archaeological samples. Overall, the populations with archaeological samples maintain similar relationships to the ones without archaeological samples. However, archaeological samples, except for the OEARC, are more closely related to the eastern side of Siberia than central and the western side of Siberia. The OEARC, which contain the Ekvens, are known as populations possibly influenced from the New World (Ackerman, 1982; King and Slobodin, 1996).

Figure 5.5 shows the contour map of CV1 in craniometrics

Table 5.4. Distance Matrix from Cranial Measurements
Including Archaeological Samples

ALUT OCMONG	BURY OEARC	CKAZA OEBURY	CMONG SAMUR	CYAT WARC	EARC	EBURY	EMONG	KOMI	NAMUR	NBURY	NJPN
0											
9.17927	0										
5.72082	1.41654	0									
7.02104	1.62295	2.13525	0								
11.73729	4.27104	3.98387	2.85224	0							
6.19009	7.33692	4.84396	3.46886	3.84230	0						
8.26852	5.19227	3.89414	2.10181	4.38489	2.76896	0					
5.25281	5.98503	3.75203	2.41520	4.71755	1.19693	0.95752	0				
11.32380	10.07033	7.05890	10.50159	12.93238	9.65053	10.55639	8.71677	0			
7.12514	5.68348	2.60786	4.15497	4.95856	3.37754	2.33957	2.07979	10.96415	0		
13.25419	13.27857	8.68399	11.12377	9.10590	6.55805	9.47101	8.02315	4.75324	9.25323	0	
14.16494	15.02273	12.82989	12.04462	14.46668	12.33593	8.28856	8.63557	10.83895	12.12123	9.16504	0
0											
7.60688	8.34443	5.59733	5.13489	6.73269	3.32265	4.42393	3.85613	6.90764	6.52586	3.06120	
6.84146	0										
20.38481	25.97489	21.56365	17.83928	14.43667	8.10843	12.35001	10.80925	23.25731	15.01158	11.01829	
14.23577	8.93988	0									
8.92518	6.69536	4.70677	3.32412	5.00263	2.74374	2.22022	1.25449	7.07178	3.63198	7.64672	
9.79536	5.48736	13.46756	0								
7.85332	15.08121	10.06349	10.45051	12.30784	5.73040	6.33216	4.71111	8.47220	7.90617	4.82902	
4.35162	3.15894	8.23092	7.25191	0							
8.23027	5.13157	3.25388	2.30610	4.39954	3.14294	2.32032	2.64036	10.03793	3.72536	7.67698	
11.24050	2.62396	13.13932	3.36636	7.93512	0						

Craniometrics (with prehistoric samples)

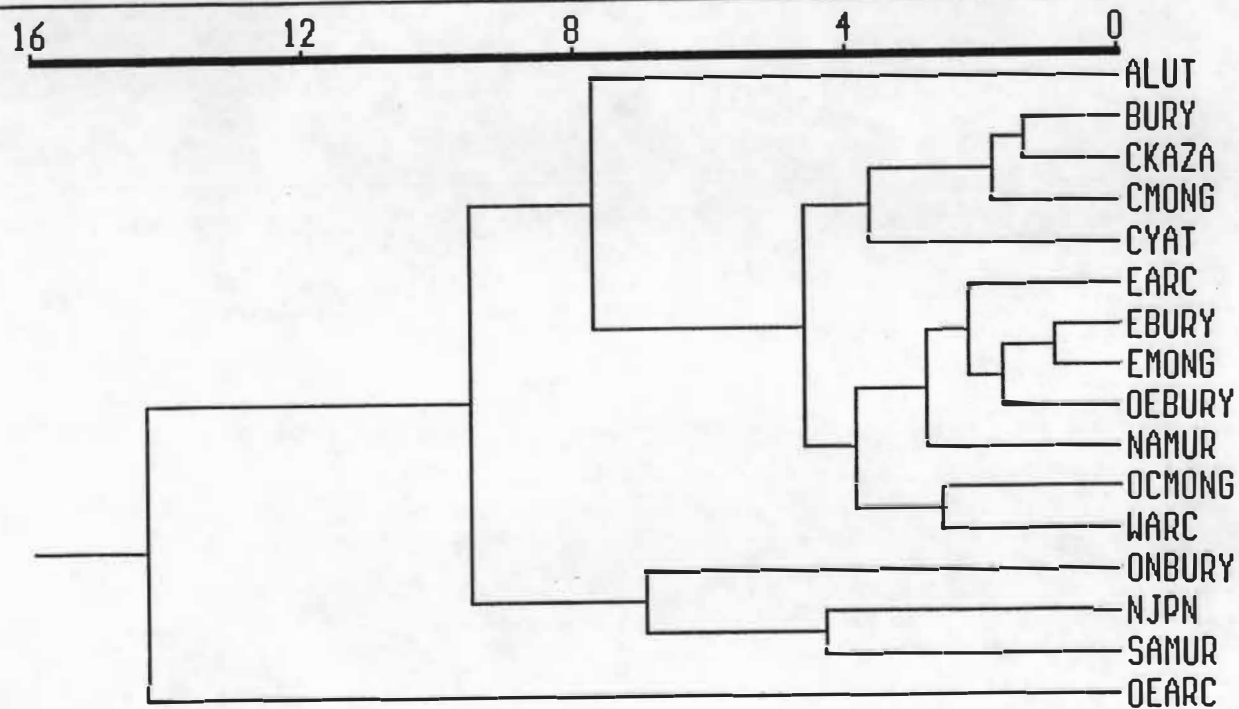


Figure 5.4. Dendrogram Based on Craniometrics
Including Prehistoric Samples

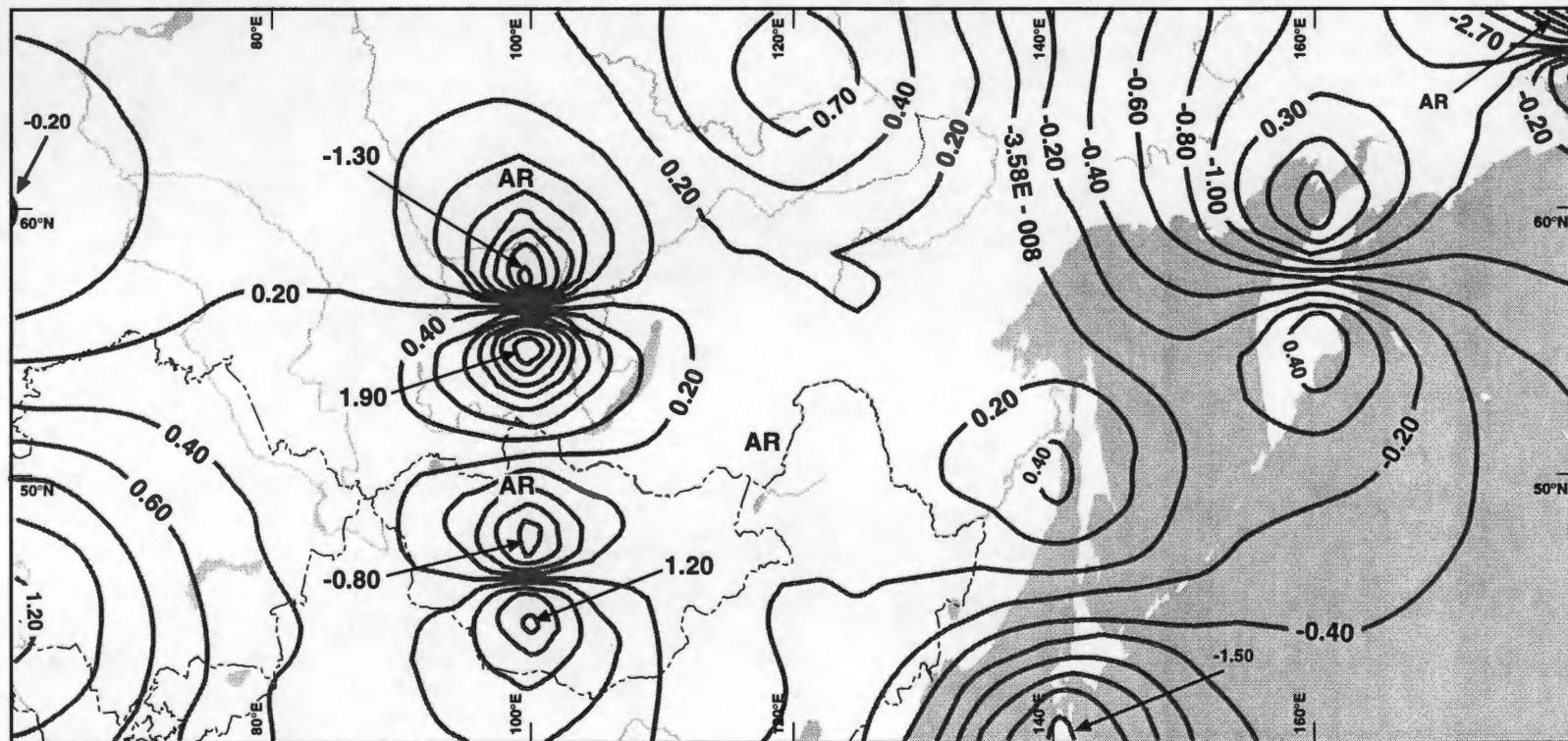


Figure 5.5. Contour Map of Craniometrics With Archaeological Samples Based on the First Canonical Variate

with archaeological crania. It illustrates 40% among group variation. As in Figure 5.4, archaeological crania from the ONBURY (100E°, 57.5N°) and OCMONG (100E°, 47.5E°) separate from the contemporary crania of the BURY and CMONG, and close to eastern side of Siberia. Compared with Figure 5.2, Mongolia and Baikal regions show chronological change in biological relationships with western and eastern regions. Such biological influences on the Baikal and Mongolia regions are also supported by cultural influences from both east and west sides of Siberia (Levin and Potapov, 1956; Levin 1963; McNeil, 1979). In addition, recent speculation of possible prehistoric connections to the Ainu (NJPN, SAMUR) origins (Bannai et al, 1996; Brace and Nagai, 1982; Hanihara, 1992) may be associated with this result as well.

b. Blood: There were not many consistent data available in the entire Siberian regions, which may distort the relationships among Siberians. Table 5.5 is the kship distance matrix of blood data, and Figure 5.6 shows the dendrogram based on the distance matrix. First, regions which contain the same ethnic groups cluster together. For instance, the ALUT and SBERI, both of which contain the Aleuts, assemble together. The NDOL and NYAT, which consist of Nganasan tribes, cluster together. In the same way, the BERI and EARC, which represent Eskimo populations, are close to one another. Another characteristics is that distant

Table 5.5. Distance Matrix from Blood Polymorphism

ALUT BERY BURY CMONG CYAT EARC EKOMI EMONG EYAT KOMI NDOL NJPN NKOMI
NYAT SARC SBERI WARC

[illegible]

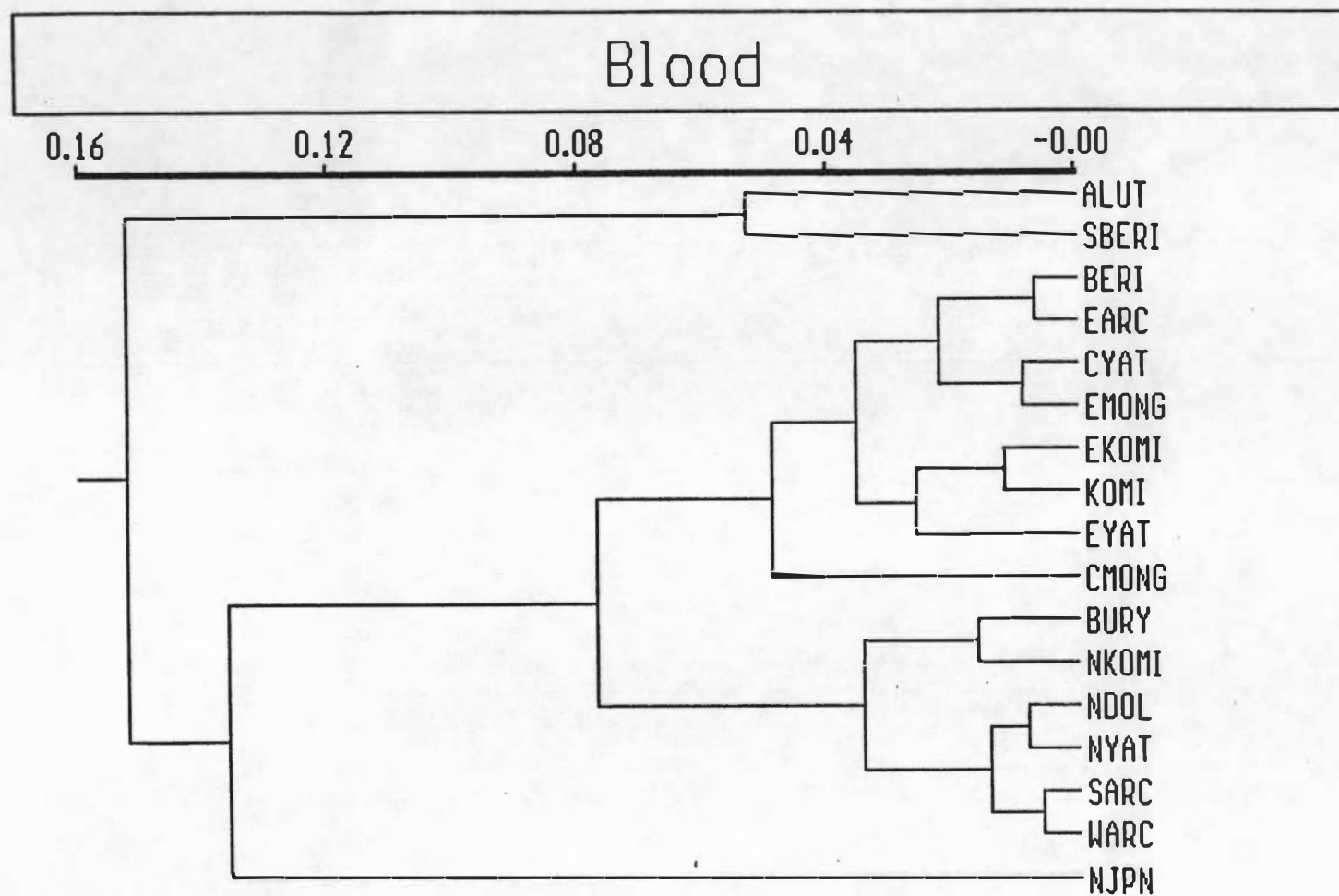


Figure 5.6. Dendrogram Obtained from Blood Data

Siberian groups cluster with southern Siberians, which is similar to craniometric results. Arctic (BERI, EARC, SARC, WARC), Western (NKOMI, KOMI, EKOMI), and Northern (NDOL, NYAT, CYAT) groups cluster with either BURY or CMONG.

In addition, wide spread tribes show various relationships with other regions of Siberia. For instance, Evenks (EMONG, EKOMI) cluster with Northern (EYAT, CYAT) and Arctic (BERI, EARC) Siberians, while Nganasans (NDOL, NYAT) show close connections with Siberians from Southern (BURY), Western (NKOMI), and Arctic (SARC, WARC) Siberians.

Furthermore, as with craniometrics, the Aleuts from the ALUT and SBERI are also isolated from other Siberians in blood data, indicating cultural and biological assimilation of the Aleuts with non-Siberian populations (Fitzhugh and Crowell, 1988; Ousley, 1995). The Ainu (NJPN), whose origins are theorized to be from one of several ethnic groups, are also isolated from other Siberians.

Figure 5.7 is the contour map based on the principal component (PC) 1, and table 5.6 presents the coordinates for alleles and groups. The genetic relationships based on principal components analyses also show poor clinal patterning. With 54.2% among group variation, the populations, including the Komis (60N°, 80E°), Yakuts (65N°, 120E°) Evens (65N°, 140E°), and Aleuts (55N°, 180E°), have high frequencies of Haptoglobin 1 and M blood types (Table 5.6 and Figure 5.7). Figure 5.7 and Table 5.6 also demonstrate that

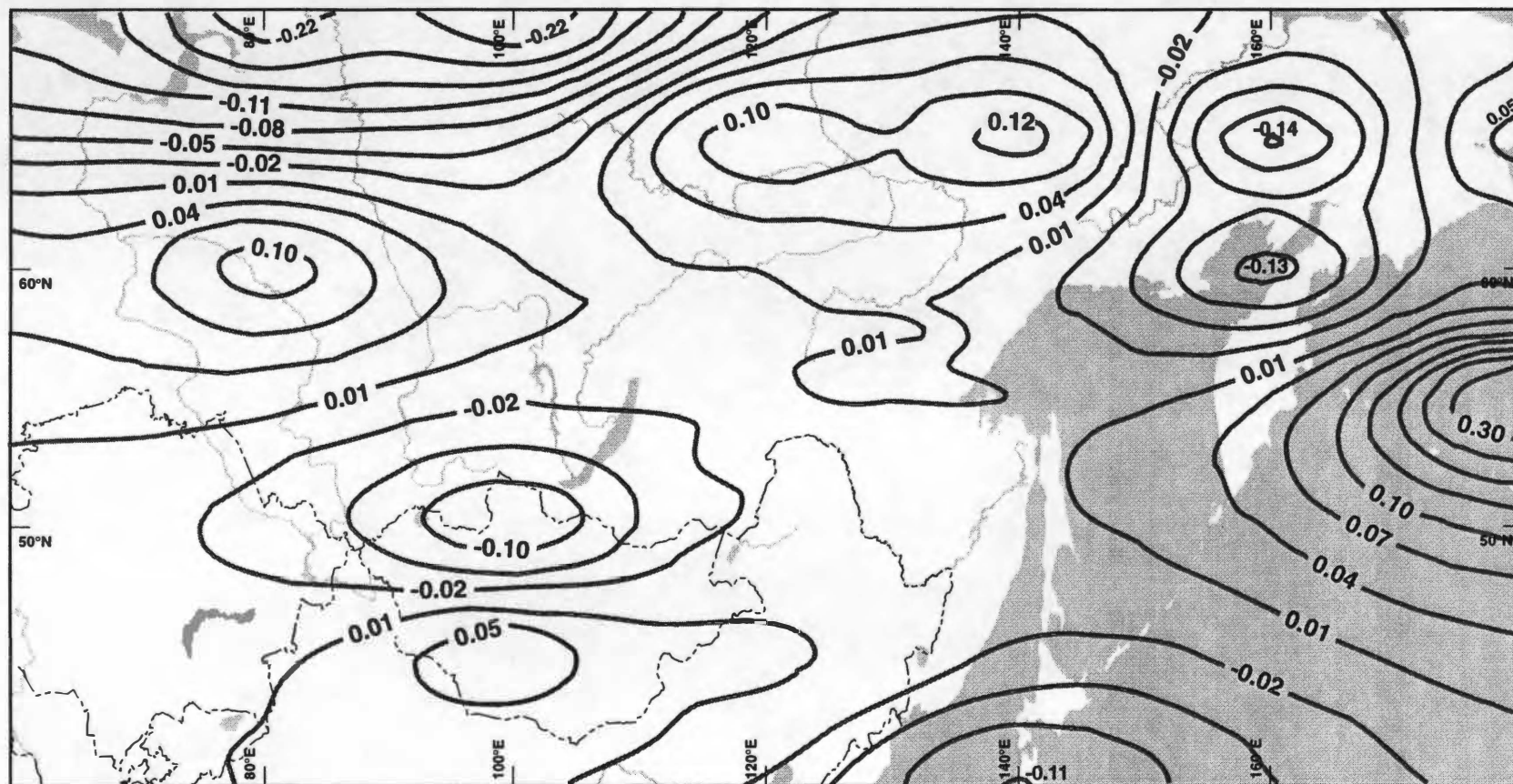


Figure 5.7. Contour Map of Blood Based on the First Principal Component

Table 5.6. Principal Components for Blood

Alleles	PC1	PC2	PC3	PC4	PC5
Rhd	0.351	1.005	-0.310	0.104	-0.017
A	0.198	0.083	0.219	-0.203	-0.161
B	-0.285	-0.343	-0.489	0.362	-0.022
O	0.049	0.178	0.164	-0.102	0.167
hp1	0.709	-0.041	0.286	0.306	-0.004
hp2	-0.700	0.040	-0.284	-0.316	-0.001
M	0.921	-0.227	-0.262	-0.175	0.015
N	-0.925	0.227	0.262	0.179	-0.013

Groups	PC1	PC2	PC3	PC4	PC5
ALUT	0.269	-0.023	0.023	-0.108	-0.022
BERI	-0.000	-0.050	-0.035	-0.047	-0.003
BURY	-0.105	-0.090	-0.034	0.057	-0.007
CMONG	0.057	0.092	-0.122	0.073	-0.025
CYAT	0.096	-0.134	-0.065	-0.020	0.005
EARC	0.054	-0.001	-0.002	-0.038	0.025
EKOMI	0.115	0.048	0.041	0.022	0.026
EMONG	0.014	-0.135	-0.112	-0.026	-0.008
EYAT	0.117	-0.099	0.049	0.028	0.022
KOMI	0.049	0.033	-0.003	0.095	0.038
NDOL	-0.218	0.009	0.121	0.004	-0.012
NJPN	-0.112	0.265	-0.098	-0.088	0.018
NKOMI	-0.112	0.031	-0.040	0.093	-0.024
NYAT	-0.231	-0.007	0.053	-0.050	-0.018
SARC	-0.126	-0.049	0.020	-0.019	0.000
SBERI	0.278	0.128	0.118	0.037	-0.028
WARC	-0.145	-0.017	0.086	-0.014	0.013

northwestern Siberians (i.e. Nganasans and Yeniseys) and the Ainu from southeastern Siberia have low frequencies of Haptoglobin 1 and M blood type. Similar biological patterns of Haptoglobin 1 and M blood with geography are also demonstrated by Cavalli-Sforza et al. (1994).

Figure 5.8, accounting for 23.4% among group variation in PC2, shows the boundary between central and east Siberia. The central Siberians, including the Yakuts, Ulchis, Evenks, Evens, and Buryats, contain lower frequencies of a Rh d blood allele than other Siberians. Distributions in PC2 also approximately match Rh d blood distributions in Asia reported in Cavalli-Sforza et al.(1994). The serological boundary in central Siberia matches a migration pattern in which ancestors of Buryats moved from southern (the Baikal) to northern (Yakutsk) regions of central Siberia, as suggested by Russian researchers (Levin and Potapov, 1956).

c. Finger Ridge Counts: The distance matrix and dendrogram obtained from finger ridge counts (FRC) are shown in Table 5.7 and Figure 5.9, respectively. Northern groups including the NDAT, NDOL, NYAT, and UKOMI are geographically close and cluster together in the dendrogram. Western groups of the NOVO, WBURY, and SKAZA are also geographically close together. In the same way that archaeological artifacts in the Itelmens (NALUT and NKAM) are similar to those in southern Siberia (Levin, 1963), FRC also reflects close relationships

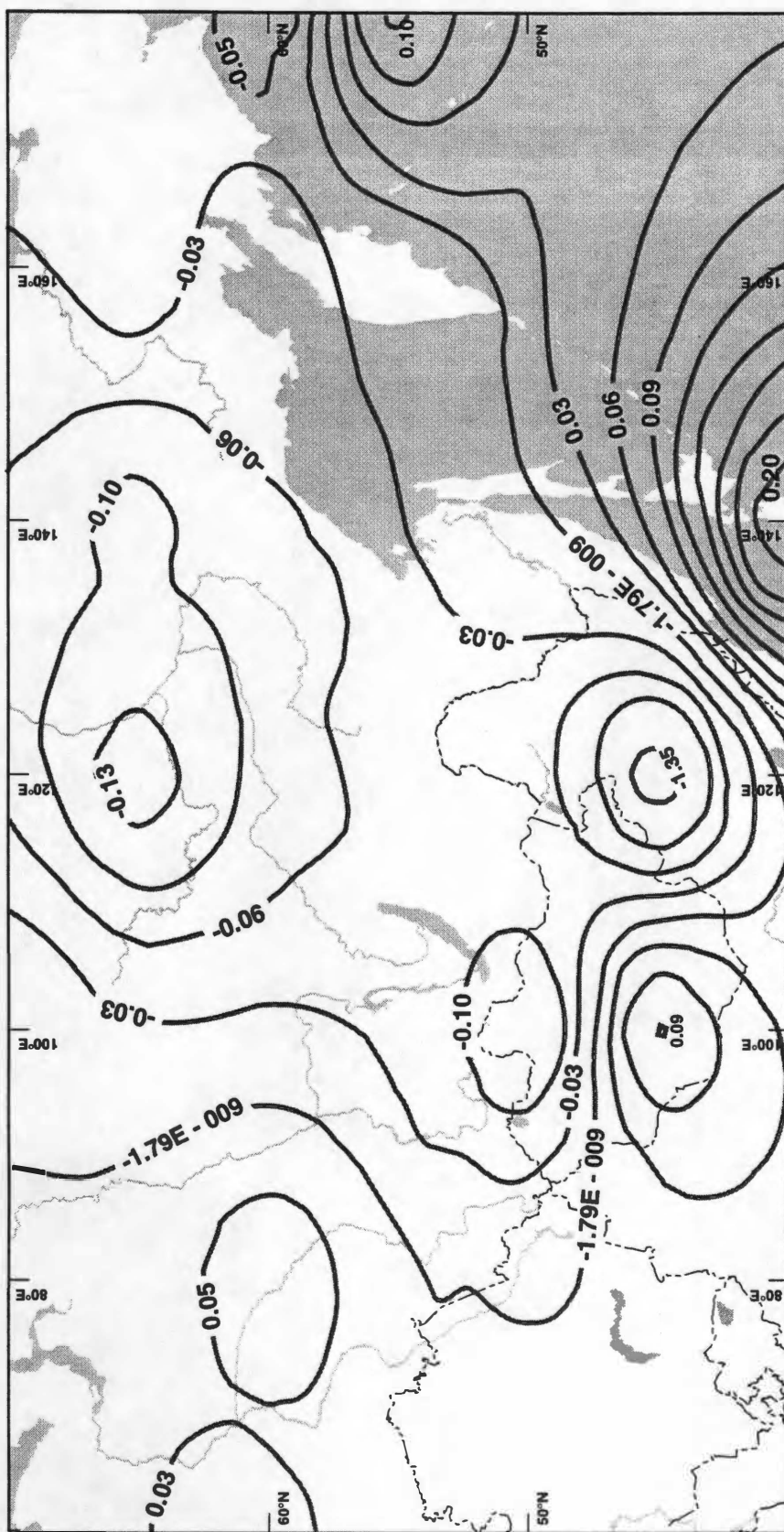


Table 5.7. Distance Matrix from Finger Ridge Counts

ALUT SARC	BURY SKAZA	CMON UKOMI	EARC WBUR	EBUR	EKOM	EMON	KOMI	NALUT	NAMUR	NDAT	NDOL	NJPN	NKAM	NOVO	NYAT
.0000															
1.3001	.0000														
1.7020	.4694	.0000													
1.8744	1.1574	1.0615	.0000												
1.3176	.1772	.1919	.8603	.0000											
.8955	.3716	.5851	.5567	.2321	.0000										
1.3319	.2620	.4850	.5649	.1122	.1253	.0000									
.6396	.3698	.7408	.7140	.3262	.1204	.2064	.0000								
.9661	.4776	.5777	1.0701	.2855	.2315	.4099	.3403	.0000							
1.7111	.9971	.5724	.9548	.4289	.7236	.4831	.8274	.9466	.0000						
1.4344	.2922	.9884	.8009	.5940	.4298	.4502	.3793	.6862	1.5977	.0000					
.7661	.3692	.9623	1.3038	.6519	.4762	.6059	.3607	.6813	1.6325	.4174	.0000				
1.5549	.6032	.7488	1.9791	.4893	.8795	.7698	.9059	.9136	.8993	1.4024	1.3673	.0000			
1.7817	.4899	.5683	1.1351	.2094	.4664	.2430	.6730	.4922	.5089	1.0411	.9596	.9187	.0000		
.6955	.4030	.4523	1.5956	.2851	.5463	.5667	.4406	.3875	.7191	1.0253	.6344	.4339	.6160	.0000	
1.1051	.6445	1.3680	.9163	.8500	.4557	.6008	.3266	.7178	1.7498	.3684	.3587	1.7964	1.1299	1.0997	.0000
1.0388	.2226	.3782	.7078	.1349	.0861	.1188	.1680	.2483	.7159	.3514	.3958	.8373	.4075	.4383	.6014
.0000															
.9541	.3642	.3169	1.3580	.2018	.5163	.4997	.5318	.3615	.5345	.9829	.8140	.4216	.5056	.0886	1.1520
.4376	.0000														
.7099	.5442	.8691	1.1705	.6269	.4476	.5605	.2511	.8201	1.0927	.6154	.4795	1.1414	1.2159	.6105	.6379
.4049	.7059	.0000													
.7808	.2772	.5463	1.7072	.2926	.5193	.5330	.4207	.4466	.8485	.8565	.6104	.3510	.6895	.0759	1.0641
.3968	.1431	.4638	.0000												

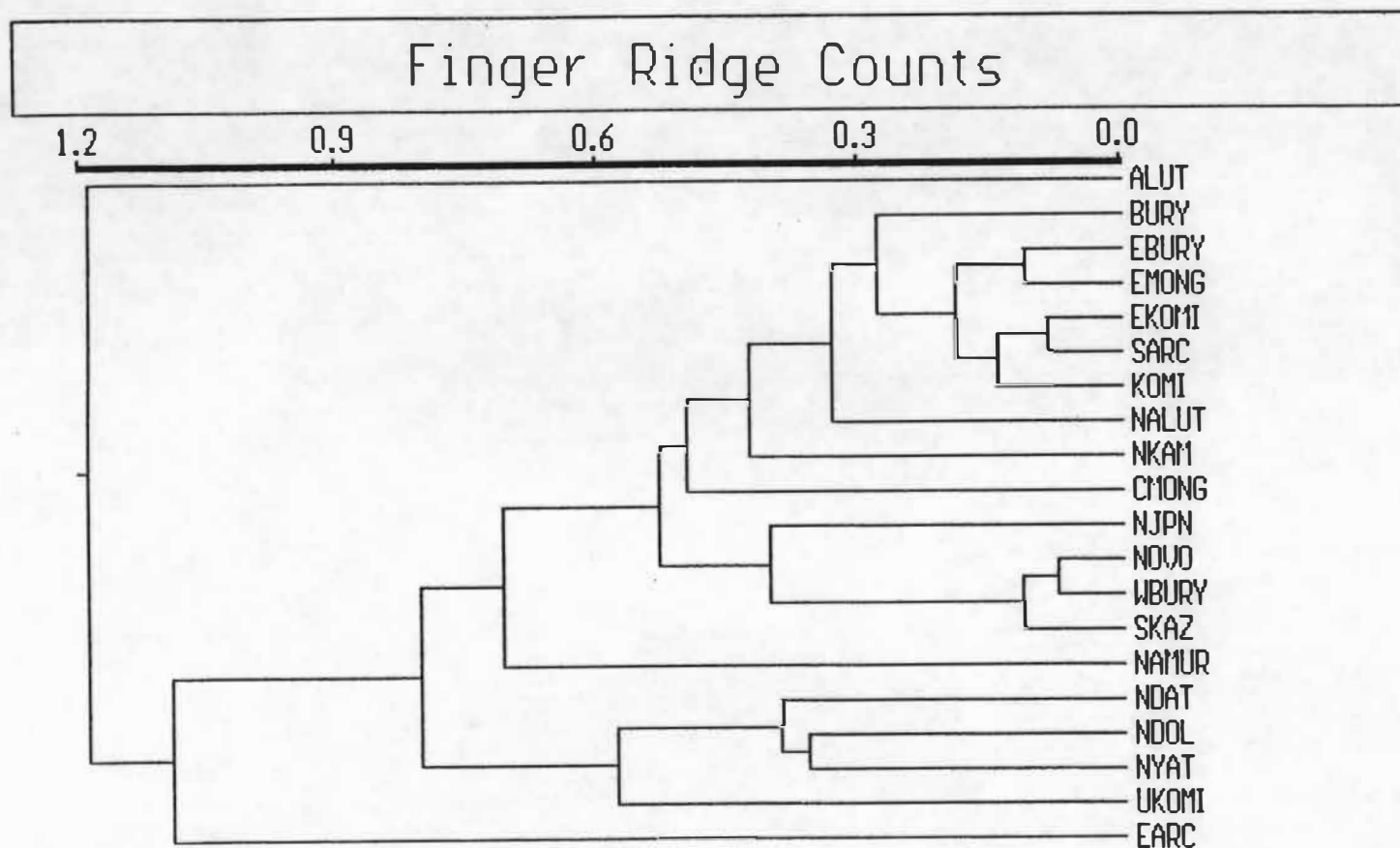


Figure 5.9. Dendrogram Obtained from Finger Ridge Counts

between the NALUT, NKAM, and CMONG.

However, some of the biological relationships using FRC are hard to interpret. For example, the SARC consisting of Koryaks and Evens clusters together with the EKOMI and KOMI, consisting of western Siberians. In addition, the NJPN of the Ainu are closer to western Siberians (NOVOS, WBURY, and SKAZA) than to eastern Siberians. I used a canonical discriminant analysis to determine whether there are further informative biological relationships among populations.

The group canonical scores and between canonical structure coefficient are shown in Table 5.8. Figure 5.10 and 5.11 are the contour maps created from CV1 and CV2 of FRC, respectively. The first CV, accounting for 33.25% of the among group variation, shows gradients from the peak at the north falling to the south, distinguishing between the northern and southern Siberians. Compared to the southern populations, the northern Siberians have higher ridge counts on digits II, III, and IV on both hands. A N-S cline in this study matches the patterns of migration and diffusion of occupancy as suggested by Levin and Potapov (1956). In addition, on the Aleutian Islands (50N°, 160E°) along the Arctic regions, where the tribes of Eskimos and Aleuts are culturally close to each other (Antropova, 1956a; Ruhlen, 1987), also shows the higher ridge counts on digit II, III, and IV.

Figure 5.11, expressing 26.31% among group variation,

Table 5.8. The Group Canonical Scores and Between Canonical Structure Coefficients in Finger Ridge Counts

Group		CAN1	CAN2	CAN3	CAN4	CAN5
ALUT	44	.3636	.6956	.4925	.1100	.0120
BURY	200	.0225	.0567	-.3577	-.0633	-.0157
CMON	56	-.3294	-.1140	-.0607	-.0566	-.4133
EARC	306	.3221	-.6389	.3654	-.0927	-.0520
EBUR	390	-.1955	-.0931	-.0916	.0441	-.0414
EKOM	140	.1742	-.0950	.0919	.0907	.0849
EMON	216	.0152	-.2403	-.0170	.0159	.1179
KOMI	224	.2709	.0701	.1185	-.0087	.1035
NALU	136	.0213	.0687	-.0032	.3718	-.0267
NAMU	228	-.4754	-.2487	.4328	-.0439	-.0018
NDAT	192	.4779	-.1278	-.3113	-.1313	-.0015
NDOL	133	.4573	.2538	-.1904	.0913	-.1602
NJPN	250	-.5167	.2939	-.1306	-.2068	.2985
NKAM	107	-.2735	-.2402	-.0900	.3745	.0630
NOVO	139	-.2292	.4054	.0386	.0970	-.0960
NYAT	91	.6666	-.0195	-.0826	.1334	.0733
SARC	319	.0949	-.0742	-.0491	.0367	-.0788
SKAZ	99	-.3101	.2379	.0390	.0758	-.1238
UKOM	120	.2985	.2523	.1313	-.3293	-.1115
WBUR	352	-.1862	.4300	-.0888	-.0375	-.0028
Eigenvalues			2.2187	1.7554	.9219	.5312
Proportion of trace			.3325	.2631	.1382	.0796
						.3754
						.0563
Digits		CAN1	CAN2	CAN3	CAN4	CAN5
LI		-.027	-.309	-.152	.017	.007
LII		.252	-.062	-.151	.133	.019
LIII		.256	-.085	-.188	.053	-.024
LIV		.239	.050	-.188	-.019	-.062
LV		.009	.064	-.291	.041	-.064
RI		-.036	-.299	-.148	.055	-.028
RII		.234	-.012	-.170	.153	-.021
RIII		.250	-.083	-.208	.007	.025
RIV		.225	.098	-.198	.005	.013
RV		-.034	.077	-.277	.058	.016

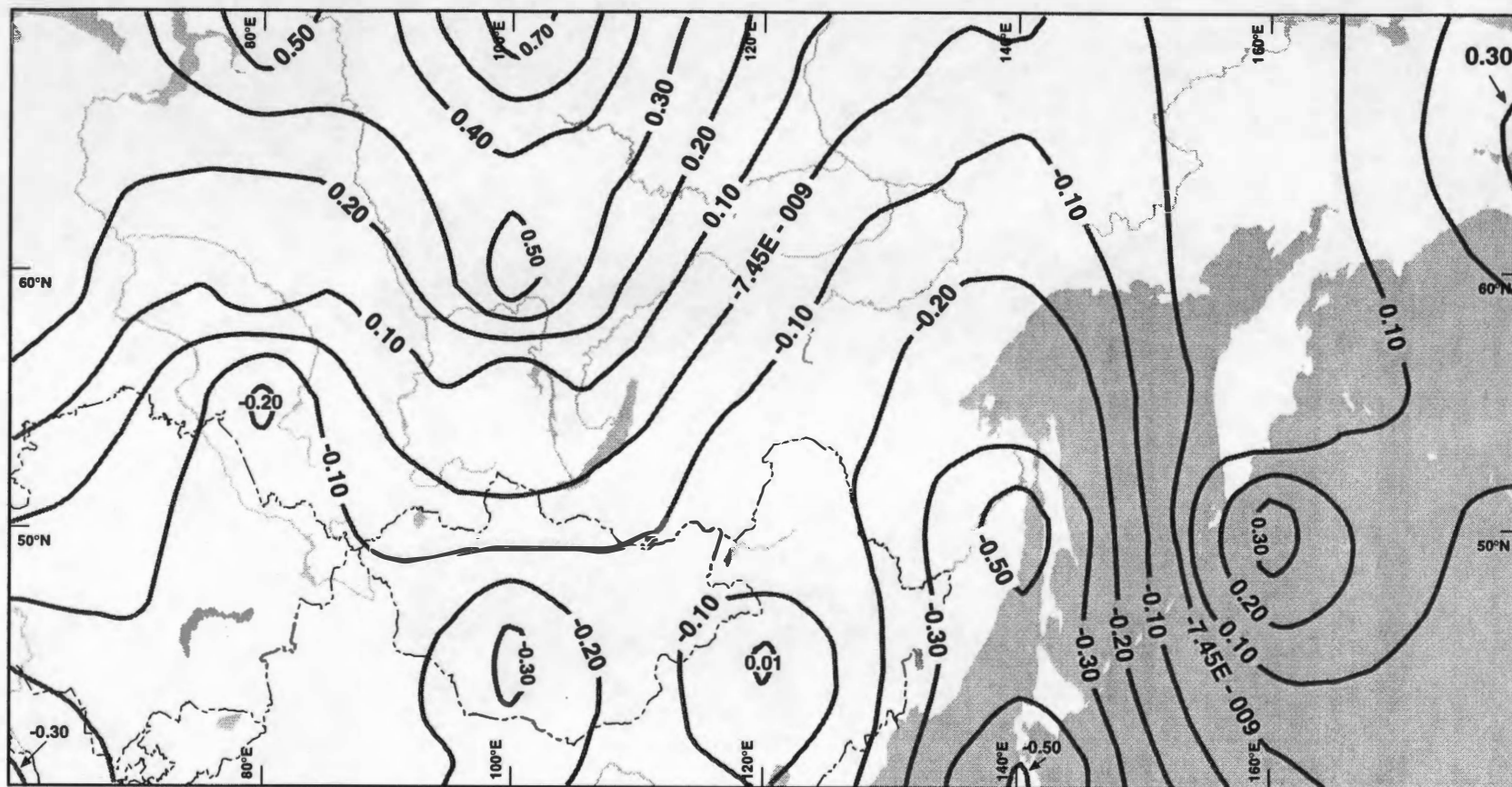


Figure 5.10. Contour Map of Finger Ridge Counts Based on the First Canonical Variate

Figure 5.11. Contour Map of Finger Ridge Counts Based on the Second Canonical Variate

shows less geographic patterning than Figure 5.10. Southwestern Siberian and Aleutian island regions contain higher canonical scores than the rest of the Siberian regions. Western Siberians and Aleuts have lower FRC on digit I in both hands, while East, Arctic, and Central Siberian samples contain higher FRC on digit I (Table 5.8 and Figure 5.11). Unlike CV1, Aleuts in CV2 show a closer relationship with Western Siberians than their neighboring groups.

d. Palm Ridge Counts: Palm ridge counts (PRC) also show some geographical as well as linguistic proximity, although the biological relationships are not as clinally distributed as FRC. Despite the same population samples as FRC, biological relationships between finger and palm ridge counts illustrate quite different pictures. They are not unusual, considering other studies which also show the different biological relationships between fingers and palms of the same samples (Jantz et al. 1992, Jantz and Chopra, 1983).

The distance matrix and dendrogram are shown in Table 5.9 and Figure 5.12, respectively. PRC shows close relationships between southern Siberians who are Mongolian-Tungus speakers (CMONG, EBURY, and EMONG). Turkic speaking people (SKAZA, NOVOS, WBURY, and NDOL) living adjacent to both Mongolian-Tungus (CMONG, EBURY, EMONG, BURY, and NDAT) and Uralic speaking people (KOMI, NYAT) closely relate to both language groups. The groups influenced by European/western cultures

Table 5.9. Matrix Distance from Palm Ridge Counts

	ALUT SARC	BURY SKAZA	CMONG UKOMI	EARC WBURY	EBURY	EKOMI	EMONG	KOMI	NALUT	NAMUR	NDAT	NDOL	NJPN	NKAM	NOVO	NYAT
.0000																
.2677	.0000															
.5372	.1704	.0000														
.2846	.3364	.7487	.0000													
.3051	.0910	.0503	.5273	.0000												
.2619	.6904	.7979	.6014	.5261	.0000											
.5551	.2226	.3283	.6744	.2155	.6148	.0000										
.1007	.2793	.2971	.5559	.1622	.2830	.5192	.0000									
1.3578	.5707	.6841	1.3743	.7700	1.7785	.4809	1.2980	.0000								
.3877	.5056	.6284	.4413	.3861	.1469	.3213	.4313	1.4068	.0000							
.6216	.1234	.1673	.8299	.1603	1.0320	.1704	.5002	.3470	.7644	.0000						
.4946	.1515	.2087	.5865	.2277	1.1578	.6763	.4130	.8561	1.0184	.3103	.0000					
.3872	.2573	.2364	.4729	.1079	.3844	.2350	.2933	1.1376	.1542	.4000	.5326	.0000				
1.7954	1.0698	1.0913	1.7318	.9916	1.6144	.3940	1.6947	.9373	.9295	.7530	1.7652	.8137	.0000			
.1649	.4134	.4350	.8002	.2914	.4283	.7119	.0390	1.4742	.6807	.6077	.5016	.5055	2.0163	.0000		
.2127	.2286	.2545	.5665	.1952	.6899	.7189	.1086	1.2445	.7894	.4644	.1486	.4536	2.0246	.1318	.0000	
.4512	.1015	.1671	.6857	.1069	.7051	.0723	.3617	.3841	.4991	.0435	.3739	.2727	.6791	.4817	.4327	
.0000																
.1566	.1161	.1915	.5348	.1120	.5413	.4101	.0791	.8422	.6009	.2567	.1964	.3630	1.5413	.1120	.0681	
.1962	.0000															
.4971	.0641	.2521	.5775	.2000	.9966	.2412	.4985	.3515	.7412	.0873	.2090	.4345	.9680	.6198	.4105	
.0904	.2291	.0000														
.4189	.0649	.0750	.6214	.0663	.7378	.1622	.2987	.4133	.5677	.0478	.2307	.2811	.9100	.4197	.2929	
.0364	.1291	.0979	.0000													

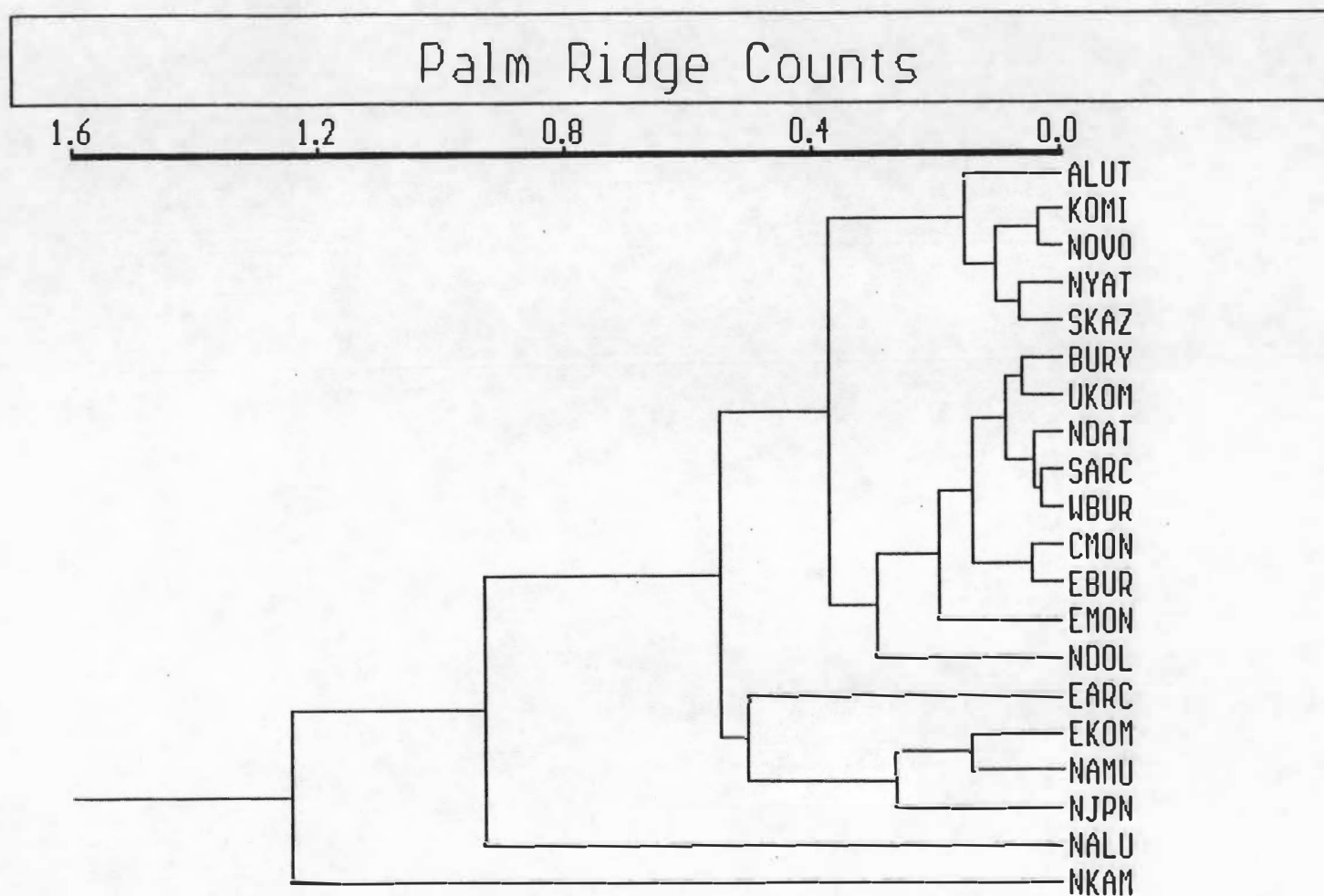


Figure 5.12. Dendrogram Obtained from Palm Ridge Counts

(KOMI, NOVO, ALUT, and SKAZA) are closely related to one another. The NDAT and SARC which contain geographically widespread Evenks cluster together.

The Itelmen (NKAM, NALUT), clustering with both Southern and Eastern Siberian groups, reflect the archaeological and cultural connections between these groups (Dikov, 1965; Levin, 1963). Furthermore, the Ainu (NJPN) are biologically close to the Nivkhis (NAMUR) as well as Kets (EKOMI) and Selkups (EKOMI). Although reasons of closeness between Ainus, Nivkhis, Kets, and Selkups are not clear, they may be associated with common lifestyles (i.e. hunters, fishermen, or secondary fishermen; Levin and Potapov, 1956) and isolated languages (i.e. Nivkhis and Kets; Ruhlen, 1987).

Table 5.10 shows the group canonical scores and between canonical structure coefficients in PRC. Figure 5.13 and 5.14 are contour maps based on CV1 and CV2 scores, respectively. CV1, accounting for 47.31% among group variation, illustrates the peak at the west (NOVOS = 55N°, 80E°), decreasing in a gradient toward the east (Figure 5.14). Western Siberians, in general, have higher a-b ridge counts in both hands than Eastern populations (Table 5.10). In addition, a strong separation exists made between north and south in the NALUT (140E°, 55N°), ALUT (55N°, 140-160E°), and NKAM (140E°, 50N°) regions. As seen in the cluster analysis, such a dichotomy reflects the archaeological and linguistic differentiations between north and south suggested by Levin and Potapov (1956)

Table 5.10. The Group Canonical Scores and Between Canonical Structure Coefficients in Palm Ridge Counts

Group	N	CAN1	CAN2	CAN3	CAN4	
ALUT	45	.4069	.0814	.0939	.1429	
BURY	207	-.0300	-.1257	.1300	-.0293	
CMON	60	-.0588	-.1581	-.1664	-.1952	
EARC	330	.2565	.1527	.5438	-.0552	
EBUR	411	.0162	-.0239	-.1101	-.1368	
EKOM	147	.3845	.5098	-.0788	.1791	
EMON	227	-.3109	.2000	-.0310	.0766	
KOMI	268	.3684	.0154	-.1727	.0413	
NALU	140	-.6433	-.3090	.1024	.3006	
NAMU	242	.0918	.5577	.0549	-.0207	
NDAT	201	-.2901	-.1927	-.0884	-.0122	
NDOL	167	.1026	-.4305	.1080	-.2076	
NJPN	85	.0211	.2748	-.0518	-.2570	
NKAM	96	-.8333	.4737	-.1060	-.1090	
NOVO	139	.4437	-.0791	-.2752	.1162	
NYAT	94	.3745	-.2694	-.0659	-.0848	
SARC	331	-.2204	-.0423	-.0862	.0707	
SKAZ	280	.1981	-.1836	-.0850	.0850	
UKOM	134	-.2050	-.2244	.1226	.0304	
WBUR	357	-.1379	-.1438	-.0656	.0109	
Eigenvalues			2.3139	1.4856	.5592	.3667
Proportion of trace			.4731	.3037	.1143	.0750
Palm ridges		CAN1	CAN2	CAN3	CAN4	
Lc-d		.156	-.032	.226	-.061	
Lb-c		.190	.245	.052	-.010	
La-b		.365	-.049	-.005	.009	
Ra-b		.355	-.013	-.006	-.048	
Rb-c		.177	.269	.043	.025	
Rc-d		.162	-.135	.229	.055	

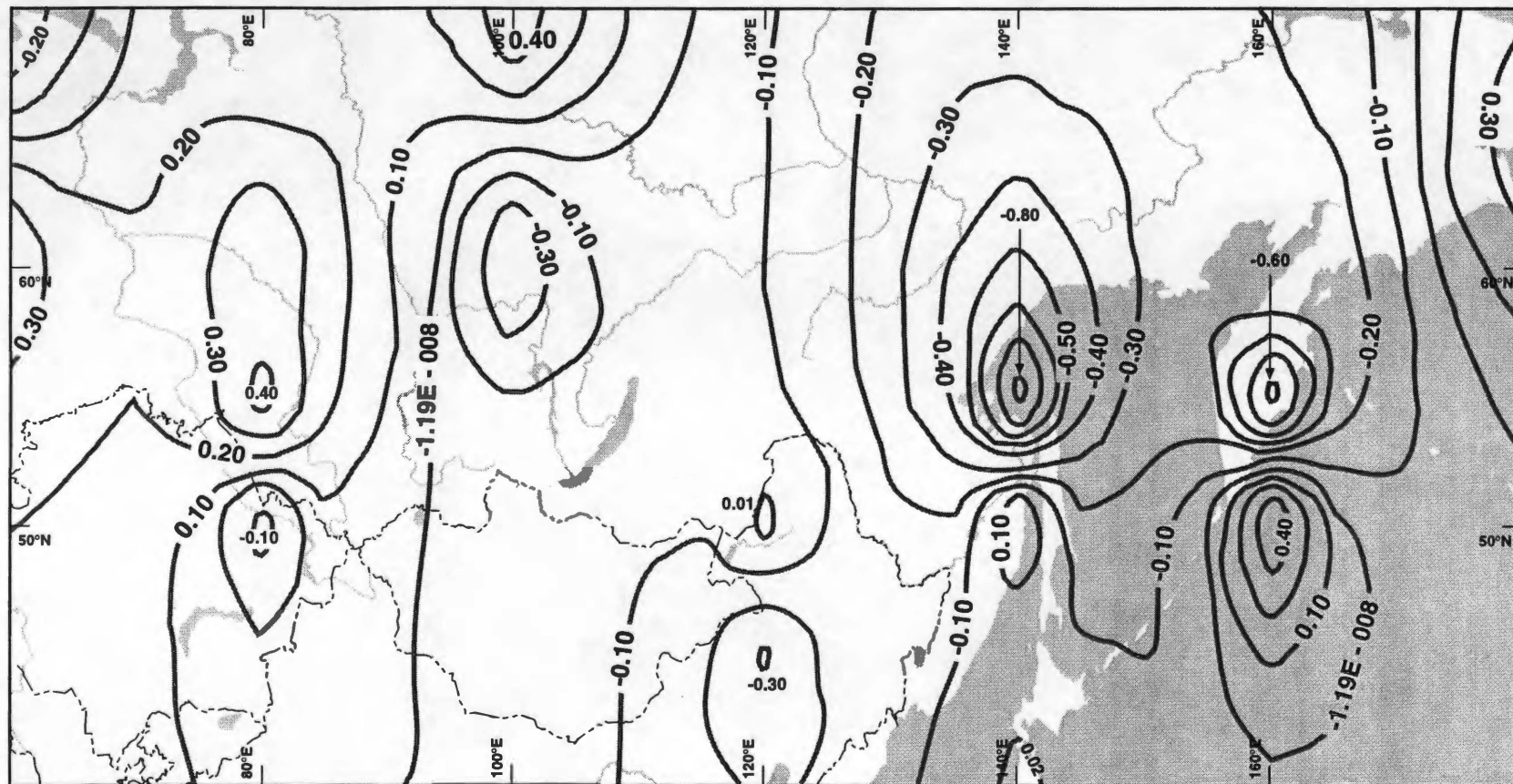


Figure 5.13. Contour Map of Palm Ridge Counts Based on the First Canonical Variate

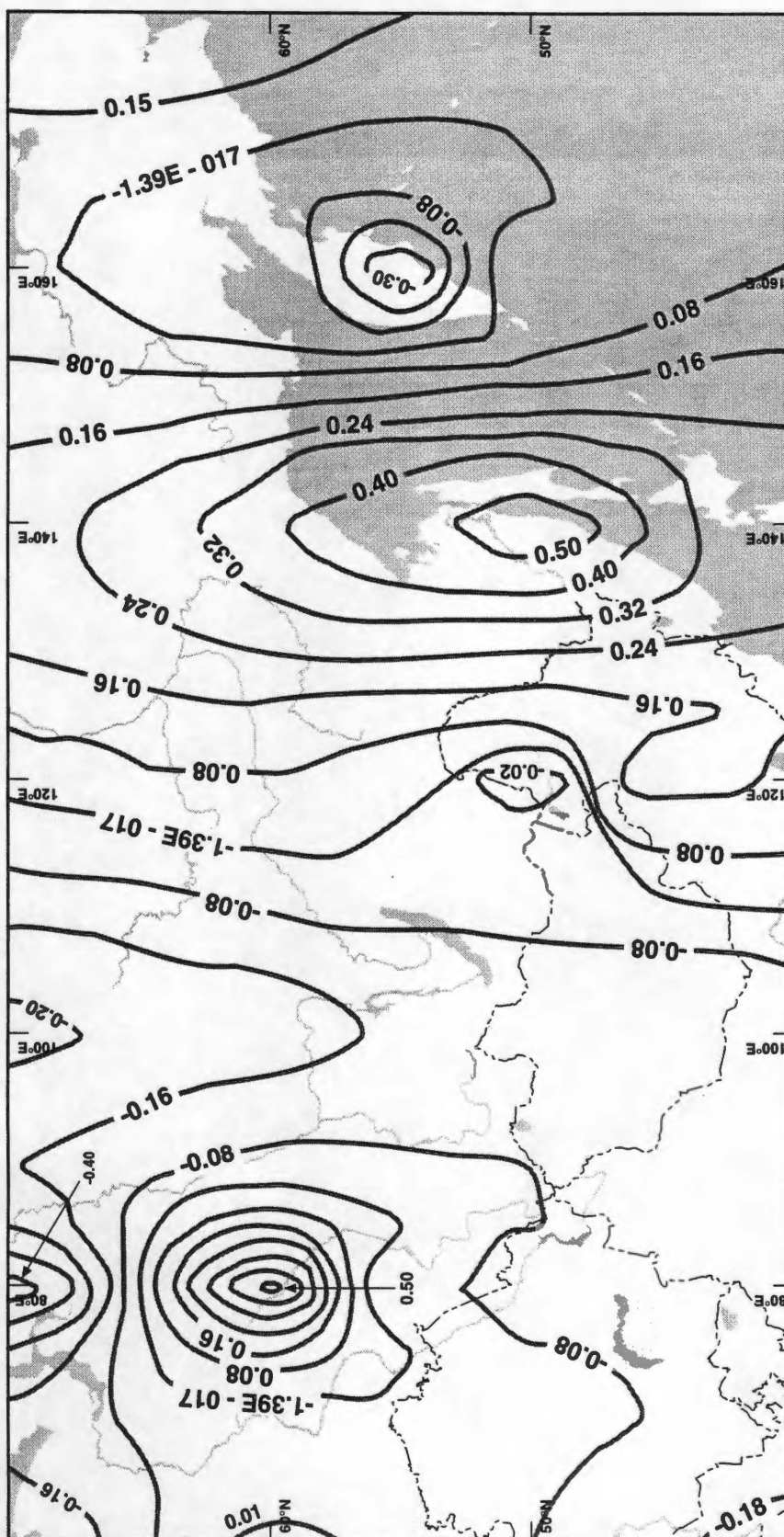


Figure 5.14. Contour Map of Palm Ridge Counts Based on the Second Canonical Variate

and Levin (1963). Furthermore, like FRC, PRC in Aleuts are similar to western Siberians, corroborating the supposition of admixture between western populations and Aleuts in history (Antropova, 1956a; Black and Liapunova, 1988).

Figure 5.14 is the map of CV2 accounting for 30.37% among group variation. It roughly shows the peak around the Sakhalin Island and Maritime area (140°E), roughly decreasing gradients towards east-west and north-south. Another peak exists around the Ob river regions (80°E). The peaks indicate that the people around these regions (i.e. Kets and Nivkhis), known as isolated language speakers and traditional hunters and fishermen, have higher b-c ridge counts in both hands than people from any other regions (Table 5.10).

Correlation between Geographical and Biological Distances

Matrix comparisons between geography, craniometrics, blood, finger and palm prints were examined with the Mantel Z-test. Table 5.11 is the summary of correlation matrices between them. Except for finger ridge counts, biological data sets show poor correlations with geography.

The correlation between geography and craniometrics ($r = -0.14$; $p = 0.25$) is low (Table, 5.11), despite an east-west relationship in craniometric results. The serological result also shows a poor correlation with geography ($r = 0.09$; $p = 0.17$). Despite independent biological data sets, relationships between crania and blood ($r = 0.71$; $p = 0.01$) as

Table 5.11. Matrix Comparisons between Geography, Crania, Blood, Fingers and Palms.

	Geography	Crania	Blood	Fingers	Palms
Geography	1.00				
Crania	-0.14	1.00			
Blood	0.09	0.71**	1.00		
Fingers	0.17**	0.46*	0.42**	1.00	
Palms	0.01	-0.21	0.001	0.18	1.00

** indicates at a significant level of $p = 0.05$

* indicates at a significant level of $p = 0.1$

well as between crania and fingers ($r = 0.46$; $p = 0.10$), show strong and moderate significant correlations, respectively. (Table 5.11).

Geographical clinal patterning in finger ridge counts reflects a significant correlation between geography and finger ridge counts ($r = 0.17$; $p = 0.04$) (Table 5.11). A significant correlation is also shown between fingers and blood ($r = 0.42$; $p = 0.03$), as a result of common N-S patterning between them. However, despite containing almost the same populations, fingers are poorly related to palms ($r = 0.18$, $p = 0.12$), which is not unexpected, compared to other studies (Jantz, et al., 1992; Jantz and Chopra, 1983). This low correlation also reflects different population structures between fingers and palms (see Population structure section in this Chapter).

As in crania, palm ridge counts also shows rough E-W clines. However, strong separation of palms between north and south around the Upper Amur and Kamchatka regions drastically decreases a correlation with geography ($r = 0.01$; $p = 0.42$) (Table 5.11). Palms also poorly correlate to the rest of the biological data sets.

CHAPTER VI

DISCUSSION

Biological Variation in Siberia (F_{st})

a) Craniometrics: F_{st} of craniometrics in this study show a high variation among Siberians, which parallels to Ousley's (1995) anthropometric study (minimum F_{st} = 0.12). However, craniometric variation estimated from worldwide regions shows less differentiation than that from Siberia. Relethford (1994) demonstrated that minimum F_{st} in craniometrics calculated from worldwide regions (Europe, Sub-Saharan Africa, Australasia, Polynesia, America, and Far East) was lower ($=0.085$) than in this study.

One of the reasons for high cranial differentiation in Siberia may be associated with the selection of measurements. When I tested worldwide cranial variation based on 11 measurements taken from Howells' data, the F_{st} ($= 0.129$) was higher than that of Relethford's results using 57 measurements (Yokota, 1997). Therefore, it is clear that the number of measurements affect cranial variation. In addition, environmental influences, selection, and/or genetic drift (along with gene flow) are considered for high cranial differentiation.

Pietrusewsky (1990), using Australia and Pacific populations, found that craniofacial variation, which

maintained homogeneity in his samples, was clinal between north and south. He suggested that such cranial differentiation was due to gene flow in restricted geography of Australia and Oceanic regions. Relethford (1991) demonstrated that anthropometric variation among Irish population was primarily differentiated by genetic drift. Sokal and Uytterschaut (1987), examining cranial variation in European populations, concluded that it is patterned by migration, expansion, and gene flow instead of selection. As in the Pietrusewsky's (1990) and Sokal and Uytterschaut's (1987) studies, this study also shows rough clinal patterns of biological data, which implies migrations along Siberian history and cultural diffusions. However, compared to low dermatoglyphic and blood variation demonstrated in this study, it is hard to accept that crania became differentiated solely by genetic drift.

Cranial size and shape variation has been demonstrated as associated with climate differences and their responses to thermoregulation (Beals, et al., 1984; Beals et al., 1983). In addition, McHenry and Giles (1971), studying heritabilities and population structures based on Melanesian anthropometrics, concluded that differentiations among tribes occurred due to both environmental and genetic effects. Therefore, it is probable that cranial variation in this study is also differentiated by environment.

Furthermore, selection is a possible mechanism for

genetic differentiation in crania because phenotypic covariance between groups generally increases as an effect of selection (Falconer, 1989). Long term selection is hard to detect because 1) mutation, which also may change variation, is difficult to separate from selection, and 2) selection to which individual genes contribute can't easily be defined by observation (Falconer, 1989). Yet, Chai (1967), investigating quantitative variation, i.e., anthropometrics, blood pressure, dermatoglyphics, and intelligence, among Taiwanese aborigines, indicated that differentiation in anthropometrics possibly resulted from natural selection along with genetic drift and different environment such as high vs low altitude. Thus, interacting with various Siberian population forces (i.e. gene flow and genetic drift, and combination of these) as well as environmental influences, selection is also possibly involved in Siberian cranial differentiation.

Because phenotypic covariance matrices have been shown to be proportional to additive genetic variance-covariance matrices (Königsberg and Ousley, 1995), the craniometric results from this study should accurately reflect the pattern of genetic differentiations, though the degree of differentiation should be more understood. However, selection and environmental influences are possible elements in describing high variation of crania in this study.

b) Blood: Serological variation among Siberians in this

study is low, which is similar to the blood variation in Siberia provided by Crawford and Enciso ($R_{st} = 0.047$) (1982). The blood variation in Siberia was lower than blood F_{st} s from worldwide regions ($F_{st} = 0.099 - 0.114$) demonstrated by other studies (Cavalli-Sforza et al., 1994; Livshits and Nei, 1990; Nei and Roychoudhury, 1982; Ryman et al., 1983). The low genetic variations may have occurred due to 1) limited blood markers available in this study, 2) nature or function, i.e., selection, of the blood systems which are used in this study, and/or 3) less diverse populations examined in this study.

Ryman et al. (1983) compared genetic variations among worldwide populations estimated from different numbers of loci. They showed that the genetic diversity of worldwide populations was relatively constant with different numbers of loci. However, other studies showed that genetic variations were sensitive to different types of blood systems (Cavalli-Sforza et al., 1994; Friedlaender, 1975). An ABO blood study from Cavalli-Sforza et al. (1994) shows relatively low F_{st} in worldwide regions, while the Duffy system seems to have "disruptive selection," differentiating between populations. Friedlaender (1975), analyzing blood markers in Melanesian populations, found that clinal distributions were seen in immunoglobulin, while ABO, MN, and Hp blood markers showed random patterns. He indicated that nonclinal patterning might have caused by selection, based on Morton et al. (1966) and Workman et al. (1963) studies in which some blood markers such

as ABO, MN, and Hp tend to maintain homogeneity in certain environments. Although how different blood systems exactly react to one another for genetic variation was unclear, limited blood markers (ABO, MN, Hp, and Rh d) used in this study and their functions in Siberian environment may have reduced genetic variation and provided homogeneity among Siberian populations.

Another reason for low blood variation among Siberians is similarities of populations. Many studies agree that as more heterogenous populations or diverse populations are involved, greater genetic diversity is observed. Cavalli-Sforza et al. (1994), Crawford and Enciso (1982), and Livshits and Nei (1990) demonstrated that, in general, among subregional or homogenous populations contain fewer variation than among worldwide or heterogenous populations. Therefore, genetic variation of blood is generally sensitive to diversity of population samples. In the same way, Siberian samples in this study also could have reduced variation because of the similar subregional populations.

c) Dermatoglyphics: Low dermatoglyphic variation among Siberian groups is observed in this study, which is consistent with results in other studies (Jantz et al., 1993 and Jantz, 1997). Jantz et al. (1993), using Lapp samples, demonstrated that Fsts were consistently low ($= 0.01 - 0.02$) in 20 ulnar and radial finger ridge counts (FRC), 10 FRC with the larger

of the radial or ulnar counts, and palm ridge counts (PRC). They also showed that high correlations exist between symmetrical finger digits (i.e. RI vs LI, RII vs LII, etc.) and palm digits (i.e. R c-d vs L c-d, R a-b vs L a-b, etc.).

In addition, dermatoglyphics are considered to be polygenic inheritance (Froehlich and Giles, 1981; Gilligan et al., 1985; Karlin, et al., 1983). As Froehlich and Giles (1981) show, dermatoglyphic traits involving polygenes are less differentiated among populations by genetic drift and environmental effects than blood and other quantitative traits. Such neutral polygenic characters of dermatoglyphics are also supported by Blangero (1988) in which he investigated covariance matrix between groups (migration matrix model) and variance matrix between groups (genetic drift model) in Nepalese populations. Therefore, it is possible that dermatoglyphic variation among Siberian groups is less differentiated due to the same reason.

Furthermore, formation of dermal ridges is completed during 17th fetal week (Babler, 1978; Cummins and Midlo, 1961) and less environmental effect is present, compared to other quantitative traits. Therefore, high correlations between variables, the selective neutrality of dermatoglyphic traits, and less environmental effect may have caused low dermatoglyphic variations among populations.

Siberian Population Relationships

Different biological data sets show common as well as different results of Siberian biological relationships. Overall, this study shows the following features of Siberian biological relationships.

a) Common biological relationships among different biological data sets

Overall, all biological data sets agree in showing that Siberian populations are mainly patterned regionally and/or linguistically. Southern Siberians who are Altaic speakers are close to one another in craniometrics, while FRC counts show that western Siberians are proximate to one another. Serological results show that regions containing the same ethnic groups, i.e., Chukchis, Eskimos, Nganasans, and Evenks, cluster together. PRC demonstrate that Turkic speaking people living adjacent to Mongolian-Tungus and Uralic speaking populations are closely related to both language groups.

Another common result among different types of biological data is that Aleuts from East Siberia are either away from the rest of Siberians or close to western Siberians who are influenced by Europeans. As I mentioned in Chapter II, the Aleuts have been heavily assimilated with the Russians since the early 1900s. The secular changes of the Aleut crania influenced by Europeans are mentioned by Harper (1975) and Szathmary (1979b). Also, researchers suggest a possible

connection between Aleuts and Northwest Amerindians based on biological analyses, archaeological artifacts, and cultural observations (Dumond, 1987; Ousley, 1995; Szathmary and Ossenberg, 1978). Although this study did not investigate the relationships between Siberians and people in the New World, such heterogenous culture and biological relationships in the Aleut certainly reflect the isolation among Siberians as well as close relationships with European influenced populations.

b) Different biological relationships among different biological data sets

Beside common biological relationships, different biological data sets which consist of different heritabilities, biological forces, and population samples, also provide different results and reflect different pieces of Siberian culture and history.

i) Crania: The distant Siberian tribes such as the EARC (Chukchis, Eskimos, and Evenks) are closer to the southern Siberians from the Baikal and Mongolia areas than to their neighboring groups including the ALUT (Aleuts) and WARC (Yukagirs). A north-south connection is also described in blood and FRC, which matches the historical connection between south and north in Siberia (Levin and Potapov, 1956). In addition, the craniometrics from prehistoric sites support Siberian dispersion from south to north. The Ekvens, whose

Neolithic sites are inhabited by contemporary Eskimos in Arctic regions, are isolated from other Siberian tribes, while the contemporary Eskimos are close to modern and Neolithic southern/eastern Siberians.

Such results are supported by archaeological evidence (Ackerman, 1982; King and Slobodin, 1996) and other biological studies (Ishida, 1993; Ousley, 1995). Recently, King and Slobodin (1996) indicate the connection between Pleistocene peoples in the Arctic Siberia and the New World by providing fluted points commonly found in Alaskan sites as well as the Uptar site, the inland site in the northeast Siberia dated around the end of the Pleistocene period. Ackerman (1982) also showed common artifacts from the Neolithic periods, i.e., cord marked and impressed pottery, that were found between the Alaskan coast and Arctic Siberian regions. Based on the archaeological evidence, the Ekven culture in the Neolithic period was more closely related to people in the New World, through Alaska. Furthermore, Ishida (1993), in his nonmetric cranial study, showed that the Ekvens were close to Canadian Eskimos and separated from Asian Eskimos, although he didn't interpret the relationships between Canadian Eskimos, Ekvens, and Siberian Eskimos. Therefore, this study suggests that the origin of Eskimos in Siberia may be recent in Asia and that Siberians may have spread from south to East Arctic regions by replacing Neolithic Arctic Siberians (OEARC), who had been associated with people in the New World.

Besides a connection between southern Siberians and distant Siberian tribes, craniometrics further demonstrate east and west influences around the Lake Baikal regions as well as chronological change in biological relationships among Siberians. As shown in Chapter V, the contour map of crania with archaeological samples illustrates that the Lake Baikal and Mongolia regions are more influenced from the east (Asia) than the west (Europe). The craniometric analyses with archaeological samples show agreement with the Asiatic connection theory previously provided by the majority of Russian researchers (Levin and Potapov, 1956; Tokarev, 1962). Therefore, it is probable that the ancestors of Buryats, who have been living in the Baikal regions, were more connected to Asians rather than Europeans.

Unlike cranial results without archaeological samples, maps of craniometrics without prehistoric samples in Chapter V illustrate west to east clinal distribution. Although few Bronze Age skeletal descriptions from the Baikal regions were made, such contemporary cranial results match the time after the metal culture was introduced: from the Bronze Age in the Lake Baikal and Mongolia regions to the 17th century when Russians intruded into Northern and Arctic Siberia (Levin and Potapov, 1956). In addition, after the Bronze Age, the Turkic speaking populations as well as Mongol tribes alternately spread their powers through Central and Southern Siberia until the 1st Millennium A.D. (Tokarev, 1962). Therefore, due to

geography as well as adjacent culture to the east (Asia) and west (Europe) in the Baikal/Mongolian regions, the biological connections between people from these regions also reflect both west and east influences. A rough east-west clinal distribution is also demonstrated in PRC.

ii) Blood: Like craniometrics and FRC, serological results show the connection between north and south in Siberia. Particularly, serological boundary in the central Siberia shown in serological contour maps is associated with a migration pattern in which ancestors of contemporary Siberian populations in Central Siberia were originated in southern (the Baikal) regions and moved to northern (Yakutsk) regions of central Siberia, as mentioned in Chapter II and III.

iii) Finger Ridge Counts: A clear north-south clinal distribution exists in the contour map based on the first canonical variate. High correlations between dermatoglyphics and geography are also demonstrated in African studies (Jantz and Hawkinson, 1979; Rosa, 1985). While Rosa (1985) indicated that clinal patterns in dermatoglyphics are possibly related to climates, the N-S cline of FRC in this study indicates migration patterns of Siberians from south to north rather than climatic reasons because north-south serological connections also exist in central Siberia.

As in a part of cranial results, the contour map based on the second canonical variate shows the rough W-E distribution, which matches the diffusion of Bronze cultures (Levin and Potapov, 1956).

The contour maps also show that the Aleuts are close to Eskimos and to western Siberians influenced from European populations. A traditional connection between Aleuts and Eskimos is linguistically and anthropologically supported by some researchers (Laughlin et al. 1979; Ruhlen, 1987; Spuhler, 1972). In addition, because Russians brought strong biological and cultural influences on western Siberians and Aleuts (Fitzhugh and Crowell, 1988; Levin and Potapov, 1956), a connection between western Siberians and Aleuts is also probable. As Froelich and Giles suggested, dermatoglyphics, which are polygenic, reflect long evolutionary history of population structure compared to serological data which are likely to be influenced by recent gene flow. The dermatoglyphics of this study also confirms long term evolutionary relationships in Aleuts including early cultural contacts with Eskimos, as well as later cultural and political influences by European populations.

Furthermore, FRC illustrate that distant Siberians (NALUT, NKAM) from the Kamchatka Peninsula are closer to southern Siberians (CMONG) than to their neighbors' tribes. Such Kamchatka-Southern biological relationships are supported by the similar archaeological artifacts found in both the

Itelmen sites (NALUT, NKAM) and southern Siberia (Levin, 1963).

iv) Palm Ridge Counts: PRC also demonstrate different pieces of Siberian history. The dermatoglyphic separation between the north and south in northeast Siberia, as seen in the NALUT (140E°, 55N°) and NKAM (140E°, 50N°) regions, matches the archaeological and cultural dichotomy between these regions. Although the origins of the Itelmen who live in the NALUT and NKAM areas are not certain, the peninsula is archaeologically and linguistically differentiated between these regions (Levin and Potapov, 1956; Levin, 1963). Although people around these regions speak the same Chukchi-Kamchatkan languages (Ruhlen, 1987), Levin and Potapov (1956) state that the languages are very different between south and north on the Kamchatka. In addition, the southern part of the Kamchatka peninsula was culturally and archaeologically influenced from the Sakhalin, Kurile, and Hokkaido Ainu, while the northern part of the Peninsula is closely related to northern Siberians of Koryaks (Levin, 1963). The Itelmens' relationships with the Ainu as well as Southern Siberian groups shown with FRC are also supported by the cluster analysis. Therefore, the cultural separation reflects biological differences on the Kamchatka peninsula.

c) The Ainu's biological relationships in Siberia

The relationships between the Ainu and other Siberian populations vary by different types of biological data. FRC in the Ainu are close to that in western Siberians with European influences, while PRC shows the closeness between the Ainu and their neighboring groups. Geographical proximity between the Hokkaido Ainu (NJPN), the Sakhalin (SAMUR) Ainu, and the Amur Siberian groups (SAMUR, EMONG, EBURY) is shown in their cranial distance matrices. The Ainu's cranial distance matrix also shows closeness to the archaeological samples including Neolithic Baikal (OCMONG) and Tagar (ONBURY) samples. Such various results of the Ainu relationships are not exceptional because researchers speculate the origin of the Ainu with various ethnic groups including prehistoric Jomons in Japan (Brace and Nagai, 1982; Hanihara, 1992; Howells, 1966; Yamaguchi, 1963), Europeans (Matsumoto and Miyazaki, 1982; Levin, 1963; Simmons et al., 1953), East Asians (Kimura, 1962; Nei and Roychoudhury, 1982; Omoto, 1972), Siberian connections (Eriksson et al., 1977; Schanfield, 1992), and Oceanic groups (Turner and Hanihara, 1977).

Although Ainu origins are still under investigation, Yokota (1994) and Yokota et al. (n.d.) showed that the Ainu in dermatoglyphics, craniometrics, and anthropometrics had generalized relationships with prehistoric populations, East Asians, Oceanics, Europeans, and Siberians, testing hypotheses

provided by researchers in their previous studies. Similarly, various relationships of the Ainu with different regions of Siberians are shown in this study.

d) The origin of Siberians

Based on craniometric results, Siberian origins are more closely related to the Baikal/Mongolia regions with Asiatic connections than any other places. Archaeological data available in this study are very few and they are mainly from Mongolia/Lake Baikal regions, which may have provided bias toward origins of Siberians connected to Mongolian regions. However, based on the reasons including 1) so far, Paleolithic and early Neolithic sites are mainly scattered in Baikal/Mongolian regions (Chapter III), 2) archaeological crania in this study shows closeness with contemporary Eastern Siberian crania, which are strongly influenced by Chinese in history (Levin and Potapov, 1956; McNeill, 1979; Spuler, 1972), and 3) distant contemporary Siberians such as Eskimos and Itelmens in this study are close to contemporary populations from Baikal/Mongolia regions, it is legitimate that at least origins of contemporary Central, East, and Arctic Siberians are more related to the Baikal/Mongolia regions with Asiatic influences, than any other places.

e) Summary of Siberian population relationships

Overall, biological data sets show that Siberian

populations are mainly patterned linguistically and/or regionally. For instance, Southern Siberians who are Altaic speakers are close to one another in craniometrics, while FRC show that western Siberians are proximate to one another. In addition, all biological data sets show that Aleuts are separated from the rest of Siberian groups, indicating the assimilation between Aleuts and non-Siberian populations, i.e., Russians and people in the New World.

Beside such common results among biological data sets, this study, utilizing different biological data sets, provides main three forces for population structures in Siberia. One is a N-S connection shown in cranial, serological, and FRC results. Second are both east and west biological influences in the lake Baikal region along with cultural contacts, as illustrated in cranial results. Finally, an W-E cline indicates the migration and diffusion of Bronze culture from west to east, as shown in cranial and PRC results. Thus, this study provides more detailed information about Siberian history than simple Siberian typological classifications previously suggested by Russian and Japanese researchers.

Biological relationships in the Ainu also are varied by different biological results. Such various relationships of the Ainu may be associated with their origins, which is still inconclusive and speculated with various hypotheses such as Asiatic, European, Siberian, Oceanic, and prehistoric connections.

Lastly, based on cranial results, this study suggests that the origins of Siberians are more relevant to southern Siberia, in association with Asiatic influences, than any other places in Siberia.

Correlation between Geography and Biological Distances

a) Significant correlations

A significant correlation exists between FRC and geography, reflecting a strong N-S cline. In addition, relationships between crania and blood as well as between FRC and blood indicate strong correlations at significant levels. The relationship between FRC and crania also shows a moderate correlation. Common biological patterning including isolated groups (i.e. the Aleut and Ainu) and a connection between distant Siberians and southern Siberian groups (or a N-S connection) may be reasons for strong correlations among crania, blood, and FRC.

b) Non-significant correlations

Despite population flow in Siberia, except for the correlations between FRC and geography, overall correlations between biological data sets and geography were poor. Craniometric results in this study show an east-west relationship as well as influences from both east and west sides of Siberia. However, factors such as 1) connections between southern Siberians and some distant Siberian groups,

and 2) some isolated tribes including the Aleut and the Ainu drastically reduced a correlation between geography and craniometrics.

A poor correlation between serology and geography shown in this study disagrees with Derish and Sokal's (1988) and some of Friedlaender's (1975) results. The population structures by serology in this study, which show that distant Siberian groups are closer to Southern Siberians than their neighboring groups, may reflect a low correlation between blood and geography. In addition, a poor correlation between them may have occurred due to 1) outlier groups such as ALUT and SBERI, 2) lack of serological data available for comparisons among many Siberians, and 3) some wide spread Siberians (i.e. Evenks, Nganasans) who are widely related to other Siberian tribes. Furthermore, as Friedlaender (1975) demonstrated that Melanesian groups were clinally patterned not with ABO and MNS alleles, but with Immunoglobulin blood, alleles used in this study, i.e., ABO, MNS, Hp, and Rh d, may not be useful markers to trace population structures in Siberia.

PRC did not show any significant correlations with other biological data sets, indicating different patterning from the rest of biological data sets. While FRC show a significant correlation with geography, PRC show poor correlations with geography because 1) strong separation exists between north and south around Upper Amur and Kamchatka regions and 2) the

population structure are patterned more linguistically than geographically.

Despite containing almost the same populations, FRC are poorly related to PRC. Some scientists speculate that a low correlation between FRC and PRC are derived from independent inheritance and/or uterine environmental effects in dermatoglyphics (Borecki, et al., 1985; Holt, 1968; Jantz and Chopra, 1983; Mulvihill and Smith, 1969; Rao and Morton, 1980; Sciulli and Rao, 1975). For instance, Sciulli and Rao's (1975) showed that different heritabilities existed for a-b, b-c, and c-d palmar ridge counts in a family study and indicated that different inheritance occurred due to uterine environmental effects. Ousley (1997) also suggests that various heritabilities exist in dermatoglyphics, which provide inconsistent results for population relationships between finger and palm prints. Thus, dermatoglyphics may show sensitive inheritance, which may have affected a poor correlation between FRC and PRC in this study as well.

CHAPTER VII

CONCLUSION

This study was able to reconstruct population structure and history in Siberia. Biological variation in Siberia are primarily patterned linguistically and regionally. For instance, people in southern Siberia, with Altaic speakers such as in the Baikal, Mongolia and Kazakhstan regions, are biologically closer to one another. In addition, this study suggests three main forces for population structures in Siberia. The first one is the dispersion of occupants from south to north, suggested by Russian researchers. Prehistoric craniometric results further support that the origins of contemporary Central, East, and Arctic Siberians are more related to the Baikal and Mongolian regions than any other places. The second force is the migration and diffusion of Bronze culture from west to east after the 1st millennium B.C. The third, there are both east (China, Mongolia) and west (Kazakhstan, Europe) biological influences in the Baikal region along with cultural contacts.

Another significant finding of this study is that such Siberian population structures and the different pieces of history are provided by different biological systems. For instance, craniometrics show the similarities to both west and east in the Lake Baikal region. While finger ridge counts

demonstrated both N-S and E-W clines, serological results also showed N-S connections. As shown in palm ridge counts (i.e. Kamchatka area) and finger ridge counts (i.e. Aleutian islands), biological relationships also reflect regional Siberian history. Thus, different systems provide a better understanding of a population structure and history than single biological data.

Finally, the typology previously adopted by Russian and Japanese scientists is not enough to describe the population structures and historical relationships in Siberia. The simple classifications of Siberians into three types (Arctic, Baikal/Southern and Eastern types) agree with some geographical and linguistic patterning found in this study. However, unlike this study, typological studies did not provide clinal distributions, migration patterns, and cultural diffusions.

Although the numerous Siberian ethnic groups still need to be studied, I hope that this study helps further investigations of biological relationships in Siberia, along with Asia and the New World.

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APPENDICES

APPENDIX A

Distance Matrix from Geography

ALUT	BERI	BURY	CHINA	CKAZA	CMONG	CYAT	DOL	EALUT	EARC	EBURY	ECHINA	EKOMI	EMONG	EYAT	GYDAN
KOMI	LENA	NALUT	NAMUR	NDOL	NBURY	NDATOM	WYAT	OKHO	ONBURY	NJPN	NKAZA	NKAM	NKOMI	NOVO	NYAT
OQMONG	OEARC	OEBURY	SAMUR	SARC	SBERI	SKAZA	SKOMI	SYAT	UKOMI	WARC	WBURY	WMONG	WCHINA	YANA	
.0															
906.6	.0														
2249.7	2640.6	.0													
2543.2	3087.1	600.0	.0												
3746.1	3850.6	1628.7	1776.2	.0											
2384.5	2858.5	300.0	300.0	1679.5	.0										
1531.7	1623.5	1096.7	1651.7	2267.3	1369.7	.0									
2528.7	2494.0	1096.7	1651.7	1369.7	1369.7	997.3	.0								
769.1	600.0	2928.6	3281.8	4300.5	3098.4	2033.5	2980.6	.0							
1096.7	300.0	2528.7	3018.0	3633.9	2769.1	1463.9	2266.8	900.0	.0						
1524.0	2070.1	769.1	1033.9	2384.5	861.2	900.0	1531.7	2249.7	2033.5	.0					
1775.2	2494.0	1033.9	917.3	2610.1	931.3	1500.0	2030.6	2543.2	2513.4	600.0	.0				
2640.6	2702.5	906.6	1414.0	1149.6	1149.6	1126.9	300.0	3155.0	2494.0	1472.9	1906.8	.0			
1628.7	2273.6	861.2	931.3	2484.6	846.4	1200.0	1774.0	2384.5	2267.3	300.0	300.0	1678.1	.0		
1096.7	1126.9	1531.7	2030.6	2769.1	1774.0	505.0	1463.9	1531.7	997.3	1096.7	1651.7	1623.5	1369.7	.0	
906.6	1181.6	1472.9	1906.8	2858.5	1678.1	626.3	1623.5	1472.9	1126.9	906.6	1414.0	1737.3	1149.6	300.0	.0
3155.0	3079.1	1472.9	1906.8	900.0	1678.1	1623.5	626.3	3589.2	2833.0	2070.1	2494.0	597.7	2273.6	2085.4	2249.7
.0															
1640.7	1556.0	1326.9	1905.8	2294.6	1614.6	300.0	946.0	2035.5	1349.6	1200.0	1800.0	1147.6	1500.0	544.6	778.1
1556.0	.0														
300.0	707.5	2143.4	2504.1	3565.0	2313.3	1311.6	2299.6	786.3	841.5	1470.2	1819.8	2436.4	1628.2	841.5	707.5
2923.8	1384.2	.0													
769.1	1472.9	1524.0	1775.2	3098.4	1628.7	1096.7	2033.5	1524.0	1531.7	769.1	1033.9	2070.1	861.2	900.0	600.0
2640.6	1326.9	786.3	.0												
2442.6	2301.7	1326.9	1905.8	1614.6	1614.6	946.0	300.0	2821.6	2055.2	1640.7	2185.0	600.0	1909.1	1349.6	1556.0
778.1	806.1	2190.2	2035.5	.0											
2143.4	2436.4	300.0	900.0	1628.2	600.0	841.5	841.5	2774.9	2299.6	786.3	1202.7	707.5	971.3	1311.6	1302.3
1302.3	1045.7	1999.9	1470.2	1045.7	.0										
2070.1	2249.7	600.0	1200.0	1678.1	900.0	626.3	626.3	2640.6	2085.4	906.6	1414.0	597.7	1149.6	1126.9	1181.6
1181.6	778.1	1889.0	1472.9	778.1	300.0	.0									
2033.5	2085.4	900.0	1500.0	1774.0	1200.0	505.0	505.0	2528.7	1891.5	1096.7	1651.7	626.3	1369.7	997.3	1126.9
1126.9	544.6	1816.6	1531.7	544.6	600.0	300.0	.0								

APPENDIX A Cont.

1470.2	1889.0	786.3	1202.7	2313.3	971.3	600.0	1311.6	2143.4	1816.6	300.0	900.0	1302.3	600.0	841.5	707.5
1889.0	900.0	1357.6	786.3	1384.2	686.0	707.5	841.5	.0							
2102.4	2340.5	450.0	1050.0	1647.0	750.0	726.5	726.5	2705.2	2190.3	835.4	1304.2	637.7	1053.8	1213.7	1234.7
1234.7	909.4	1940.0	1464.3	909.4	150.0	150.0	450.0	680.7	.0						
1033.9	1906.8	1775.2	1822.7	3403.8	1776.2	1651.7	2513.4	1775.2	2030.6	1033.9	917.3	2494.0	931.3	1500.0	1200.0
3087.1	1905.8	1202.7	600.0	2561.5	1819.8	1906.8	2030.6	1202.7	1858.3	.0					
3539.9	3589.2	1524.0	1775.2	300.0	1628.7	2033.5	1096.7	4059.1	3363.1	2249.7	2543.2	906.6	2384.5	2528.7	2640.6
600.0	2035.5	3342.2	2928.6	1326.9	1470.2	1472.9	1531.7	2143.4	1464.3	3281.8	.0				
786.3	1302.3	1470.2	1819.8	2969.1	1628.2	841.5	1816.6	1470.2	1311.6	786.3	1202.7	1889.0	971.3	600.0	300.0
2436.4	1045.7	686.0	300.0	1787.5	1357.6	1302.3	1311.6	686.0	1322.2	900.0	2774.9	.0			
2980.6	2833.0	1531.7	2030.6	1200.0	1774.0	1463.9	505.0	3363.1	2576.3	2033.5	2513.4	626.3	2267.3	1891.5	2085.4
300.0	1349.6	2732.9	2528.7	544.6	1311.6	1126.9	997.3	1816.6	1213.7	3018.0	900.0	2299.6	.0		
2774.9	2923.8	786.3	1202.7	971.3	971.3	1311.6	600.0	3342.2	2732.9	1470.2	1819.8	300.0	1628.2	1816.6	1889.0
707.5	1384.2	2596.2	2143.4	900.0	686.0	707.5	841.5	1357.6	680.7	2504.1	786.3	1999.9	841.5	.0	
2035.5	1949.4	1200.0	1800.0	1909.1	1500.0	544.6	544.6	2442.6	1724.8	1326.9	1905.8	778.1	1614.6	946.0	1147.6
1147.6	408.6	1787.5	1640.7	408.6	900.0	600.0	300.0	1045.7	750.0	2185.0	1640.7	1384.2	946.0	1045.7	.0
2313.8	2748.0	150.0	450.0	1648.0	150.0	1231.7	1231.7	3011.6	2647.7	802.8	972.7	1024.5	840.8	1650.7	1571.9
1571.9	1470.2	2225.4	1570.5	1470.2	450.0	750.0	1050.0	871.0	600.0	1769.9	1570.5	1544.3	1650.7	871.0	1350.0
.0															
1208.1	450.0	2482.3	2991.1	3528.2	2733.1	1400.3	2158.7	1050.0	150.0	2029.6	2533.9	2395.6	2276.8	960.6	1127.7
2713.0	1259.8	937.3	1580.5	1936.9	2241.2	2013.5	1804.3	1796.4	2125.4	2104.4	3252.9	1340.4	2450.9	2643.3	1620.9
2606.6	.0														
1490.3	1976.3	763.3	1111.7	2345.1	905.8	750.0	1418.2	2192.7	1922.5	150.0	750.0	1382.4	450.0	966.0	799.4
1976.3	1050.0	1407.4	763.3	1510.6	722.6	799.4	966.0	150.0	747.3	1111.7	2192.7	722.6	1922.5	1407.4	1185.2
824.3	1910.9	.0													
861.2	1678.1	1628.7	1776.2	3244.1	1679.5	1369.7	2267.3	1628.7	1774.0	861.2	931.3	2273.6	846.4	1200.0	900.0
2858.5	1614.6	971.3	300.0	2294.6	1628.2	1678.1	1774.0	971.3	1647.0	300.0	3098.4	600.0	2769.1	2313.3	1909.1
1648.0	1837.2	905.8	.0												
600.0	597.7	2070.1	2494.0	3394.0	2273.6	1126.9	2085.4	906.6	626.3	1472.9	1906.8	2249.7	1678.1	626.3	597.7
2702.5	1147.6	300.0	906.6	1949.4	1889.0	1737.3	1623.5	1302.3	1808.9	1414.0	3155.0	707.5	2494.0	2436.4	1556.0
2169.5	690.3	1382.4	1149.6	.0											
786.3	300.0	2774.9	3175.6	4073.2	2969.1	1816.6	2732.9	300.0	600.0	2143.4	2504.1	2923.8	2313.3	1311.6	1302.3
3331.7	1787.5	686.0	1470.2	2558.1	2596.2	2436.4	2299.6	1999.9	2513.7	1819.8	3821.7	1357.6	3095.8	3127.8	2190.2
2870.3	750.0	2068.0	1628.2	707.5	.0										
3959.4	4115.0	1775.2	1822.7	300.0	1776.2	2513.4	1651.7	4544.8	3907.3	2543.2	2702.5	1414.0	2610.1	3018.0	3087.1
1200.0	2561.5	3794.5	3281.8	1905.8	1819.8	1906.8	2030.6	2504.1	1858.3	3539.9	600.0	3175.6	1500.0	1202.7	2185.0
1769.9	3805.8	2520.1	3403.8	3638.9	4327.8	.0									
3342.2	3331.7	1470.2	1819.8	600.0	1628.2	1816.6	841.5	3821.7	3095.8	2143.4	2504.1	707.5	2313.3	2299.6	2436.4
300.0	1787.5	3127.8	2774.9	1045.7	1357.6	1302.3	1311.6	1999.9	1322.2	3175.6	300.0	2596.2	600.0	686.0	1384.2
1544.3	2980.8	2068.0	2969.1	2923.8	3574.1	900.0	.0								

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1472.9	1737.3	906.6	1414.0	2273.6	1149.6	300.0	1126.9	2070.1	1623.5	600.0	1200.0	1181.6	900.0	626.3	597.7
1737.3	600.0	1302.3	906.6	1147.6	707.5	597.7	626.3	300.0	637.7	1414.0	2070.1	707.5	1623.5	1302.3	778.1
1024.5	1583.5	450.0	1149.6	1181.6	1889.0	2494.0	1889.0	.0							
2821.6	2595.4	1640.7	2185.0	1500.0	1909.1	1349.6	544.6	3145.0	2327.8	2035.5	2561.5	778.1	2294.6	1724.8	1949.4
600.0	1181.6	2558.1	2442.6	408.6	1384.2	1147.6	946.0	1787.5	1262.7	2969.7	1200.0	2190.2	300.0	1045.7	806.1
1773.7	2196.6	1909.8	2703.2	2301.7	2868.3	1800.0	900.0	1556.0	.0						
900.0	626.3	2033.5	2513.4	3235.0	2267.3	997.3	1891.5	1096.7	505.0	1531.7	2030.6	2085.4	1774.0	505.0	626.3
2494.0	946.0	600.0	1096.7	1724.8	1816.6	1623.5	1463.9	1311.6	1716.5	1651.7	2980.6	841.5	2266.8	2299.6	1349.6
2148.6	503.5	1418.2	1369.7	300.0	841.5	3494.5	2732.9	1126.9	2055.2	.0					
2928.6	3155.0	769.1	1033.9	861.2	861.2	1531.7	900.0	3539.9	2980.6	1524.0	1775.2	600.0	1628.7	2033.5	2070.1
906.6	1640.7	2774.9	2249.7	1200.0	786.3	906.6	1096.7	1470.2	835.4	2543.2	769.1	2143.4	1096.7	300.0	1326.9
802.8	2899.0	1490.3	2384.5	2640.6	3342.2	1033.9	786.3	1472.9	1326.9	2528.7	.0				
3098.4	3394.0	861.2	931.3	846.4	846.4	1774.0	1200.0	3746.1	3235.0	1628.7	1776.2	900.0	1679.5	2267.3	2273.6
1149.6	1909.1	2969.1	2384.5	1500.0	971.3	1149.6	1369.7	1628.2	1053.8	2610.1	861.2	2313.3	1369.7	600.0	1614.6
840.8	3160.7	1622.1	2484.6	2858.5	3565.0	931.3	971.3	1678.1	1614.6	2769.1	300.0	.0			
3281.8	3638.9	1033.9	917.3	931.3	931.3	2030.6	1500.0	3959.4	3494.5	1775.2	1822.7	1200.0	1776.2	2513.4	2494.0
1414.0	2185.0	3175.6	2543.2	1800.0	1202.7	1414.0	1651.7	1819.8	1304.2	2702.5	1033.9	2504.1	1651.7	900.0	1905.8
972.7	3426.9	1792.0	2610.1	3087.1	3794.5	917.3	1202.7	1906.8	1905.8	3018.0	600.0	300.0	.0		
1326.9	1147.6	1640.7	2185.0	2703.2	1909.1	544.6	1349.6	1640.7	946.0	1326.9	1905.8	1556.0	1614.6	300.0	600.0
1949.4	408.6	1045.7	1200.0	1181.6	1384.2	1147.6	946.0	1045.7	1262.7	1800.0	2442.6	900.0	1724.8	1787.5	806.1
1773.7	866.2	1185.2	1500.0	778.1	1384.2	2969.7	2190.2	778.1	1524.0	544.6	2035.5	2294.6	2561.5	.0	

APPENDIX B

Cranial Variation

Data available for: 13 populations and 11 variables
 Data selected for: 12 populations and 11 variables

Heritability = 1.000

Correction for sampling bias was requested, and any
 negative distances or r_{ii} values were set equal to zero

Variables used in this analysis:

GOL	BNL	XCB	XFB
BBH			
ZYB	OBB	OBH	NLB
NLH			
WNB			

Populations used in this analysis:

Population	Sample size	Population size	Weight
ALUT	25	1	0.083
BURY	67	1	0.083
CKAZA	75	1	0.083
CMONG	71	1	0.083
CYAT	36	1	0.083
EARC	114	1	0.083
EBURY	26	1	0.083
EMONG	35	1	0.083
NAMUR	12	1	0.083
NJPN	48	1	0.083
SAMUR	28	1	0.083
WARC	11	1	0.083
Total	548		

Population	Biased r_{ii}	Unbiased r_{ii}	se
ALUT	0.203275	0.183275	0.036100
BURY	0.142317	0.134854	0.018451
CKAZA	0.073461	0.066794	0.012529
CMONG	0.055564	0.048522	0.011200
CYAT	0.134864	0.120975	0.024504
EARC	0.065951	0.061565	0.009629

APPENDIX B. Cont.

EBURY	0.042304	0.023073	0.016149
EMONG	0.028701	0.014416	0.011464
NAMUR	0.079745	0.038079	0.032636
NJPN	0.324245	0.313828	0.032904
SAMUR	0.197833	0.179975	0.033651
WARC	0.073583	0.028128	0.032743

$F_{st} = 0.118487$
 Unbiased $F_{st} = 0.101124$
 $se = 0.006304$

Relethford-Blangero Analysis:

Mean Within-group Phenotypic Variance = 0.796

Population	r(ii)	Within-group Phenotypic Variance		
		Observed	Expected	Residual
ALUT	0.203275	0.822	0.719	0.102
BURY	0.142317	0.851	0.774	0.076
CKAZA	0.073461	0.829	0.836	-0.007
CMONG	0.055564	0.852	0.853	0.000
CYAT	0.134864	0.865	0.781	0.083
EARC	0.065951	0.767	0.843	-0.076
EBURY	0.042304	0.781	0.865	-0.084
EMONG	0.028701	0.803	0.877	-0.074
NAMUR	0.079745	0.781	0.831	-0.049
NJPN	0.324245	0.731	0.610	0.121
SAMUR	0.197833	0.879	0.724	0.155
WARC	0.073583	0.590	0.836	-0.246

Principal Coordinates Analysis (Biased R Matrix):

There are 11 non-zero eigenvalues, listed below:

0.6255
 0.2836
 0.2064
 0.0994
 0.0903
 0.0658
 0.0287
 0.0122
 0.0052

APPENDIX B Cont.

0.0042

0.0006

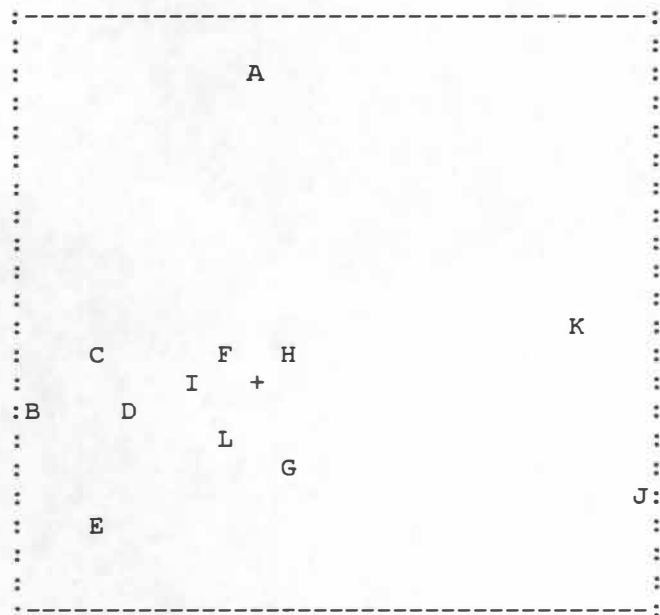
The first eigenvalue accounts for 44.0 % of the variation
The second eigenvalue accounts for 19.9 % of the variation

The first two eigenvalues collectively account for 63.9 % of the variation

First two eigenvectors (scaled by the square root of their eigenvalues):

	I	II
ALUT	0.0108	0.4366
BURY	-0.2859	-0.0432
CKAZA	-0.1909	0.0419
CMONG	-0.1673	-0.0303
CYAT	-0.2226	-0.1852
EARC	-0.0188	0.0448
EBURY	0.0262	-0.1026
EMONG	0.0410	0.0252
NAMUR	-0.0751	-0.0129
NJPN	0.4977	-0.1735
SAMUR	0.4155	0.0728
WARC	-0.0307	-0.0737

Plot of First Two Scaled Eigenvectors:



APPENDIX B Cont.

Population Symbol

ALUT	A
BURY	B
CKAZA	C
CMONG	D
CYAT	E
EARC	F
EBURY	G
EMONG	H
NAMUR	I
NJPN	J
SAMUR	K
WARC	L

Centroid +

R Matrix (biased):
(standard errors in parentheses)

ALUT	0.203275	(0.036100)
BURY	0.142317	(0.018451)
CKAZA	0.073461	(0.012529)

APPENDIX B Cont.

CMONG	0.055564	(0.011200)
CYAT	0.134864	(0.024504)
EARC	0.065951	(0.009629)
EBURY	0.042304	(0.016149)
EMONG	0.028701	(0.011464)
NAMUR	0.079745	(0.032636)
NJPN	0.324245	(0.032904)
SAMUR	0.197833	(0.033651)
WARC	0.073583	(0.032743)

ALUT	BURY	-0.008108	(0.018699)
ALUT	CKAZA	0.018527	(0.015045)
ALUT	CMONG	-0.007387	(0.014275)
ALUT	CYAT	-0.078000	(0.021033)
ALUT	EARC	0.003419	(0.013310)
ALUT	EBURY	-0.050741	(0.019521)
ALUT	EMONG	0.002351	(0.016695)
ALUT	NAMUR	-0.020328	(0.028400)
ALUT	NJPN	-0.050809	(0.026256)
ALUT	SAMUR	0.026635	(0.024657)

APPENDIX B Cont.

ALUT	WARC	-0.038833	(0.029298)
BURY	CKAZA	0.079618	(0.010953)
BURY	CMONG	0.065616	(0.010656)
BURY	CYAT	0.051727	(0.015461)
BURY	EARC	-0.039925	(0.009458)
BURY	EBURY	-0.016961	(0.015640)
BURY	EMONG	-0.035948	(0.013420)
BURY	NAMUR	-0.005080	(0.022867)
BURY	NJPN	-0.089290	(0.017684)
BURY	SAMUR	-0.133408	(0.017944)
BURY	WARC	-0.010559	(0.023715)
CKAZA	CMONG	0.020757	(0.008435)
CKAZA	CYAT	0.025010	(0.012402)
CKAZA	EARC	-0.027369	(0.007814)
CKAZA	EBURY	-0.024707	(0.011654)
CKAZA	EMONG	-0.027876	(0.009972)
CKAZA	NAMUR	0.020844	(0.016967)
CKAZA	NJPN	-0.081627	(0.015315)
CKAZA	SAMUR	-0.073252	(0.014520)
CKAZA	WARC	-0.003387	(0.017519)
CMONG	CYAT	0.031060	(0.011745)
CMONG	EARC	-0.007172	(0.007533)
CMONG	EBURY	0.003802	(0.010464)
CMONG	EMONG	-0.005860	(0.008934)
CMONG	NAMUR	-0.019395	(0.015183)
CMONG	NJPN	-0.065709	(0.015145)
CMONG	SAMUR	-0.081992	(0.013826)
CMONG	WARC	0.010716	(0.015618)
CYAT	EARC	0.021650	(0.010991)
CYAT	EBURY	-0.005433	(0.015966)
CYAT	EMONG	-0.018628	(0.013651)
CYAT	NAMUR	0.011927	(0.023218)
CYAT	NJPN	-0.085545	(0.021759)
CYAT	SAMUR	-0.093090	(0.020327)
CYAT	WARC	0.004457	(0.023941)
EARC	EBURY	-0.000187	(0.010794)
EARC	EMONG	0.022852	(0.009251)
EARC	NAMUR	0.002886	(0.015756)
EARC	NJPN	-0.059306	(0.013001)
EARC	SAMUR	0.012901	(0.012803)
EARC	WARC	0.004302	(0.016312)
EBURY	EMONG	0.018098	(0.009626)
EBURY	NAMUR	0.012823	(0.016253)
EBURY	NJPN	0.014949	(0.023130)
EBURY	SAMUR	-0.002966	(0.019116)
EBURY	WARC	0.009017	(0.016355)

APPENDIX B Cont.

EMONG	NAMUR	0.008627	(0.013680)
EMONG	NJPN	-0.005125	(0.019879)
EMONG	SAMUR	0.016294	(0.016357)
EMONG	WARC	-0.003487	(0.013740)
NAMUR	NJPN	-0.054349	(0.033901)
NAMUR	SAMUR	-0.030419	(0.027833)
NAMUR	WARC	-0.007282	(0.023156)
NJPN	SAMUR	0.176279	(0.025083)
NJPN	WARC	-0.023715	(0.035249)
SAMUR	WARC	-0.014813	(0.028739)

Diagonals of Unbiased R Matrix:

(standard errors in parentheses; these are the same as for the biased matrix)

ALUT	0.183275	(0.036100)
BURY	0.134854	(0.018451)
CKAZA	0.066794	(0.012529)
CMONG	0.048522	(0.011200)
CYAT	0.120975	(0.024504)
EARC	0.061565	(0.009629)
EBURY	0.023073	(0.016149)
EMONG	0.014416	(0.011464)
NAMUR	0.038079	(0.032636)
NJPN	0.313828	(0.032904)
SAMUR	0.179975	(0.033651)
WARC	0.028128	(0.032743)

D-Square Matrix (biased):

(standard errors in parentheses)

ALUT	BURY	0.361808	(0.056436)
ALUT	CKAZA	0.239682	(0.045264)
ALUT	CMONG	0.273613	(0.048701)
ALUT	CYAT	0.494138	(0.073266)
ALUT	EARC	0.262388	(0.045289)
ALUT	EBURY	0.347060	(0.066064)
ALUT	EMONG	0.227274	(0.049978)
ALUT	NAMUR	0.323676	(0.079989)
ALUT	NJPN	0.629139	(0.078321)
ALUT	SAMUR	0.347838	(0.064970)
ALUT	WARC	0.354523	(0.086246)
BURY	CKAZA	0.056542	(0.016003)
BURY	CMONG	0.066648	(0.017604)
BURY	CYAT	0.173725	(0.034482)

APPENDIX B Cont.

BURY	EARC	0.288117	(0.033080)
BURY	EBURY	0.218541	(0.043243)
BURY	EMONG	0.242914	(0.041152)
BURY	NAMUR	0.232221	(0.060474)
BURY	NJPN	0.645141	(0.060807)
BURY	SAMUR	0.606966	(0.070188)
BURY	WARC	0.237016	(0.063407)
CKAZA	CMONG	0.087512	(0.019610)
CKAZA	CYAT	0.158305	(0.032297)
CKAZA	EARC	0.194150	(0.026227)
CKAZA	EBURY	0.165178	(0.037030)
CKAZA	EMONG	0.157914	(0.032567)
CKAZA	NAMUR	0.111518	(0.041567)
CKAZA	NJPN	0.560959	(0.055424)
CKAZA	SAMUR	0.417798	(0.057309)
CKAZA	WARC	0.153817	(0.050694)
CMONG	CYAT	0.128307	(0.029341)
CMONG	EARC	0.135859	(0.022309)
CMONG	EBURY	0.090265	(0.027572)
CMONG	EMONG	0.095985	(0.025617)
CMONG	NAMUR	0.174100	(0.052138)
CMONG	NJPN	0.511227	(0.053489)
CMONG	SAMUR	0.417382	(0.057718)
CMONG	WARC	0.107716	(0.042575)
CYAT	EARC	0.157515	(0.030376)
CYAT	EBURY	0.188034	(0.044680)
CYAT	EMONG	0.200821	(0.042587)
CYAT	NAMUR	0.190756	(0.058284)
CYAT	NJPN	0.630198	(0.070071)
CYAT	SAMUR	0.518877	(0.072665)
CYAT	WARC	0.199532	(0.061608)
EARC	EBURY	0.108628	(0.028677)
EARC	EMONG	0.048948	(0.017116)
EARC	NAMUR	0.139924	(0.045449)
EARC	NJPN	0.508809	(0.049135)
EARC	SAMUR	0.237981	(0.041192)
EARC	WARC	0.130930	(0.045736)
EBURY	EMONG	0.034809	(0.019338)
EBURY	NAMUR	0.096402	(0.043380)
EBURY	NJPN	0.336650	(0.056563)
EBURY	SAMUR	0.246068	(0.054087)
EBURY	WARC	0.097852	(0.045044)
EMONG	NAMUR	0.091193	(0.040443)
EMONG	NJPN	0.363196	(0.053628)
EMONG	SAMUR	0.193946	(0.044702)

APPENDIX B Cont.

EMONG	WARC	0.109258	(0.045741)
NAMUR	NJPN	0.512687	(0.092517)
NAMUR	SAMUR	0.338415	(0.080356)
NAMUR	WARC	0.167892	(0.068474)
NJPN	SAMUR	0.169521	(0.039197)
NJPN	WARC	0.445257	(0.089299)
SAMUR	WARC	0.301041	(0.078163)

D-Square Matrix (unbiased):

(standard errors in parentheses; these are the same as for the biased matrix)

ALUT	BURY	0.334345	(0.056436)
ALUT	CKAZA	0.213016	(0.045264)
ALUT	CMONG	0.246571	(0.048701)
ALUT	CYAT	0.460250	(0.073266)
ALUT	EARC	0.238002	(0.045289)
ALUT	EBURY	0.307830	(0.066064)
ALUT	EMONG	0.192988	(0.049978)
ALUT	NAMUR	0.262010	(0.079989)
ALUT	NJPN	0.598722	(0.078321)
ALUT	SAMUR	0.309981	(0.064970)
ALUT	WARC	0.289068	(0.086246)
BURY	CKAZA	0.042413	(0.016003)
BURY	CMONG	0.052143	(0.017604)
BURY	CYAT	0.152374	(0.034482)
BURY	EARC	0.276268	(0.033080)
BURY	EBURY	0.191848	(0.043243)
BURY	EMONG	0.221166	(0.041152)
BURY	NAMUR	0.183092	(0.060474)
BURY	NJPN	0.627261	(0.060807)
BURY	SAMUR	0.581646	(0.070188)
BURY	WARC	0.184099	(0.063407)
CKAZA	CMONG	0.073803	(0.019610)
CKAZA	CYAT	0.137749	(0.032297)
CKAZA	EARC	0.183097	(0.026227)
CKAZA	EBURY	0.139281	(0.037030)
CKAZA	EMONG	0.136961	(0.032567)
CKAZA	NAMUR	0.063185	(0.041567)
CKAZA	NJPN	0.543876	(0.055424)
CKAZA	SAMUR	0.393274	(0.057309)
CKAZA	WARC	0.101696	(0.050694)
CMONG	CYAT	0.107376	(0.029341)
CMONG	EARC	0.124431	(0.022309)
CMONG	EBURY	0.063992	(0.027572)

APPENDIX B Cont.

CMONG	EMONG	0.074657	(0.025617)
CMONG	NAMUR	0.125391	(0.052138)
CMONG	NJPN	0.493768	(0.053489)
CMONG	SAMUR	0.392482	(0.057718)
CMONG	WARC	0.055219	(0.042575)
CYAT	EARC	0.139240	(0.030376)
CYAT	EBURY	0.154914	(0.044680)
CYAT	EMONG	0.172647	(0.042587)
CYAT	NAMUR	0.135200	(0.058284)
CYAT	NJPN	0.605893	(0.070071)
CYAT	SAMUR	0.487131	(0.072665)
CYAT	WARC	0.140188	(0.061608)
EARC	EBURY	0.085012	(0.028677)
EARC	EMONG	0.030276	(0.017116)
EARC	NAMUR	0.093872	(0.045449)
EARC	NJPN	0.494006	(0.049135)
EARC	SAMUR	0.215738	(0.041192)
EARC	WARC	0.081090	(0.045736)
EBURY	EMONG	0.001292	(0.019338)
EBURY	NAMUR	0.035505	(0.043380)
EBURY	NJPN	0.307003	(0.056563)
EBURY	SAMUR	0.208980	(0.054087)
EBURY	WARC	0.033166	(0.045044)
EMONG	NAMUR	0.035241	(0.040443)
EMONG	NJPN	0.338493	(0.053628)
EMONG	SAMUR	0.161803	(0.044702)
EMONG	WARC	0.049518	(0.045741)
NAMUR	NJPN	0.460604	(0.092517)
NAMUR	SAMUR	0.278891	(0.080356)
NAMUR	WARC	0.080771	(0.068474)
NJPN	SAMUR	0.141247	(0.039197)
NJPN	WARC	0.389386	(0.089299)
SAMUR	WARC	0.237729	(0.078163)

APPENDIX C

Serological Data Summary

Map	Group
<hr/>	
NJPN	Ainu
ALUT	Aleut
EARC	Siberian Eskimo, Inupik, Yerl
BURY	Buryat
WBURY	Tofalar, Touvin, Chelkanian
SARC	Chukchi, Koryak, Commander I. Aleut
BERI	Coastal Chukchi, Yupik
DOL	Dolgan, Yenisey
EYAT	Even, Yukagir (taiga), Yakut
EKOMI	Evenk, Selkup
CYAT	Even
KOMI	Forest Nentsi, Komi, Nentsy
NKOMI	Forest Nentsi, Russian
CKAZA	Kazakh, Ural
GYDAN	Yukagir (tundra)
CMONG	Mongolian
EMONG	Most Eastern Evenk, Negidal, Nenets, Ulchi
NDOL	Nganasan
NYAT	Nganasan
NAMUR	Nivkhi
SBERI	Pribilof I. Aleuts
WARC	Reindeer Chukchi

APPENDIX D

Kinship Output

NUMBER OF POPULATIONS 17
NUMBER OF ALLELES 8
SAMPLE SIZE BY GROUP

100	100	100	100	100	100	100	100	100	100	100	100
100	100	100	100	100							

ALLELES

Rhd	A	B	O	hp1	hp2	M	N
-----	---	---	---	-----	-----	---	---

ALLELE FREQUENCIES BY GROUP

ALUT	0.055	0.300	0.037	0.660	0.430	0.580	0.770	0.226
BERI	0.025	0.210	0.155	0.635	0.290	0.710	0.580	0.420
BURY	0.000	0.160	0.240	0.598	0.300	0.700	0.472	0.528
CMONG	0.140	0.180	0.220	0.600	0.350	0.650	0.575	0.425
CYAT	0.000	0.190	0.195	0.615	0.350	0.650	0.680	0.320
EARC	0.050	0.210	0.118	0.688	0.338	0.662	0.592	0.408
EKOMI	0.080	0.210	0.097	0.695	0.425	0.575	0.583	0.417
EMONG	0.000	0.180	0.235	0.590	0.280	0.720	0.640	0.360
EYAT	0.000	0.201	0.140	0.660	0.440	0.560	0.620	0.380
KOMI	0.080	0.150	0.175	0.673	0.415	0.585	0.530	0.470
NDOL	0.000	0.220	0.110	0.660	0.270	0.730	0.310	0.690
NJPN	0.190	0.200	0.090	0.710	0.160	0.840	0.450	0.550
NKOMI	0.070	0.170	0.230	0.600	0.310	0.690	0.420	0.580
NYAT	0.000	0.223	0.130	0.647	0.200	0.800	0.354	0.646
SARC	0.000	0.200	0.160	0.646	0.263	0.737	0.450	0.550
SBERI	0.130	0.300	0.015	0.685	0.555	0.445	0.640	0.360
WARC	0.000	0.206	0.116	0.678	0.284	0.716	0.398	0.604

MEAN ALLELE FREQUENCIES

Rhd	4.823529E-02
A	.2064706
B	.1449118
O	.6494117
hp1	.3329412
hp2	.6676471
M	.5331765
N	.4667059

APPENDIX D Cont.

KINSHIP MATRIX

ALUT	0.086	0.005	-0.033	0.003	0.029	0.018	0.028	0.007	0.031	0.001	-0.056	-0.029	-0.041	-0.055	-0.030
	0.071	-0.035													
BERI	0.005	0.006	0.003	-0.004	0.010	0.002	-0.005	0.012	0.002	-0.006	-0.005	-0.006	-0.004	0.001	0.003
	-0.012	-0.002													
BURY	-0.033	0.003	0.024	-0.006	0.003	-0.008	-0.017	0.013	-0.004	-0.003	0.018	-0.014	0.016	0.020	0.016
	-0.042	0.013													
CMONG	0.003	-0.004	-0.006	0.033	-0.000	-0.000	0.007	0.000	-0.007	0.012	-0.026	0.023	0.009	-0.024	-0.016
	0.017	-0.022													
CYAT	0.029	0.010	0.003	-0.000	0.032	0.006	0.002	0.027	0.021	-0.001	-0.030	-0.038	-0.014	-0.024	-0.006
	0.001	-0.017													
EARC	0.018	0.002	-0.008	-0.000	0.006	0.005	0.006	0.002	0.006	-0.000	-0.013	-0.003	-0.010	-0.011	-0.006
	0.013	-0.007													
EKOMI	0.028	-0.005	-0.017	0.007	0.002	0.006	0.018	-0.010	0.012	0.010	-0.020	-0.006	-0.012	-0.026	-0.016
	0.043	-0.014													
EMONG	0.007	0.012	0.013	0.000	0.027	0.002	-0.010	0.032	0.009	-0.006	-0.018	-0.024	-0.004	-0.007	0.003
	-0.027	-0.009													
EYAT	0.031	0.002	-0.004	-0.007	0.021	0.006	0.012	0.009	0.027	0.006	-0.021	-0.046	-0.016	-0.025	-0.009
	0.026	-0.011													
KOMI	0.001	-0.006	-0.003	0.012	-0.001	-0.000	0.010	-0.006	0.006	0.014	-0.011	-0.004	0.004	-0.017	-0.010
	0.020	-0.009													
NDOL	-0.056	-0.005	0.018	-0.026	-0.030	-0.013	-0.020	-0.018	-0.021	-0.011	0.062	0.014	0.020	0.057	0.029
	-0.045	0.041													
NJPN	-0.029	-0.006	-0.014	0.023	-0.038	-0.003	-0.006	-0.024	-0.046	-0.004	0.014	0.100	0.016	0.023	0.001
	-0.013	0.005													
NKOMI	-0.041	-0.004	0.016	0.009	-0.014	-0.010	-0.012	-0.004	-0.016	0.004	0.020	0.016	0.024	0.019	0.010
	-0.028	0.011													
NYAT	-0.055	0.001	0.020	-0.024	-0.024	-0.011	-0.026	-0.007	-0.025	-0.017	0.057	0.023	0.019	0.059	0.031
	-0.060	0.039													
SARC	-0.030	0.003	0.016	-0.016	-0.006	-0.006	-0.016	0.003	-0.009	-0.010	0.029	0.001	0.010	0.031	0.019
	-0.040	0.021													
SBERI	0.071	-0.012	-0.042	0.017	0.001	0.013	0.043	-0.027	0.026	0.020	-0.045	-0.013	-0.028	-0.060	-0.040
	0.110	-0.033													
WARC	-0.035	-0.002	0.013	-0.022	-0.017	-0.007	-0.014	-0.009	-0.011	-0.009	0.041	0.005	0.011	0.039	0.021
	-0.033	0.029													

APPENDIX D Cont.

TRACE= .6786892
WAHLUND F= 0.03992

EIGENVALUES AND PERCENT OF TRACE

0.36782	54.19500
0.15899	23.42573
0.08877	13.07890
0.05615	8.27342
0.00687	1.01286
0.00000	0.00000

COORDINATES FOR ALLELES

Rhd	0.351	1.005	-0.310	0.104	-0.017	0.000
A	0.198	0.083	0.219	-0.203	-0.161	0.000
B	-0.285	-0.343	-0.489	0.362	-0.022	0.000
O	0.049	0.178	0.164	-0.102	0.167	0.000
hp1	0.709	-0.041	0.286	0.306	-0.004	0.000
hp2	-0.700	0.040	-0.284	-0.316	-0.001	0.000
M	0.921	-0.227	-0.262	-0.175	0.015	0.000
N	-0.925	0.227	0.262	0.179	-0.013	0.000

COORDINATES FOR GROUPS

ALUT	0.269	-0.023	0.023	-0.108	-0.022	0.000
BERI	-0.000	-0.050	-0.035	-0.047	-0.003	0.000
BURY	-0.105	-0.090	-0.034	0.057	-0.007	0.000
CMONG	0.057	0.092	-0.122	0.073	-0.025	0.000
CYAT	0.096	-0.134	-0.065	-0.020	0.005	0.000
EARC	0.054	-0.001	-0.002	-0.038	0.025	0.000
EKOMI	0.115	0.048	0.041	0.022	0.026	0.000
EMONG	0.014	-0.135	-0.112	-0.026	-0.008	0.000
EYAT	0.117	-0.099	0.049	0.028	0.022	0.000
KOMI	0.049	0.033	-0.003	0.095	0.038	0.000
NDOL	-0.218	0.009	0.121	0.004	-0.012	0.000
NJPN	-0.112	0.265	-0.098	-0.088	0.018	0.000
NKOMI	-0.112	0.031	-0.040	0.093	-0.024	0.000
NYAT	-0.231	-0.007	0.053	-0.050	-0.018	0.000
SARC	-0.126	-0.049	0.020	-0.019	0.000	0.000
SBERI	0.278	0.128	0.118	0.037	-0.028	0.000
WARC	-0.145	-0.017	0.086	-0.014	0.013	0.000

APPENDIX E

Variation of Finger Ridge Counts

Multivariate Fst= .01641
 Unbiased = .01071

Univariate Fst's

LI	.0211808	.0184418
LII	.0205050	.0175470
LIII	.0316533	.0289070
LIV	.0236993	.0217088
LV	.0182967	.0152741
RI	.0232076	.0203465
RII	.0207299	.0184084
RIII	.0315373	.0287166
RIV	.0246578	.0225818
RV	.0204153	.0180070

principal components analysis and Fst

1	.02397	.02120
2	.03694	.03369
3	.02384	.02085
4	.03023	.02729
5	.01789	.01534
6	.00366	.00216
7	.00791	.00571
8	.00704	.00474
9	.00799	.00560
10	.00328	.00156

Eigenvectors of within covariance matrix

Eigenvalues	200.961	38.640	21.027	14.367	10.661	9.762	8.064	6.877	5.508	4.415
Proportion	.62745	.12064	.06565	.04486	.03329	.03048	.02518	.02147	.01720	.01378

[illegible]

Model mean square	1763.99	500.19	214.28	185.79	42.40	13.06	19.90	14.50	15.69	4.19
F-ratio	8.778	12.945	10.191	12.932	3.977	1.337	2.467	2.108	2.848	.948
F-ratios have 19 and 3703 degrees of freedom										

APPENDIX F

Variation of Palm Ridge Counts

Multivariate Fst= .01997
Unbiased = .01239

Univariate Fst's

Lc-d	.0154594	.0124696
Lb-c	.0335245	.0305393
La-b	.0500257	.0472592
Ra-b	.0431105	.0401971
Rb-c	.0357698	.0325910
Rc-d	.0185556	.0152947

principal components analysis and Fst

1	.03054	.02744
2	.03333	.03037
3	.03837	.03537
4	.00589	.00438
5	.00793	.00502
6	.00249	.00128

Eigenvectors of within covariance matrix

Lc-d	.626	.345	.204	.603	.225
.182					
Lb-c	.308	-.577	.233	-.365	.443
.433					
La-b	.260	-.140	-.616	.050	-.508
.522					
Ra-b	.277	-.151	-.657	.005	.458
-.509					
Rb-c	.338	-.551	.292	.190	-.491
-.469					
Rc-d	.504	.450	.087	-.682	-.210
-.167					

Eigenvalues	110.029	61.997	30.624	16.157	8.076
6.053					
Proportion	.47236	.26615	.13147	.06936	.03467
.02598					

APPENDIX F Cont.
principal Component Scores

ALUT	3.604	-1.272	-.901	-.107	-.585	-.002
BURY	.742	1.380	.088	.160	.003	.055
CMON	-1.998	.561	-.883	-.099	.678	.035
EARC	6.238	.121	.903	-.199	.234	.040
EBUR	-.763	-.277	-.533	.217	.332	.062
EKOM	2.400	-4.735	-.058	-.652	-.314	-.167
EMON	-1.972	-.475	1.699	.167	-.111	-.233
KOMI	1.084	-1.681	-1.775	-.151	-.235	-.008
NALU	-4.324	3.934	1.998	-1.123	-.286	-.022
NAMU	1.737	-3.765	1.398	-.047	.222	-.120
NDAT	-2.687	1.911	.261	.435	-.066	-.132
NDOL	.942	2.784	-1.447	.172	.397	.430
NJPN	.217	-2.044	.393	.586	.648	.057
NKAM	-5.435	-1.002	4.120	1.136	.379	-.329
NOVO	.702	-1.566	-2.528	-.028	-.615	.016
NYAT	1.632	.505	-2.416	-.001	.019	.181
SARC	-2.198	.605	.540	.111	-.209	-.017
SKAZ	.358	.370	-1.429	-.198	-.347	.063
UKOM	-.768	2.320	.571	.164	-.208	.366
WBUR	-1.642	1.128	-.110	-.148	.071	-.109
Model mean square	1412.89	758.10	376.97	27.03	18.26	
4.97						
F-ratio	12.841	12.228	12.310	1.673	2.261	.821
F-ratios have 19 and	3922	degrees of freedom				

APPENDIX G

Matrix Comparison between Geography and Crania

===== MXCOMP ===== 3/31/97 22:57 =====

X matrix: C:\WORDPERF\DOC\NOKOMI\GEONOKOM

type=2, size=12 by 12, nc=none

Y matrix: C:\WORDPERF\DOC\NOKOMI\NOARKOMI

type=2, size=12 by 12, nc=none

X matrix stored in RAM memory.

Y matrix stored in RAM memory.

N = 66

Mean X = 1543.74091 SSx = 40916831.81955

Mean Y = 6.17819 SSy = 957.05361

Tests for association:

Matrix correlation: r = -0.14573
(= normalized Mantel statistic Z)

Approximate Mantel t-test: t = -0.706
Prob. random Z < obs. Z: p = 0.2402

Out of 1000 random permutations:

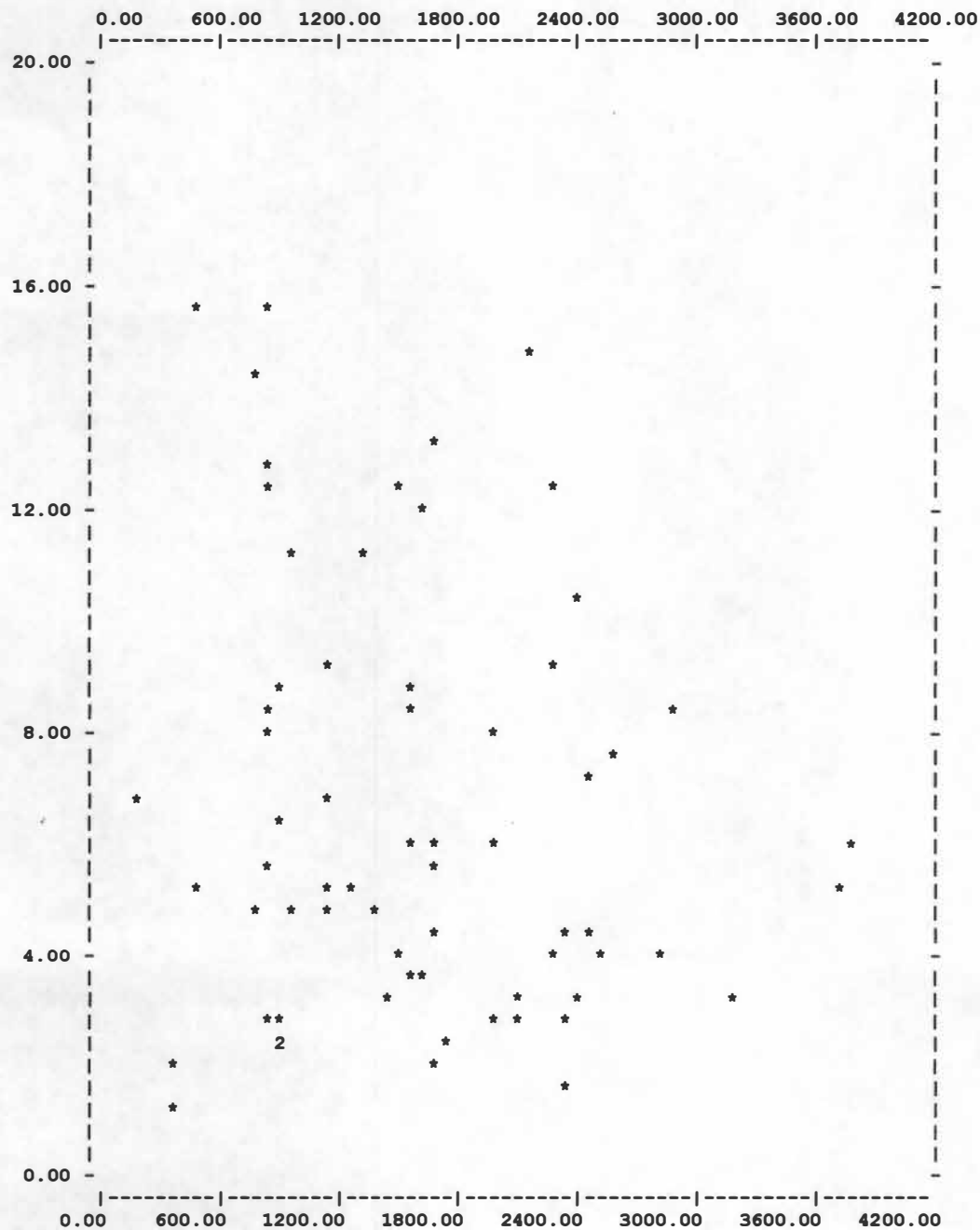
257 were < Z, 0 were = Z, and 743 > Z

(The observed comparison is not included in these counts.)

The one-tail probability is:

p[random Z <= observed Z] = 0.2580

APPENDIX G Cont.



APPENDIX H

Matrix Comparison between Geography and Serology

===== MXCOMP ===== 4/8/97 15:11 =====

X matrix: A:\GEOKPBL2

type=2, size=17 by 17, nc=none

Y matrix: A:\KPBLGEO

type=2, size=17 by 17, nc=none

X matrix stored in RAM memory.

Y matrix stored in RAM memory.

N = 136

Mean X = 1631.40000 SSx = 83903578.86000

Mean Y = 0.08485 SSy = 0.56483

Tests for association:

Matrix correlation: r = 0.09239
(= normalized Mantel statistic Z)

Approximate Mantel t-test: t = 0.971
Prob. random Z < obs. Z: p = 0.8342

Out of 1000 random permutations:

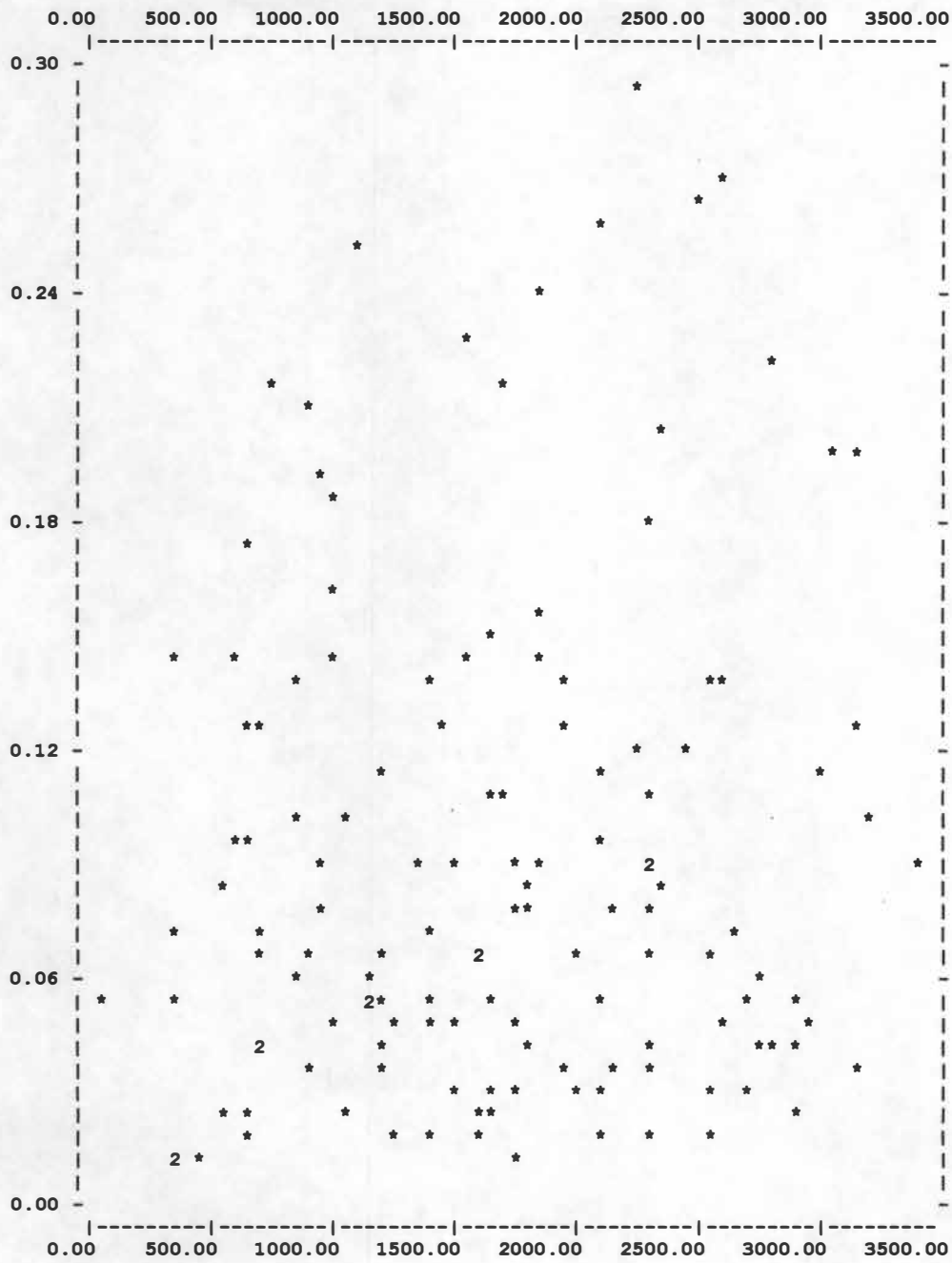
824 were < Z, 0 were = Z, and 176 > Z

(The observed comparison is not included in these counts.)

The one-tail probability is:

p[random Z >= observed Z] = 0.1770

APPENDIX H Cont.



APPENDIX I

Matrix Comparison between Geography and Finger Ridge Counts

```
===== MXCOMP ===== 4/8/97 15:17 =====  
X matrix: C:\WORDPERF\DOC\MXCOMP\GEOFP  
type=2, size=20 by 20, nc=none  
Y matrix: C:\WORDPERF\DOC\MXCOMP\FINDS  
type=2, size=20 by 20, nc=none  
X matrix stored in RAM memory.  
Y matrix stored in RAM memory.  
N      =      190  
Mean X = 1653.75316 SSx = 126021356.09311  
Mean Y =      0.69339 SSy =      32.04104
```

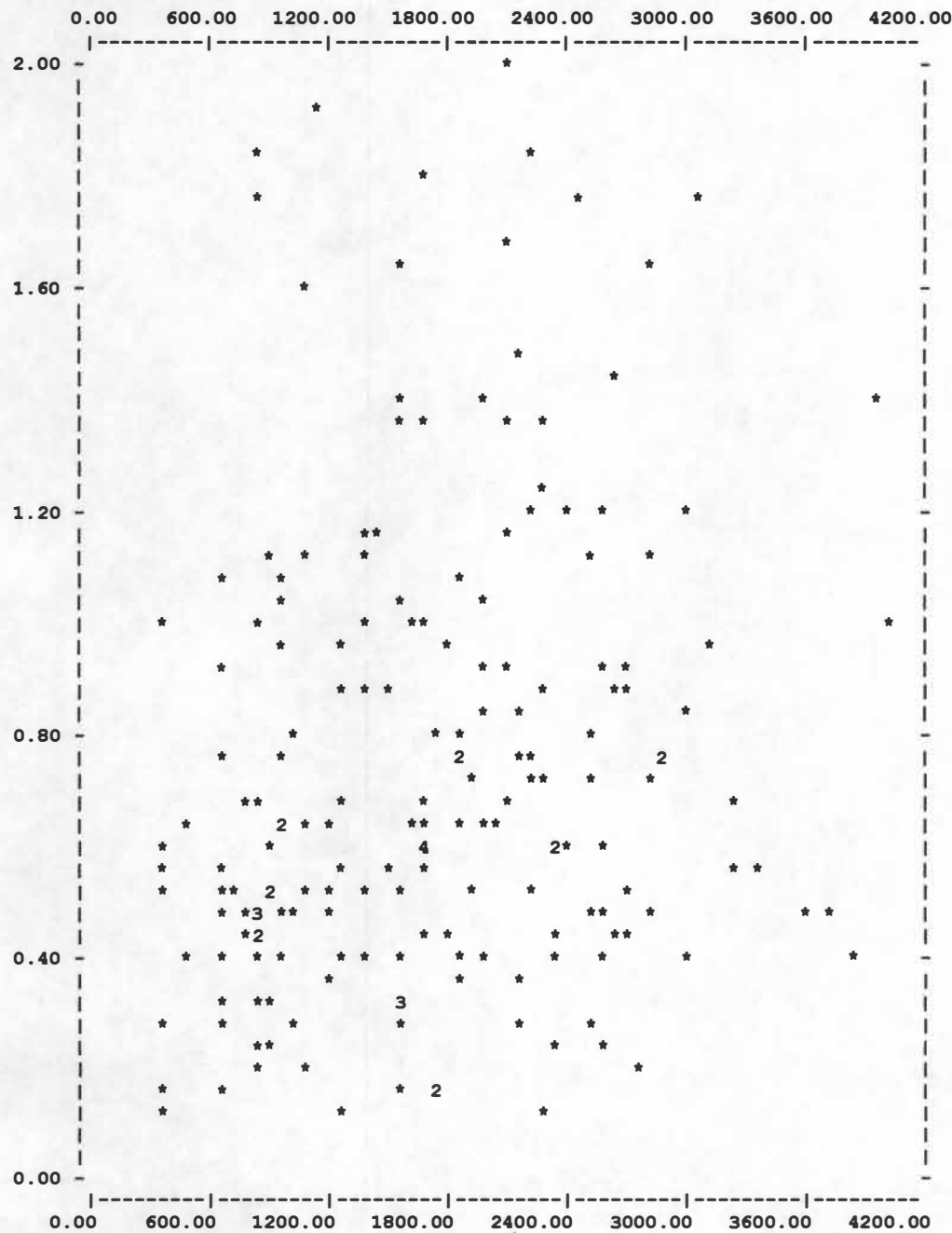
Tests for association:

Matrix correlation: r = 0.17471
(= normalized Mantel statistic Z)

Approximate Mantel t-test: t = 1.821
Prob. random Z < obs. Z: p = 0.9657

Out of 1000 random permutations:
 961 were < Z, 0 were = Z, and 39 > Z
(The observed comparison is not included in these counts.)
The one-tail probability is:
 p[random Z >= observed Z] = 0.0400

APPENDIX I Cont.



APPENDIX J

Matrix Comparison between Geography and Palm Ridge Counts

```
===== MXCOMP ===== 4/8/97 15:20 =====  
X matrix: C:\WORDPERF\DOC\MXCOMP\PALMDS  
type=2, size=20 by 20, nc=none  
Y matrix: C:\WORDPERF\DOC\MXCOMP\GEOPP  
type=2, size=20 by 20, nc=none  
X matrix stored in RAM memory.  
Y matrix stored in RAM memory.  
N      =      190  
Mean X =      0.51448 SSx =      32.95073  
Mean Y = 1645.34842 SSy = 125867869.51453
```

Tests for association:

```
Matrix correlation:      r =      0.01367  
(= normalized Mantel statistic Z)
```

```
Approximate Mantel t-test:  t =  0.134  
Prob. random Z < obs. Z:   p = 0.5532
```

Out of 1000 random permutations:

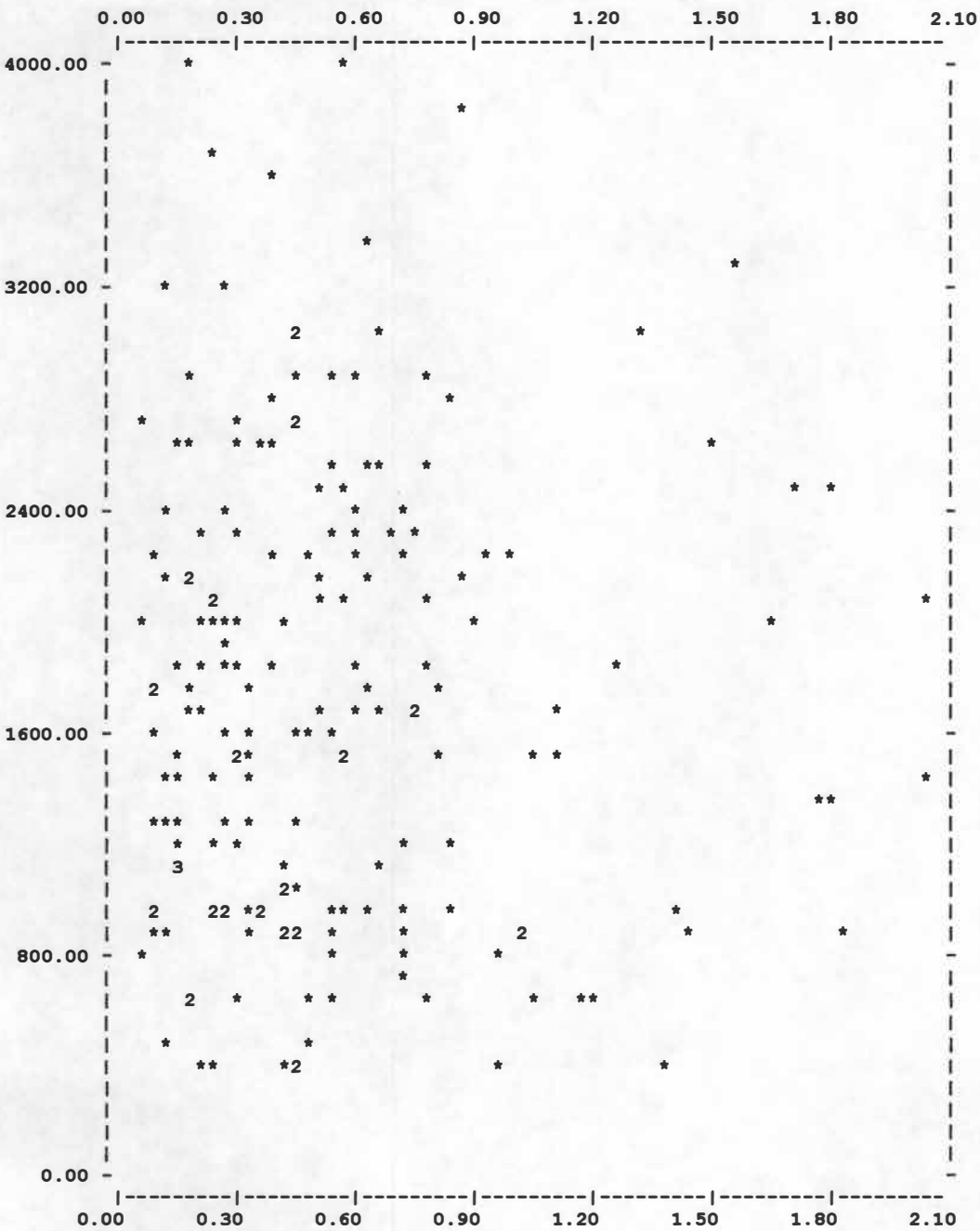
586 were < Z, 0 were = Z, and 414 > Z

(The observed comparison is not included in these counts.)

The one-tail probability is:

p[random Z >= observed Z] = 0.4150

APPENDIX J Cont.



APPENDIX K

Matrix Comparison between Crania and Blood

===== MXCOMP ===== 3/31/97 22:44 =====

X matrix: C:\WORDPERF\DOC\NOKOMI\KPBLNOK

type=2, size=8 by 8, nc=none

Y matrix: C:\WORDPERF\DOC\NOKOMI\NOKKPBL

type=2, size=8 by 8, nc=none

X matrix stored in RAM memory.

Y matrix stored in RAM memory.

N = 28

Mean X = 0.09157 SSx = 0.10264

Mean Y = 7.90119 SSy = 639.68872

Tests for association:

Matrix correlation: r = 0.71659
(= normalized Mantel statistic Z)

Approximate Mantel t-test: t = 2.317
Prob. random Z < obs. Z: p = 0.9898

Out of 1000 random permutations:

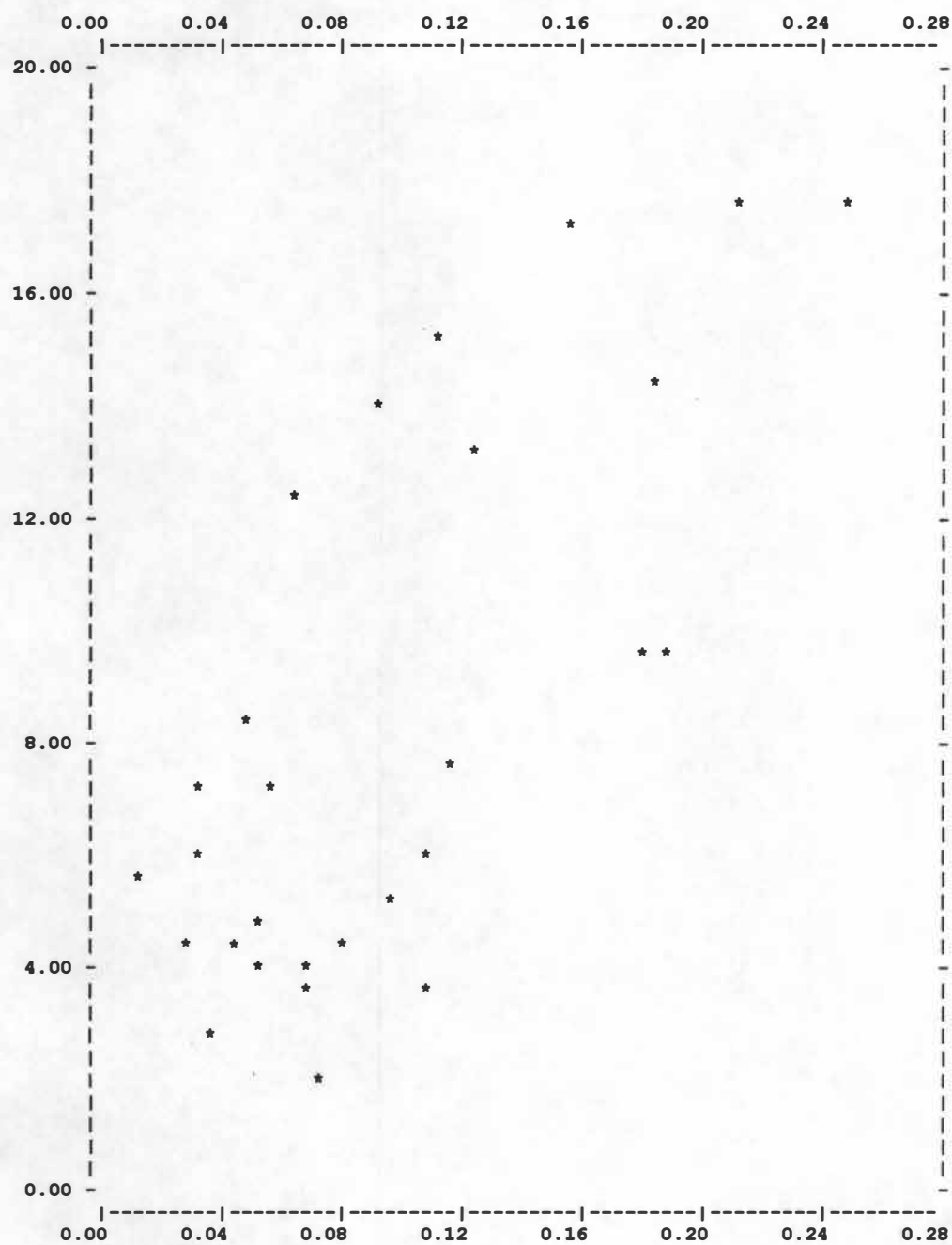
991 were < Z, 0 were = Z, and 9 > Z

(The observed comparison is not included in these counts.)

The one-tail probability is:

p[random Z >= observed Z] = 0.0100

APPENDIX K Cont.



APPENDIX L

Matrix Comparison between Crania and Finger Ridge Counts

===== MXCOMP ===== 3/31/97 22:51 =====

X matrix: C:\WORDPERF\DOC\NOKOMI\NOKOMIFP

type=2, size=8 by 8, nc=none

Y matrix: C:\WORDPERF\DOC\NOKOMI\FPNOKOMI

type=2, size=8 by 8, nc=none

X matrix stored in RAM memory.

Y matrix stored in RAM memory.

N = 28

Mean X = 6.30524 SSx = 452.20165

Mean Y = 0.89499 SSy = 7.79163

Tests for association:

Matrix correlation: r = 0.46144

(= normalized Mantel statistic Z)

Approximate Mantel t-test: t = 1.359

Prob. random Z < obs. Z: p = 0.9129

Out of 1000 random permutations:

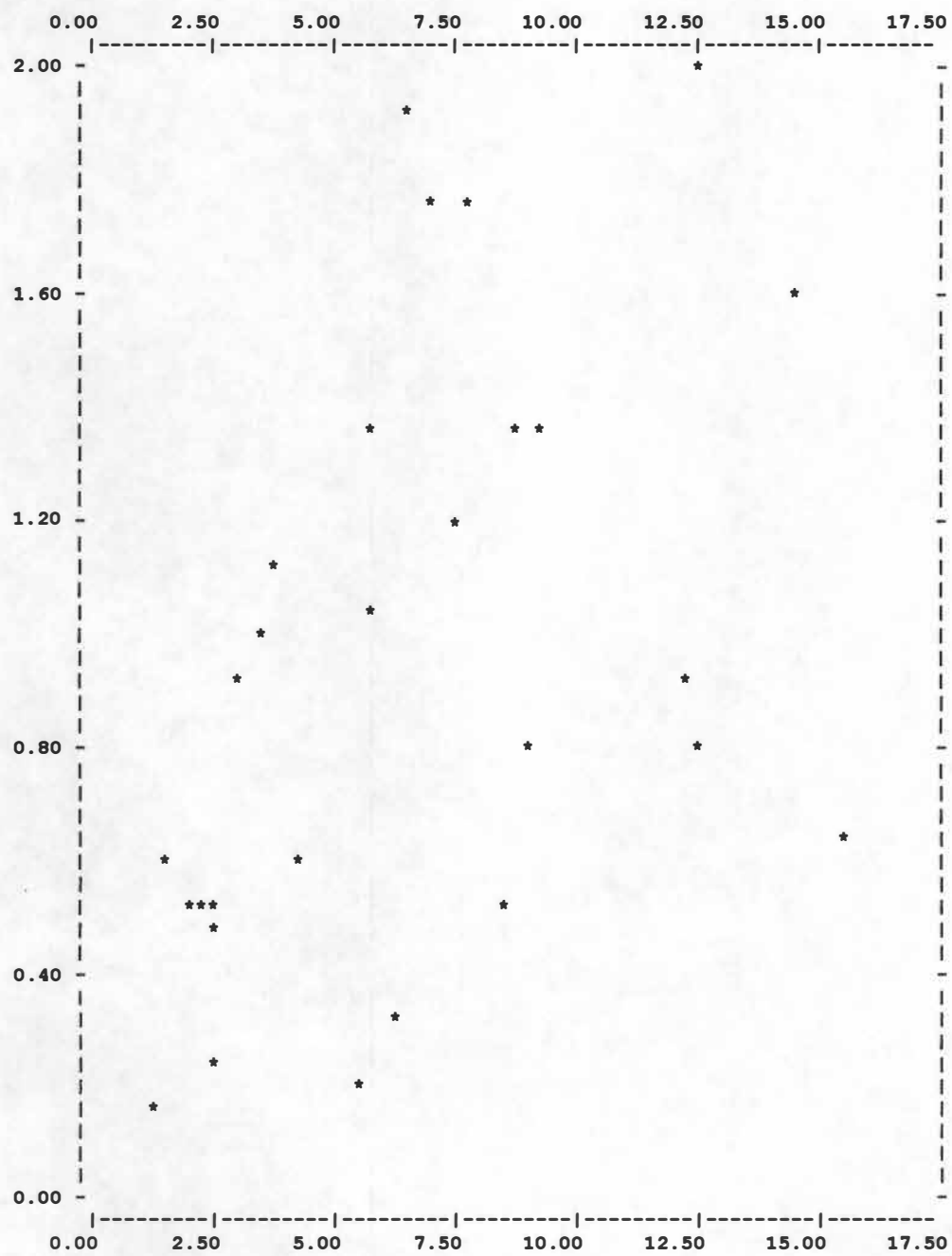
900 were < Z, 0 were = Z, and 100 > Z

(The observed comparison is not included in these counts.)

The one-tail probability is:

p[random Z >= observed Z] = 0.1000

APPENDIX L Cont.



APPENDIX M

Matrix Comparison between Crania and Palm Ridge Counts

```
===== MXCOMP ===== 3/31/97 22:48 =====  
X matrix: C:\WORDPERF\DOC\NOKOMI\NOKOMIFP  
type=2, size=8 by 8, nc=none  
Y matrix: C:\WORDPERF\DOC\NOKOMI\PMNOKOMI  
type=2, size=8 by 8, nc=none  
X matrix stored in RAM memory.  
Y matrix stored in RAM memory.  
N      =      28  
Mean X =      6.30524 SSx =      452.20165  
Mean Y =      0.35128 SSy =      0.87166
```

Tests for association:

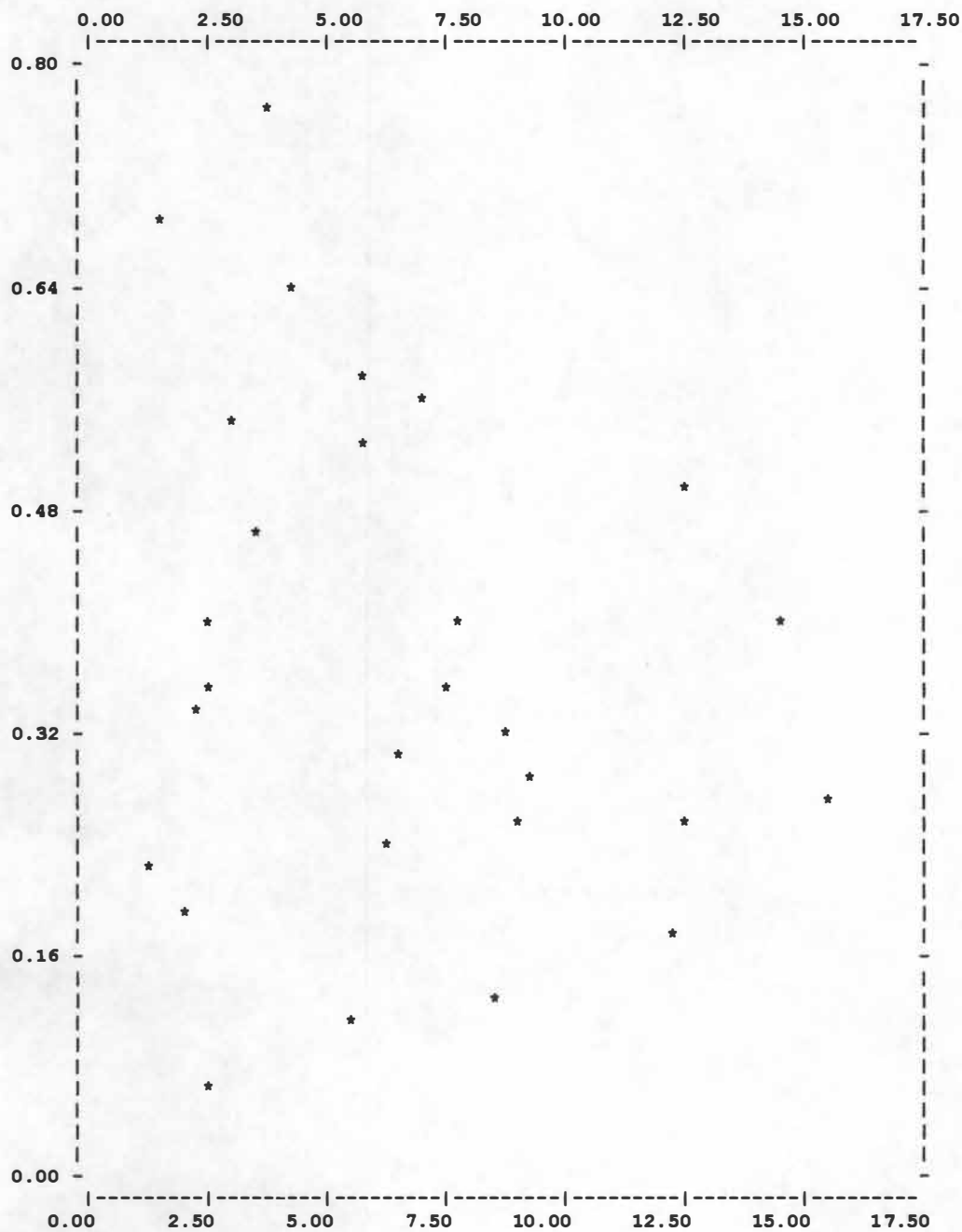
```
Matrix correlation:      r =      -0.20129  
(= normalized Mantel statistic Z)
```

```
Approximate Mantel t-test:  t = -0.768  
Prob. random Z < obs. Z:   p = 0.2214
```

Out of 1000 random permutations:

```
237 were < Z, 0 were = Z, and 763 > Z  
(The observed comparison is not included in these counts.)  
The one-tail probability is:  
p[random Z <= observed Z] = 0.2380
```

APPENDIX M Cont.



APPENDIX N

Matrix Comparison between Blood and Finger Ridge Counts

===== MXCOMP ===== 4/8/97 15:24 =====

X matrix: A:\KPBLFP2

type=2, size=11 by 11, nc=none

Y matrix: A:\FPKPBL2

type=2, size=11 by 11, nc=none

X matrix stored in RAM memory.

Y matrix stored in RAM memory.

N = 55

Mean X = 0.08851 SSx = 0.20033

Mean Y = 0.75309 SSy = 12.13007

Tests for association:

Matrix correlation: r = 0.42110

(= normalized Mantel statistic Z)

Approximate Mantel t-test: t = 1.943

Prob. random Z < obs. Z: p = 0.9740

Out of 1000 random permutations:

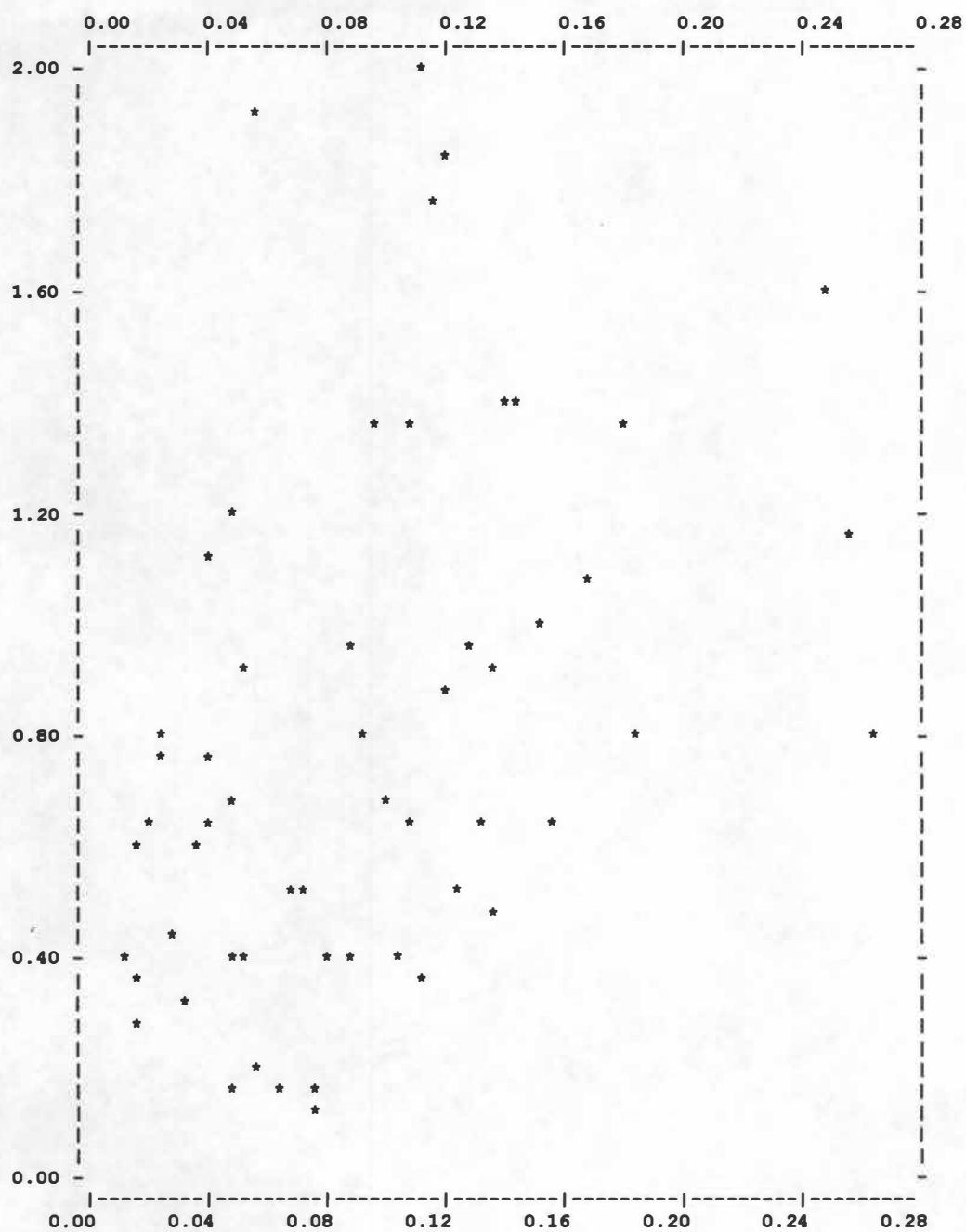
965 were < Z, 0 were = Z, and 35 > Z

(The observed comparison is not included in these counts.)

The one-tail probability is:

p[random Z >= observed Z] = 0.0360

APPENDIX N Cont.



APPENDIX O

Matrix Comparison between Blood and Palm Ridge Counts

===== MXCOMP ===== 4/8/97 15:25 =====

X matrix: A:\KPBLFP2

type=2, size=11 by 11, nc=none

Y matrix: A:\PPKPBL2

type=2, size=11 by 11, nc=none

X matrix stored in RAM memory.

Y matrix stored in RAM memory.

N = 55

Mean X = 0.08851 SSx = 0.20033

Mean Y = 0.41128 SSy = 2.67179

Tests for association:

Matrix correlation: r = 0.00129

(= normalized Mantel statistic Z)

Approximate Mantel t-test: t = 0.007

Prob. random Z < obs. Z: p = 0.5029

Out of 1000 random permutations:

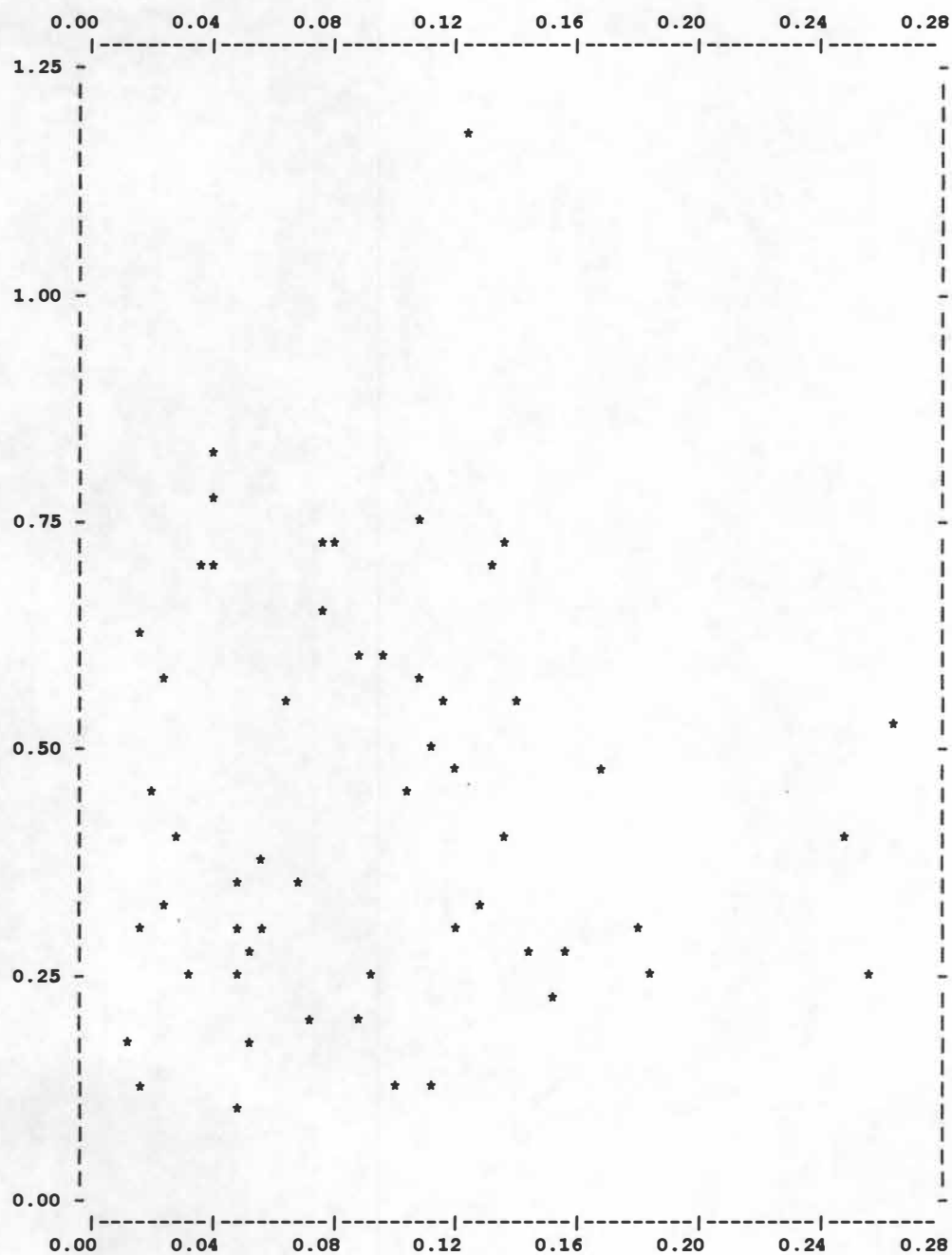
537 were < Z, 0 were = Z, and 463 > Z

(The observed comparison is not included in these counts.)

The one-tail probability is:

p[random Z >= observed Z] = 0.4640

APPENDIX O Cont.



APPENDIX P

Matrix Comparison between Finger and Palm Ridge Counts

===== MXCOMP ===== 4/8/97 15:28 =====

X matrix: C:\WORDPERF\DOC\MXCOMP\FPMTEST

type=2, size=20 by 20, nc=none

Y matrix: C:\WORDPERF\DOC\MXCOMP\PMFTEST

type=2, size=20 by 20, nc=none

X matrix stored in RAM memory.

Y matrix stored in RAM memory.

N = 190

Mean X = 0.69339 SSx = 32.04104

Mean Y = 0.51448 SSy = 32.95073

Tests for association:

Matrix correlation: r = 0.18344
(= normalized Mantel statistic Z)

Approximate Mantel t-test: t = 1.224
Prob. random Z < obs. Z: p = 0.8895

Out of 1000 random permutations:

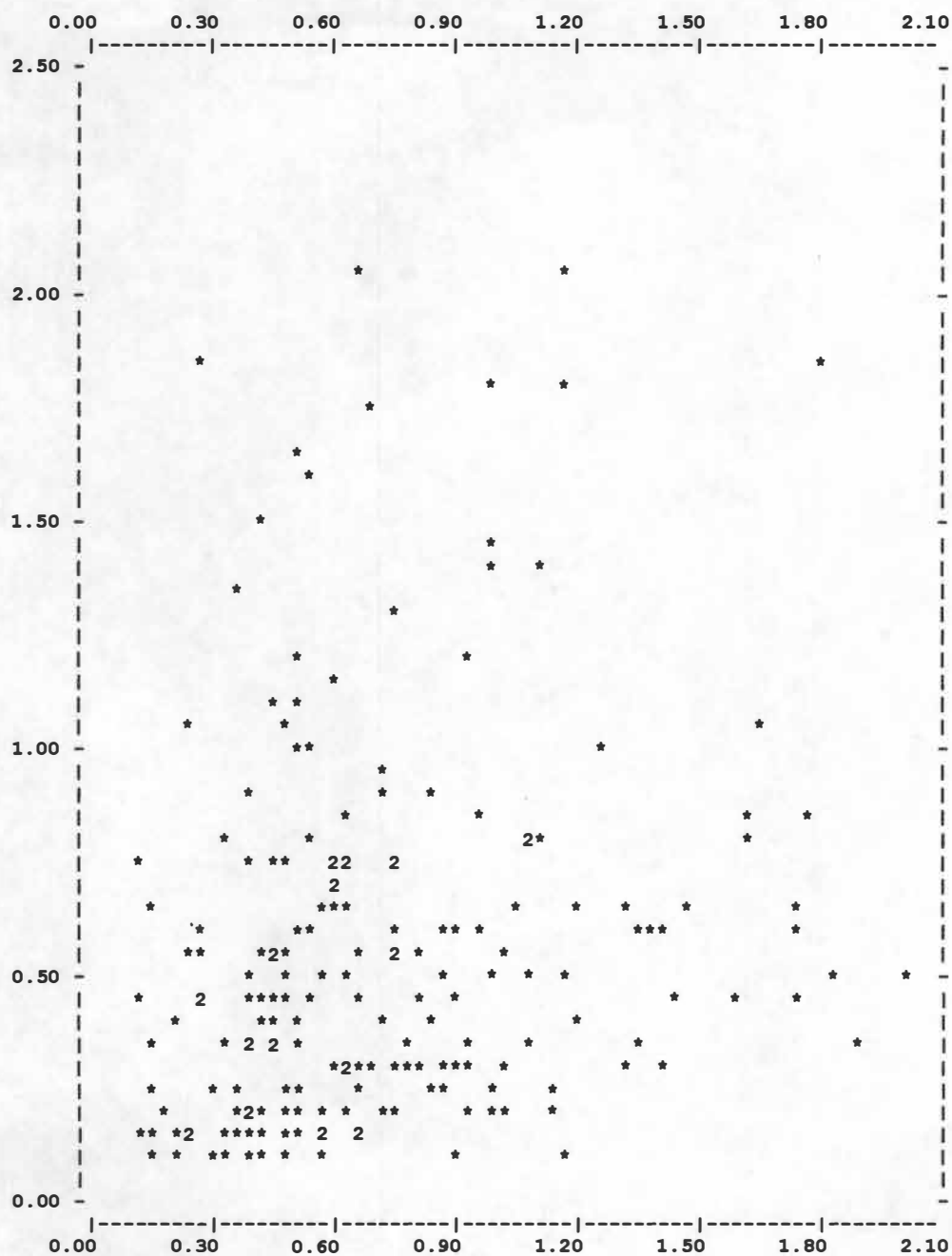
882 were < Z, 0 were = Z, and 118 > Z

(The observed comparison is not included in these counts.)

The one-tail probability is:

p[random Z >= observed Z] = 0.1190

APPENDIX P Cont.



VITA

Miyo Yokota was born in Kyoto, Japan on August 31, 1965. She attended Kyoto Women's University, Japan, majoring in literature in 1983. During her undergraduate work, she met a cultural anthropologist, received inspiration from his work, and became interested in studying cultural anthropology. After receiving her B.A. in 1988, she came to the United States to study anthropology at the Western Michigan University, MI. During her Master's program, her focus gradually shifted from cultural to biological anthropology. She received her M.A. in anthropology in 1991.

Miyo attended the University of Tennessee in 1992 to pursue her ph.D. in biological anthropology. Since then, she has been a graduate assistant for Dr. Richard Jantz in his dermatoglyphic research.