

SOCIOCULTURAL BIOLOGY:
STUDIES IN THE EVOLUTION OF SOME NETSILINGMIUT AND OTHER
SOCIOCULTURAL BEHAVIORS.

by

COLIN JOHN IRWIN
M.A. University of Manitoba, 1981

DISSERTATION

Submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in
Social Science in the Graduate School of Syracuse University

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This dissertation attempts to examine the causes of human prosocial and antisocial behavior as a phenomena of human nature and culture. However the thesis to be developed here begins with the premise that the nature/nurture dichotomy is essentially false. Culture, it is suggested, has evolved to advance life and is subject to a process of natural selection. This approach to an understanding of human nature, culture and behavior is termed sociocultural biology and is explored by analyzing three aspects of Eskimo sociality.

Firstly female infanticide amongst the Eskimo is shown to be a temperature dependent phenomenon. The principle evolutionary ultimate causes are identified as a combination of human birth sex ratio, sex role specialization, male mortality, environmental conditions and optimal foraging strategies. It is noted that the control of the Eskimo sex ratio is not accomplished by a physiological process but rather by a cultural proximate mechanism.

Secondly a brief review is made of the biological and cultural evolutionary theories that could contribute to an evolutionary analysis of kinship. By separating questions of "ultimate cause" from questions of "proximate cause" it is suggested that kinship can perform an instrumental role as a cultural proximate mechanism in the regulation of adaptive behavior. Correlations were found between these kin terms, associated normative behavior and adaptive behavior.

Thirdly it is suggested that aspects of ethnocentrism could be artifacts of our human evolutionary past when hunter/gatherers lived in small populations comprised of inbred demes. By applying the principles of kin selection the parameters for ethnocentric behavior are examined. Correlations were found to be present between cultural, genetic and behavioral variation consistent with the theory that cultural differences could have become proximate mechanisms for group behaviors.

In order to move beyond the limited sociality of the tribe it is suggested that nothing short of a revolution in human affairs must have taken place. Models are developed to help illustrate this sociocultural change. It is hoped that these models, and the theoretical perspective that support them, could possibly be developed to better understand subjects as diverse as descriptive morality and applied social science.

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CONTENTS

	Page
PREFACE	IV
LIST OF TABLES	VI
LIST OF FIGURES	VII
Chapter	
INTRODUCTION	1
I DATA AND DATA COLLECTION	10
II THE SOCIOCULTURAL BIOLOGY OF NETSILINGMIUT FEMALE INFANTICIDE	26
III THE SOCIOCULTURAL BIOLOGY OF NETSILINGMIUT KINSHIP	45
IV A STUDY IN THE EVOLUTION OF ETHNOCENTRISM	74
V SOCIOCULTURAL BIOLOGY: TOWARD THE STUDY OF NATURAL SOCIAL ENGINEERING	106
APPENDIX	154
BIBLIOGRAPHY	189

PREFACE

This dissertation attempts to examine the causes of human prosocial and antisocial behavior as a phenomenon of human nature and culture. However the thesis to be developed here begins with the premise that the nature/nurture dichotomy is essentially false. In this perspective culture is viewed as adaptive. Culture, it is suggested, has evolved to advance life and is subject to a process of natural selection. This approach to an understanding of human nature, culture and behavior is termed sociocultural biology and is explored by analysing some aspects of Eskimo sociality. From these studies of Netsilingmiut female infanticide, kinship and ethnocentrism, the possibility of applying such theory to the behavior of humans in complex modern populations is discussed.

The notion that culture is adaptive is neither original or new. However the force of this simple idea, that forms the basis of this thesis, was borne of my experiences amongst the Eskimo for whom culture is the key to their triumph over the Arctic environment. First and foremost then I must thank the Eskimo, particularly the Canadian Inuit, for the kindness and generosity they bestowed upon me with no thought of recompense. Without the stimulation of their beneficence this study would not have begun let alone reached completion. My Netsilingmiut wife Kunga was principally responsible for the collection and translation of the ethnographic materials and data, questionnaires, genealogies, mythologies and autobiographies. She also provided me with a first line on cognitive analysis whenever it was needed in the vain hope that I might become fluent in Inuktitut. My father-in-law, Kako and particularly my mother-in-law, Aupudluck must be thanked for patiently answering an unending series of frequently very tedious questions. They have no doubt advised all their friends against permitting their daughters to marry social scientists. The list of Eskimo who have taken me into their homes covers many of the extended families from the different tribes that line the Arctic coast from Alaska to Greenland, I must thank them all. However one person, Karmoyak of Cambridge Bay, deserves a special mention for respecting me as a younger brother when I needed the care and attention of an adopted son.

At the University of Manitoba my advisor Klauss Klostermier (Religion) and the other members of my interdisciplinary committee Michael Stack (Philosophy) and Joan Townsend (Anthropology) must be thanked for allowing me to pursue an interdisciplinary approach to questions of morality. For the same reason my advisor Donald Campbell (Schweitzer Chair) and Alexander Rosenberg (Philosophy) at Syracuse University with William Shields (Environmental and Forest Biology) of the State University of New York at Syracuse deserve special thanks for their toleration of my "Jack of all trades master of none" approach to scholarship. Additionally Paul Churchland at the University of Manitoba must be thanked for introducing me to the Evolutionary Epistemological work of Campbell. Further, without the hours and days of work that eventually grew into weeks, the empirical analysis in this thesis could not have been completed unless William Starmer (Biology) at Syracuse University had helped me write the computer programs needed to interpret my data.

The Inuit provided me with the questions and data, my committee members freely handed me the scholarship needed from their respective disciplines, but all this would have been left unused and undone without financial support. For my first two years at the University of Manitoba my wife paid my way by working as the Eskimo interpreter at the Winnipeg General Hospital in Manitoba. Since then my work has been supported by the Social Science and Humanities Research Council of Canada with a Masters Scholarship and Doctoral Fellowship as well as bursaries and loans from the Government of the Northwest Territories Department of Education. My field trips to the Canadian Arctic were paid for by the Northern Studies Committee at the University of Manitoba and last but not least the New York State Board of Regents Schweitzer Chair at Syracuse.

The people and institutions acknowledged here were all equally indispensable to the completion of this work. Had any of them not been there when needed this thesis would likely have never been brought to a conclusion.

LIST OF TABLES

	Following Page
1 Eskimo Juvenile Sex Ratio	27
2 Eskimo Adult Sex Ratio	27
3 Eskimo Sex Ratio in Greenland	27
4 Eskimo Demographic and Environmental Variables	28
5 Pearson's Product Moment Correlations	29
6 Netsilingmiut Cognates for the Taking of Human Life	37
7 Characteristics of Netsilingmiut Kinship Terms	52
8 Correlation Matrix	53
9 Distance/Relatedness for Occupants of Nunatsiaqput	58
10 Adult Interactants of Nunatsiaqput	60
11 Child Play Groupings and School Drop-Outs	62
12 Frequency Distribution of f in Nunatsiaqput	63
13 Some Netsilingmiut Terms of Kinship Adoption and Extension	63
14 Effective Population Size of Five Eskimo Tribes	89
15 Migration Rates Between Five Eskimo Tribes	90
16 Modeled Coef. of Consanguinity Within and Between Tribes	90
17 Variance in Dialect, Distance and Modeled Coef. of Consanguinity	94

LIST OF FIGURES

	Following Page
1 Map of Data Points for Female Infanticide	28
2 Variation of Girls/100 Boys with Annual Mean Temperature	29
3 Adult Interactants of Nunatsiaqput	60
4 Child Play Groupings	62
5 Frequency Distribution of f in Nunatsiaqput	63
6 Principle Eskimo Tribes to the West of Hudsons Bay	90
7 Modeled Coef. of Consanguinity Within and Between Tribes	90
8 Variance in Dialect, Distance and Modeled Coef. of Consanguinity	94
9 Genetic and Linguistic Change in a Stepping Stone Model	95
10 Innate Capacity for Cooperation and Competition	115
11 Innate Capacity for Cooperation and Competition in Humans	116
12 Individual Eskimo Sociogenetic Environment	116
13 Relative Fitness of Genotypes and Culturtypes	123
14 Genetic and Cultural Variation	123
15 Culturally Enhanced Eskimo Sociogenetic Environment	126
16 Modern Losses in Eskimo Sociogenetic Environment	133
17 Modern Additions to Eskimo Sociogenetic Environment	133
18 Eusocial Insect Sociogenetic Environment	135
19 The Evolution of Some Processes of Selection	136
20 Moral Matrix	141
21 Extended Moral Matrix	142
22 Moral Matrix for "Golden Rule"	143
23 Moral Matrix for "Treat All Men As Your Brother"	143
24 Nation State Moral Matrix	143
25 Muti-Racial Nation State Moral Matrix	143
26 Opposing Nation State Moral Matrix	143

INTRODUCTION

My experiences amongst the Eskimo (Irwin 1974), who have been described as a good natured and peaceful people (Briggs 1970), left me with the impression that there was not only a great deal of variability between the virtue of individuals but that this variability extended to groups of individuals, societies. This premise, no doubt colored by a 1960's youthful idealism, is of course challengeable. Some groups, at some period in their history may act genocidally toward an ethnic minority or a racially distinctive neighbor while other societies do not. In some societies a totalitarian aristocracy may have total freedom of action over a subjugated, enslaved work force, while, in other societies, the polarization of the classes may not be nearly so extreme. If these descriptions are correct then the premise has an existence in fact and this fact invites the question, why?

It is frequently argued that an individual may lack virtue due to a weakness of personality and character or absence of a loving childhood or moral education. However, this kind of explanation cannot begin to explain the immoral behavior of societies; between and within societies. If this question can be answered, then the possibility may exist to better engineer the social institutions men have created to minimize the misery man is able to inflict upon his fellow man. In brief, the question being formulated here is, why aren't humans nicer than they are and why are they frequently so maliciously nasty? But niceness and nastiness, virtue and immorality are both difficult to measure and define. Therefore, to avoid the complexities of metaethics and provide this study with variables that can be measured the question can be rephrased in terms of pro-social and anti-social behavior. To whom and why do humans frequently act pro-socially, that is, contribute to their well being? While, toward other humans, on other occasions, why are they indifferent or even anti-social, that is, detract from their well being?

The pursuit of "why?" questions in the social sciences leads to functionalism and functional explanations in the social sciences have a poor reputation because it is so easy to explain away almost any cultural phenomena as being adaptive. All too frequently many different adaptive explanations can be made up to rationalize the same phenomena with equal conviction and persuasion while being completely inconsistent. "Why?" questions are the essence of scientific inquiry, be it social, biological or physical science. Unfortunately asking "why" questions would appear to be easy while determining what constitutes an adequate answer to a "why" question is what makes science and the philosophy of science difficult. Rudner (1966) details ten steps required to providing a phenomenon with a functional explanation. These range from the description of the phenomenon through the description of the functional system of which it is a part, to a theory that explains the workings of that system. He concludes that these requirements are rarely if ever met in the social sciences principally due to the lack of comprehensive bodies of "respectable" theory.

If a unity of science view is taken of scientific theory, in which theories concerning a particular functional system are to be entrenched in high order theories, then, social science theories, theories about human social behavior, must necessarily be part of theories about life. It could be argued that humans are, in some special way, separate from life as life is understood by biologists. This point can be argued as a question of metaphysics; however the success of modern medicine is based on the premise that man can be understood as a biological phenomenon. The comparative failure of social science to mend man's social ills may therefore be traceable to the rejection of the biological premise. (For a philosophical analysis of these arguments see Rosenberg 1980.)

In comparison to the social sciences biology is dominated by a single comprehensive theory, Neo-Darwinian Evolution, adaptive change brought about by variation and natural selection. Biology, in the context of general evolution theory, is a stable paradigm, although, aspects of evolution theory are controversial and are

continually updated. One of the recent revisions may help overcome some of the problems of ambiguity of conflicting functional explanations. This revision recommends that a biological phenomenon have its historical evolutionary development incorporated into the description of the functional system of which it is a part. For example the fingers and thumb of the human hand could be explained as being part of an adaptive system for the manipulation of objects. But to explain why this is done with four fingers and an opposing thumb requires an examination of the fossil record associated with the evolution of limbs in the vertebrates. In like manner, answering more fundamental questions like, why should humans manipulate objects at all? may be helped by going deeper into the evolutionary record until, perhaps, the point is reached where animals separated from plants. This aspect of the analysis of adaptive function, termed teleonomics, is to be found in the work of Pittendrigh (1958), Williams (1966) and Mayr (1974).

Mayr perceptively understood that these kinds of enquiries into function were equally appropriate for explaining aspects of living organisms and human machines (Mayr 1974). Machines such as the automobile are designed to enhance locomotion so, for example, the design of the car's controls are directly traceable to the evolution of the human limbs, feet and hands, etc. Cars do not require for more than two foot pedals to be operated at the same time as humans only have two feet. However, what is true of machines may be equally true of culture. Humans cannot learn more than they are able to remember without the aid of learning machines (computers, books etc.) and what humans can know is severely restricted by the limitations of their senses (Churchland 1979). This may all appear very obvious, but as the evolutionary history of human pro-social behavior is examined, in the studies to be presented here, it will hopefully become clear that facts related to this evolution are far from being trivial.

In the study of human culture the importance of the historical dimension has frequently been given more attention in the humanities than in the social sciences. Such studies have spawned specialized methodologies such as the use of hermanutics in

tracing and describing the origins and processes of change in ideologies. These methods have had their influence on the social sciences, for example, historicism in the sociology of knowledge, but such analyses are far from the mainstream of contemporary studies. Historical descriptions of cultures and ideologies are provided with a theoretical framework, that can be a subset of the theory of evolution by natural selection, in theories of sociocultural evolution. This subject has been treated from broad perspectives, that seek to explain the major forces influencing the creation of cultural institutions associated with, politics, law and religion by, for example, Bellah (1970), Parsons (1977) and Campbell (1982). The intricacies of the processes of cultural evolution are to be found in the analyses of Pulliam and Dunford (1980), Boyd and Richerson (1980) and in the evolutionary epistemology of Campbell (1977). Genetic aspects of the evolution of human behavior are best described in the discipline of sociobiology reviewed by Wilson (1975) and Alexander (1979) with careful attention being given to the development of behavior by developmental biologists such as Bateson (1983). Lumsden and Wilson (1981, 1983) attempted a synthesis of some of these various aspects of the evolution of human behavior. However this attempt has probably failed due to their underestimation of the relative importance of cultural evolutionary forces (Boyd and Richerson 1983). Campbell (1983) may have come closer to a true synthesis of the sociobiological and cultural evolutionary aspects of human behavior than the other scholars mentioned above. However a single theoretical perspective may have to bring together questions of cultural and biological behavioral development, cultural and biological evolutionary history and the processes and mechanisms of cultural and biological change. This has not been done and even if it were accomplished such a theory could become so complex it may become impossible to work with as an applied thesis. This difficulty of complexity, the traditional separation of the biological and social sciences and philosophical or ideological, apriori, objections (Campbell 1979a, Alexander 1979) to the possibility of a complete synthesis

in areas such as ethics (for an exception to this see Burhoe 1981) places the application of evolution theory to human behavior and culture at the periphery of social science.

Finding an answer to the question, "Why aren't humans nicer than they are?" would seem to be caught between a traditional social science that has failed and an evolutionary social science that is too complex to succeed. This dissertation is therefore an attempt to "test the waters" of the evolutionary paradigm, with this question, in a number of focused studies selected for their possibility of success. If culture is a complex elaboration of the biological processes of human evolution this elaboration should be least complex and therefore most accessible to analysis amongst hunter/gatherer societies. Additionally, if a description of the evolutionary history of any phenomenon is an important step toward providing that phenomenon with a functional explanation, then, from this perspective, the most important event in human evolutionary history may have been the point at which culture first began to elaborate adaptive biological behavior and social structure. By researching the bio-cultural juncture amongst a hunter/gatherer society, where it is most clearly accessible to examination, it may be possible to splice the biological evolution of man to human cultural evolution. The eventual detailing of this critical link in human evolutionary development will hopefully allow for the functional analyses of any cultural phenomena with a depth traceable to genetics. Williams sums up the importance of the historical perspective as follows:-

"No complete explanation of a biological phenomenon can be achieved without an inquiry into its evolutionary development, and a teleonomic analysis would not proceed far without the use of historical data. The analysis would disclose much that is functionally inexplicable. The inversion of the retina, the crossing of the respiratory and digestive systems, and the use of the urethra for both excretory and male reproductive functions represent errors in the organization of the human body. They have no functional explanation but can be understood as aspects of functional evolution. Historical considerations are also necessary in explaining the many functionally arbitrary limitations that are always apparent in

the design of an organism: Why is man a mere biped and not a Centaur?

Williams 1966 pp. 263.

To these questions I wish to add; why is man so socially limited to the point of being anti-social? The rest of this dissertation is an attempt to make a number of studies directed to answering this question as it is manifest in the social behavior of a hunter/gatherer society, the Netsilingmiut. These studies, summarized below, also provide opportunities for illustrating what may eventually become elements in a comprehensive evolutionary theory of man.

In chapter 1 "Data and Data Collection" it is noted that the choice of which hunter/gatherer group to study was principally determined by the authors ten years of Arctic experience and marriage into a Netsilingmiut family now living in Hudson's Bay. The recent history of the Netsilingmiut, living in one of the most inaccessible regions of the Arctic, is sketched from the descriptions of Ross (1835), Boas (1907), Amundsen (1908), Rasmussen (1931), Balikci (1970) and Williamson (1974) and a contemporary settlement, Chesterfield Inlet, is profiled. It is suggested that the genetic, behavioral and cultural descriptions of the Netsilingmiut, needed for these studies, can be gained from interviews. With this point in mind the general problem of translation and reliability in the collection of verbal data is discussed and a methodology is developed that attempts to combine the benefits of polls and expert opinion. Data collection was begun in 1976 with the recording of life histories and myths. In 1980 Netsilingmiut normative ethics were described and central moral terms were cognitively analyzed. Finally in 1982, these "open ended" studies were expanded with the collection of detailed genealogies, focused interviews and "experiments" using ranking and other structured schedules of questions.

In chapter 2 "The Sociocultural Biology of Netsilingmiut Female Infanticide" an interdisciplinary analysis of Netsilingmiut female infanticide is made in order to demonstrate the explanatory power of theories that integrate the principle elements of sociobiology and cultural anthropology. Female infanticide amongst the Eskimo is

shown to be a temperature dependent phenomenon. This observation leads to an analysis of the behavior that identifies the principle evolutionary ultimate causes as a combination of human birth sex ratio, sex role specialization, male mortality, environmental conditions and optimal foraging strategies. It is noted that the control of the Eskimo sex ratio is not accomplished by a physiological process but rather by a cultural proximate mechanism. This mechanism, termed a coadaptive culturetype, is described as being comprised of culture traits that include a value, a rationalization, a cognate and a metaphysic. The benefits of these cultural proximate mechanisms over possible physiological counterparts are suggested to be a faster response time to environmental change and an overriding of phylogenetic inertia. Previous analysis of infanticide by biologists and cultural anthropologists have always neglected some of the elements of the description and explanation presented here. It is suggested that only a comprehensive analysis can provide sufficient understanding of these kind of human phenomena to make a predictive science of the study of man. Such a science might be termed sociocultural biology. If pursued it may, in principle, provide explanations for all the major beliefs, cognates, values and rationalizations of any culture.

In chapter 3 "The Sociocultural Biology of Netsilingmiut Kinship" a brief review is made of the biological and cultural evolutionary theories that could contribute to an evolutionary analysis of kinship. By separating "Why?" questions of "ultimate cause" from "How?" questions of "proximate cause" it is suggested that kinship can perform an instrumental role as a cultural proximate mechanism in the regulation of adaptive behavior. If this thesis is correct then kin terms, associated normative behavior and adaptive behavior should correlate. This hypothesis was tested empirically for the Netsilingmiut kinship system. Variation in a wide range of biological and cultural characteristics of kinship were found to significantly correlate. Socially instituted partnerships, adoption and kinship extension were also analyzed within the context of the same evolutionary theories. Given the success of this limited study it is suggested that further cross cultural analysis may eventually lead to a robust evolutionary theory

of kinship. It is concluded that the benefits of such a theory would be the use of a biological reference language that would not, a priori, define kinship. Additionally, both kinship, as a cultural phenomenon that communicates normative behavior through meaning, and realized adaptive behavior, would be explained by the same theory.

In chapter 4 "A Study in the Evolution of Ethnocentrism" an examination of the evolutionary history of human group behavior suggests that the phenomenon of ethnocentrism has a significant genetic component. This aspect of human nature is understood to be an artifact of man's evolutionary past when hunter/gatherers lived in natural human populations comprised of inbred demes. By applying the principles of kin selection to such a genetic environment, the parameters for ethnocentric group behavior are examined. It is hypothesized that cultural, genetic and behavioral differentiation are interdependent in such societies. This thesis was examined empirically amongst the Netsilingmiut, and their adjacent tribes, in the Central Canadian Arctic. Significant correlations were found to be present between these variables such that cultural differences could have evolved to become proximate mechanisms, or badges, for group behaviors. It is suggested that these mechanisms continue to function in ultrasocial societies that have abandoned inbreeding. In this way the genetic component of ethnocentrism can continue to be a pervasive force in the development of behaviors in modern populations. Through a fuller understanding of the evolution and individual development of ethnocentrism it is hoped that this frequently destructive human trait can be better controlled.

Finally in chapter 5 "Sociocultural Biology: Toward the Study of Natural Social Engineering" it is suggested that in order to understand the failings of human sociality it may be necessary to adopt a perspective that can combine human sociobiology with the more traditional approaches used to study sociocultural behavior. An attempt is made to sketch out what could possibly develop into a synthesis of sociobiological and cultural evolution theory. It is suggested that such a theoretical approach to the study of human behavior would eventually have to take account of

several poorly understood aspects of human evolution such as: (1) Human evolutionary history including the sociogenetic structure of hunter-gatherer populations. (2) The proximate mechanisms of human sociality. (3) The processes of cultural evolution. While attempting to keep these points in mind, a review is made of what are probably the principal Netsilingmiut sociocultural adaptations that may contribute to enhanced cooperation in their society. In order to move beyond the limited sociality of the tribe to ultrasociality it is suggested that nothing short of a revolution in human affairs must have taken place. Models are developed to help illustrate the enormity of this sociocultural change. These models, and the theoretical perspective that support them, could possibly be of value in developing a better understanding of subjects as diverse as descriptive morality and applied social science. This chapter, and the dissertation, concludes with a brief discussion of these issues.

As well as describing the biological and cultural elements that go into formulating an evolutionary/functional analyses of the phenomena cited in these studies, the studies, hopefully, make steps toward a true synthesis of human biological and cultural evolution. That theory, with all its necessary detail, is far from complete. However such a perspective, that would take as its founding premise the idea that culture is subject to the same evolutionary forces as biology, and is therefore essentially a biological phenomenon, could be termed sociocultural biology. Unlike much of the recent work in sociobiology such a theory would endeavor to take full account of the instrumental role culture plays in the evolution, development and control of human behavior.

Chapter 1

Data and Data Collection

The Netsilingmiut

As participant observation is an important element in ethnographic research the choice of which hunter/gatherer society to study was made for me by virtue of the fact that I had spent almost ten years amongst the Eskimo (Irwin 1974) and my wife is Netsilingmiut. The Eskimo first migrated from what is now Siberia to the North American Arctic as much as seven to nine thousand years ago (Giddings 1967, Bandi 1969). The Netsilingmiut traditionally lived to the north of Hudsons' Bay, on the coast of the Arctic Ocean in the vicinity of King William Island and Boothia Peninsula. This region of the Arctic, even by Polar standards, is considered to be inaccessible and inhospitable so that the first contact this tribe had with westerners was with explorers in search of the Northwest Passage. The ill fated Franklin Expedition probably had contact with the Netsilingmiut, but the first explorer to reach these people and live to tell of them was Ross (1835). In the 19th century the Netsilingmiut traded indirectly with the Hudsons' Bay Company and whalers through trade with their Eskimo neighbors to their south (Rasmussen 1930a). In the 20th century they began to make their own expeditions to trading posts in Hudsons' Bay in an effort to cut out the "middle man" (see maps Figures 1 & 6). The economic benefits of this trade were so great that in the 1920's approximately a third of the Netsilingmiut, including my wife's grandparents, migrated to the west coast of Hudsons' Bay permanently. The Netsilingmiut were described by the explorer Amundson (1908) and the anthropologist Boas (1901, 1907) prior to this migration and by Rasmussen (1930a, 1931) after the migration. In the mid 1960's the Canadian government began to provide housing, schooling and nursing services for the Eskimo at the established trading posts and missionaries. Balikci (1970), with the cooperation of Father Van de Velde (who also has a doctorate in

anthropology) made a series of documentary films on the Netsilingmiut (Balicki 1966) just prior to their settlement. Since the acculturating events of the 1960's, that effectively marked the beginning of the end of their traditional nomadic way of life, the Netsilingmiut who migrated to Hudson's Bay were studied by Williamson (1974).

The traditional Netsilingmiut numbered approximately 500 men, women and children (Boas 1907, Rasmussen 1930a,1931) and occupied their hunting grounds with a population density of only 1 in 200 square miles. Today they are the predominant tribe in six Arctic settlements, three on the Arctic Ocean coast at Pelly Bay, Spence Bay and Gjoa Haven and three in Hudson's Bay at Repulse Bay, Chesterfield Inlet and Rankin Inlet. Small numbers of Netsilingmiut are to be found in five adjacent settlements, Cambridge Bay, Eskimo Point, Coral Harbour, Igloolik and Baker Lake. I first began to live and hunt with the Netsilingmiut in Cambridge Bay in 1971 and traveled between this settlement, Gjoa Haven and Spence Bay in 1972 (Wake 1973) and to Pelly Bay and Repulse Bay in 1973 (Irwin 1974). My wife's family live in Chesterfield Inlet and although data for this dissertation was collected there, cultural ethnographic material from the whole region contributed to the data base. Studies completed in different communities have been attributed to the single fictitious settlement of Nunatsiaqput, created to provide a degree of anonymity for the informants.

My wife's home of Chesterfield Inlet is typical of a small contemporary Arctic community. It is therefore given a brief description here as being representative of the social environment in which these studies were completed. (The principle source for this description is the N.W.T. Data Book, Devine 1982).

Location, 63° 21' N, 90° 2' W. On a low, narrow coastal strip, sandy to gravelly land surrounded by low granite outcrops, and inland lakes.

Climate, Average annual precipitation:14.9cm rainfall, 112.9cm snowfall. July mean high 12.9°C, low 4.4°C. January mean high -28.1°C, low -35.6°C.

Settlement History, In 1912 a Hudson's Bay Company post was built to take advantage of the local white fox trade and a mission was established by Father Turquetil. The Oblates completed a hospital in 1931 along with a Grey Nun convent which was expanded to include an old peoples home in 1938 and boarding school in 1954. The school provided an education for many catholic school children from all over the Central Canadian Arctic. The government took over responsibility for the delivery of medical and educational services in each settlement in the region in 1970. Since this time the mission has been in decline. After the introduction of permanent housing for the Eskimo in the late 60's and 70's (totaling 43 units by 1982) the community was given local political powers with Hamlet status in 1980.

Demography, (For 1980). Population, 281. Sex distribution, 48.4% male, 51.6% female. Age distribution; 0-4, 11.7%; 5-14, 28.5%; 15-64, 56.9%; 65+, 2.9%. Approximate median age, 18. Ethnic distribution, 94.3% Eskimo, 5.7% other. Languages spoken, Inuktitut and English.

Economy, apart from work provided by the hamlet council, Hudson's Bay Company and Co-op stores, housing association, school and mission the major activities are hunting, fishing, trapping and carving. Renewable resources include char, trout, white fish, seal, walrus, beluga, caribou, fox, wolf and a 1981 quota of 8 polar bear.

Infrastructure, Transportation and Communication, Power is supplied by a 650 kW. diesel generator. Water is chlorinated and delivered by tank truck to each house. Newer housing units are now constructed with pumpout tanks for sewage, older houses use bagged facilities. Weekly air services are provided by light aircraft to the regional administrative center of Rankin Inlet (Population 980 in 1980). Most freight and supplies are delivered once a year by a tug and barge operation that, amongst other essentials, brings in approximately 1.5 million litres of diesel for power and heating and 0.25 million litres of gas. Communications are available through the Anik satellite for telephone, one radio and one T.V. channel. The nearest Royal Canadian Mounted

Police are stationed at Rankin Inlet. Medical services are provided from the single nurse, nursing station. The mission hospital, run by the Grey Nuns, is now the St. Amants Center for the Handicapped and Retarded.

Education, In 1981 the school employed four teachers from southern Canada and two local Eskimo classroom assistants. The number of children in grades K-6 were 77 and in grade 7 and up, 5. After grade 9 the children have to go to a regional center for higher education.

Data Required

A theory that attempts to develop a synthesis of the sociobiological and cultural perspectives on human nature will have to demonstrate the existence of relationships between genetic, environmental, behavioral and cultural variables. The studies presented here will therefore require data collection on these variables as they are expressed amongst the Netsilingmiut population. Environmental parameters such as temperature, precipitation, sea ice cover and hours of sun light are all available from various government publications. Variables in the genetics of populations, such as the coefficient of relationship, can be computed from known mating behavior represented by genealogies and migration rates. In the absence of the observation of these behaviors it is necessary to rely on the reports of these behaviors from informants, either newly collected or taken from the ethnographic reports of other anthropologists. As the verbal reports of informants must be relied upon for data on mating behavior there can be little objection to the collection of other behavioral and cultural data using the same methods. However these methods are subject to the difficulties inherent in translation and the accuracy of reporting. This problem will be dealt with in general below, but is given further attention, in each study, where specific data requirements use tailored methods. Some of the studies require data on the behavior, genetics and culture of the Netsilingmiut as these variables were expressed prior to their settlement in permanent communities. In this case the confirmation and elaboration of previously collected ethnographies can provide an indispensable source of otherwise inaccessible data. The

principle ethnographies used were those of Boas(1901, 1907), the 5th Thule Expedition (Birket-Smith 1928, 1929 and Rasmussen 1930a, 1930b, 1931) and Balikci(1970).

The Translation and Reliability of Data

If the verbal reports of behavior are to be used in place of the observation of behavior those reports must be understood with emic meaning. For example, parentage by adoption or reincarnation must be distinguished from biological parentage, if genetic genealogies are to be drawn up. The Netsilingmiut moral system may be considered to be an interdependent set of functional beliefs that relate cognates, values, metaphysics and mythology to events and actions. From this perspective descriptions of that system would have to be made with Netsilingmiut meaning, at least in so far as that is possible (Quine 1960). This can be accomplished by acquiring a holistic perspective on the culture through participant observation or, in other words, assimilating native meaning by "going native." Additionally careful linguistic analysis can be used to dissect the field of meaning of key terms using the methods of cognitive anthropology.

This linguistic work was begun in 1980 for my masters thesis, Inuit Ethics and the Priority of the Future Generation. Initially, with my wife as a bilingual informant, using cognitive techniques such as taxonomies, domain analysis, ranking and componential analysis, key moral terms were identified. However these terms lacked descriptive meaning that was eventually made accessible using an open ended method developed by Boehm (1980). He summarizes the problem of translation and his solution as follows:-

Special epistemological problems arise when exotic systems of ideas and affects are studied by a foreigner. Difficulties in knowing "the native view" are discussed, and a partial solution for this epistemological problem is proposed. Exemplification through substantive semantic analysis of a key morality term used by Montenegrin tribesman results in a descriptive portrait of the moral self. In contrast to certain trends in ethnographic semantics, which are antiseptically formal, overstructured, unduly selfcontained, or static, emphasis here is placed upon open-ended semantic inquiry and fuller articulation with the general ethnographic context by

taking native decisions and social processes into direct account.

Boehm 1980.

Although my wife helped considerably with the early linguistic work, the collection of data and the almost endless translation of stories and myths, she could not, as a bilingual informant, be relied upon for folk definitions (Werner & Campbell 1970). In practice, when these definitions were solicited from bilingual informants, they nearly always gave a straight translation term which turned out to be far removed from the traditional emic understanding. However, Boehm's methodology of numerically tabulating the occurrence of themes in a large sample of definitions was not completely followed either.

In the Eskimo culture, authority, knowledge and wisdom rest with the oldest generation. If a younger person was asked what a certain ethical term meant, they sometimes ventured an answer but more frequently expressed their lack of expertise in the matter and referred me to one of the elders of the community. Thus, in collecting the definitions of those considered to be the "sages" of the village, both the consensus and the authority of the community was taken into account. As it turned out, these few venerated informants, who took time to teach me in a professor/student relationship, were most consistent in their responses. This perhaps reveals a flaw in Boehm's methodology as it uses an etic epistemology of consensus by numeration. Of course this may have been valid amongst the Montenegrins, but among the Eskimo, an appeal to the authority of the elders is the correct epistemology. In short, while using emic folk definitions the accuracy of those definitions is discerned by emic standards of truth.

Emic standards of truth can be continued to be used in many of the inquiries to be made here. In effect this is the difference between establishing knowledge by means of a poll and establishing knowledge by means of expert opinion. If the Netsilingmiut were continuing to live a traditional life then the poll method may have still been appropriate. Rasmussen sampled up to 50 percent of the population on various issues in 1922. However, only a few persons now remain alive from that era and thus by having

these informants clarify, validate, contradict and add to Rasmussen's findings, a combination of poll and expert opinion methodology is created.

Data Collection

The ethnographies of the explorers and anthropologists mentioned earlier, coupled with my own experiences in the Arctic, provided a data base that could be elaborated to address the specific questions raised in the studies presented here. This data collection began with an open ended, unstructured approach in 1976 that was followed up with increasingly focused data collection in 1980 and 1982.

The restraints of interview schedules rarely allow for the informant to lay bare the motives and state of conscience of themselves and others in regard to morally sensitive events. It is not sufficient to merely know when and under what circumstances A killed B, or A refused to share his food with B. From an ethical point of view it is necessary to know if A thought he was acting rightly or wrongly and how he felt about the moral predicament he was in. This important but subjective aspect of the research is dependent on the honesty and openness of the informant. On these points I was able to record the autobiographies of Aupudluck and Kako. In 1976 my mother in law, Aupudluck, related her life history to her daughter, my wife. Aupudluck is by nature a very open person, such that in this mother/daughter situation she laid bare all her values, hopes and fears as she was confronted with the difficult situations of her life. Her husband, Kako, who has a more reserved personality, gave a more factual account of his life. It too is a remarkable story but, unlike Aupudluck's account, it does not provide a holistic perspective of the world view that shapes Eskimo morality. Kako however did provide more than fifty myths that deal nearly exclusively with questions of ethics and cosmology. For him they are historical stories of a distant past, a "Golden Era" of superlative events. Some of these myths and brief excerpts from Aupudluck's autobiography are to be found in the studies that follow.

In 1980 a cognitive analysis was made of the key concepts in Eskimo ethics using the elders of Chesterfield Inlet as informants. These were Kako, Aupudluck,

Hugeak, Ipiak, Samutuk and Egalak. They also answered extensive questions on moral issues such as infanticide, suicide, murder, taking animal life, care for environment, cannibalism, sharing limited resources and capital punishment. The results of this work, Aupudluk's autobiography and some of Kako's myths are to be found in my master's thesis (Irwin 1981). On the question of continuity of sources it is worth noting that my father-in-law met Rasmussen or "Kunoo" as he is known to the Eskimo in 1922. At the time Kako was nine years old. It is also worth noting why my father-in-law patiently instructed me in Eskimo ethics and related issues. I might have thought it was to preserve a body of knowledge before it was lost with the passing of his generation, or because the research institutes I worked for provided me with the funds to bring my family, including his daughter, to visit him at his home. However, he carefully explained to me that he was giving me all the help he could because I was now providing for his daughter and grandchildren and that by contributing to my success at university he was advancing the well being of his progeny. Although I didn't realize it at the time, this was my first lesson in the Eskimo ethic that gives priority to the future generation (Irwin 1980).

In 1982 the limited number of elderly informants (four) at Chesterfield Inlet were expanded by including the 8 elders of Repulse Bay. Three of these informants were Netsilingmiut, and one each was Kanimiut, Ukusiksalingmiut, Kingimiut, Igloolingmiut and Ivilingmiut. These informants provided detailed genealogical data (principally my mother and father-in-law) and answered a structured interview schedule to cross validate questions focused at specific issues raised in the studies. Additionally, younger informants were asked specific series of questions directed toward the composition of hunting, visiting and play groups. One of the biggest problems in drawing up an interview schedule may not be considering what questions address what problems, but rather what questions phrased in what ways are informants likely to give honest answers to. This may be particularly true of sensitive moral issues. Therefore, in

order to come to terms with this problem the tentative interview schedule was put through the following refinement process.

(1) The interview schedule was run through completely with my Netsilingmiut wife for an initial collection of data.

(2) The questions were rephrased in order to eliminate misunderstandings and ambiguities generated through translation.

(3) The questions were organized into those that were appropriately male and female categories by Netsilingmiut standards of sex domain.

(4) The two schedules so formed were reordered to place the most entertaining subjects first and the most sensitive issues last.

(5) My wife went through the female schedule with her mother as informant and I went through the male schedule with my father-in-law as informant.

(6) Both schedules were revised to minimize the effects of embarrassing issues bringing a halt to the interview process.

(7) The new schedules were then used amongst the four elderly informants in Chesterfield Inlet. These data were analyzed and the schedule further revised.

(8) The revised schedule was used amongst the elderly men and women of Repulse Bay.

(9) All the data was further analyzed and additional data were collected in Chesterfield Inlet.

The results of these interviews are often cited in the studies as references to field notes in which case the collective opinion or description obtained in the interviews is the source of the ethnographic data. By way of illustrating the character of this data base the following interview is reproduced as an example.

Sample Interview

Location: Repulse Bay. Date: October 7th 1982

(1) Q. What are your names and who were you named after?

A. My names are Marke and Tungrilik. I was named after my fathers step brother.

(2) Q. Sex and Age?

A. Male. I am older than Aupudluck (approximately 80), Aupudluck is very young compared to me. Tavok (same age as Kako, approximately 69) is younger than me.

(3) Q. Who were your parents?

A. My father was Saumik and my mother was Kiaksak.

(4) Q. Where were you born.

A. Just before Spence Bay at a place called Netsilik.

(5) Q. Who were your brothers and sisters?

A. My older brother (deceased) was Ulikatok. My younger brother, Mangomakslak, died near Netsilik lake. Ukuk Itingruarut was my older sister.

(6) Q. What is your wife's name?

A. Angugatsiak.

(7) Q. What was her tribe?

A. Igloodikmiut, her father was Palia.

(8) Q. How many children do you have and what are their names?

A. I have five children, Morrice, Theresa, Pukuk, Roland and Tiaksuk.

(9) Q. Were any of your children adopted by you or by someone else?

A. None of our own children were adopted but we adopted Utuk, Saumik and Kativaunuk.

(10) Q. Who were they adopted from?

A. One each from Lukie's brother, Theresa and Pukuk.

(11) Q. Where did you live on the land before you were married?

A. Netsilik.

(12) Q. Who were the people you camped with then?

A. Isukuk, Sukork, my father's uncle Usuliak, Kaukoktok and Upsuktout.

(13) Q. Where did you live on the land after you were married?

A. Around Repulse Bay, which we called Ukusiksalik then, for the first three years.

(14) Q. Who were the people you camped with then?

A. Sannuktuk and his older brother Tavok, Inuksatuajuk, Kumagut and his older son Amagrarlik and younger son Iktugreleguk.

Q. How did you get along without many close relatives around?

A. We had lots of fun. Inuit don't fight each other but before I was born they were as bad as the white people.

(15) Q. Who did you have to listen to before you were married?

A. Only my parents.

(16) Q. Who did you have to listen to after you were married?

A. My older brother while he was alive.

(17) Q. How did they share the meat in the old days when you lived on the land?

A. When they used to camp with all their relatives they would build their igloos. Then they would take their meat to the biggest igloo and share the meat there by cutting off a piece as it was passed around.

(18) Q. Is the way people share meat today different?

A. Today it is very different. If you put a piece of meat on the floor they cut a piece off and eat it by themselves.

(19) Q. What relatives were you not allowed to talk to?

A. There used to be a lot, some have died and some are still alive. It's O.K. to talk to uncles and aunts but not to Idlukuark (some one you can not talk to or about), Ike (opposite sex sister or brother-in-law) and some non-relatives.

(20) Q. Can you tell any old stories about war with indians?

A. No, but I heard that Tunrit had a war with the Inuit. The Tunrit were half white, they were very strong and lifted enormous rocks.

(21) to (25) were questions about wars with Indians and were left out because of the negative response to question (20).

(26) Q. Can you tell any old stories about war between Inuit?

A. I have heard of such wars between tribes who were our ancestors.

(27) Q. Who was fighting?

A. The Netsilingmiut and Sinimiut.

(28) Q. Where were they fighting?

A. At a place called Ithuuktokvik, on the other side of Netsilik.

(29) Q. Who got killed?

A. Only the men.

(30) Q. What happened to the women and children?

A. The ones that got left behind used to go to their relatives and be looked after there.

(31) Q. Why did they fight?

A. When either of these groups visited each other and a visitor got killed then they would fight for revenge.

(32) Q. Before the white man came could anyone own the land?

A. The land did not belong to anyone. The people hunt seals on the ice in winter and go to hunt at different places at different times. No one owned the land, it was there for the hunters.

(33) Q. Before the white man came could anyone own the animals and fish.

A. The animals didn't belong to anyone when they were alive. Only when they were dead did they belong to the hunter.

(34) Q. Who did the fish traps belong to?

A. When people make a fish trap more than one person would make it. They would catch fish in it and anyone who came along could fish there.

(35) Q. Who did the caribou crossings belong to? (Note, went directly to question 36.)

(36) Q. What happened to someone who wanted to keep a hunting place like a fish trap?

A. If there was a greedy man the people would get angry at him. Men might fight with him in a match in which they would take turns to hit each other on the shoulder and temple. They might even kill the greedy man and fish in his trap.

(37) Q. What happened when people from another tribe came to fish at a trap that was being used by the people who had always lived and fished there?

A. Such a thing would have been very dangerous a long long time ago. If a stranger, from a different tribe, came into the camp the people might kill the person from the distant land. That is why life could be frightening in those days.

(38) Q. How were arguments between men settled?

A. If two men disagreed with each other they might ignore each other and say nothing. But after a while they might say something directly to each other and then they would have a boxing match by taking turns to hit each other on the shoulder and temple. After that they would get along well again.

(39) Q. Did your people trade with other Inuit tribes before the white man came?

A. I don't know, possibly, but those people were very very poor. Their only belongings were parts of animals and skins. They had nothing to trade.

(40) (Q. This general hunting question replaced by question 41 to 43.)

(41) Q. Before the white man and rifle which tribe were best at hunting seals on the ice in winter?

A. In the winter time I have hunted seals at Oksoktok, Ukusiksalik, Netsilik and Ugulik. From all the places I have been to on the ice the Arviliquarmiut were best.

(42) Q. Before the white man and rifle which tribe were best at hunting sea mammals in open water in the summer?

A. The Naujamiut, the people from Repulse Bay.

(43) Q. Before the white man and rifle which tribe were best at hunting carabou in the summer?

A. The Arviliquarmiut.

(44) Q. What are Itlureet (translation - ritual cousins)?

A. Itlureet were people who were not from the same place. When they saw each other they had friendly competitions, for fun.

(45) Q. Did you or your father or grandfather have an Itluk?

A. No.

Q. Did you ever know two Itlureet?

A. I missed my only chance to see two such men. It was my only chance and I regret missing them. They were a Kitdlinermiut and a Netsilingmiut. I was in an igloo and didn't know they were having a contest. They were Itloktutiyuk (verb of Itlureet).

(46) Q. What were their names and tribes?

A. The Netsilingmiut was Sutuklook and the Kitdlinermiut was Megitgark.

(47) Q. How did they become Itlureet?

A. The Netsilingmiut lost that time, he got a bleeding nose. Perhaps the Kitdlinermiut was using his shamanistic abilities to have more power. The Kitdlinermiut heard the Netsilingmiut was strong and the Netsilingmiut heard the Kitdlinermiut was strong so they became Itlureet. They were the strongest of each tribe.

(48) Q. What did they do when they met? (Note, answered above.)

Q. Did they have a song contest as well?

A. Yes.

Q. Do you know any of those songs?

A. I forgot them but Tavok would know some.

(49) Q. Did all young men, in those days, have to find an Itluk?

A. Yes, everyone had to have one long before I was born, but not anymore.

(50) Q. What was wrong with not having an Itluk?

A. Nothing.

(51) Q. What were all the tribes who had Itlureet?

A. Kidtlinermiut, Netsilingmiut. When a person was traveling from another land and when the people heard of this a man might say, "My Itluk is coming." When the traveler arrived they would have a contest. When they first met they would try to box each other with blows to the shoulder and temple. Then they would have a drum dance and song contest. Then they were officially Itlureet. The first strength contest introduced the men to each other and gave them something to ridicule their opponent about in the song contest. Thus, in their second and subsequent meetings, they would sing songs to each other, about each other.

(56) Q. Did Oksoktomiut, Netsilingmiut, Sininmiut, Arvilikjuarmiut (Netsilik subtribes) and other tribes intermarry in the old days?

A. In the old days Sininmiut, Netsilingmiut, Arvilikjuarmiut and Oksoktomiut were really very different tribes. Theresa (referring to interviewer's wife) is Netsilingmiut and my father has seen her grand father when they were little children. Oksoktomiut could marry Netsilingmiut and vice versa, they married each other. More recently they could marry Igloolingmiut and Kingimiut but I don't think they could in the old days.

(52) Q. Many people used to kill themselves in the old days. Why did they do this?

A. If their husbands or children died they would commit suicide.

(53) Q. Why do you think white men have wars?

A. I think they fight each other because there are so many of them. Perhaps a person from their country was murdered and then they made war for revenge.

Q. Could killing the baby girls reduce the number of Inuit?

A. Yes, but they killed them because they didn't have much and were starving. They used to kill the girls, only the baby girls.

(54) Q. Why do you think the Inuit didn't have wars?

A. Because there aren't enough Inuit, that is why we don't have wars. There are so many white people. If their leader says "make war" then they have war!

(55) Q. Is there anything I forgot? Is there anything you would like to add?

A. Nothing.

Chapter 2

The Sociocultural Biology of Netsilingmiut Female Infanticide

Introduction

The Arctic environment is so actively hostile to life that the Eskimo found that they must not only adapt their technology for hunting, clothing and shelter to the needs of survival, but that they must also tailor their social relationships and beliefs to the same needs (Rasmussen 1931, Weyer 1932, Balikci 1968). In the traditional culture the most unfortunate of these adaptations was the killing of approximately 50 percent of all baby girls for the Netsilingmiut (Boas 1901, Rasmussen 1931). This high rate of female infanticide invites numerous moral, social and biological questions.

Sex ratio manipulation by means of infanticide is a well documented and much discussed topic in both sociobiology and cultural anthropology. In particular, female infanticide has received special attention by students of hunter gatherers such as the Eskimo. By combining previous studies with some new data in an analysis of systematic female infanticide among the Netsilingmiut an attempt will be made to demonstrate how both cultural anthropology and sociobiology are indispensable to a causal understanding of such phenomena, at least, in so far as cause can be determined. This interpretation attempts to integrate these disparate perspectives on human nature by taking account of both the evolutionary ultimate causes and the cultural proximate mechanisms of human behavior. Questions about the proximate mechanisms of behavior can be characterised as being "How?" questions while ultimate causes can be understood as "Why?" questions. The "Why?" of Netsilingmiut female infanticide will be addressed first.

Ultimate Cause

Biologists have attempted to apply theories of individual selection (Fisher 1930) and kin selection (Trivers and Willard 1973) to the problem of adjusting human sex ratios in order to maximize reproductive success. If these or other evolutionary theories cannot explain the infanticide data presented here then reservations about the prospects for human sociobiology may be well founded, in as much as the Eskimo, given their circumstances, must be considered a triumph of human adaptability.

Female infanticide amongst the Eskimo has been reported by many anthropologists, ethnographers and explorers (Jackson 1880, Nelson 1899, Smith 1902, Boas 1907, Stefansson 1914, Jennes 1922, Rasmussen 1927, Birket-Smith 1929, Weyer 1932). It has even been reported as a rare contemporary phenomenon through female infant neglect (Williamson 1974). The ratio of girls to boys given in Table 1 imply that female infanticide was common, although to varying degrees across Arctic North America. These figures were compiled by Weyer (1932) from data collected by Smith (1902), Boas (1907), Hansen (1914), Jennes (1922), Birket-Smith (1928, 1929) and Weyer (1932). The figures given in Table 2 show how the situation of more boys than girls is turned around in the adult population to give more women than men. These data, also compiled by Weyer (1932), were collected by Boas (1888, 1907), Smith (1902), Hansen (1914), Stefansson (1914), Jennes (1922), Birket-Smith (1928, 1929), Mathiassen (1928) and Weyer (1932). This reversal is due to a subsequent high mortality rate among young male hunters inexperienced in the techniques of Arctic survival (Nansen 1893, Mauss & Beuchat 1904-5, Bilby 1923, Birket-Smith 1928). This observation is further supported by additional data (Table 3) on the sex ratio of Eskimo populations in Greenland which show a female bias, irrespective of age, due to a combination of high male mortality and low rates of female infanticide (Weyer 1932). These figures are compiled from population statistics collected by Birket-Smith (1928). Weyer tells us that:-

"The death rate among young men is especially high;
within the period dealt with by Bertelsen, proportionally four

Table 1

Eskimo Juvenile Sex Ratio

<u>Location or Tribe</u>	<u>No. of Girls</u>	<u>No. of Boys</u>	<u>Girls/100 Boys</u>
1 Cape Prince of Wales (Weyer 1932)	46	50	92
2 Cape Smyth (Smith 1902)	14	27	52
3 Bernard Harbour (Jenness 1922)	18	21	86
4 Netsilingmiut (Boas 1907)	66	138	48
5 Sinamiut (Boas 1907)	7	12	58
6 Sauniktumiut (Boas 1907)	33	41	80
7 Qaernermiut (Birket-Smith 1929)	11	24	46
8 Coast Padlimiut (Birket-Smith 1929)	26	31	84
9 Interior Padlimiut (Birket-Smith 1929)	20	28	71
10 Hauneqtormiut (Birket-Smith 1929)	10	13	77
11 Harvaqtormiut (Birket-Smith 1929)	15	23	65
12 Qaenermiut (Boas 1907)	27	38	71
13 Aivilikmiut (Boas 1907)	15	27	56
14 N. Greenland exclusive of Thule (Birket-Smith 1928)	773	803	96
15 South Greenland (Birket-Smith 1928)	1106	1058	104
16 East Greenland (Birket-Smith 1928)	117	118	99
17 East Greenland (Hansen 1914)	128	99	129

Table 2
Eskimo Adult Sex Ratio

<u>Location or Tribe</u>	<u>No. of Females</u>	<u>No. of Males</u>	<u>Females/100 Males</u>
1 Cape Prince of Wales (Weyer 1932)	29	30	97
2 Cape Smyth (Smith 1902)	52	45	116
Cape Bexley (Stefansson 1914)	10	19	53
3 Bernard Harbour (Jenness 1922)	42	46	91
4 Netsilingmiut (Boas 1907)	123	119	103
5 Sinamiut (Boas 1907)	13	13	100
6 Sauniktumiut (Boas 1907)	58	46	126
7 Qaernermiut (Birket-Smith 1929)	30	25	120
8 Coast Padlimiut (Birket-Smith 1929)	28	22	127
9 Interior Padlimiut (Birket-Smith 1929)	31	25	124
10 Hauneqtormiut (Birket-Smith 1929)	18	13	129
11 Harvaqtormiut (Birket-Smith 1929)	21	17	123
12 Qaernermiut (Boas 1907)	46	35	131
13 Aivilikmiut (Boas 1907)	34	26	131
Igloolingmiut (Mathiassen 1928)	161	146	110
Baffin Island (Boas 1888)	119	111	107
14 N. Greenland exclusive of Thule (Birket-Smith 1928)	2321	2918	115
15 South Greenland (Birket-Smith 1928)	2801	2421	116
16 East Greenland (Birket-Smith 1928)	234	211	111
17 East Greenland (Hansen 1914)	175	146	120

Table 3

Eskimo Sex Ratio in Greenland for Total Population

In 1923 (Birket-Smith 1928)

<u>Location or Tribe</u>	<u>No. of Females</u>	<u>No. of Males</u>	<u>Females/ 100 Males</u>
Upernivik	586	523	112
Umanak	731	682	107
Godhavn	188	170	111
Ritenbenk	296	284	104
Jacobshavn	324	271	120
Christianshaab	284	271	105
Egedesminde	<u>807</u>	<u>772</u>	<u>105</u>
Total North Greenland West Coast	3198	2973	108
Holstensborg	401	413	97
Sukkertoppen	696	580	120
Godthaab	644	612	105
Frederikshaab	493	417	118
Julianehaab	<u>1837</u>	<u>1583</u>	<u>116</u>
Total South Greenland West Coast	4071	3605	113
Total West Coast	7269	6578	111

and a half times as many men of the age group thirty to thirty-five died as did within the same age-group in Denmark. This enormous rate of mortality among younger men is due primarily to the dangers of their hunting activities. Drowning in kayaks is the fate of many. In South Greenland in 1889 the death rate among males from this cause alone was 9.3 per thousand male population, or almost as high as the death rate from all causes in the United States in recent years."

Weyer pp.127-128, 1932.

Thus male mortality may be a contributing cause to the practice of Eskimo female infanticide but such a conclusion would in turn require a causal explanation that would probably be environmental. In traversing the North American Arctic by dog team (Irwin 1974) I became aware of great heterogeneity of the environment. This led me to the hypothesis that severity of environment might be related to differences in the rate of infanticide. Figure 1 maps the data points from tables 1 and 2 where figures are available for both the child and adult sex ratio. Two features of the environment seem likely to be related to severity in producing a high death rate among young hunters. These are probably low temperatures, and lack of light during much of the year. As hunters the Eskimo are dependent on the abundance of game. The size, distribution and population density of caribou, birds and trout are dependent on plant life whose growth is restricted by low temperature and limited sunlight. The availability of sea mammals is also restrained by temperatures, as this effects sea ice cover which in turn limits access to whales and walrus which unlike seals do not make and maintain winter breathing holes. Table 4 compiles the data used for the observation points given in figure 1 along with annual mean temperature (U.S. Dept. of Commerce 1965, Orvig 1970), latitude (which is an index of available sunlight), and an index of the change in sex ratios between the child and adult populations. This index, biased by a higher male mortality than female mortality, was generated by subtracting girls per 100 boys from adult females per 100 males. The index is therefore dependent on a function of its composite variables and should be regarded with some suspicion as errors in the originating variables will show up in the new variable to produce correlated error between these three variables. However it does not follow that any correlation found

Table 4

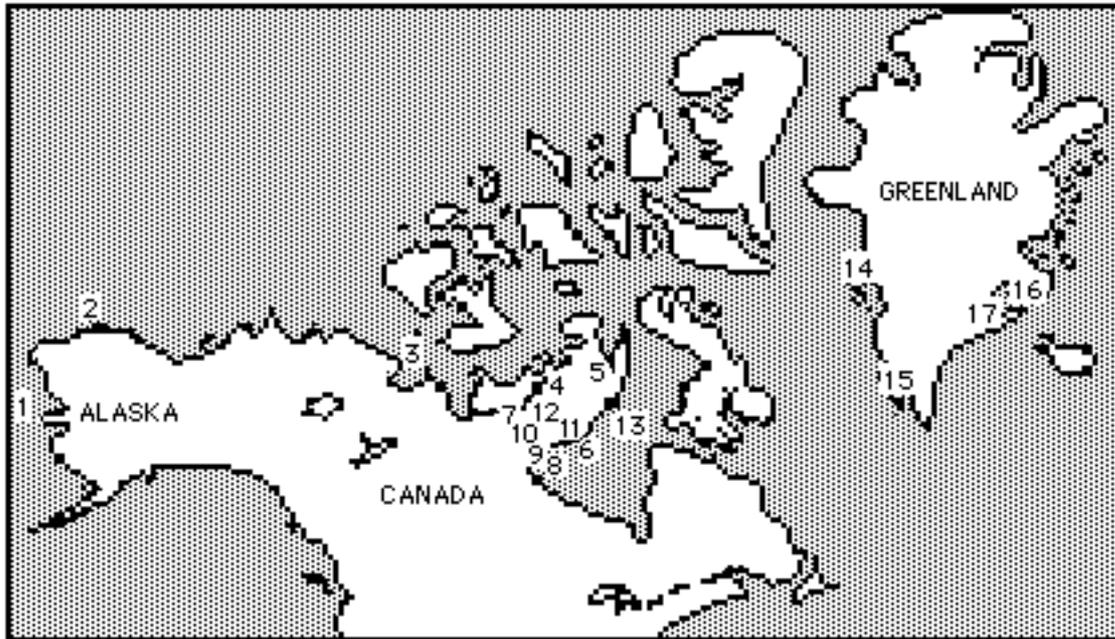
Demographic and Environmental Aspects of Eskimo Megapopulation
Location (Loc), Girls/100 Boys (Girl), Females/100 Males (Fem), Annual Mean
Temperature (Temp), Male Mortality Index (Mort), Latitude (Lat).

<u>Loc</u>	<u>Girl</u>	<u>Fem</u>	<u>Temp</u>	<u>Mort</u>	<u>Lat</u>
1	92	97	-4.9	5	65.5
2	52	116	-12.5	64	71.5
3	86	91	-11.5	5	67.8
4	48	103	-13.7	55	69.5
5	58	100	-13.7	42	69.5
6	80	126	-11.3	46	63.4
7	46	120	-11.9	74	64.3
8	84	127	-9.1	43	61.0
9	71	124	-9.1	53	61.0
10	77	129	-11.9	52	64.3
11	65	123	-11.9	58	64.3
12	71	131	-11.9	60	64.3
13	56	131	-11.1	75	66.5
14	96	115	-3.9	19	70.0
15	104	116	+1.8	12	61.0
16	99	111	-0.4	12	66.0
17	129	120	-0.4	-9	66.0

Table 4B, Averaging of Geographically Grouped Data Points From Figure 1.

<u>Loc</u>	<u>Girl</u>	<u>Fem</u>	<u>Temp</u>	<u>Mort</u>	<u>Lat</u>
1	92	97	-4.9	5	65.5
2	52	116	-12.5	64	71.5
3	86	91	-11.5	5	67.8
4	53	102	-13.7	49	69.5
(4 & 5 above)					
5	71	126	-11.0	55	63.2
(6,7,8,9,10,11 & 12 above)					
6	56	131	-11.1	75	66.5
7	107	116	-0.7	9	66.0
(14,15,16 & 17 above)					

FIGURE 1



DATA POINTS FOR FEMALE INFANTICIDE

between these variables is entirely unavoidable. If mortality was not sexually biased, if males and females died at approximately the same rates, then the difference between the child and adult sex ratios would be zero. In this case there would be no correlation of mortality with the sexually biased juvenile sex ratio created by female infanticide except for that generated by correlated error. However there is no correlated error between the male mortality index and the geophysical/environmental variables such that correlations between the male mortality index and temperature or latitude are available for analysis and interpretation. Another potential difficulty with the data is Galton's problem (Naroll & Cohen 1970), created by the geographic grouping of the observation points. This difficulty can be overcome by averaging the data for the Netsilingmiut sub populations, observations 4 and 5, the group of points on the west coast of Hudson's Bay, observations 6 to 12, and the Greenland observations, points 14 to 17. This data set is given in Table 4B and Pearson's product moment correlations for all the variables from both data sets are given, in Table 5, with levels of significance.

The most significant results are obtained for the correlation of juvenile sex ratio, annual mean temperature and the mortality index giving coefficients significant at the $p < 0.001$ for the 17 observation point data set (Figure 2). However this significance is only maintained at the $p < 0.01$ level for the 7 observation point data set for the juvenile sex ratio with temperature and mortality. The adult sex ratio also significantly correlates with mortality and latitude for the 17 point data set at the $p < 0.04$ level, but the adult sex ratio/latitude correlation drops out at the $p < 0.554$ level for the 7 point data set. Thus low temperature, as an index of the harshness of the environment, would seem to be one of the probable ultimate causes of female infanticide among the Eskimo. One might have expected the male mortality index to correlate still higher with temperature, since the hypothesized causal chain, is from harsh environment to male mortality to female infanticide. This index is, however, of poor quality, containing the errors of both of its source indices. The very low correlations with latitude is probably due to the warm ocean currents that flow north around Alaska and Greenland, providing

Table 5

Pearson's Product Moment Correlations

For Data Given in Table 4 & 4B

From Table 4, 17 Observations

<u>Variables</u>	<u>Correlation</u>	<u>Significance p<</u>
Girl/Fem	-0.069	0.792
Girl/Temp	+0.852	0.001
Girl/Mort*	-0.885*	0.001*
Girl/Lat	-0.254	0.325
Fem/Temp	-0.065	0.804
Fem/Mort*	+0.525*	0.030*
Fem/Lat	-0.502	0.040
Temp/Mort	-0.757	0.001
Temp/Lat	-0.248	0.338
Mort/Lat	-0.018	0.946

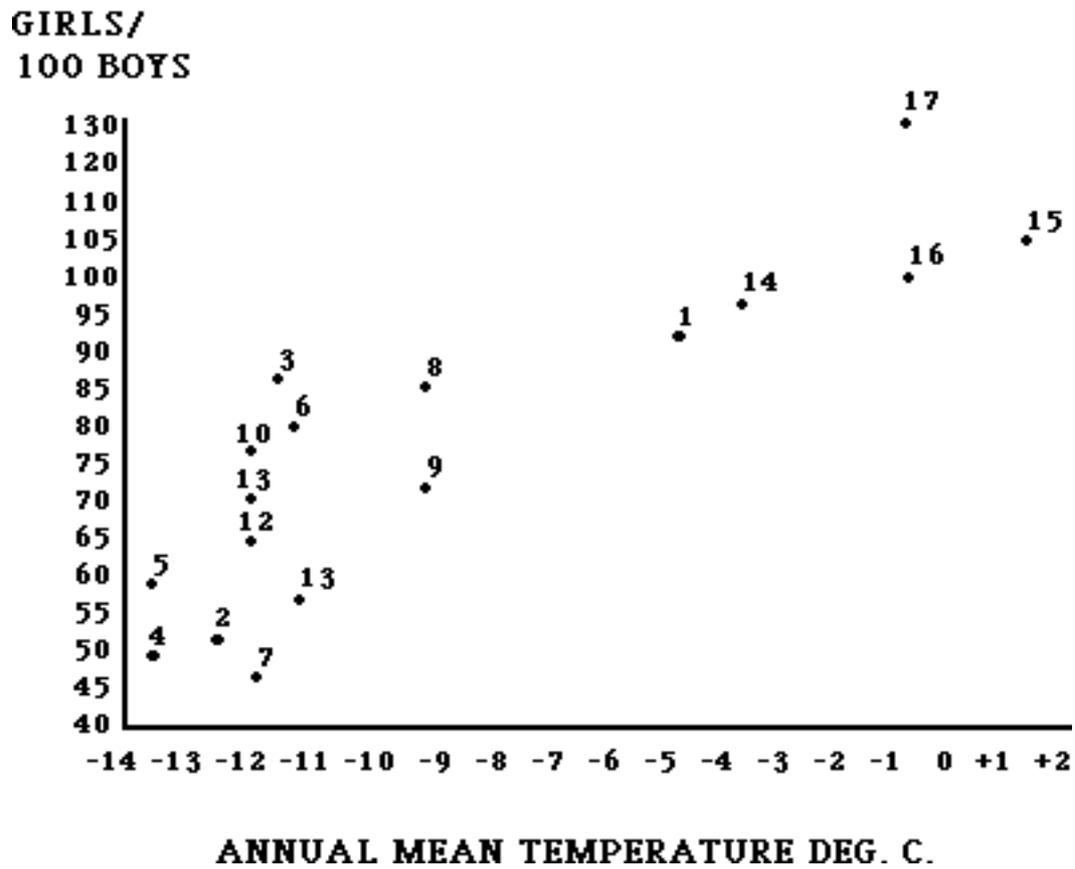
From Table 4B, 7 Observations

<u>Variables</u>	<u>Correlation</u>	<u>Significance p<</u>
Girl/Fem	-0.335	0.463
Girl/Temp	+0.875	0.010
Girl/Mort*	-0.884*	0.008*
Girl/Lat	-0.510	0.242
Fem/Temp	-0.029	0.950
Fem/Mort*	+0.737*	0.059*
Fem/Lat	-0.273	0.554
Temp/Mort	-0.642	0.120
Temp/Lat	-0.451	0.310
Mort/Lat	+0.230	0.620

* Subject to Correlated Error.

FIGURE 2

**VARIATION OF GIRLS/100 BOYS (GIRL) WITH
ANNUAL MEAN TEMPERATURE (TEMP)**



an ample supply of marine mammals. This fact would seem to more than compensate for the costs of darkness, making the brighter yet colder latitudes of the central continental arctic significantly less hospitable to human life.

As the thesis of this chapter rests on the conclusions of this analysis it should be pointed out that these significant correlations do not stand alone but are supported by the ethnographic reports of many researchers in different parts of the arctic at different times. All these reports attribute the sex and age biasing of the population statistics to female infanticide and high male mortality. In the absence of more independent data, which is difficult or impossible to come by, the recorded accounts of cause of death provided by the researchers and their Eskimo informants can be taken into account in weighing the merits of this argument. Schrire and Steiger (1974) point out that Eskimo infanticide data, collected more recently than that used here, will be influenced by prohibitions on infanticide introduced by western missionaries and legal agencies. This may be partly true of the data set used here as Weyer (1932) points out that the low rate of female infanticide in Greenland is due to such influences. However if this data point is taken out of Table 4B a significant correlation of 0.757 is produced at the $p < 0.081$ level for the remaining 6 observation points. It would be possible to continue this process of data rationalization until little or no data is left but, given the strength of the correlations found here, the fact that the data was compiled by Weyer with no view to demonstrating a temperature correlation, and the breadth and depth of the supportive ethnographic record two conclusions may be drawn as follows:-

- (1) Eskimo female infanticide is temperature dependent.
- (2) Male mortality restores balance to the adult Eskimo sex ratio.

Although the extreme severity of arctic existence would seem to be a significant contributing cause of Eskimo female infanticide, this correlation does not explain why sex ratio manipulation is the appropriate response to the environmental pressure. For an explanation of this, evolutionary theories of sex ratio must be examined. Prominent amongst these theories is Fisher's (1930), which is based on the

premise that the mean reproductive success of each sex is inversely related to their frequency in the population. From this thesis Fisher makes two conclusions that are pertinent to an analysis of the Eskimo data.

(1) If the cost of producing male and female progeny are the same, the average parent will produce a 50:50 sex ratio.

(2) If the cost of producing one sex exceeds the cost of producing the other sex, then the sex ratio will be biased against the more costly sex.

As Fisher pointed out, this second conclusion becomes more complex when mortality is sexually biased. In humans, the cost per male born will be less than the cost per female born if the males die more frequently before parental investment is completed. However the cost per male successfully raised to maturity will be more than it is for females as some investment in males will have been unproductive and must be added into the cost of rearing males. According to Fisher, this produces a male biased sex ratio at birth and a female biased sex ratio at maturity in humans.

The Eskimo data would at first appear to be an extreme example of this phenomena, inasmuch as the combined effects of female infanticide and male mortality does produce a slightly female biased adult population. However it can be argued that the cost per male born in the traditional Eskimo society exceeds the cost of each female born as half the female pregnancies are terminated at birth to make way for a male pregnancy (Rasmussen 1931), with the result that it effectively takes one and a half pregnancies to produce a Netsilingmiut male infant. This issue is further complicated by what may be an arbitrary decision as to the time of termination of parental care. The Netsilingmiut are patrilocal, so that mature but inexperienced males may continue to receive parental care after their sisters have left home. This bias in parental investment may be compensated for in part by the systematic adoption by the parents of their daughter's first son, so that the daughter's individual fitness is contributed to in spite of her absence.

Computing the costs and benefits of female pregnancy termination, patrilocal son investment and systematic daughter's progeny investment may be so difficult as to make the application of Fisher's theory to this problem impossible. However, Fisher's theory would seem to explain the approximately 50:50, male/female, birth sex ratio in humans, a ratio, which, for the Eskimo, would appear to be maladaptive. Based on the paper by Trivers and Willard (1972) that postulates the circumstances under which a deviation from a 50:50 sex ratio may be of benefit to an organism Dickman (1979) has produced a model for human sex ratio manipulation in stratified societies and Hughes (1981) has produced a model for application to hunter gatherers such as the Eskimo. Essentially this model develops the idea that parents will manipulate the sex ratio so as to favor the more altruistic sex who contribute more to future generations through their cooperation than does the less altruistic sex. This model predicts that if the net benefits of brotherly cooperation (m_{max}) are compared with the net benefits of sisterly cooperation (f_{max}), with m_{max} greater than f_{max} , it will be to the benefit of the parent to practice female infanticide. As Hughes correctly points out this situation may frequently arise in patrilocal societies that practice cooperative hunting such as the Netsilik and Yanomamo. Unfortunately the Eskimo cooperators die at such an alarming rate that the adult population has a slight female bias. This fact does not necessarily disprove Hughes' model, but it does suggest that Hughes' thesis is not a complete explanation in this particular case.

Leigh (1970) and Maynard-Smith (1978) point out that if sex differences in mortality continue after the termination of parental investment then the optimum sex ratio will not be affected as the diminished group of survivors will be increasingly successful. In a human context this thesis would predict that polygynous relationships should develop in societies with high male mortality. The high frequency of polygyny in numerous human situations adds weight to this thesis but it is not a common solution among the Eskimo to deal with their sex ratio problem. Of 58 Netsilingmiut families Rasmussen (1931) surveyed in the Central Arctic in 1923, 54 were monogamous, one

was polyandrous and only three were polygynous. The Netsilingmiut do not have cultural prohibitions on adult males or females from having more than one partner so why do not adult males that are surviving beyond parental care regularly have more than one wife, as a cultural alternative to female infanticide?

Perhaps the answer to this question lies in the unusual degree of division of labor to be found among the Eskimo. This division of labor is in turn probably dependent on two biological restraints, one phylogenetic the other ecological.

(1) Human sexual dimorphism restricts the nursing of infants to females.

(2) Arctic foraging which is frequently limited to large mammals, generally excludes nursing females from hunting activities.

These two restraints could possibly produce a situation in which nearly all the food gathering is done by the males. In this case the number of wives and progeny the male is able to support is dependent on his foraging ability. In the Arctic the dangers of hunting are such that it takes on average the sequential lives of two Netsilingmiut males to support one female and raise her progeny. In this kind of model a parent's fitness can be seen to be maximized by constraints similar, but not identical to, those operating in Fisher's theory. If an excess of females are produced they will lack males to provide for them and they and their progeny will die. If insufficient females are produced then male foraging capacity will be wasted.

The restraining effects nursing has, on the interchangeability of sex roles, may be a sufficient explanation for the sexual division of labor in this case. If so further argument will be redundant, however, Schrire and Steiger (1974) conclude:-

"Although the practice is no longer current, we are bound to suggest a far more efficient way of culling these populations, by simply modifying the traditional sexual division of labor. Instead of insisting that only men hunt, women might have been trained for the task. This type of role exchange did occur traditionally under extraordinary conditions (Kemp, pers. comm.) but normally only males were regarded as potential providers."

Schrire and Steiger

1974.

It could be argued that females are not morphologically so well equipped, as males, to the rigors of hunting, such activities can produce miscarriages (Chapter 3, *The Sociobiology of Netsilingmiut Kinship*). However both male and female Eskimos would find this suggestion for cultural modification ridiculous and would be quick to point out that women don't know how to hunt and if the woman died in a hunting accident the man would be unable to look after her orphaned infants. This observation highlights yet another restraint on the exchange of sex roles, namely, cultural specialization. In the Arctic the technologies of hunting, clothing manufacture and child care are so sophisticated no one individual is able to become proficient at all these skills. Thus not only does an Eskimo require a mate for reproduction but Eskimo can not even survive without the food or clothing provided by their partner. As learning these separate skills begins in infancy and as their teaching is retained within each sex, a gradual evolution toward some females acquiring hunting technology could not take place. In other words the possibility of teaching females to hunt was prohibited by cultural inertia in much the same way as phylogenetic inertia kept males from acquiring the capacity to nurse infants. The evolution of either capacity, hunting females or nursing males would have required radical and substantial changes in the Eskimo coadaptive culturetype and/or genotype. This, it is suggested, did not happen as moving from one adaptive peak to another, in both cultural and/or genetic terms, frequently requires traversing a maladaptive valley. (For genetic topographic models of fitness, upon which this model of cultural inertia is based, see Wright (1929, 1970, 1977). Such a model, when applied to epistemic evolution, may equally well describe the dynamics of paradigm shift (Kuhn 1962) in the sociology of knowledge).

Other ultimate causes could possibly be added to the ones mentioned here that seem to be instrumental in forging the phenomena of Eskimo female infanticide. However, the principle elements are probably those identified here. These causes can be summarized as follows:-

- (1) An approximately 50:50 slightly male biased birth sex ratio (Fisher 1930).
- (2) A preference for male infants when the benefits of male cooperation exceed the benefits of female cooperation (Trivers and Willard 1973, Hughes 1981).
- (3) A preference for polygyny due to male bias in post parental care mortality (Maynard-Smith 1978).
- (4) A need to establish a balance between male capacities to forage and female capacities to reproduce.
- (5) Sex role specialization in hunting, clothing manufacture and child rearing due to phylogenetic and cultural limitations and inertia.

Although causes 2 and 3 may effect the Eskimo population, they are probably not as important as causes 1, 4 and 5 in producing the very high rates of female infanticide to be found. This analysis concerning the why of Eskimo female infanticide is as yet only half a possible explanation of the phenomena. The question of how the behavior occurs must now be examined.

Proximate Mechanism

Questions concerning the "how" of Eskimo female infanticide are questions that center on the proximate mechanisms of behavior, in contrast with the ultimate evolutionary causes. Mechanisms for altering progeny sex ratios in invertebrates are common (Hamilton 1967, Trivers & Hare 1976, Charnov, Hartogh, Jones & van den Assem 1981), but problems of phylogenetic inertia with regard to the physiology of sex determination may prevent the evolution of such mechanisms in mammals (Beatty 1970, Williams 1979, Maynard-Smith 1980). Some examples of possible adaptive mammalian sex ratio manipulation, including human, have been suggested but they are generally thought not to be significant (see Clutton-Brock & Albon 1982, for a review). The possibility that male sex ratio bias in the Eskimo may be in part a genetic trait that can be manipulated physiologically before birth can not be totally ruled out. However ethnographic descriptions of the Eskimo attribute the principle determinants of this ratio

to the costly behavior of female infanticide. This begs the question as to what the proximate mechanisms of this behavior are and how did they evolve? It is conceivable that this behavior was genetically controlled but if this were the case then modern Eskimos might be expected to continue to practice high levels of female infanticide and they don't. The proximate mechanisms are therefore most likely cultural and the beliefs associated with the behavior of female infanticide are the likely proximate mechanisms. It should be pointed out here that culture is not limited to being a mere instrument of behavior, it is much else besides, for example, culture is a repository for knowledge, and a vehicle and mechanism for the refinement of that knowledge. However examining the processes of cultural evolution (Campbell 1975, 1977, Boyd & Richerson 1980, 1983, Pulliam & Dunford 1980, Bateson 1983 a & b) with regard to vehicles, mechanisms and units of selection, for the culture traits to be described here, is beyond the scope of this dissertation.

The methods of cognitive and cultural anthropology can be used to identify and describe beliefs. Each belief can be considered to be a culture trait, and those traits considered to be pertinent to the behavior under examination could be termed a coadaptive culturetype for female infanticide. Several such culture traits can be identified: a value, a rationalization, a metaphysic, and a cognate.

In order to facilitate the association of certain values or ethical notions of praiseworthy or blameworthy behavior with certain acts it is necessary to provide cognitive separations of such acts. As with English, the Eskimo distinguish the taking of human life into the praiseworthy or accepted categories (such as execution) and unacceptable or immoral categories (such as murder). The Eskimo differ from the English in classifying suicide as acceptable, and in having no cognate for war. Directly relevant to the problem of this paper is the fact that infanticide of an as yet unnamed baby is acceptable, and has a separate term, contrasting with murder. Table 6 gives these terms and cognates.

The Eskimo metaphysics of reincarnation produce a situation in which the qualities of personhood are synonymous with the name. In traditional times names, and with it sanctity and personhood, were normally given by the oldest, most senior relatives. When a child was born and until it was named, the grandparents generally had the authority of life and death over the baby. Providing no extraordinary circumstances such as starvation prevailed, the infant would be promptly named if it was a boy. However, it would only receive a name if it was a girl under the most favorable conditions, such as plenty of food, a promise of future marriage, or a general surfeit of boys in that particular family group. In more recent times, now that female infanticide is no longer a required practice, naming is done during pregnancy so that sanctity and personhood is given to the fetus before the sex is known. (The names employed are traditionally given without regard to the sex of the baby or the ancestor previously holding the name.)

In spite of the appearance of a certain stoic cruelty in these matters, it should be understood that the event of female infanticide was always accompanied with considerable emotional difficulty. Such deaths were perceived as necessary, "they could not be helped," but the accompanying distress, particularly for the mother, was not perceived as in any sense good. To take one example from my own family-by-marriage. Aupudluk had thirteen children of which three are now living. The grandparents would not give her first daughter by her third and present husband a name. The parents wanted to keep the child but would not go openly against the wishes of the older relatives and therefore could not give the baby a name themselves. Consequently the infant existed without sanctity and personhood for several months, until an unrelated elderly friend took pity on her and gave the infant a name. Unfortunately, that girl died when she was six. But because she was loved so much her name was given to the next daughter when she was born. Aupudluk's husband, Krako, explained, "Infanticide was mostly for the baby girls when there were too many girls and not enough boys. Those infants didn't

Table 6

Netsilingmiut Cognates for the Taking of Human Life

<u>English</u>	<u>Eskimo</u>	<u>and</u>	<u>Literal Translation</u>
Baby abandonment	Nutaraarluk Baby		Iksingnaoktauyaq Leave it - some one - doing it
Baby freezing	Nutaraarluk Baby		Qiqititauyoq Freeze it - some one - doing it
Suicide	Inminik Self		Pitariok He or she took it
Self murder (not used)	Inminik Self		Inuaktok He or she took a human
Murder	Inuaktok He or she took a human		
Revenge Killing or Execution	Akeyauok Back - he or she - him or her did		
Two people fight	Unatuktook Fight - them (two)		
Many people fight	Unatuktoot Fight - them (many)		
War	None		

have names. Sometimes they were named before birth but naming during delivery was most popular. Nowadays the names are often given during pregnancy."

Balikci, in his paper "Female Infanticide on the Arctic Coast" (Balikci 1967), reaches essentially the same conclusions as those presented here, i.e., the practice is an adaptation to the harsh environment. However, he also concludes as does Freeman (1970, 1971), that it is to some degree a sexist act, inasmuch as females are less valued than males. While in my judgment this is not totally true for adult Eskimos or girls after they are named, it is undoubtedly true for unnamed infants. Still today the birth of a boy is seen as an occasion for much praise of the mother, while the birth of a girl is frequently treated with indifference.

In addition to the metaphysical manipulation of the sanctity and the sexually biased value of infants, the rational analysis of their predicament also influences the occurrence of Eskimo female infanticide. Rasmussen's experience as an ethnographer and explorer, who lived off the land in the Arctic, provides a unique insight to the logic employed.

"A hunter must take into consideration that he can only subject himself and his constitution for comparatively few years to all the strain that hunting demands. Competition is keen, and if he has no very special natural gifts and enjoys no unusually good health, he need not be very old before he can no longer hold his own with the young. Now if he has sons, they will as a rule be able to step in and help just when his own physique is beginning to fail. Thus it is life's own inexorability that has taught them the necessity of having as many sons as possible. Only by that means may they be certain that they will not need to put the rope round their own neck too early; for it is the common custom that old people, who can no longer keep themselves, prefer to put an end to their life by hanging rather than drag themselves through life in poverty and helpless old age.

Nalangiaq once said to me: 'Life is short. We all want to be as prosperous as we can in the time we are alive. Therefore parents often consider that they cannot 'afford' to waste several years nursing a girl. We get old so quickly, and so we must be quick and get a son. That is what we parents think, and in the same way we think for our children. If my

daughter Quertilik had a girl child I would strangle it at once.
If I did not, I think I would be a bad mother."

Rasmussen pp. 140, 1931.

This analysis does not master the math of Fisher's theory or similar evolutionary stable strategies that may model the dynamics of sex ratios so as to maximize fitness in future generations (MacArthur 1965). Nonetheless the Eskimo's logical conclusions concerning the need for female infanticide demonstrate a rare ability to approach a sensitive moral issue empirically. However the quotation from Rasmussen's informant, Nalangiaq, does raise two more issues that may require comment. Firstly, although it has been argued that Eskimo sex ratio manipulation promotes individual fitness, including the mothers, more often than not it is the grandparents who order the infanticide. This aspect of the behavior may be in part due to a need for a dominant member of the extended family to over ride the natural maternal instincts of the mother. However, a single mother who kept all her daughters, while those around her killed some of theirs, could be at an advantage. This possibility may be circumvented by a mother in law making sure a daughter in law gains no reproductive benefits over her own children in whom she has a greater genetic interest. Thus, unlike Fisher's individual fitness model, the analysis made here may additionally have to be viewed from the perspective of the individual and/or inclusive fitness of the grandparents whose interests can be different to those of the mother (Trivers 1974, Alexander 1974). Secondly, although Nalangiaq and Rasmussen rationalize the benefits of female infanticide in terms of practical advantages the perceived function is not increased fitness in future generations. This observation does not necessarily undermine the thesis developed here as the content of any belief can be of less importance than the beliefs adaptive value from the perspective of evolutionary epistemology. However, if Eskimo female infanticide was practiced, as Nalangiaq and Rasmussen suggest, so as to systematically eliminate the first females born to any family then the first children to mature in any family would be male hunters and

providers. In this way the manipulation of the age, as well as sex structure, of the Eskimo population, may also be adaptive (Freeman 1971).

Some sociobiologists might still wish to argue that the culture traits for female infanticide identified here could be genetically determined insofar as they could be part of a genetically preferred coadaptive culturetype (Lumsden & Wilson 1981). Two observations would seem to cast doubt on the application of such a hypothesis in this instance. First, and presumably maladaptively, the mother of the infant that is put to death is distressed sometimes to the point of rebellion against those ordering the infanticide. Second, now that the Eskimo have been brought under the care of a welfare state, female infanticide is almost non-existent, and the associated culture traits have been modified or abandoned.

It should be noted that in traditional times there always was a biological evolutionary selective pressure for a male biased sex ratio among the Eskimo. Mothers that produced more males would be more successful, as they would have fewer female pregnancies wasted through the culturally instituted practice of female infanticide. Why then didn't a genetic proximate mechanism for male biased sex ratio evolve? What possible advantage was gained from the employment of a cultural proximate mechanism? The human sex ratio is slightly male biased and this tendency can possibly be moved a few percentage points under some environmental conditions (Parkes 1926, Teitelbaum 1972, McMillen 1974). However the Netsilingmiut would seem to require a 2 to 1 male biased birth sex ratio and perhaps this extreme imbalance could not evolve due to phylogenetic limitations or inertia.

This analysis may be correct, but a more sophisticated analysis is possible in which cultural proximate mechanisms are distinctly superior to genetic determinates. The Eskimos do not live in a homogeneous environment, as indicated by the data in table 1, 2 and 3, and figure 1. Nor is the Eskimo megapopulation static, inasmuch as it has been created by successive waves of migration from Siberia and Alaska through Canada to Greenland (Giddings 1967, Bandi 1969). These migrations have taken place

approximately every millennium. Thus the Eskimo population have been continually moving through an annual mean temperature gradient of some 15 degrees centigrade, requiring different optimal rates of female infanticide. The presence of large amounts of ancient whale bone in the Central Arctic where the Netsilingmiut presently live suggest that the people of that region used to hunt whales. The severity of summer ice cover precludes the penetration of many species of whales into these regions today. This suggests that the Central Arctic climate was warmer in its not too distant past, and that the inhabitants could have maximized their reproductive success with a lower rate of female infanticide. These observations on climatic changes and migrations of the megapopulation would place the Eskimo in an environment that imposed selective pressures on sex ratio bias with fluctuations that ranged from decades to centuries to millennia. These time frames are too short in evolutionary terms for a genetic proximate mechanism to adjust to the changing conditions with sufficient speed. (See Lumsden & Wilson's 1000 year rule, 1981.) In this circumstance a cultural proximate mechanism with its inherent plasticity and fine tuned by its rational components has considerable adaptive advantage over a genetic mechanism (Campbell 1977, Mason 1979, Burhoe 1981, Pulliam & Dunford 1981, Shields 1982, Boyd & Richerson 1983). Unfortunately this cultural process remains maladaptive in terms of the superfluous female pregnancies, but both phylogenetic and cultural inertia are such that no natural solution to the pressures of selection will ever be perfect.

Discussion

The evolutionary theories of Fisher, Trivers and Willard, Maynard-Smith and Hughes that seek to explain the dynamics of the phenomena of sex ratio would seem to be indispensable to providing a causal explanation of Eskimo female infanticide. However none of the theories appear to provide a complete analysis of the ultimate causes in this case as they fail to identify the importance of sexually biased Eskimo foraging. This of course is not the fault of these theoreticians as they were not writing

specifically on Netsilingmiut female infanticide. However this fact helps emphasize the complexity of biological and cultural processes. Any complete sociobiological analysis may have to be species specific, site specific and time specific. This problem of specificity characterizes human sociobiology since humans live in such a wide range of environments in contrast with other animals.

Another major and possibly more serious difficulty with applying sociobiological theory to humans is the frequent failure to address the proximate mechanisms of behavior. This criticism might be fairly leveled at Hughes' analysis of the evolution of sex ratio manipulation in hunter gatherer societies. Perhaps Hughes only wished to address the question of ultimate cause, but if so his presentation would have benefited by him saying as much. The proximate mechanisms of human behaviour will frequently be cultural, due to phylogenetic restraints and the superior fine tuning that can only be achieved by the more rapidly responsive cultural mechanisms. Human sociobiologists frequently ignore the instrumental role culture plays in the occurrence of human behavior. Ultimate causes may be an indispensable element in a scientific theory or analysis of any human phenomena. However sociobiologists should not be surprised when cultural anthropologists characterize their explanations as trivial, in the absence of specifying the role of cultural proximate mechanisms.

The analysis of Eskimo female infanticide by Weyer and more particularly the analysis of the behavior amongst the Netsilingmiut by Balikci support the thesis that the behavior is due to environmental pressures. However these pressures are identified as the need for population control so that the Eskimo population would not exceed the carrying capacity of their habitat. Although such pressures exist and are expressed in terms of "r and K selection" (MacArthur and Wilson 1967) most evolutionary biologists now accept the thesis that all organisms continually maximize their fitness and would not sacrifice their own progeny to benefit other members of the population (for an analysis of this issue see Williams 1966, Wilson 1975). But does it matter if cultural anthropologists do not always identify the precisely correct set of ultimate causes as

long as they describe the cultural facts accurately? Is acquiring proficiency in a new and complex discipline like sociobiology to be considered essential?

These questions might be addressed from the philosophy of social science as to whether a certain theory is or is not scientific because it is or is not complete nomologically (Nagel 1979, Rosenberg 1980). This dissertation seeks to resolve such issues by example rather than philosophic inquiry. The test of the relative merits of various analyses is in terms of which allows for a more or less useful interpretation of the facts. The analysis of Weyer and Balikci fails to address the complex dependent relationships that exist among birth sex ratio, sex role specialization, male mortality, environmental conditions and optimal foraging strategies. These are such that a change in any one of the variables should produce a change in rate of female infanticide, and subsequent changes in the beliefs associated with the pertinent cultural proximate mechanisms. Their lack of biological sophistication is no doubt due to the fact that their work preceded the recent growth of sociobiology. However, contemporary social science that fails to understand the ultimate causes of human behavior is omitting an indispensable element from the explanation, prediction or control of the processes of cultural change. Under these circumstances cultural anthropologists should not be surprised if sociobiologists in return sometimes perceive or characterize such work as being superficial.

Conclusion

Human sociobiologists primarily direct their attention to the biological "Why?" questions, while cultural anthropologists are more concerned with cultural "How?" questions. This compartmentalization of disciplines results in incomplete or confused descriptions and explanations of human phenomena. The perspective used here regards nature versus nurture to be a false dichotomy. Nature and nurture, biology and culture are dependent phenomena (Bateson 1982). Unfortunately the sciences of sociobiology and cultural anthropology neglect this fact in their respective descriptive titles. As a

constructive step toward an integration of these perspectives one might better name the scientific study of man sociocultural biology. At the very least the kind of analysis of Netsilingmiut female infanticide made here can best be so characterized.

Such theory is not offered as a replacement for other social science or biological theories but rather as an extension of each of them, incorporating them into an evolutionary framework of cause and effect. In this way coadaptive culturetype includes some of the explanatory principles of structural functionalism and cognitive anthropology. The individual and inclusive fitness interests of sociobiology may frequently translate into material and economic costs and benefits. However these translations would not be made for their own sake but for the purpose of providing a causal explanation. In this context it now seems reasonable to suggest that the kinds of explanations provided here for some Eskimo metaphysical beliefs, cognates, values and rationalizations may, in principle, be achieved for all the major beliefs, cognates, values and rationalizations of any culture (Campbell 1975). Such an explanation does not necessarily demean these phenomena. Metaphysical beliefs that may be just plain wrong for a correspondence epistemology may nonetheless mirror a social system ecological necessity. They may frequently contain profound insights into the relation of humans to their human and physical environment in which the beliefs have evolved.

Chapter 3

The Sociocultural Biology of Netsilingmiut Kinship

Introduction

More has probably been written on the sociobiology of the relationships that exist within the family than for any other level of human social organization. (For reviews see Alexander 1979 and van den Berghe 1979). None the less the extent to which biological concepts and theory impinge upon kinship is still a question for much debate in anthropological theory (Sahlins 1976, Harris 1979) and the philosophy of social science (Rosenberg 1980). It is not the objective of this chapter to enter this debate at the theoretical or philosophical level with a view to resolving the controversy. The purpose of this study is to briefly review some of the biological theory that could go into an explanation of kinship and to then develop a series of empirical tests and methods to test the strengths of such hypotheses.

It is hoped that the kind of analysis made here will disprove extreme positions that take the view that biological theories, such as kin selection (Hamilton 1964), have nothing to say about kinship. Sahlins' comments are typical of this perspective:

"Firstly, no system of human kinship relations is organized in accord with the genetic coefficients of relationship as known to sociobiologists. Each consists from this point of view of arbitrary rules of marriage, residence, and descent, from which are generated distinctive arrangements of kinship groups and statuses, and determinations of kinship distance that violate the natural specifications of genealogy. ---
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Second, as the culturally constituted kinship relations govern the real processes of cooperation in production, property, mutual aid, and marital exchange, the human systems ordering reproductive success have an entirely different calculus than that predicted by kin selection ----."

Sahlins 1976, pp.57

Many anthropologists may find the reviews of Alexander and van den Berghe an adequate rebuttal of Sahlins. However human kinship is extremely complex such that an adequate biological understanding of any particular system may have to be site specific in order to take all biological theories of cooperative behavior and environmental factors into account (Chapter 2, *The Sociocultural Biology of Netsilingmiut Female Infanticide*).

Kinship, if viewed as a mechanism for adaptive human behavior, may be in part a product of reciprocal altruism (Trivers 1971), group cooperation (Campbell 1975, Boyd & Richerson 1980, Abruzzi 1982), optimal mate choice (Shields 1982a & b, Bateson 1983a), optimal foraging strategies (Smith 1983), and parental manipulation (Alexander 1974) in addition to kin selection (Hamilton 1964) and associated theories of dominance (West Eberhard 1975) or exploitation (Betzig 1982). Very possibly these theories of biological and biologically based cultural evolution can not explain all the intricacies of kinship. However this issue can be addressed as an empirical question by attempting to apply such theories systematically to kin systems in order to test the limits of biological explanation. This has been done in a broad perspective cross culturally by Alexander and van den Berghe using some of the previously mentioned theories. However such analysis necessarily leave many anomalies of kinship unaddressed and there by make valid openings for the critics of human sociobiology and biological forms of cultural evolution.

The thrust of this study will be to attempt a biological understanding of all the kin terms of one kin system in order to gauge the limits and possible strengths of various competing or complementary evolutionary theories. In other words what is to be attempted here is greater depth of understanding as opposed to greater breadth. Hopefully, if this analysis is for the most part successful, other anthropologists and ethnographers will improve on the methods developed here with comparative work that may eventually lead to a general theory of kinship that is essentially evolutionary in character.

Biological explanations of behavior can be conveniently separated into evolutionary questions of ultimate cause that focus on why a behavior should exist at all and descriptions of the proximate mechanisms of a behavior that attempt to detail how a given behavior occurs. A biological understanding of kinship would not consider kinship, in its social anthropological form, an ultimate cause of behavior. Ultimate cause, in evolutionary theory, is understood in terms of fitness which is most frequently, but not always, cashed out in terms of relative reproductive success. Kinship may be most appropriately understood biologically as a cultural proximate mechanism that mediates ultimate cause and resultant adaptive behavior. In an effort to clarify this distinction the evolutionary theories that could go into an explanation of the ultimate causes of kinship will be reviewed first followed by a brief analysis of the instrumental role kinship could play as a proximate mechanism of behavior. This analysis will in turn be followed by an empirical study and discussion.

The Ultimate Causes of Kinship

Prominent amongst the evolutionary theories that must go into a biological explanation of kinship is Hamilton's (1964) theory of kin selection. This theory turns on the concept of inclusive fitness such that a behavior is expected to evolve providing the ratio (K) of gain in fitness, for the beneficiary, to loss in fitness, for the donor, exceeds the reciprocal of the average coefficient of relationship of the interactants (r) :-

$$K > 1/r$$

In the absence of inbreeding r for siblings is a 1/2, for an uncle 1/8 and so on (Wright 1922). Thus, kin selection predicts, any helping or altruistic behavior is more likely to evolve amongst close relatives than distant relatives when the costs and benefits remain constant. This model can possibly account for pro-social behavior between parents and progeny, between siblings and all the kinship relationships that are essentially consanguinial. However it does not account for the altruism that would exist between unrelated parents or other essentially affinial relationships. West Eberhard (1975) overcomes this problem with the formulation:-

$$K > 1/r_{ABy}$$

Where r_{ABy} is the relatedness of the altruist and the young of the beneficiary. In practice the consanguinial and affinial components of relationship become mixed in many cultures when, for example, first cousin marriage is preferred. However this element in the calculus of kin selection is built into West Eberhard's model such that if human behavior is in part determined by coefficients of relationship then altruism should correlate more strongly with r_{ABy} than r_{AB} . The coefficient of relationship of the other members of a population (West Eberhard 1975) and inbreeding in a population (Hamilton 1975, Breden and Wade 1981, Shields 1982a) can also effect the calculus of kin selection but these aspects of genetics that deal more with group behavior are beyond the scope of this chapter (For an analysis of these issues see Chapter 4, A Study in the Evolution of Ethnocentrism). Certainty of parentage from a females perspective and a diminished certainty of parentage from the males perspective may also give behavior associated with coefficients of relatedness a sexual bias (Barash, Holmes and Greene 1978).

Unlike kin selection, Trivers (1971) theory of reciprocal altruism, is not dependent on the existence of a genetic kinship relationship between partners involved in a mutually beneficial behavior. Symbiosis and mutualism in plants and animals, and contracts between humans may all be examples of reciprocal altruism. Likewise the existence of kinship between distantly or unrelated individuals may be more a product of reciprocal altruism than kin selection particularly if the benefits of cooperation are evenly dispersed.

However, if the benefits of a kinship relationship between distantly or unrelated individuals is very one sided, and is not obviously exploitive (Betzig 1982), then theories that involve the evolution of group benefits may have to be examined. The models of Campbell (1975,1983) and Boyd and Richerson (1980) provide for the evolution of culture traits that can benefit the members of a society who hold and practice such adaptive traits. Typically these theories seek to explain cultural

phenomena such as political order, religious ethics, law and ethnocentrism (See also Abruzzi 1982 on ethnocentrism) but there is no reason why some aspects of kinship should not have developed as part of a general coadaptive culture type for pro-sociality. In a similar way the benefits of optimal foraging (Smith 1983) could also create kinship culture traits.

The costs and benefits of inbreeding (Shields 1982a & b, Bateson 1983a) and associated interpretations of incest avoidance have become a test case for the discipline of human sociobiology (Bixler 1981, van den Berghe 1983, Bateson 1983b). Van den Berghe (1983) discriminates between incest proper, sexual relations within the nuclear family and inbreeding within a limited and partially genetically isolated population. However van den Berghe then fails to correct his values of relationship (r) to take this into account. This point is mentioned to illustrate how confused the debate presently is. Most biologists would agree that there is a genetic cost to intense inbreeding of an incestuous kind. This fact could certainly explain the behavior, belief and morality of avoiding sexual relations between parents, their progeny and full sibs as well as the association of such behavior, belief and morality with the appropriate kin terms. However the extension of such a prohibition beyond the nuclear family is undoubtedly a far more complex phenomena that could be a function of both the genetic costs and benefits as well as economic costs and benefits through the break up or establishment of alliances. Such alliances, and their associated kin terms, could be understood in a natural selection context within the theoretical perspective of cultural evolution reviewed earlier (Campbell 1975, Boyd & Richerson 1980, Abruzzi 1982, Smith 1983). In this way cultural and biological theories of optimal mate choice are not necessarily in conflict but rather each party to the debate has recognized a different aspect of a complex biological process.

Dominance can evolve as a product of egoistic parental manipulation (Alexander 1974) and kin selection (West Eberhard 1975) where by reproductively more mature and productive individuals are helped by close kin who are less

reproductively capable. Given the long period of development in humans, preparatory to reproduction, it probably follows that children should be helpers subordinate to their parents and, to a lesser degree, younger sibs should help older sibs. In a hostile environment like the Arctic competence in raising progeny may come to an individual later in life compared to persons in a kinder climate. If this is so then dominance amongst the Eskimo may not merely be a cultural expression of a biological predisposition but additionally a sociocultural extension of that biological process. In other words dominance should be a well developed trait of Eskimo society such that developmental relationships within the family and kinship should play an instrumental role in establishing a dominance hierarchy. The nature of this instrumental role that views kinship as a mediating proximate mechanism of adaptive behavior will now be examined.

Kinship as a Proximate Mechanism

Without the evolution of processes by which animals recognize or some how identify their kin the theory of kin selection could not operate in the natural world. Therefore, not surprisingly, the proximate mechanisms of kin recognition are increasingly well researched and well understood as biological processes for much of the animal kingdom (For reviews see Holmes & Sherman 1983, Shields 1983, Lewin 1984). These mechanisms can function using phenotypic variation such as scent or pheromones (Gilder & Slater 1978, Greenberg 1979, Buckle & Greenberg 1981, Bateson 1980, 1982, Vidal 1982), developmental contact or imprinting (Lorenz 1935, Michener & Sheppard 1972, Hess 1973, Leon 1975, 1978, Porter et al 1978, 1981), culturally acquired variation or badges (Nottebohm 1969, Chapter 4, A Study in the Evolution of Ethnocentrism) and spacial displacement (Hoogland & Sherman 1976, Holmes & Sherman 1982). Most probably all these mechanisms operate to various degrees in humans particularly within the nuclear family. However beyond the nuclear family culturally acquired kinship could facilitate the operation of kin selected

behaviors in humans with more precision and range than is found in other animals (Campbell 1983).

For example the proximate mechanism of sibling identification in many animals is early developmental contact. This is also true of humans but additionally my parents tell me that a certain individual is my brother or sister. I have additionally been told by my parents that I have a half sister, whom I have never met, in Australia, by my father's deceased first wife. This half sister likewise knows of my existence so if I were to go to Australia or if she were to visit me in America we would naturally stay with each other, we would freely enter into a potentially costly reciprocal altruism pact because we were closely related. But the proximate factor that controlled that behavior was not developmental contact, it was the linguistic report of my parents that this person was my half sister and my acceptance of the belief.

This example illustrates how human kinship can extend kin oriented behavior in space and time. However the thesis being developed here is attempting to develop the hypothesis that human kinship goes far beyond mere kin selected behavior to provide proximate mechanisms for the operation of numerous complex adaptive behaviors that are to be explained by various aspects of evolution theory. In this perspective kinship systems may be understood as coadaptive culturetypes that help to mediate behaviors as diverse as optimal mate choice, environmental adaptation and pro-sociality. Such a view goes beyond what is popularly understood to be sociobiology and may be more appropriately termed sociocultural biology (Chapter 2, *The Sociocultural Biology of Netsilingmiut Female Infanticide*).

Providing the major elements of such theory have been identified in their biological and cultural evolutionary forms an empirical study of any kinship system should now be possible in which each kin term will distinctly correlate with a specific repertoire of adaptive behavior. At least this should be true in principle. In practice, however, the complexity of the bio/cultural system and the existence of some functionally neutral or maladaptive culture traits will probably render a perfect analysis

impossible. Given these difficulties and my many years of experience traveling and living amongst the Inuit of Alaska, Canada and Greenland (Irwin 1974) the Netsilingmiut "Eskimo" kinsystem, that may be distinguishable for its relative simplicity, was selected for analysis.

Empirical Study

The Netsilingmiut kinsystem has been described in detail by Rasmussen (1931) and Balikci (1970) and the accuracy of these ethnographies are confirmed by my own field work. By adding in the sex of the speaker, as part of the field of meaning of each kin term, 62 distinctive kin cognates were generated that represent almost the complete Netsilingmiut kinsystem. These cognates provided the basis for 62 observation points about which to correlate various cultural and biological characteristics (Table 7).

The cultural variables were produced by asking an elderly monolingual informant a series of identical questions focused on each term as follows:-

(1) Do you listen to this person? This question is directed toward culturally perceived dominance (Dom.) or subordination with yes, no or maybe answers.

(2) Can you marry this person? This question isolates the limited group of potential mates (Mate) for any individual in terms of social norms.

(3) Can you speak to this person? In the Netsilik culture social distance in terms of dominance and sexual relations is often achieved with rules limiting conversation (Talk).

(4) Can you say the name of this person? As with conversation the use of a persons name is another form of social distancing or familiarity (Name).

A fifth cultural variable (Help) was generated by asking an informant to arrange the kin terms, written on cards, in a ranking order according to who they would help most and least. Six biological variables were then generated as follows:-

(1) The sex of the person using the kin term (Sex Ego).

(2) The sex of the person being referred to by the kin term (Sex).

Table 7

Cultural and Biological Characteristics of Netsilingmiut Kinship Terms

Obs.#Kin Term	Sex Ego	Sex Dom.	Mate	Name	Talk	Help	rAB	rABy	Opt.	Rep.	
1 Angayoq Older sister**	1*	1*	1*	3*	3*	1*	6	.5	.25	3*	1*
2 Nuka Younger sister	1	1	3	3	3	1	9	.5	.25	3	3
3 Arnakatti First Cousin	1	1	2	3	3	1	25	.125	.0625	3	2
4 Anana Mother	1	1	1	3	2	1	4	.5	.25	3	1
5 Atchuk Aunt or aunt-in-law	1	1	1	3	2	1	20	.25	.125	3	1
6 Arnarvio Mother's sister	1	1	1	3	2	1	19	.25	.125	3	1
7 Ningio Grandmother	1	1	1	3	2	2	16	.25	.125	3	1
8 Amaoq Great grandparent	1	1	1	3	2	2	17	.125	.0625	3	1
9 Panik Daughter	1	1	3	3	1	1	7	.5	.25	3	3
10 Anga Brother's children	1	1	2	3	2	1	24	.25	.125	3	3
11 Norrak Sister's Children	1	1	3	3	2	1	11	.25	.125	3	3
12 Irngutak Grandchildren	1	1	3	3	1	2	14	.25	.125	3	3
13 Umua Affinal female same generation	1	1	2	3	2	1	28	0	.25	3	2
14 Samiak Husband's sister	1	1	2	3	2	1	27	0	0	3	2
15 Idloq Second cousin	1	1	2	3	2	1	29	.0625	.03125	3	2
16 Saki Mother-in-law	1	1	1	3	1	1	3	0	.25	3	1
17 Ani Brother	1	3	2	3	1	3	10	.5	.25	3	2
18 Atata Father	1	3	1	3	2	2	5	.5	.25	3	1
19 Akka Uncle or uncle in law on father's side	1	3	1	3	2	2	21	.25	.125	3	1
20 Anga Brother's children	1	3	3	3	2	2	23	.25	.125	3	3

Obs.#	Kin Term	Sex Ego	Sex Dom.	Mate	Name	Talk	Help	rAB	rABy	Opt.	Rep.	
21	Iktoq Grandfather	1	3	1	3	2	2	15	.25	.125	3	1
22	Amaoq Great grandparent	1	3	1	3	2	2	18	.125	.0625	3	1
23	Irnik Son	1	3	2	3	1	1	8	.5	.25	3	3
24	Angak Uncle or uncle-in-law on mother's side	1	3	3	3	1	2	22	.25	.125	3	1
25	Norrak Sister's children	1	3	3	3	3	2	12	.25	.125	3	3
26	Irngutak Grandchildren	1	3	3	3	3	2	13	.25	.125	3	3
27	Ui Husban	1	3	1	1	3	1	1	0	.5	1	2
28	Ai Affinal male same generation	1	3	2	3	2	2	26	0	.25	1	2
29	Sami Father-in-law	1	3	1	3	3	1	2	0	.25	3	1
30	Angayoq Older brother	3	3	2	3	2	1	8	.5	.25	3	1
31	Nuka Younger brother	3	3	3	3	2	1	9	.5	.25	3	3
32	Angutekatte First cousins	3	3	2	3	2	1	23	.125	.0625	3	2
33	Atata Father	3	3	1	3	2	1	2	.5	.25	3	1
34	Akka Uncle or uncle-in-law on fathers side	3	3	1	3	2	1	13	.25	.125	3	1
35	Angak Uncle or uncle-in-law on mothers side	3	3	1	3	2	1	20	.25	.125	3	1
36	Iktoq Grandfather	3	3	1	3	2	2	6	.25	.125	3	1
37	Amaoq Great grandparent	3	3	1	3	2	2	5	.125	.0625	3	1
38	Irnik Son	3	3	2	3	2	1	11	.5	.25	3	3
39	Kangia Nephew	3	3	2	3	2	1	18	.25	.125	3	3
40	Uyoroq Sister's children	3	3	2	3	2	1	12	.25	.125	3	3
41	Irngutaq Grandchildren	3	3	3	3	1	1	25	.25	.125	3	3
42	Ningao Affinal male same generation	3	3	3	3	1	1	14	0	.25	3	2
43	Sakiak Wife's brother	3	3	2	3	2	2	32	0	0	3	2
44	Saki Father-in-law	3	3	1	3	2	1	28	0	.25	3	1
45	Nukangor Wife's younger sister's husband	3	3	2	3	2	1	30	0	0	3	3

Obs.#	Kin Term	Sex Ego	Sex Dom.	Mate	Name	Talk	Help	r _{AB}	r _{ABy}	Opt.	Rep.	
46	Angayungroq Wife's older sister's husband	3	3	2	3	2	1	33	0	0	3	1
47	Idloq Second cousin	3	3	2	3	2	1	31	.0625	.03125	3	2
48	Naya Sister	3	1	2	3	2	3	16	.5	.25	3	2
49	Angutekatte First cousins	3	1	2	1	2	3	24	.125	.0625	1	2
50	Anana Mother	3	1	1	3	2	2	3	.5	.25	3	1
51	Atchuk Aunt or aunt-in-law	3	1	1	3	2	2	22	.25	.125	3	1
52	Arnarviq Mother's sister	3	1	1	3	2	2	21	.25	.125	3	1
53	Ningio Grandmother	3	1	1	3	2	2	7	.25	.125	3	1
54	Amaoq Great grandparent	3	1	1	3	2	2	4	.125	.0625	3	1
55	Panik Daughter	3	1	2	3	2	2	10	.5	.25	3	3
56	Kangia Brother's children	3	1	2	3	2	2	19	.25	.125	3	3
57	Uyoroq Sister's children	3	1	2	3	2	2	15	.25	.125	3	3
58	Irngutak Grandchildren	3	1	3	3	1	2	26	.25	.125	3	3
59	Nuliak Wife	3	1	2	1	1	1	1	0	.5	1	2
60	Ai Affinal female same generation	3	1	2	3	3	3	29	0	.25	1	2
61	Saki Mother-in-law	3	1	1	3	2	3	27	0	.25	3	1
62	Ukua Son's wife	3	1	3	3	2	3	17	0	.25	3	3

Notes_____

*Female__ 1
*Male_____ 3
*Yes_____ 1
*Maybe__ 2
*No_____ 3

**These translations are only approximate for calculating r_{AB} and r_{ABy}. For more detailed translations see Rasmussen (1931) and Balikci (1970).

(3) Reproductive maturity (Rep.) based on whether the kin was older (yes-1), the same age (maybe-2), or younger (no-3) than ego.

(4) The coefficient of relationship between ego and the person being referred to (r_{AB}), in the absence of inbreeding.

(5) The coefficient of relationship between ego and the young of the person being referred to (r_{ABy}), in the absence of inbreeding.

(6) Optimal mate choice (Opt.) assessed as a function of restricting intense inbreeding of an incestuous kind (sibling or parent-offspring) and finding a mate of the same generation.

A canonical correlation of the five cultural variables with the six biological variables was completed using the SAS statistics package. Four separate procedures, Wilks' Lambda, Pillai's Trace, Hotelling-Lawley Trace and Roy's Greatest Root, all give a probability of $p < 0.0001$ to the possibility that the biological and cultural phenomena vary at random. This result disproves extreme perspectives in anthropological theory that seek to completely separate the study of human culture from human sociobiology.

However some of the criteria that went into this data may appear arbitrary. For example it could be argued that young females could do better by marrying older more experienced hunters. Additionally, as marriages are arranged, matings could be established in order to maximize benefits to the parents and not the young couple. Given these kinds of complications interpretations of the correlation coefficients in the correlation matrix (Table 8) should proceed cautiously. Perhaps the most interesting results are the strong relationship that exists between dominance (Dom.) and reproductive maturity (Rep.), and between helping (Help) and the coefficients of relationship (r_{AB} and r_{ABy}). As would be expected from West Eberhard's (1975) analysis of these issues r_{ABy} , focused on both affinal and consanguinial kinship, produces a slightly stronger correlation than r_{AB} , focused only on consanguinial kinship. This result prompts the conclusion that West Eberhard's (1975) interpretation of kin

Table 8

Correlation Matrix of Netsilingmiut Kinship Biological/Cultural Characteristics

	<u>Sexego</u>	<u>Sex</u>	<u>Dom.</u>	<u>Mate</u>	<u>Name</u>	<u>Talk</u>	<u>Help</u>	<u>rAB</u>	<u>rABy</u>	<u>Opt.</u>	<u>Rep.</u>
Sexego	1.000	0.096	-0.026	-0.060	0.138	0.110	-0.064	-0.064	-0.049	-0.040	0.027
Sex	0.096	1.000	0.042	0.075	0.000	-0.195	-0.007	-0.005	-0.044	0.059	-0.018
Dom.	-0.026	0.042	1.000	0.041	-0.212	-0.001	0.210	0.053	-0.030	0.002	<u>0.804</u>
Mate	-0.060	0.075	0.041	1.000	-0.013	-0.029	0.184	0.231	<u>-0.415</u>	<u>0.761</u>	-0.029
Name	-0.116	0.000	-0.212	-0.013	1.000	0.007	-0.002	-0.082	-0.040	-0.127	-0.077
Talk	0.138	-0.195	-0.001	-0.029	0.007	1.000	0.106	-0.012	-0.043	-0.187	-0.054
Help	0.110	-0.007	0.210	0.184	-0.002	0.106	1.000	<u>-0.496</u>	<u>-0.564</u>	-0.004	0.120
rAB	-0.064	-0.005	0.053	0.231	-0.082	-0.012	<u>-0.496</u>	1.000	0.224	<u>0.331</u>	0.112
rABy	-0.049	-0.044	-0.030	<u>-0.415</u>	-0.040	-0.043	<u>-0.564</u>	0.224	1.000	<u>-0.425</u>	0.027
Opt.	-0.040	0.059	0.002	<u>0.761</u>	-0.127	-0.187	-0.004	<u>0.331</u>	<u>-0.425</u>	1.000	-0.038
Rep.	0.027	-0.018	<u>0.804</u>	-0.029	-0.077	-0.054	0.120	0.112	0.027	-0.038	1.000

Number of Observations: 62

The entries are product-moment correlations. Values above 0.25 are significant at the $p < 0.05$ level and values above 0.32 are significant at the $p < 0.01$ level (These values are underlined).

selection (Hamilton 1964) is an important theory for the analysis of both human kinship and kinship related behavior.

The results of the canonical correlations suggests that kinship terms, and their associated fields of meaning, could act as proximate mechanisms for specific repertoires of biologically adaptive behaviors. This conclusion can possibly be further illustrated by reviewing the data in table 7 to assess to what extent each kin term does correspond with a unique combination of biological characteristics. The sex of ego separates the 62 cognates into two groups. These groups are further subdivided into four groups by the sex of the term, leaving approximately 16 cognates in each group. The difference between r_{ABy} and r_{AB} corresponds to the affinal component of relationship separated from the consanguinal component. This element in the biological variables provides yet another point for the discrimination of each term effectively dividing each group of cognates into two groups of approximately 8 kin terms each. These terms can be ranked by their values of r_{AB} or r_{ABy} that have a range from 0.0 to 0.5 leaving no more than two or three cognates in each group of kin terms sharing similar biological characteristics. However a further discrimination can be made in respect to reproductive maturity such that each kin is either less, equally or more reproductively mature than ego. In this way all 62 kin cognates which are normatively discreet can also be understood to be biologically discreet thus facilitating their use as proximate mechanisms for their specific repertoire of biologically adaptive behaviors such as precisely structured altruism and optimal mate choice.

If this conclusion is correct then the Netsilingmiut using this kin system should behave in accordance with it's underlying biological principles. In the traditional culture the preferred mate choice was for first cousins. First cousin marriage is the norm for most hunter/gatherer's (Service 1971, Chagnon 1982). This fact is underscored by the observation that Balikci (1970) and Rasmussen (1931) both neglected the kin term Nuleq, a child's spouse's parent. These ethnographers failed to note this term because it is so very rarely used, since such persons are nearly always also related by a

consanguinial tie, and the collateral term takes precedence. These preferred, and possibly optimal (Shields 1982, Bateson 1983), kin matings are distinguished by the kin terms for first cousins as Aupudluck notes:-

"I am married to my Angutekatti. Because the parents are worried about their daughters they arrange their marriage to Angutekatti or Arnakatti. They want the parents in law to be close relatives so the marriage will go well later in life. The daughter would not be married to strangers."

Aupudluck 1982.

Within the nuclear family the correlation of coefficients of relationship and altruism may be self evident but such a correlation within the extended family as a whole possibly requires empirical verification. Several studies have confirmed such a correlation (Hames 1979, Morgan 1979) by mapping observed altruistic and interactive behavior onto coefficients of relationship (r_{AB}) determined from genealogies. These analyses have typically focused on a single behavior such as child play, hunting partnerships or visiting patterns as recording these activities required many months of carefully directed observation. However many behaviors can be quickly surveyed if an informant's verbal reports of behaviors are used. In other words a wider range of behaviors may be more quickly examined by employing the traditional methods of cultural anthropology as opposed to the methods developed by animal behaviorists. Studying humans has many inherent advantages for sociobiologists not the least of which is the ability to determine genealogies from interviews without the need to observe matings. Methodologically the limiting of questions and interviews to the examination of mating behavior and not other behaviors would seem to be inconsistent.

By exploiting the advantages of linguistic reports a wide range of behaviors were sociobiologically analyzed for an arctic community that uses the Netsilingmiut kinship system. The settlement, which shall be referred to as Nunatsiaqput to retain its anonymity, had a native population of 224 when the survey was made, exclusive of missionary, nursing, teaching and trading post staff. As with many studies in cultural

anthropology a sociobiological analysis that attempts to correlate behavior and coefficients of relationship (r_{AB} or r_{ABy}) must proceed from the collecting of genealogies. The coefficient of relationship (r_{AB}) is a simple function of the coefficient of consanguinity (f_{AB}) (Wright 1922). The calculation of this coefficient (f_{AB}) can be made by employing an analysis of the biological genealogies of A and B such that common ancestors increase the value of f_{AB} . In theory this requires a full biological pedigree of each member of the population being studied. An approximation to this can be obtained through interviews to the extent that parenting is known or reported.

The population structure of modern arctic settlements is very young, and much of the population of a community will frequently share a relatively small pool of grandparents. Genealogies could be collected separately for each individual in each house, but this would produce very repetitious data. The conditions of data collection on pedigrees are reported in more detail below, suffice it to say here, that in order to impose on my informants as little as possible the bulk of the genealogical data were collected from a few elderly members of the village. Some of these individuals had a direct genetic investment in as much as 50 percent of the local population. Occasionally some genealogical data were unavailable because it was genuinely forgotten so fictitious ancestors were invented to fill in gaps in the data. Also, some intense inbreeding was not brought to my attention as some informants were very conscious of the missionaries (present since the 1920's) prohibitions on such relationships. These cases result in net results for f_{AB} lower than they would in fact be in reality. This error tends to work against the hypothesis that pro-social behavior positively correlates with relatedness, and therefore cannot explain any results supporting that hypothesis. However this is not true of the underreporting of extramarital relationships with strangers. Hopefully this kind of error has been kept to an acceptable minimum.

In the Netsilingmiut kin system kinship can be established by sharing a biological relationship, or by being partners in a reciprocal altruism pact, or by sharing a name that is part of a metaphysical relationship, or by being adopted. These aspects of

kinship will be examined later but it should be noted here that in order to establish a genetic genealogy it is necessary to isolate biological kinship from all other forms of kinship with a cognitive analysis of kinship terminology. Each individual in the community was assigned an index card with biological and all other cultural kin data on it, such that parents, sibs, spouses and progeny could be cross referenced and checked to confirm the accuracy of the data. Finally each individual was allocated a number which identified them in a computer program that calculated f_{AB} for everyone in the data base using the coefficient of parentage method. This program, written with the assistance of Prof. W. Starmer, analyzed the genealogies to a depth of four generations while taking into account the effects of both inbreeding and overlapping generations. There were 224 individuals that were compared to each other for a total of 50,176 analysis. These data were reported out as a matrix which was then available for other comparative analyses dealing with aspects of behavior such as who hunted with whom and who lived where, relative to the other members of the community (See Appendix for raw data and computer programs).

Given a need for numerous tests and limited resources and time variously targeted interviews were employed. Both repetition and cross-validation by different methods are desirable in any research. The present study may be stronger on the latter. Many aspects of the data were collected only once, or from one informant. But if different tests produce similar results, then support may be gained for both the hypothesis and methodologies. The range of tests and interview techniques can be illustrated for data on kinship and relatedness as follows:-

Distance.

Coefficients of consanguinity and relatedness frequently negatively correlate with distance. By focusing on this fact it can be argued that optimal foraging strategy theory (Hames 1979) provides an alternative hypothesis to kin selection as a causal explanation for the choice of interactants in pro-social behavior. From this theory,

humans interact more because they live close to each other, not because they are more related. As it happens the settlement of Nunatsiaqput is a recent invention of the Canadian government, established by providing housing and other facilities in the mid 1960's. Consequently housing occupancy has not naturally evolved in the community across generations. This fact makes possible an analysis comparing the predictions of the two theories. Does distance apart, or f_{AB} , better predict cooperative or interactive behavior?

A partial examination of this question was achieved by comparing inter-household f ("genetic distance") with spatial distance. This was done using a computer program that could access the f_{AB} matrix of Nunatsiaqput and calculate the mean f of designated groups of individuals. To do this for all of the 38 house holds in the settlement would have involved several weeks of work to prepare, compute and analyze 38 separate data sets. Thus a single house hold was selected whose head was a member of the largest extended family in the community and who also appeared to live in close proximity to several of his relatives. The results of this analysis are given in table 9. A weak and insignificant correlation of -0.117 was produced when inter house hold f 's were compared with distance taken from a surveyor's map of the village. It is possible that the weak correlation could have become significant if the number of observation points was increased by including analysis between all house holds (38 X 38 observations) but it would seem unlikely that the correlation coefficient would have increased greatly in value as most of the other families had fewer relatives in Nunatsiaqput. Thus the significant correlations between f and behavior, to be reported below, can't be explained by the proximity of the individuals, alone.

Hunting

Morgan (1979) was able to produce a positive correlation between the make up of Eskimo whale hunting crews and coefficients of relatedness. I have obtained similar results for the hunters of Nunatsiaqput using an interview, rather than actual

Table 9

Distance/Relatedness for Occupants of Nunatsiaqput

Correlation coefficient for mean household f/Distance is -0.117

This gave a "t test" of 0.498

<u>House #</u>	<u>/</u>	<u>House#</u>	<u>Mean Household f</u>	<u>Distance in 100's of feet</u>
1		2	0.03125	2
1		3	0.0	2
1		4	0.05	2
1		5	0	3
1		6	0.02678571	3
1		7	0	5
1		8	0.046875	4
1		9	0.0625	4
1		10	0	5
1		11	0.125	3
1		12	0.015625	6
1		13	0	8
1		14	0.03645833	8
1		15	0.125	6
1		16	0.05208333	4
1		17	0.0625	6
1		18	0.03125	6
1		19	0.03125	7
1		20	0.03327546	8
1		21	0.03515625	9
1		22	0.03125	11
1		23	0	13
1		24	0.00975625	11
1		25	0.01041667	12
1		26	0.006076389	15
1		27	0.03125	5
1		28	0	16
1		29	0.1041667	17
1		30	0.0150463	14
1		31	0.04375	14
1		32	0.02441406	15
1		33	0.05729167	15
1		34	0.04375	Out of Settlement
1		35	0.05902778	9
1		36	0	10
1		37	0	7
1		38	0.004557292	13

observations of team composition. A lifetime male member of the community was firstly asked to identify those men who regularly hunted. This would mean they owned a snowmobile and sled, probably owned a freight canoe and outboard motor and were involved in some hunting activity at least weekly. From the 38 house holds a list was produced of 33 such men. Summer hunting and fishing with canoes tends to be incorporated with family camping activities that would necessarily correlate with f . However winter caribou hunting with snowmobiles generally involves two or three men teaming up together for mutual safety in case of accident or mechanical failure. Such partnerships, unlike family activities, at least have the potential for being flexible and unrestrained by family ties.

Thus the informant was asked to identify the men each hunter had teamed up with during the past winter. This questioning produced 33 groups of individuals varying in size from 2 to 8 with a mean of approximately 5 as some individuals were more gregarious than others or possibly had wider family connections. This sample excluded 4 men that regularly preferred to hunt alone and 4 other individuals that were described only as "hunting and sharing with many". Using the f_{AB} matrix of Nunatsiaqput the mean coefficient of consanguinity within each group of hunters was compared to the mean coefficient between each group using the same computer programs as before. It should be noted that as an individual could be in more than one hunting group (but not more than one house hold) the computer program was written to disregard identical pairs, with an f of 1.0, that would distort the mean value of f for between group comparisons. The results of these analyses are given in table 10 and are plotted in figure 3. The probability that the null hypothesis, that f and choice of hunting partners, does not correlate is disproved at the $p < 0.001$ level of significance. This is graphically illustrated by the absence of any overlap in the standard error of the mean f within each group and the mean f between each group.

Visiting

A similar experiment using a female lifetime member of the community as informant produced a list of 41 adult females (women of child bearing age). Against this list each female was checked against every other female with the question. "Does this woman visit this woman at her house?" This produced groups of females ranging in size from 2 to 14 with a mean of approximately 6. From these women's data two residences emerged as being unusually popular. It turned out that these houses were being used for regular card games. These two groups, or houses, were therefore analyzed separately in addition to their inclusion in the "visiting" analysis (see table 10 and figure 3). The visiting females produced kin-relatedness results almost as strong as for the groups of hunting partners with the same $p < 0.001$ level of significance. The card players, however, did not, which might suggest that card playing for money is as much a competitive activity as it is a cooperative activity if further analysis were to produce similar results. It should be noted that if the card players, with their insignificant correlation, were taken out of the "visiting" analysis then that correlation would increase. Additionally all these analyses would probably produce stronger results if they were weighted for frequency providing closer relatives were more often visited or chosen as hunting partners than more distant relatives. This hypothesis, however, was not tested.

Consanguinial and Affinial Kinship, f , r_{AB} and r_{ABy}

One final analysis of these data sets is given in table 10 to illustrate the importance of understanding behavior and kinship as a function of the coefficient of relationship of an interactants progeny, i.e. r_{ABy} not r_{AB} . Due to a preference for patrilocality of the 39 married couples, ten females had come into the community leaving their parents elsewhere, while the same was true for only five males. Of these marriages with outsiders, the mean f for the interactants of these individuals was much lower than for their non-migrant counterparts, it was even less than the mean f of the

Table 10

Adult Interactants of Nunatsiaqput

<u>Groups</u>	<u>Female</u>	<u>Female</u>	<u>Hunting</u>	<u>Hunter</u>	<u>Card</u>
<u>Visitors</u>	<u>Migrants</u>	<u>Partners</u>	<u>Migrants</u>	<u>Players</u>	
Number of Groupings	41	10	33	5	2
Mean f Within Groupings	0.0427812	0.0166667	0.0250000	0.0696720	0.0271652
Mean f Within Spouse's Groupings	-----	0.1241817	-----	0.0740625	-----
Variance Within Groupings	0.0008215		0.0033209		0.0000071
Standard Error Within Groupings	0.0044764		0.0100316		0.0018812
Mean f Between Groupings	0.0222849		0.0290592		0.0232111
Variance Between Groupings	0.0006275		0.0011846		
t for Null Hypothesis	4.534446		4.01062		
<u>D. F.</u>	859		559		
<u>Significance p<</u>	0.001		0.001		

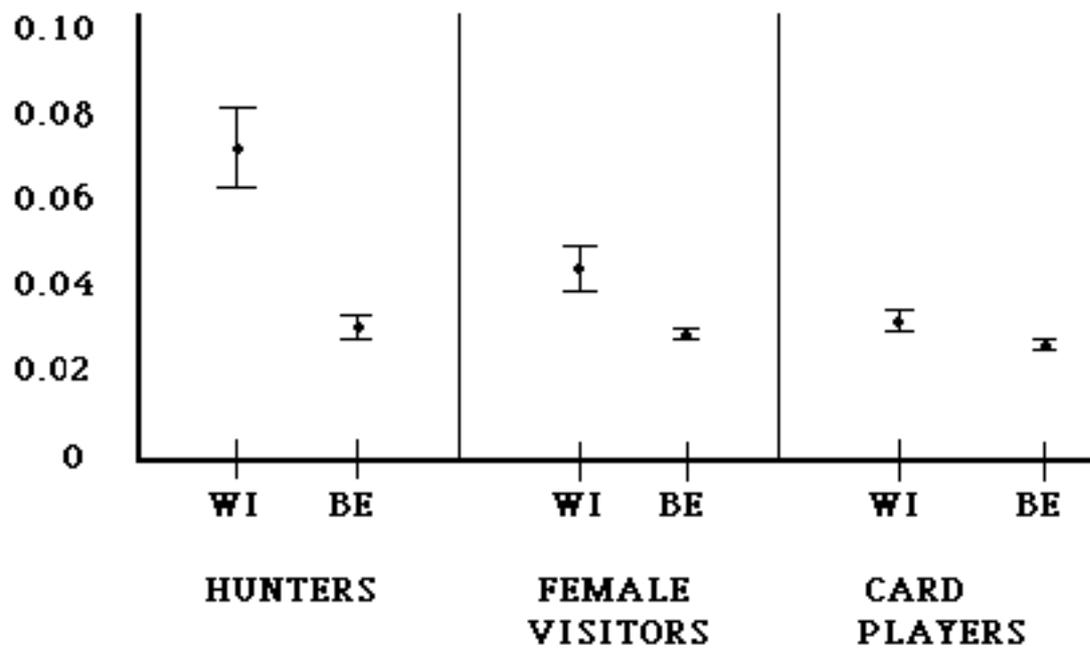
One Way Anova for 2 Groups of Card Players Not Significanat, p<0.7957

<u>Source of Variation</u>	<u>Degrees of Freedom</u>	<u>Sumes of Squares</u>	<u>Mean Squares</u>	<u>F</u>
Total	275	1.3410		
Card Groups	2	0.0022	0.0011	0.2287
Error	273	1.3388	0.0049	

FIGURE 3.

**ADULT INTERACTENTS OF NUNATSIAQPUT:f FOR HUNTERS
FEMALE VISITORS AND CARD PLAYERS WITH STANDARD
ERROR WITHIN AND BETWEEN GROUPINGS.FROM TABLE 10**

**COEFFICIENT
OF
CONSANGUINITY
(f)**



WI. MEAN f WITHIN GROUPINGS

BE. MEAN f BETWEEN GROUPINGS

entire Nunatsiaqput population. If however, these analysis are computed with respect to the genealogy of their spouse, and there by also their progeny, by substituting the spouses genealogy in place of their own, the mean values of f are much increased. Indeed, these values are considerably higher than any of the comparable values for the previous analysis given in table 10. This striking result may be in part an aberration of the limited number of migrants available for this analysis. Non the less several hypothetical conclusions may be developed as follows:-

- (1) Behavior and Kinship should be analyzed in terms of r_{ABy} and not r_{AB} or f_{AB} .
- (2) The comparatively high dependence of migrants on their spouses family for friendships and hunting partnerships, particularly for females, may suggest a sexually biased inertia for the late (post marriage) development of relationships.

Interestingly a similar result was obtained for the non-inuit store manager when his hunting companions were compared to his store clerk. An identical result would have been obtained if the manager had married the clerk's sister making him a brother in law. In this way the clerk can be understood as a surrogate affinal kin in respect to behavior. Perhaps this single example illustrates a hypothetical principle of behavior that can be phrased as follows:-

- (3) The proximate mechanisms of primitive social behavior and structure are manipulated to produce novel social behavior and structure in ultrasocial societies (for a fuller analysis of this hypothesis see Chapter 4, A Study in the Evolution of Ethnocentrism).

Play

In order to gain some perspective on the development of the behavior patterns described above, an experiment was run in which each child attending school in Nunatsiaqput had its name written on a separate card. These cards were then sorted by one of the children into the groups that played together. These groups were then

subsequently combined into larger groups with the question, "Which groups get along best with which groups?" until only two groups remained. As before mean f within groups was compared with mean f between groups and these results, which are all significant, are presented in table 11 and illustrated in figure 4. Additionally, by way of illustrating the possible value of sociobiology in applied social science, school drop outs are compared with those who regularly attend school. This result is also significant and probably reflects the social and economic strength of the largest extended family in the community. Nepotism, it would appear, begins in school. Perhaps the most impressive of these results is the fact that the difference in mean f between groups actually increases as the groups become larger. This is in keeping with Chagnon's (1979) descriptions of tribal fissioning. Thus, if the Eskimo described here were not collected into a contemporary artificial community, these groups of children might be expected to fission when they become adult. Given the visiting patterns of the adult females, the seeds of genetic and behavioral polarization of the community are no doubt set in early childhood since the infants accompany their mothers from household to household.

Genetic Environment

The potential for the effects that coefficients of relationship may have on behavior in the population of Nunatsiaqput as a whole can be examined further by analyzing the general genetic environment of the community with respect to f . The present population structure of Nunatsiaqput is not typical of a traditional population structure due to an absence of female infanticide, relatively negligible infant mortality, lowered male mortality, and high migration rates. However a frequency distribution of f for the members of the largest extended family in the community is probably reflective of the genetic environment of a traditional band or kin group. In order to reduce the effects that age may have on the distribution of the frequency of f four individuals were selected from each of the four generations in the community. Their coefficients of

Table 11

Child Play Groupings and School Drop-Outs

<u>Number of Play Groupings</u>	25	12	7	3	2	2
<u>Mean f Within Groupings</u>	0.04966	0.05174	0.03880	0.03913	0.03517	0.02328
<u>Variance Within Groupings</u>	0.00153	0.00096	0.00005	0.00001	0.00000	0.00000
<u>Standard Error Within Groupings</u>	0.00782	0.00896	0.00277	0.00186	0.00145	0.00007
<u>Mean f Between Groupings</u>	0.02144	0.01898	0.02008	0.01361	0.00627	0.01712
<u>Variance Between Groupings</u>	0.00055	0.00232	0.00017	0.00016		
<u>Standard Error Between Groupings</u>	0.00136	0.00187	0.00192	0.00741		
<u>"t test" for Null Hypothesis</u>	3.55303	3.57603	4.64316	3.33971		
<u>D. F.</u>	323	76	26	4		
<u>Significance p<</u>	0.001	0.001	0.001	0.029		

One Way Anova for 2 Play Groups.

Significance, p<0.0001

<u>Source of Variation</u>	<u>Degrees of Freedom</u>	<u>Sumes of Squares</u>	<u>Mean Squares</u>	<u>F</u>
Total	3827	8.5460		
Play Groups	2	0.7273	0.3636	177.8964
Error	3825	7.8187	0.0020	

One Way Anova for School Drop-Outs/School Goers

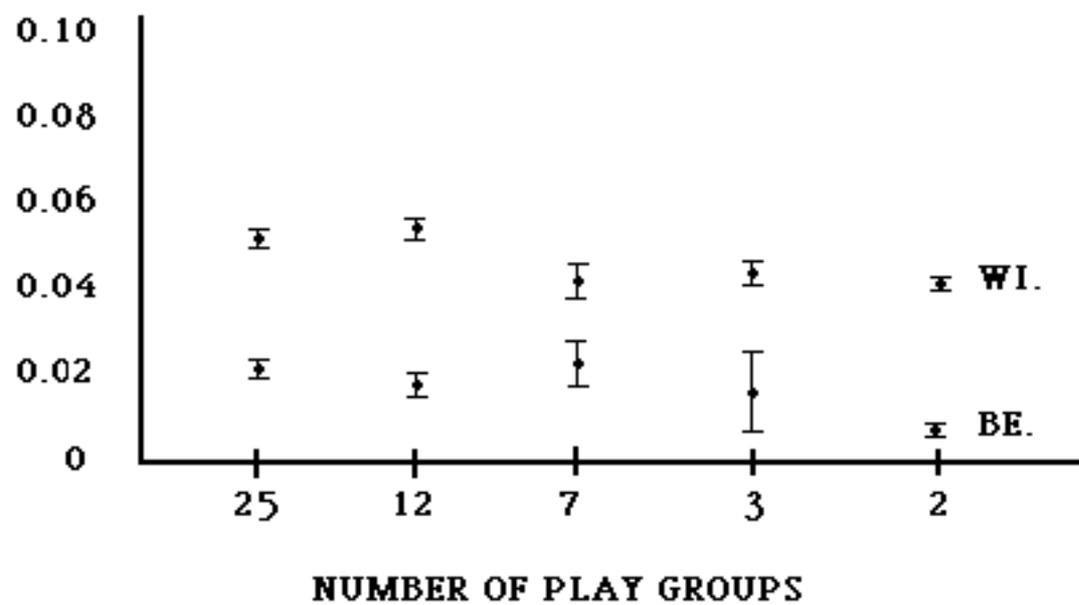
Significance, p<0.0070

<u>Source of Variation</u>	<u>Degrees of Freedom</u>	<u>Sumes of Squares</u>	<u>Mean Squares</u>	<u>F</u>
Total	2555	5.3019		
Drop/Go	2	0.0206	0.0103	4.9777
Error	2553	5.2813	0.0021	

FIGURE 4

**CHILDREN OF NUNATSIAQPUT SORTED INTO PLAY GROUPS
f WITH STANDARD ERROR WITHIN AND BETWEEN GROUPS
FROM TABLE 11.**

**COEFFICIENT
OF
CONSANGUINITY
(f)**



WI. MEAN f WITHIN GROUPINGS

BE. MEAN f BETWEEN GROUPINGS

consanguinity were analyzed for frequency with respect to every other member of the settlement. These results are given in table 12 and illustrated in figure 5. The members of this family have direct (r_{AB}) genetic relationships with approximately 50% of the population. Most of these relationships would be covered by Netsilingmiut kin terminology. Additionally many indirect (r_{ABy}) affinal relationships, left out of this analysis, would also be covered by kin terms. Thus many, if not the majority, of the relationships of this kin group and the rest of Nunatsiaqput can be described from both a genetic and kinship perspective that is represented by the shaded portion of the bar graph in figure 5. However the elderly members of Nunatsiaqput are able to create kin terms for almost every individual in their community. Some of these aspects of kinship, that go beyond a simple interpretation of kin selection and behavior, will now be examined.

Adoption

Adoption, and subsequent investment by step-parents in unrelated children, would appear to be a behavior that opposes the processes of kin selection. Such individuals are often referred to with special or qualified kin terms in the Netsilingmiut kin system. These kin terms are given in table 13. However adoption, when it does take place, should at least be more frequent for close relatives than distant relatives, if kin selection has any influence on this behavior. In the settlement of Nunatsiaqput with a population of 224 there were 22 adoptions, nearly all within the community. Of these 10 were grandchildren, 4 were the children of a brother or sister, 3 were the grandchildren of a brother or sister, 2 were from the same tribe, 1 was from an intertribal marriage and 2 were from other tribes. The mean coefficient of consanguinity of the 44 adopters and 22 adoptees (f_{AB}) was 0.15 while the mean coefficient of consanguinity for Nunatsiaqput was only 0.02.

Apart from this confirmation of the influence of the processes of kin selection the very high rate of adoption is worth further examination and possible explanation. As

Table 12

Frequency Distribution of f in Nunatsiaqput [Total pop. 224]

For 4 Members of Largest Extended Family From Each of 4 Generations,

Great Grandparent, Grand Parent, Parent and Child.

<u>f</u>	<u>% Great Grandparent</u>	<u>% Grand Parent</u>	<u>% Parent</u>	<u>% Child</u>	<u>% Average</u>	<u>% Total Pop.</u>
0.2500000	2.7	6.4	7.6	3.6	5.075	5.075
0.1875000	2.7	0.0	0.0	0.0	0.675	5.750
0.1562500	0.0	2.8	0.0	0.0	0.700	6.450
0.1250000	16.7	17.0	9.8	7.6	12.775	19.225
0.0937500	0.0	0.5	0.0	0.0	0.125	19.350
0.0781250	0.0	0.0	2.7	0.0	0.675	20.025
0.0625000	22.1	19.1	12.1	10.7	16.000	36.025
0.0468750	0.0	2.3	0.0	0.0	0.575	36.600
0.0312500	4.1	0.0	12.5	16.1	8.175	44.775
0.0156250	0.0	1.8	2.2	12.1	4.025	48.800
0.0078125	0.0	0.0	1.3	0.9	0.550	49.350

FIGURE 5

FREQUENCY DISTRIBUTION OF f IN NUNATSIAQPUT

(TOTAL POPULATION 224). FROM TABLE 12.

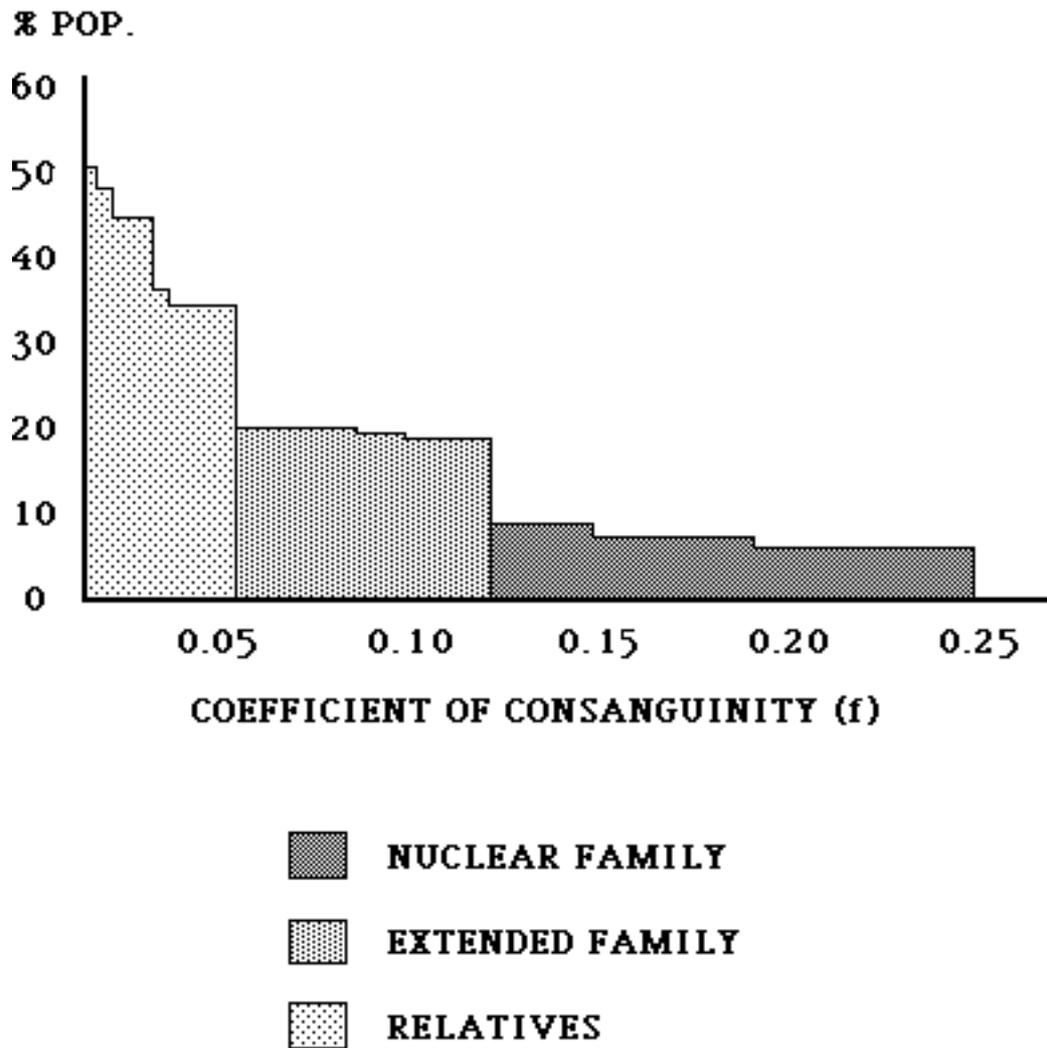


Table 13

Some Netsilingmiut Terms of Kinship Adoption and Extension

<u>Term of Adoption</u>	<u>Transliteration</u>	<u>Translation</u>
Tiguark	Adopted	Adopted Child
Tiguark Agut	Adopted Man	Adopted Son
Tiguark Arknaq	Adopted Woman	Adopted Daughter
Tiguarksiga	Adopted-The one who-Me	Adopted Parent
Tiguarksiga Agut	Adopted-The one who-Me-Man	Adopted Father
Tiguarksiga Arknaq	Adopted-The one who-Me-Woman	Adopted Mother

<u>Term of Extension</u>	<u>Translation</u>
Aniginitanuargrak	Not my little brother
Aninuarak	That little man is my brother
Takeeksagraluagra	Was to be my mother or father in law
Aeeksagraluagra	Was to be my affinal kin of opposit sex
Atataluargrah	Perfect to be my father
Atcheearq	The one that I am named after
Taunugaittooq	Side of a seal partner
Angatanuarkuluga	My new little mother's brother or sister's husband
Angaluarkulook	Perfect to be my mother's brother or sister's husband
Anggaqtahnuarq	New mother's brother or sister's husband
Angahluargrah	Just right mother's brother or sister's husband
Anguteqatinnaga	My nice child of my brother
Innequnaeqateega	My me and her are ugly
Innikunaqtuteekulugah	My little me and her are ugly
Anaqateksakuluga	To be my little children of sisters

pointed out earlier, reproductive maturity may have evolved with dominance amongst the Eskimo as a culturally enhanced biologically adaptive process. This, it is suggested, is due to the harshness of the arctic environment that makes the specialized cultural skills of hunting, clothing manufacture and child care more difficult to learn and become proficient at. This proposition is illustrated by the early experiences of Aupudluck:-

" I have had twelve children in all. Out of the twelve there are only five alive now, some of them died. Two of the babies were not alive when they were born. One was premature and the other one was nine months old but it came out dead.

I had been traveling with my husband and I didn't know I was expecting. I was so excited and happy about going hunting with my husband that I was running along-side the sled and jumping on it. We were alone as I had left my children with their grandmother. It was a very lovely day, it was not cold and we were having a great time. I would run beside the sled when the dog team was going fast and jump on the sled to get on while it was going. It was getting darker so I was feeling a little cold. To keep warm I kept on running and jumping on the sled. I didn't realize that I was squashing my baby inside me.

My husband had just finished the igloo and I had just stopped bringing the things inside when I felt the first pain of the delivery. I knew it was coming out. When it came out the head was all squashed. So I said to my husband, "It came out but it hasn't cried yet."

So he came up to me and said "ehhhh" which means that something was wrong. We had a little laugh but it was not a real laugh, and then he said, "The head is all squashed up. You have done it today when you were running along beside the sled and jumping on it."

He had been telling me to be careful when we were traveling with the dog team. But I had said it wouldn't happen, it wouldn't die. My husband had even told me, "The baby could die because you're jumping on the sled."

So we just had a laugh as the baby was not alive when it came out. My sister-in-law cried for the dead baby. She had sewn all the cloths for the baby. She had made a hat for it and boots for it so perhaps that is why she cried. When she was crying she said, "I'm going to throw the baby's cloths away." So we just laughed at her.

It was about that time when I almost lost my little daughter. She almost froze. I must have been so clumsy. I had

gone home to sleep with my husband. That is when I almost froze my little daughter. I woke my husband up and we cried when no one else could hear us. My husband died that summer.

When it was about two years old my father told me to give it to my cousin because he knew that I could not look after the baby well. I did not know how to take care of a baby. My cousin had many babies, but they all died when they were a few days or a year old, she never had any success with a healthy baby. That is why my father told me to give the baby to her, because I could not look after it as well.

Aupudluck 1977.

It should be noted that laughter in the above situation was a typically Eskimo stoic response to a tragic occurrence that could not be corrected.

The individual costs of raising children and grandchildren are easy to understand in the context of kin selection. Humans, like all organisms, are genetically predisposed to freely dispense care on their own infants. However this is not so true of the offspring of more distant relatives. Thus the adoption of such individuals may require some cultural prompting. The abandonment of orphaned children would represent an enormous loss of invested resources to a kin group especially if the children had passed the early years of high infant mortality. Consequently, it should come as no surprise, that one of the most popular themes in Eskimo mythology addresses the wrong of neglecting unwanted homeless children. The following example of such a myth also provides a cosmology of thunder and lightning. A recurrent problem in moral philosophy and game theory is the difficulty of coming to terms with a successful cheater. This myth, as with much religious ethics, overcomes this dilemma by providing a metaphysical retribution for wrong doing. The contemporary demise of similar metaphysical beliefs must necessarily weaken the effectiveness of religious ethics and thus place a greater burden on other pro- social mechanisms such as law.

"There was once a boy and a girl who were brother and sister. They were left behind by the other people in their band because they did not have a mother or a father.

The brother would tell the girl. " What do we want to be? What do we want to be? Do we want to be musk oxen? Do

we want to be musk oxen? If we are strong black musk oxen we can fight with our horns."

Again the boy would say to his sister, "What do we want to be? What do we want to be?"

His sister would answer, " We could be polar bears. But if we are polar bears we might fight with each other."

They were sitting inside the rocks of an old tent ring when the little boy asked his sister what they wanted to be.

He said, " Do we want to be thunder?" The girl remained completely silent and began to concentrate on the old tent ring that surrounded them. The boy found two rocks that were tools, that were left behind by their band and had been used for making fire. The girl found a skin and stretched it into a drum. Then the orphan boy started to strike the two rocks together and great sparks leapt from his hands. He had made lightning. The girl started to hit the drum that she had made and it thundered. Each beat on the tight skin made a beat that roared across the land. And so the abandoned children became thunder and lightning. The sister was thunder, the brother was lightning and they went in search of the people that were not kind to them when they lived together in the same camp. The people had been cruel to the boy and girl so they went to their band's camp and raged a thunderstorm on them. The brother and sister made the thunder and lightning last for many days until the wicked people were all killed. People came to see the destruction from other hunting camps. They found the people there were all dead, killed because they had been so cruel to the little boy and the little girl.

The distant travelers who came to see these wretched people that had been in this first thunderstorm were in the exact same position as when the thunderstorm started. Some people were sitting up, some people were standing up, some people were lying down, some people were working, cooking, some people were playing, children were playing, including the babies, from the eldest to the youngest, the people never moved even when the other people came to see them.

And the dogs, some of them were lying down, some of them were standing up, some of them were under the rocks trying to get away from the thunder. They were all looking, staring vacantly at the same empty open ground.

And one traveler touched a dog and it disintegrated to a pile of ashes. So all the travelers went about and touched all these people that were in the thunderstorm. They all became ashes.

The brother and sister that had become thunder and lightning had done that to them because those thoughtless people were so cruel to the orphans. So that is why my mother and father used to tell me never to be mean to children who do not have parents because children that are not loved by anyone

can become anything , an animal, the thunder, anything that could be vengeful and dangerous.

Aupudluk 1977.

The analysis of Netsilingmiut adoption sketched here, from the perspective of sociocultural biology, may be summarized as follows:-

(1) Kinship by adoption is separated from other forms of kinship with separate kin terms.

(2) Adoption is restrained to preferences for close kin by the processes of kin selection.

(3) Adoption of close kin by reproductively more mature members of the extended family may benefit the inclusive fitness of all those involved in the adoption.

(4) In order to maximize the investment of a kin group in child rearing the adoption of orphans is culturally encouraged by values, norms and metaphysical beliefs embodied in mythology.

Kinship Extension

The dominance hierarchy of the extended family regulated the distribution of resources amongst kin. Reciprocal altruism within the tribe was not so rigidly regulated and was therefore strengthened with the cultural institutionalizing of sharing partnerships (for a review see Alliance In Eskimo Society, Edt. Guemple 1971). The reciprocal behaviors of seal meat sharing (Franz Van de Velde 1956, Balikci 1970, Trivers 1972), name sharing gift exchange (Guemple 1966, Irwin 1981), wife sharing (Guemple 1961) and various forms of kin extension (Burch 1975) were principally limited to tribal members. Amongst the traditional Netsilingmiut this would minimize the costs of cheating. Given the need for cultural enforcement of partnerships and the limitation of these partnerships to the approximately 200 adults of the tribe, outside an individual's extended family, reciprocal altruism can be seen as a limited biological prosocial mechanism in humans, constrained by the costs and benefits of kin selection

(Chapter 4, A Study in the Evolution of Ethnocentrism). Although each member in these partnerships is referred to with a specific term that is associated with the obligations of the partnership these relationships may or may not be a form of kinship or kinship extension depending on the definition of these concepts. However, in practice, the Netsilingmiut regularly elaborate their affinal and consanguinal kin system with the network of relationships established by shared names and adoption. Using these various systems in combination my wife, and thereby, I, her husband, have always been able to establish kinship with other Netsilingmiut in the half dozen settlements they occupy in the contemporary Central Arctic. These surrogate relationships allow mobile individuals to "plug in" to other extended families and thus enjoy the welfare of a surrogate kin group. In this way cultural kinship extension can be understood biologically as a form of reciprocal altruism between extended families within the confines of the tribe. As a member of a surrogate kin group I must respect the patriarchs and matriarchs of that group. Conversely my juniors must show deference to me. As with other forms of partnerships, this surrogate kin extension, is a complex prosocial phenomenon that combines the various necessities and complexities of kin selection and reciprocal altruism, with the latter a constrained elaboration of the former.

This complexity is illustrated by the fact that my mother in law, Aupudluck, has a discreet surrogate kin term for each of the members of her community who are not otherwise related by a more obvious biological bond. Some of these terms are given in table 13. This phenomenon effectively integrates the extended families that make up her community into a single social unit that none the less provides each individual a separate place with its unique set of advantages and obligations. Today, my mother in law is one of the few people remaining alive in her settlement who is able to cognitively construct such a complex social edifice. As with the loss of belief in myth and metaphysical retribution, the abandonment of this sophisticated kin system will further undermine the pro-social inventions of the Netsilingmiut culture. In such ways the institutional moral fabric of all aboriginal peoples is subject to erosion in contact with

Western culture, an erosion that is apt to create the appearance, and reality, of social failure. The pro-social mechanisms of modern ultrasocial societies may be so complex as to make the mechanisms described here look simple by comparison. However these ultrasocial mechanisms are themselves not immune to social change. The current success of western civilization is probably as much a product of luck and chance as it is a product of design. Hopefully, humans will develop a skill for design in this area of scientific inquiry before their luck runs out.

Discussion and Conclusion

The analysis of Netsilingmiut kinship made here, from a combined biological and sociocultural evolutionary perspective, may now be compared with the descriptions and associated conclusions of other ethnographers and anthropologists with different theoretical outlooks. Descriptively there are, for all intents and purposes, no significant differences between the records of Rasmussen (1931), Balikci (1970) and my own field notes. Both Rasmussen and Balikci chose to separate partnerships from kinship while Guemple (1966) in describing the almost identical social phenomena for the Eskimo of the Balcher Islands preferred a more integrated approach. The descriptions given here lean more towards Guemple's open ended perspective that does not establish the limits of kinship a priori. However this definitional or theoretical issue can be settled antecedent to description such that descriptively there are no significant ethnographic differences between any of the previously cited works.

The principle conclusions, as empirical generalizations, are also very similar. Balikci summarizes these as follows:-

"Likewise, the Netsilik system was admirably suited to the hunting way of life. Despite the fact that extended families were not rigidly structured, they did exist, with the result that the nuclear family was only in exceptional cases forced to fend for itself. Boys had the opportunity of acquiring their technical and general knowledge from a number of older relatives. The system was remarkably flexible. At any given time, a nuclear family could break away and join another group. Affinial ties could be exploited

and substituted for consanguinial bonds. Kinship and affinal alignments often provided the organizational framework for necessary collaborative activities, of which there were many. The list of the various collaborative forms among the Netsilik is truly impressive. They extended to the fields of food acquisition, distribution and consumption, borrowing, help during crises, etc. There is no doubt that the extent and flexibility of collaboration were vital factors in Netsilik survival. Yet because of its very flexibility, the kinship system had to be supplemented by additional binding mechanisms. These were the numerous patterned dyadic relationships which established social bonds primarily between non-kinsmen. The most important such mechanism was the seal-meat-sharing pattern, remarkable indeed for its rigidity. Collaborative forms determined by biogeographic or technological factors, consanguinial and affinal ties, and the patterned dyadic bond, all worked together to produce a complex network of relationships which made for the social cohesion the Netsilik needed to hunt and live together.

Balikci 1970 pp. 241 &

242

Although it is not possible to speak for them, Rasmussen and Guemple would almost certainly agree with most of these conclusions and hopefully the reader of this dissertation is drawn to a similar understanding of the Netsilingmiut social condition. Given this accord of description and conclusion what, if anything, has the evolutionary analysis made here added to our understanding of Netsilingmiut kinship and possibly human relationships in general? In what ways can the sociobiology of kinship elaborate or replace a strictly sociocultural analysis of kinship? Perhaps this question can best be addressed by attempting to resolve or clarify some of the issues of kinship raised in the structural analysis of Guemple (1966) as follows:-

(1) Guemple, like Balikci (1970), considers the extended family a more flexible social system than the highly structured sociobiological behavior described here may suggest. This difference in description and conclusion may be due to this study's focus on a partly aculturated artificial settlement made up of the elements of a number of extended families. Guemple's and Balikci's field work preceded the recent establishment of village communities. The possibility that emergent behavior in these communities has been shaped by biological forces suggests that the processes of

socioculture change are as much the product of the necessities of sociobiology (Chagnon 1982) as they are a product of cultural contact and social change.

(2) Guemple characterizes his own studies as having an "open perspective" and being "multidimensional." In contrast, Guemple suggests "unidimensional" treatments of kinship separate consanguinial and affinal relationships from "fictive" or "pseudo" kinship and "closed" perspectives separate kinship from other forms of status reckoning. When sociobiological theories, such as kin selection and reciprocal altruism, are used to analyze kin terminology and associated behavior the apriori barriers to analysis created by "fictive," "pseudo" and "closed" break down. A central core of Netsilingmiut affinal and consanguinial terminology and behavior is analyzable in terms of high coefficients of r_{ABy} and r_{AB} but these coefficients continue to effect relationships throughout the tribe and possibly between tribes. Partnerships may principally be a product of the benefits of reciprocal altruism, but these partnerships, amongst the Netsilingmiut, are principally limited to the tribal population that share a common level of genetic relatedness created by a high level of tribal endogamy (Chapter 4, A Study in the Evolution of Ethnocentrism). It would appear to be impossible to separate Netsilingmiut kinship and behavior into classes that could be said to be exclusively determined by kin selection or reciprocal altruism. The kinship system studied here, in respect to fields of meaning and associated behavior, would appear to be shaped by a number of evolutionary theories, non of which are mutually exclusive. This conclusion possibly compliments Guemple's views on an "open-ended" methodology but may also overcome some of the difficulties he recognizes as inherent in his theory.

(3) In abandoning many of the limiting conventions of descriptive anthropology, with regard to kinship, Guemple realized that comparative studies would become increasingly cumbersome and there by less effective. This observation led Guemple to the additional conclusion that:-

A kin type primitive language is simply inadequate to the task of producing a meaningful type analysis of the kinship universe! But the problem involved in developing a more adequate reference language is great, perhaps because abandonment of a genealogical reference language robs us of any device for translating the native categories into English.

Guemple (1966)

pp.212

Guemple goes on to suggest that his structural approach may overcome this problem, it very possibly does. However the sociobiological analysis made here, when combined with an understanding of the instrumental role of kinship terminology as a proximate mechanism, may also overcome this problem with an even greater potential for explanation.

Firstly the evolutionary theories used here, were developed to address questions of behavior in general. Which organism cooperates, competes, mates with which organism under what circumstances? The theories are primarily theories of action not meaning. However, when the "how?" of social behavior and action is examined questions of proximate cause and communication are raised. Communication necessitates meaning and in humans kinship can be one of the many vehicles of such meaning. By reversing this line of argument it is possible to progress from a linguistic analysis of kinship to a behavioral analysis and vice versa.

Secondly the language of sociobiology is not limited to explaining kin or kinship related behavior. It can, using a variety of evolutionary theories, be applied to all aspects of behavior. There are no apriori limitations on its application to a narrow class of human social phenomena or, indeed, any aspect of life anywhere in the universe. By using the language of the biological sciences as a reference language all barriers of etic classification are broken, at least within the domain of that class of phenomena known as life.

These claims can be defended as issues in the philosophy of science (Nagel 1979), social science (Rosenberg 1980) and biology (Rosenberg 1984) in so far as an attempt is made to explain human kinship and its associated behavior in terms of theory

that is complete nomologically. However the complexity of sociobiology and human kinship is such that the limited attempt made here to analyze Netsilingmiut kinship can only represent a first effort at substantiating the ambitious claims just made for human sociobiology. Even if these theoretical conclusions are accepted in principle the adoption of such theory in practice will depend on the analytic and predictive power of the theory. In the absence of detailed cross cultural studies the prospects for such theoretical robustness are speculative. The debate over the extent to which human sociobiology can contribute to the social science of sociocultural anthropology is plagued by ideological rhetoric (Alper et. al. 1976). Hopefully the methods used here will be improved upon to help facilitate the resolution of this scientific question by empirical procedures.

Chapter 4

A Study In The Evolution Of Ethnocentrism.

Introduction.

The study of group behavior in humans has been most extensively carried out by social scientists' inquiries into the phenomena of ethnocentrism. LeVine and Campbell (1972) considered the biological basis of human group behavior as being beyond the scope of their comprehensive survey of theories of ethnocentrism. Wilson, in his reference to that study, suggests that such viable qualitative laws would be explained by evolutionary sociobiology (E.O.Wilson,1975,1978). This position is summed up by Wilson in On Human Nature:

"Culture elaborates the rites of passage--initiation, marriage, confirmation, and inauguration--in ways perhaps affected by still hidden biological prime movers. In all periods of life there is an equally powerful urge to dichotomize, to classify other human beings into two artificially sharpened categories. We seem able to be fully comfortable only when the remainder of humanity can be labeled as members versus nonmembers, kin versus nonkin, friend versus foe.

E.O.Wilson,1978 pp. 72

In as much as ingroup cooperation is one of the characteristics of ethnocentrism (LeVine and Campbell 1972) theories that explain the biological evolution of altruism (for example: Hamilton 1964, Trivers 1971, Wade 1979, D.S.Wilson 1980, Boorman & Levitt 1980, Eshel & Cavalli-Sforza 1981, for reviews see E.O.Wilson 1975 and Alexander 1979) will contribute to an analysis of ethnocentric behavior. In referring to the behavior of xenophobia, a fear of strangers, it has been suggested that it may be a genetically triggered response to morphological differences produced by population isolation (Hamilton 1975, Alexander 1979) and in-group cooperation in inbred populations (Hamilton 1975). However these observations on one

aspect of ethnocentrism fall short of developing a full explanation of the group behaviors referred to by Wilson, and Levine and Campbell. Boyd and Richerson (1980) develop a model for the cultural group selection of ethnocentric behavior and ingroup altruism that attempts to overcome the limitations on models of cooperative behavior restricted to individual and inclusive fitness interests. Abruzzi (1982) develops another cultural evolution model of ethnocentrism based on the ecological concept of ethnic groups adapting to various niches.

As all these theories may be correct, as they are not necessarily mutually exclusive, the objective of this study is not to create yet another model for the possible evolution of human group behavior and extensive ingroup altruism and then argue its merits. The methodology to be used here is to closely examine the evolution of human population structure in order to better understand which models and which theories best describe the selective forces that have dominated and shaped human group behavior. In other words, the question at hand is: What social evolutionary path have humans most likely gone down as opposed to what paths could humans have gone down? The rationale behind this methodology is stimulated by theoretical perspectives in the biological sciences that attempt to gain a better understanding of phenomena through an examination of their evolutionary history (Pittenbrigh 1958, Williams 1966, Mayr 1974). The importance of this approach to biological questions is summed up by Williams as follows:

"No complete explanation of a biological phenomenon can be achieved without an inquiry into its evolutionary development, and a teleonomic analysis would not proceed far without the use of historical data. The analysis would disclose much that is functionally inexplicable. The inversion of the retina, the crossing of the respiratory and digestive systems, and the use of the urethra for both excretory and male reproductive functions represent errors in the organization of the human body. They have no functional explanation but can be understood as aspects of functional evolution. Historical considerations are also necessary in explaining the many functionally arbitrary limitations that are always apparent in

the design of an organism: Why is man a mere biped and not a Centaur?"

Williams 1966 pp. 263

By uncovering the details of human social evolution it is hoped that an understanding of ethnocentrism can be arrived at. If such a description and explanation is for the most part correct it is further hoped that an adequate foundation can be created for developing some applied solutions to the problems of human group behavior. This approach to the study of human nature is endorsed by Wilson (1975) in his suggestion that man can be frequently understood as a Pleistocene hunter/gatherer. Thus what amounts to an archaeological investigation into the human genetic environment should begin by examining homo sapiens as they existed in primitive or natural population structures. This examination of natural human populations can be separated into several distinct but related questions:-

(1) Descriptively what, if any, is the typical social and genetic structure of natural human populations?

(2) How would such a structure effect social behavior from the perspective of biological theories of altruistic behavior?

(3) What are the proximate mechanisms maintaining population structure and associated social behavior?

Questions one and two address issues related to the ultimate causes of group social behavior and will be dealt with first.

The Descriptive Structure of Natural Human Populations.

Perhaps one of the best studies of a primitive megapopulation is to be found in Norman B. Tindale's Aboriginal Tribes Of Australia (Tindale 1974). This encyclopedic compendium of the 600 tribes that, until recently, occupied 100% of the Australian land mass provides a detailed description of the structure of a hunter/gatherer megapopulation. Tindale notes that tribe size varies between 250 and 750 individuals

and that the mean is probably between 450 and 500. However this variation in tribe size is accompanied by variations in density of population that range from 1 in 3 to 1 in 50 square miles. In contrast while the Netsilingmiut of Arctic Canada (on which the present analysis will focus) also have a tribe size of 450 to 500 (Boas 1901 and 1907, Rasmussen 1930b and 1931) they have a density of only 1 in 200 square miles. Environmental pressures, such as resource distribution, can account for these enormous changes in population density (Weyer 1932, Tindale 1974). Given the similarity in the tribe size it would seem unreasonable to conclude that this number is also determined by environmental factors. This phenomenon was referred to as "The Magic Numbers '25' and '500': Determinates of Group Size in Modern and Pleistocene Hunters" by Lee, DeVore, Binford, Birdsell, Damos, Freeman, Hiatt, Sahlins and Washburn (Lee and DeVore 1968). No single conclusive explanation was offered at that time to explain this consistent tribe size of 500.

Tindale goes on to describe the marriage structure of the population as follows:-

(1) Within the extended family first cousin marriage is the preferred mating arrangement (Tindale 1974).

(2) Within the clan or hordes marriages are preferred within the horde (Tindale 1974).

(3) Marriage beyond the group of hordes that make up the tribe is restricted by low rates of migration (Tindale 1953).

(4) Each tribe belongs to one of five or six groups of tribes and between these groups migration rates are reduced to almost zero (Tindale 1953).

This degree of positive assortative mating would have produced considerable inbreeding within each tribe. Tindale does not comment on the effects this might have on coefficients of relatedness. However Spielman, Neel and Li (1977) have calculated a

theoretical probability of identity by descent for homologous alleles at roughly 0.5 amongst the tribe members of the 47 Yanomama villages they studied in South America. Spielman, Neel and Li also suggest that this degree of inbreeding may be typical of all primitive hunter/gatherers which would include the Australian Aboriginals and the Eskimo. Estimating inbreeding coefficients in such populations is problematic. However it may be concluded from the various descriptions of modern and pleistocene hunter/gatherers that:-

(1) Primitive tribes or what may be called natural human populations were composed of approximately 500 individuals (Boas 1907, Lee, DeVore, Binford, Birdsell, Damos, Freeman, Hiatt, Sahlins and Washburn 1968, Tindale 1974).

(2) These natural human populations or demes were predominantly endogamous or inbred (Tindale 1953, Spielman, Neel and Li 1977).

The question that can now be asked is to what extent could this kind of social structure affect the genetic structure of the population and to what extent would that genetic structure determine social behavior.

The Social Behavior of Inbred Populations.

Dominant amongst theories of social behavior is Hamilton's theory of kin selection (Hamilton 1964). This theory rests on the concept of inclusive fitness such that a behavior is expected to evolve providing the ratio K (where K = the ratio of gain in fitness, for the beneficiary, to loss in fitness, for the donor), exceeds the reciprocal of the average coefficient of relationship of the interactants (r) :-

$$K > 1/r$$

In the absence of inbreeding, r for siblings is $1/2$, for an uncle $1/8$ and so on. However, if a group of relatives inbred then r would increase (Wright 1922) and the degree and number of interactants with whom altruistic acts could evolve could

increase (Hamilton 1975, Breden and Wade 1981, Shields 1982a). The benefits of such a system would be limited only by the costs of inbreeding. (For a review of the costs and benefits of inbreeding see Shields 1982a). If the costs of inbreeding are very high then kin selection alone would not explain the evolution of extreme altruism in humans beyond the extended family. If inbreeding costs are moderate then a considerable amount of altruism could evolve in a group of relatives. But if the costs of inbreeding are lower than is popularly believed then a large but well defined group of individuals could behave very altruistically to other group members. This would be possible even when the acts of altruism were themselves quite costly to the actor.

West Eberhard (1975) pointed out that the relatedness of the altruist and beneficiary (r_{AB}) must be greater than the average relatedness of A with all other individuals in the breeding population as a whole (\bar{r}), (See also Hamilton 1964 & 1970, Williams 1966). Most authors' examinations of kin selection assume a large panmictic population in which \bar{r} is small such that r_{AB} is always greater than \bar{r} . However the human populations examined here are highly structured, to such an extent, that inbreeding should be taken into account when considering questions of the evolution of social behavior. The formulas needed for this analysis are available from the work of Wright (1922, 1943 and 1951) as follows:-

$$r_{AB} = \frac{2f_{AB}}{\sqrt{(1+f_A)(1+f_B)}} \quad (1), \text{ (Wright 1922)}$$

Where f = coefficient of consanguinity.

$$(1-f) = (1-f_{Gen})(1-F) \quad (2), \text{ (Wright 1943, 1951)}$$

Where f_{Gen} = coefficient of consanguinity from a genealogy and F = coefficient of consanguinity due to inbreeding of the population. By using expression (2) to correct

f_{AB} , f_A and f_B in expression (1) for inbreeding in the population (F) we can express r_{AB} in terms of f_{Gen} (genealogy) and F (population) as follows:-

$$r_{AB} = \frac{2[1-(1-f_{AB})(1-F)]}{\sqrt{[2-(1-f_A)(1-F)][2-(1-f_B)(1-F)]}} \quad (3)$$

Additionally:-

$$\bar{r} = \frac{1}{n} \sum_{i=1}^n r_{AB} \quad (4)$$

Where n is the size of the population. By substituting (3) in (4) we have:-

$$\bar{r} = \frac{1}{n} \sum_{i=1}^n \left\{ \frac{2[1-(1-f_{AB})(1-F)]}{\sqrt{[2-(1-f_A)(1-F)][2-(1-f_B)(1-F)]}} \right\} \quad (5)$$

From the formulas (3) and (5) it is possible to examine the relationship between r_{AB} and \bar{r} in a structured population. For example in a theoretical population of identical individuals that some how came into being spontaneously $r_{AB} = \bar{r}$ would become 0 when $F=1$. Providing such an imaginary population was not in competition with other populations then no altruistic behavior would develop between its genetically identical interactants due to inclusive fitness interests alone. However reciprocal altruism is not generally restricted by coefficients of relatedness (Trivers 1971) and could develop in these circumstances. This thought experiment may help us better understand the behavioral relationships that exists between populations in the natural world. Pro-social behavior evolves as a function of both the genetic similarity of A and B and the genetic differentiation between A, B and other potential interactants.

If what is true of individuals is equally true of groups then social behavior is likely to be structured hierarchically if the groups are genetically so structured. Additionally differences between r and \bar{r} could produce a polarizing of hostility between genetically differentiated groups. The hierarchical and polarizing properties of group social behavior predicted here as a consequence of applying the principles of kin selection to inbred groups are consistent with the principal forces of ethnocentrism as described by LeVine and Campbell (1972).

The social concentration of genetic closeness is limited by the costs of inbreeding. An analysis of this issue is to be found in the work that stimulated the thesis developed in this chapter, Shields', Philopatry, Inbreeding And The Evolution Of Sex (Shields 1982 a). Shields theory of optimal inbreeding predicts that primitive humans would have been one of the many complex animals that would have possessed a genetically optimal level of inbreeding achieved through philopatry and positive assortative mating. This in turn would have been favored because it facilitated the maintenance of genotypic continuity by means of sexual reproduction (Shields 1982a and b).

Shield's thesis of optimal inbreeding, or similar theories (See Optimal Outbreeding, Bateson 1983a) could provide an initial basis for the development of natural human populations of inbred demes in which various ethnocentric behaviors could evolve. Hamilton's theory of kin selection (1964) taken alone could possibly provide an explanation for the evolution of inbred human populations in as much as the members of such groups would be readily disposed to cooperation. But the size of such populations would vary. One set of circumstances might favor a relatively small group of highly inbred individuals, and other circumstances might favor a relatively large group of slightly inbred individuals. However the uniformity actually found in the size of natural human populations (Lee, DeVore, Binford, Birdsell, Damos, Freeman, Hiatt, Sahlins and Washburn 1968, Tindale 1974) suggests that forces other than the benefits of cooperation are at work in determining group size. A technical analysis of whether

Hamilton's (1964), Shields' (1982a and b) or Bateson's (1983a) theories, or theories of population structure in general (Mayr 1963, Wright 1978), or group size (Cohen 1971, Wilson 1975), separately or in concert explain the existence of primitive human groups, made up of inbred demes, is beyond the scope of this dissertation. However, thus far, it may be suggested that:-

(1) Modern and pleistocene hunter/gatherers existed as natural human populations comprised of inbred demes (Lee, DeVore, Binford, Birdsell, Damos, Freeman, Hiatt, Sahlins and Washburn 1968, Tindale 1953 and 1974, Spielman, Neel and Li 1975).

(2) Given the genetic structure of such populations the theory of kin selection (Hamilton 1964) can explain the production of hierarchical and polarizing group social behavior.

(3) The theoretical possibility of such a system may not be precluded from existence by the genetic costs of inbreeding (Shields 1982a and b Bateson 1983a).

For a more complete understanding of ethnocentrism, particularly in the form of modern nationalism, it is necessary to explain how these processes can continue to be operative in societies that have lost a primitive genetic structure. This requires combining the preceding analysis with an analysis of the evolution of the proximate mechanisms of such behaviors. This analysis in turn, it is suggested, rests on the proposition that genetic and cultural differences evolved in parallel in primitive societies so that cultural differences became proximate mechanisms for behaviors based on genetic differences between groups.

The Proximate Mechanisms of Group Behavior

Nearly all sociobiologists are agreed on the impossibility of any organism being able to "read" the true genetic coefficient of relatedness of another conspecific

(Holmes & Sherman 1983). Therefore, if societies are to be structured in accordance with degrees of relatedness then the organisms in that society must possess mechanisms that at least approximately reflect the kinship of other members of the society. Further, in so far as social behavior may be governed by relatedness, then such proximate mechanisms will play an instrumental role in the activation of those behaviors. Given this situation such proximate mechanisms could become the "keys" or "levers and buttons" of genetically based innate social behavior, at least within the parameters of developmental learning (Bateson 1983b). Identifying these mechanisms (For reviews see Holmes & Sherman 1983, Shields 1982a, Lewin 1984) may therefore be an empirical question of considerable importance in developing a better understanding of the evolution of human cooperation and competition. For many animals these mechanisms can function using phenotypic variation such as scent or pheromones (Gilder & Slater 1978, Greenberg 1979, Buckle & Greenberg 1981, Bateson 1980, 1982, Vidal 1982), developmental contact or imprinting (Lorenz 1935, Michener & Sheppard 1972, Hess 1973, Leon 1975, 1978, Porter et al 1978, 1981), learned songs (Marler and Tamura 1962, Nottebohm 1969, 1972) and spacial displacement (Hoogland & Sherman 1976, Holmes & Sherman 1982).

Most probably all these mechanisms operate to various degrees in humans, particularly within the nuclear family. For example the evidence so far assembled points to a general innate tendency for children raised together not to mate (Shepher 1971, Alexander 1974). Conversely, young adolescents of different parentage, but of the same deme or tribe, might be predisposed to mate (Shields 1982 a & b, Bateson 1983a). In these cases the proximate mechanisms could be differentially triggered by the number of contacts and the critical period of the contacts (Bateson 1979). Such a model suggests numerous early childhood contacts would generate an aversion to mating, while numerous early adolescent contacts would develop a propensity to mating, providing an earlier aversion had not already developed. Coupled with these aversions and propensities to mating would be differentiated degrees of altruism

correspondent with underlying differentials in degrees of relatedness. In accordance with kin selection theory it would be expected that the altruism associated with an aversion to mating would be stronger than the altruism associated with a propensity to mating, at least within the tribe. Beyond the tribe a xenophobic relationship would exist correspondent with a propensity not to mate unless the investment is minimal. This situation may apply in the case of captured females or rape (Shields and Shields 1983). Again, in accordance with kin selection theory, there would be little unconditioned predisposition for altruism toward members of other tribes due to underlying low coefficients of relatedness. This absence of prosociality would in part be proximately activated by an almost total lack of developmental contact. The interdependent system of positive assortative mating, cooperation, competition and primitive or natural social structure, speculatively described here, is probably over simplified. Preference for first cousin mating (Service 1971, Bateson 1980, Shields 1982a) probably adds another level of biologicaly controlled behavior to the system, between the family and the tribe.

It may not be too difficult to memorize the individual identities of a limited number of parents, siblings and other frequently contacted relatives. Remembering all the members of a tribe of 500 is a more difficult, but not impossible task. Being certain about who belonged to which tribe or who was not a member of a group of tribes could be very difficult indeed. To deal with this problem, natural selection has repeatedly evolved a proximate mechanism known to biologists as badging. Badges can be learned and may be one of the simplest, most rudimentary forms of culture presently known. Nottebohm (1969, 1972) has detailed various bird songs as being learned and identified with particular inbreeding demes (See also Marler and Tamura 1962, and Baker and Cunningham 1985 in press for a review). Of the mechanisms for kin identification originally identified by Hamilton (1964), Holmes and Sherman (1982) consider the possibility of recognition alleles (innate badges) as most problematic. However, this "green beard effect", as Dawkins (1976, 1982) calls it, is essentially what badging is, the only difference being humans (and some song birds) don't grow different colored

beards to identify kin, they may wear false beards of different colors in the form of culture. Baker and Cunningham (1985 in press) have suggested that human dialects, like song bird dialects, may also function as population markers. There are many methodological difficulties to the measuring and correlation of genetic and linguistic differences in natural or primitive human populations (For a review see Jorde 1980) however such correlations have been found (White and Parsons 1973, Crawford et al 1981).

Thus many aspects of culture which vary dramatically from tribe to tribe could be understood as learned and culturally transmitted ethnocentric expressions of a genetic predisposition to group bonding and badging, rather than as adaptations of tribe to tribe differences in immediate ecology. Differences in dialect, dress, art, symbol, ritual, scarification and body paint symptomatic of group membership could fall into this class of culture traits. This would be especially true when sexual organs are involved, as in various forms of circumcision, which become cultural and tribal requirements for acceptable mates. This thesis does not dismiss the differential effects of the physical environment on tribal differences in culture. However, given two tribes in a similar environment at a similar level of technological and social evolution, most cultural differences may be assumed to be of the badging variety. As badging of the kind described here evolved, at least in part, to determine questions of mate choice, then it would follow that tribal enculturation of this variety should be completed prior to mating (Bateson 1979, Shields 1982a). Thus it comes as no surprise that young adolescents are particularly impressionable and prone to the creation and wearing of badges with which to identify their ethnocentric in-groups. The biological nature of these forms of cultural badges, be they dress, dialect or etiquette, offers an explanation for humans being more likely to be pro-socially disposed toward others displaying the same badges and negatively disposed towards those displaying different badges. Given the goal or value of ultrasociality at the one world level, it is a matter of ironic tragedy that race is one badge that can not be changed or mimicked.

The natural manipulation of the proximate mechanisms of primitive social behavior and social structure could be one of the means by which ultrasocial societies are created. If this is so, understanding these proximate mechanisms and the details of their operation may provide suggestions as to means by which society could better control the undesirable effects of ethnocentric badging. However, any attempt to use this knowledge as part of an applied social science would be grossly premature without more empirical examination and refinement of the hypotheses proposed here. One of the central principles in this attempt at theory building is the proposition that genetic, behavioral and cultural differentiation evolved in parallel in primitive societies. Testing this thesis at the tribal level of social organization requires the positive correlation of genetic and cultural change across tribal boundaries and the association of those changes with changes in social behavior. Although these different variables have been shown to correlate (genetic variation and/or cultural variation and/or behavioral variation) in separate studies an attempt will be made here to compare all three variables for the Netsilingmiut Eskimo and their adjacent tribes as follows:-

- (1) Genetic variation between the Netsilingmiut and adjacent tribes.
- (2) Linguistic variation between the Netsilingmiut and adjacent tribes.
- (3) Netsilingmiut prosocial behavior within the badged population.
- (4) Social behavior between the badged populations.

Genetic Variation Between the Netsilingmiut and Adjacent Tribes.

The Eskimo megapopulation is believed to have been produced by an expansion of Yukaghi hunters from Siberia to Alaska. These peoples then expanded from the North Pacific coast of North America along the Arctic coast to the North Atlantic coast of Greenland. This founder event produced a megapopulation with close genetic affinities that are none the less structured by geographic isolation and linguistic barriers (Crawford and Enciso 1982). Additionally various forms of selection may have

contributed to the genetic differentiation in the population. Optimal inbreeding (Shields 1982a) and optimal outbreeding (Bateson 1983a) would seem to predict selection against immigrants which would in turn increase genetic differences between the subdivisions of a megapopulation. However the empirical evidence is presently not conclusive on this issue. Chapman and Jacquard's (1971) work on the Jicaque Indians of Honduras demonstrate immigrant increases in fitness while Jacquard's (1974) later work amongst the Bedik of Eastern Senegal demonstrate selection against immigrant genes. Additionally the "death" of kin groups (subpopulations) and tribes (populations) would contribute to genetic differentiation. Rasmussen notes several kin groups and a tribe that went extinct within the living memory of his informants (Rasmussen 1930a, 1930b). These reports amount to approximately one in ten tribes and one in ten subtribes being lost per generation:-

"According to the records I had obtained down at Chesterfield from Mgr. Turquetil, who is particularly well acquainted with all Eskimo matters in these regions, there had previously been about 600 people living round about Hikoligjuaq, but through the hunger periods of the last generation these had been so decimated that the census I took only gave about 100 people. -----Auruatuaq divided the Caribou Eskimos into Qaernermiut, Harvaqtormiut, Padlermiut, Tahiuarmiut and Hauneqtormiut. Of these the Tahiuarmiut had died out through starvation three years before. Only three men was he able to name as survivors: Ulimaut, Nivkuarhe and Ijerqutikit with their families."

Rasmussen 1930a pp. 36.

Although the genetics of primitive human populations have been rarely studied with a view to analyzing behavior between populations, there is no reason in principle why this should not be done. If primitive populations are shown to be genetically differentiated, then the respective values of r , f_{Gen} and F of the members of the populations being studied should enable us to make predictions about the potentials for cooperation and competition. In this case the coefficient of consanguinity within and

between populations and any subdivisions of the populations must be calculated and this in turn is dependent on migration rates (m) and effective population size (N_e), (Wright 1931). The founder effect, natural selection, number of generations, variations in success rates, positive assortative mating and group extinctions will all influence the degree of inbreeding. However these influences will mostly tend to increase inbreeding within the megapopulation as a whole and the population subdivisions of that megapopulation. Thus any calculation of the coefficient of consanguinity of populations that ignores some of these influences will be an underestimate of the true value of the coefficient. Nonetheless this figure is important as a relative index of relatedness that will in turn predict the probabilities of intergroup cooperation and competition.

The analytic models most commonly used to calculate inbreeding and consanguinity coefficients within and between populations are derived from Wright's (1931) island model:-

$$f = \frac{1}{4N_e m + 1}$$

Where the effective population size (N_e) is:-

$$N_e = \frac{4N_m N_f}{N_m + N_f}$$

Where N_m is the number of reproductive males and N_f is the number of reproductive females randomly mating. Unfortunately most (possibly all) "stepping stone" models (For example Kimura & Weiss 1964, Weiss & Kimura 1965, Maruyama 1969,1970,1971) are not sufficiently complex to allow for different migration rates in different directions between different populations and subpopulations of different sizes such as are found in natural human populations. Through procedures developed with the assistance of Prof. W. T. Starmer this difficulty was overcome by running a computer simulation (See Appendix for program) that, unlike analytic models,

generated genotypes that mated, reproduced and migrated in accordance with specified values of N_e and m . After a set number of generations these genotypes were compared with each other to determine the realized value of F . Using this model it was possible to discriminate where in a structured natural human population marked differences in relatedness occurred in association with various values of N_e and m .

Effective population size (N_e), as a function of reproductive males and females, has changed radically since the time of the surveys of Boas, 1902 and Rasmussen, 1922 (Boas 1907, Rasmussen 1930b and 1931). Low infant mortality has reduced the average age of the population and better nutrition has increased the fertility of females. For these reasons Rasmussen's and Boas' data were used to calculate N_e rather than contemporary data. Of the 259 Netsilingmiut included in Rasmussen's survey in the region Pelly Bay, Adelaid Peninsula and Belliot Strait 150 were males and 109 were females as this is inclusive of the infant population which is biased by female infanticide. However Boas' 1902 survey separates the child and adult sex ratios to give 66 girls, 108 boys, 123 adult females and 119 adult males (Boas 1907). The adult sex ratio balance is restored by high rates of male mortality (Weyer 1932) and computes to give an effective population size of approximately 50 percent of the gross population. Figure 6 illustrates the approximate geographic locations of the Eskimo tribes to the west of Hudson's Bay prior to Rasmussen's survey of 1922 (Rasmussen 1931). From these maps and surveys, contemporary surveys (Devine 1982) and an assessment of the gross increase in the population from Rasmussen's time to the present it is possible to assess the sizes of the tribes and Netsilik subtribes as given in Table 14.

The Netsilik as described by Rasmussen and Boas are perceived by my informants to be subdivided into the subpopulations of the Arvilikjuarmiut, Sinimiut, and Netsilingmiut. By going through Rasmussen's lists of married couples my 1982 informants in Repulse Bay and Chesterfield Inlet were able to make 226 identifications of couples they had known who had at least one partner from these subtribes. The breakdown of these identified pairs into subtribe and tribe is given in Table 15 with

Table 14

<u>Tribe</u>	<u>Population</u>	<u>Ne</u>	<u>Tribe #</u>
Netsilik	450	225	1
Ukusiksalingmiut	164	82	2
Caribou	500	250	3
Igloodik	500	250	4
Copper	800	400	5

<u>Netsilik Subtribe</u>	<u>Population</u>	<u>Ne</u>	<u>Subtribe#</u>
Arvilikjuarmiut	236	118	1
Sinimiut	56	28	2
Netsilingmiut	158	79	3

Effective populatin size (Ne) of tribes adjacent to the Netsilik and the
Netsilik subtribes. (See text for explanation).

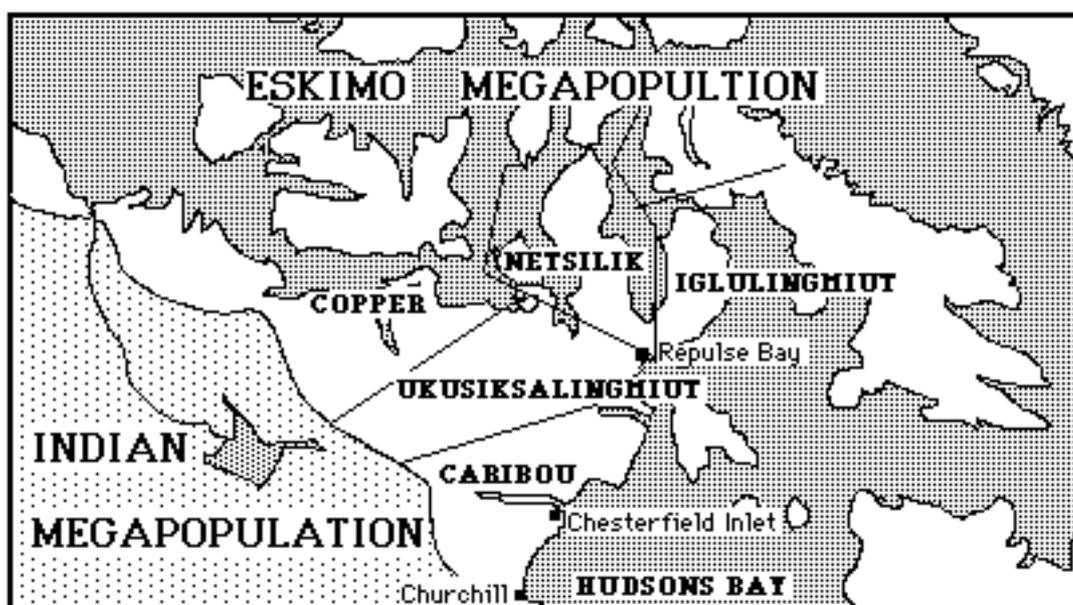
appropriate migration rates based on the assumption that as many individuals migrated out as migrated in. These data only provide information for the Netsilik, the tribes adjacent to the Netsilik and the subtribes of the Netsilik. No information was available for migration rates between the tribes and subtribes adjacent to the Netsilingmiut. Clearly more empirical data would be valuable in this area. However, by making the assumption that patterns of migration between these tribes were similar to rates of Netsilingmiut migration then, this data can be used to compute whether the Netsilingmiut tribe or subtribes or both were probable units of significant genetic differentiation in the megapopulation.

Using the values from tables 14 and 15 four computer runs to 75 generations were averaged to establish relative realized coefficients of consanguinity within and between the subpopulations and populations. Along with the distance between the geographic center of each tribe and subtribe these results are given in Table 16. Tribe 2, the Ukusiksalngmiut, in terms of population size, migration rate and possibly cultural and linguistic similarity (Rasmussen 1931) more closely resemble a Netsilingmiut subpopulation than a truly separate tribe. If this data point is removed from the data set in table 16 and the remaining points are plotted (Figure 7) to compare the inbreeding between Netsilik subpopulations and adjacent tribes a significant difference is found at the tribe to tribe level of social and genetic structure. However this result is not necessarily true of all Eskimo tribes as the unusually large tribe of the Copper Eskimo are divided into eight subtribes of approximately 100 individuals each. These subtribes are described by Weyer and Jenness as follows:-

"The groups are generally comparatively small and far apart. And since there is no rule of exogamy requiring marriage to be between members of separate groups, there is naturally a strong bond of kinship in each settlement."

Weyer 1932 pp. 204.

FIGURE 6



ESKIMO TRIBES 1922



TREE LINE

PRINCIPLE ESKIMO TRIBES TO THE WEST OF HUDSONS BAY

Table 15

<u>Tribe</u>	<u>#Migrants/Generation</u>	<u>%Migration Rate</u>
1 to 2	8 in 225	3.55
1 to 3	1 in 225	0.44
1 to 4	4 in 225	1.78
1 to 5	2 in 225	0.89
2 to 1	8 in 82	9.65
3 to 1	1 in 250	0.4
4 to 1	4 in 250	1.6
5 to 1	2 in 400	0.5

<u>Subtribe</u>	<u>#Migrants/Generation</u>	<u>%Migration Rate</u>
1 to 2	3 in 146	2.05
1 to 3	9 in 146	6.16
2 to 1	3 in 34	8.82
2 to 3	6 in 34	17.6
3 to 1	9 in 98	9.18
3 to 2	6 in 98	6.12

Netsilik identified tribe and subtribe pairs with derived migration rates (m) as percentage of Ne. (See text for explanation).

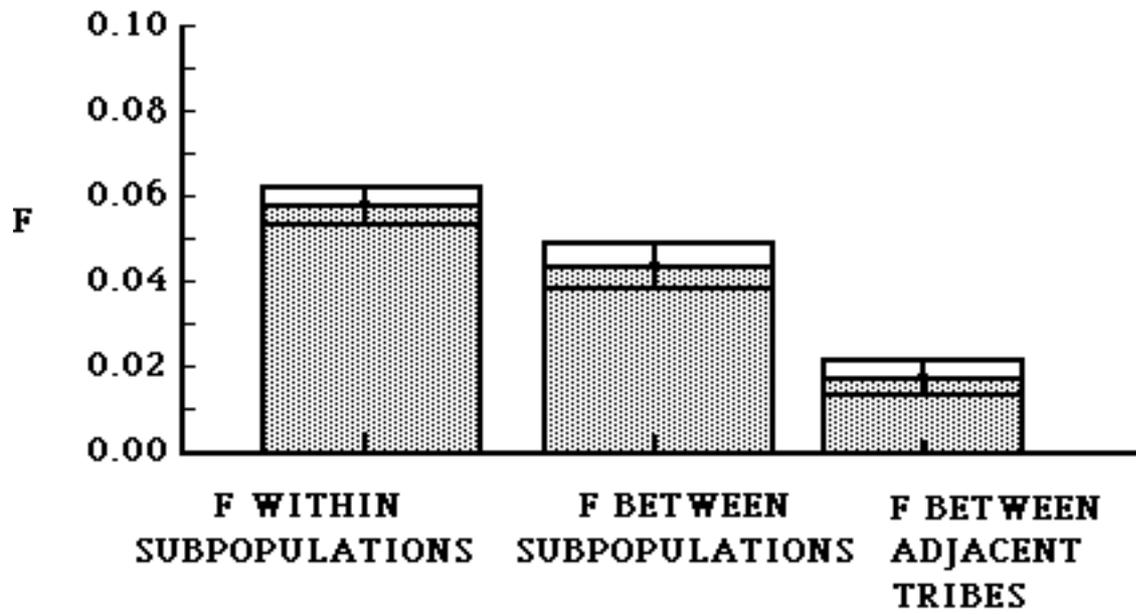
Table 16

<u>Within Subtribe</u>	<u>Distance Miles</u>	<u>Average F Modled</u>	<u>Mean F</u>	<u>Standard Error</u>	<u>Mean Distance</u>
1	0	0.065			
2	0	0.058			
3	0	0.054			
-	-	-	0.059	0.0032	0
<u>Between Subtribes</u>	<u>Distance Miles</u>	<u>Average F Modled</u>	<u>Mean F</u>	<u>Standard Error</u>	<u>Mean Distance</u>
1 & 2	100	0.036			
1 & 3	120	0.052			
2 & 3	100	0.040			
-	-	-	0.043	0.0048	107
<u>Between Adjacent Tribes</u>	<u>Distance Miles</u>	<u>Average F Modled</u>	<u>Mean F</u>	<u>Standard Error</u>	<u>Mean Distance</u>
1 & 2	182.5	0.048			
1 & 3	365.0	0.018			
1 & 4	255.5	0.024			
1 & 5	365.0	0.012			
-	-	-	0.026	0.0079	292
<u>Between Adjacent Tribes**</u>	<u>Distance Miles</u>	<u>Average F Modled</u>	<u>Mean F</u>	<u>Standard Error</u>	<u>Mean Distance</u>
1 & 3	365.0	0.018			
1 & 4	255.5	0.024			
1 & 5	365.0	0.012			
-	-	-	0.018	0.0034	292

**Between adjacent tribes with tribe 2 (Ukusiksalingmiut) data point removed.

Coefficients of consanguinity within and between the subtribes and adjacent tribes of the Netsilik with geographic distance. (See text for explanation).

FIGURE 7



**INBREEDING ($F \pm 2$ STANDARD ERRORS) FOR THE NETSILIK
SUBPOPULATIONS, TRIBE AND ADJACENT TRIBES**

"The inhabitants of a settlement are all, or nearly all, nuatkattait, connected, that is, by blood or marriage ----- The nuatkattait owe special duties to one another. They must provide for each other in sickness, take care of the aged and infirm, the widows and the orphans, and support each other in the blood feud. This gives the community its solidarity. It has a corporate unity, and is called by a tribal name, the suffix miut added to the name of the region it inhabits, or to a prominent place in that region, such as a lake or river.

Jenness 1922 pp. 86.

It should be noted that these "tribes" are perceived as being members of a single tribe, the Wahleniqmiut, by their neighboring tribes, the Netsilik, Ukusiksalingmiut and Carabou Eskimo (Rasmussen 1930a, Irwin field notes). The Copper Eskimo subtribes may thus be more genetically isolated than other subtribes. This feature of the population structure could possibly increase inbreeding in order to compensate for the loss of inbreeding intensity due to having an unusually large tribe size of 800, N_e 400 (Jenness 1922). Interestingly there are very small differences in dialect between some of these groups (Birket-Smith 1929). Such differences in dialect are not found amongst the subtribes of the Netsilik unless the Ukusiksalingmiut are considered to be a Netsilik subtribe (Rasmussen 1931, Irwin field notes).

A further qualification of the results presented here concerns recent changes in migration rates. These changes can be assessed by collecting genealogies and computing migration rates in each generation. For the Netsilingmiut extended family, of which I am a member by marriage, the migration rate in my wifes generation is 55%, in her parents generation 40%, in her grandparents generation 30%, in her great grandparents generation 2% and in the great great grandparents generation 0%. The sample size in the great great grand parent generation was too small to conclude the migration rate was as low as 0% and the sharp increase in migration rate in the grand parents generation was due to the general migration of this family to Hudson's Bay in the 1920's. However the trend is clear, migration rates are rapidly increasing such that:-

(1) The migration rates used in the simulation here are probably higher than those to be found in a traditional natural human population.

(2) Comparative studies with other hunter/gatherer populations should take recent changes in migration rates into account.

One last issue concerning influences on migration rates amongst the Eskimo is raised by the practice of wife exchange (For a review see Guemple 1961). Although such behavior undoubtedly increased genetic migration rates in the recent past, wife exchange in the traditional culture probably had little effect on inbreeding or outbreeding as such partnerships were generally made between hunting partners who were members of the same kin group.

The evidence presented here supports the thesis that natural human populations are far from being panmictic. Various combinations of selection and positive assortative mating contribute to a genetic environment that is demic with genetic relatedness higher within the smallest functional subunit above the family, and lower for all larger aggregates. These differences in coefficients of relatedness, particularly between tribes, creates structures in the genetic environment that could precipitate the evolution of ethnocentric behavior.

Linguistic Variation Between the Netsilingmiut and Adjacent Tribes.

Numerous physical anthropologists have measured cultural and linguistic differentiation with a view to using such coefficients as indexes of genetic differentiation (For a review see Jorde 1980). These studies typically correlate course grained differences between language types among the numerous tribes of a megapopulation that occupies a diverse environment (Crawford et al 1981, Kirk 1982). However, the present study is particularly concerned with cultural differences between adjacent interacting tribes where the cultural differentiation could have evolved as a proximate mechanism guiding intertribal behavior. In order to test this hypothesis it is

necessary to select a group of adjacent tribes that belong to the same megapopulation, live in a fine grain environment and are not geographically isolated. Language, as dialect, was chosen as the culture trait to study as it is easy to quantify and measure. Crawford and Enciso (1982) point out that language, distance, environmental change and geographic barriers can all contribute to genetic differentiation. But if boundary effects, produced by differences in dialect, are to be demonstrated, then the other parameters must be held constant, in order to rule out simpler diffusion or dispersal views of linguistic change. The group of Eskimo tribes living on the west coast of Hudson's Bay come close to meeting these conditions. By way of contrast the Eskimos living on Baffin Island are isolated by a geographic barrier, namely Hudson's Bay, and the Indians to the south are isolated by an abrupt environmental boundary, the tree line.

Rasmussen's Fifth Thule expedition produced detailed studies of dialect differentiation amongst the tribes of Eskimos being studied here (Five Hundred Eskimo Words, Birket-Smith 1928 and 1929, Rasmussen 1932). Using this data base a computer program (See Appendix) was written to measure phonetic differences between words of the same cognate by comparing phonetic spellings of the word. A coefficient of dialect differentiation (d) was computed as a percentage of common characters, in each cognate, in each dialect from 50 cognates placed in a matrix. Thus for a language compared with itself $d=1$ and when compared to other dialects $d<1$ but >0 . Finally from the genetic model of these tribes already created from knowledge of migration rates and effective population sizes it is possible to compare changes in d with changes in F (coefficient of consanguinity due to inbreeding).

Where a positive correlation is found the badge could be effective but not elsewhere in the population. Rasmussen (1931) considered all the Netsilik he described, including their various subtribes, to speak with virtually one dialect in 1922. These kinds of badges could therefore not be used effectively to discriminate subtribes or various relatives or extended families within the tribe. This point is confirmed by the

following observations from a Netsilingmiut now living at Chesterfield Inlet in Hudson's Bay:-

"The Netsilingmiut, Arvilikjuarmiut and Siningmiut all speak the same language (Netsilik subtribes). The Karmanikjuarmiut, Padlarmiut, Sadlermiut and Ivilikjuarmiut (Tribes adjacent to the Netsilik) all speak different languages. The Ukusiksalingsmiut and Arvilikjuarmiut speak the same language but a few words are different."

Kako 1982.

This is not so true of the Copper Eskimo subtribes (Birket-Smith 1929) or the Netsilik that migrated south to the west coast of Hudson's Bay. This group would appear to be an example of tribal expansion and fission of the variety described by Chagnon (1979) and they would appear to be forming a new dialect (Irwin field notes). Within the tribe proximate mechanisms other than dialect, such as identification, developmental contact and the kinship system would have to discriminate coefficients of consanguinity due to pedigree (f_{Gen}). However, between tribes, dialect could very possibly perform the function of discriminating coefficients of consanguinity due to inbreeding (F).

The results of the computer analysis to measure the coefficient of dialect differentiation (d) are given in table 17 along with, the distance between the center of each tribe, the number of tribes that separate each tribe and the coefficient of consanguinity due to inbreeding in the population (F). Figure 8 illustrates this data graphically with a step chart of F and d plotted against the distance between tribes. There can be little doubt that dialect differences between tribes correspond with genetic differences between tribes. However the question of whether these differences correspond with a boundary effect needs to be addressed further.

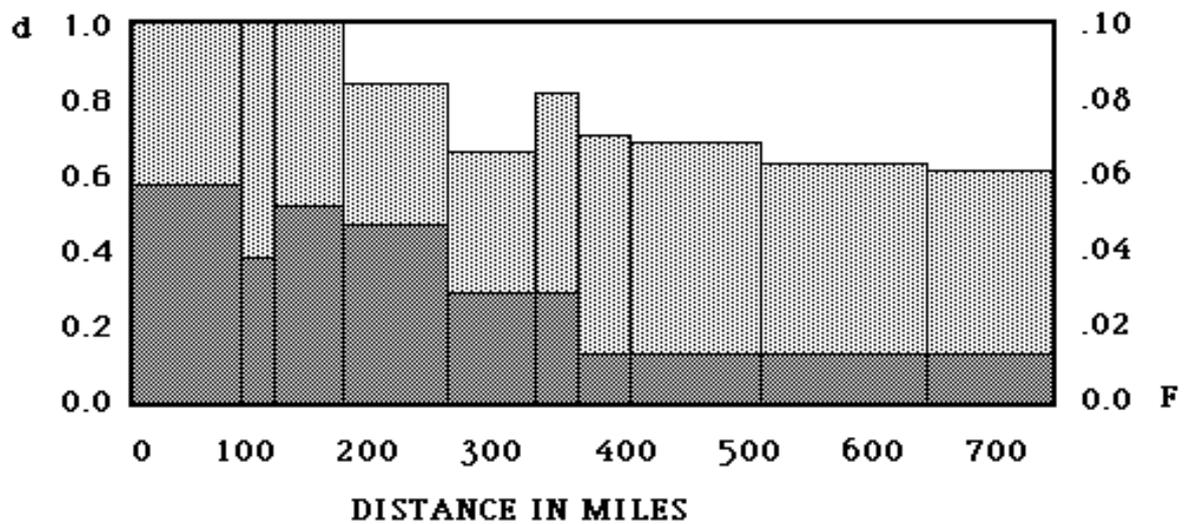
Several researchers have come to the conclusion that linguistic differences do affect genetic differences between human populations (White and Parsons 1973, Crawford et.al. 1981, Crawford and Enciso 1982). However Kirk (1982) comes to the

Table 17

<u>Subtribes</u> <u>From Table 1</u> <u>Within</u>		<u>Distance</u>	<u>d.</u>	<u>F.</u>
1		0	1	0.065
2		0	1	0.058
3		0	1	0.054
<u>Subtribes</u> <u>From Table 1</u> <u>Between</u>		<u>Distance</u>	<u>d.</u>	<u>F.</u>
1 & 2		100	1	0.036
1 & 3		120	1	0.052
2 & 3		100	1	0.040
<u>Tribes From</u> <u>Table 1</u> <u>Between</u>	<u># Of Tribes</u> <u>Appart</u>	<u>Distance</u>	<u>d.</u>	<u>F.</u>
1 & 2	1	182.5	0.87	0.048
1 & 3	1	365.0	0.74	0.018
1 & 4	1	255.5	0.68	0.024
1 & 5	1	365.0	0.76	0.012
2 & 3	1	182.5	0.77	-
2 & 5	2	365.0	0.69	-
3 & 5	1	328.5	0.81	-
3 & 4	2	511.0	0.64	-
3 & 5	1	401.5	0.72	-
4 & 5	2	657.0	0.63	-

Table of Dialect Differentiation (d)/ Distance Miles/ # Of Tribes Appart/
Coefficient of Consanguinity due to Inbreeding (F) for the Five Eskimo Tribes to
the West of Hudson's Bay. (Figure 6 & Table 14)

FIGURE 8

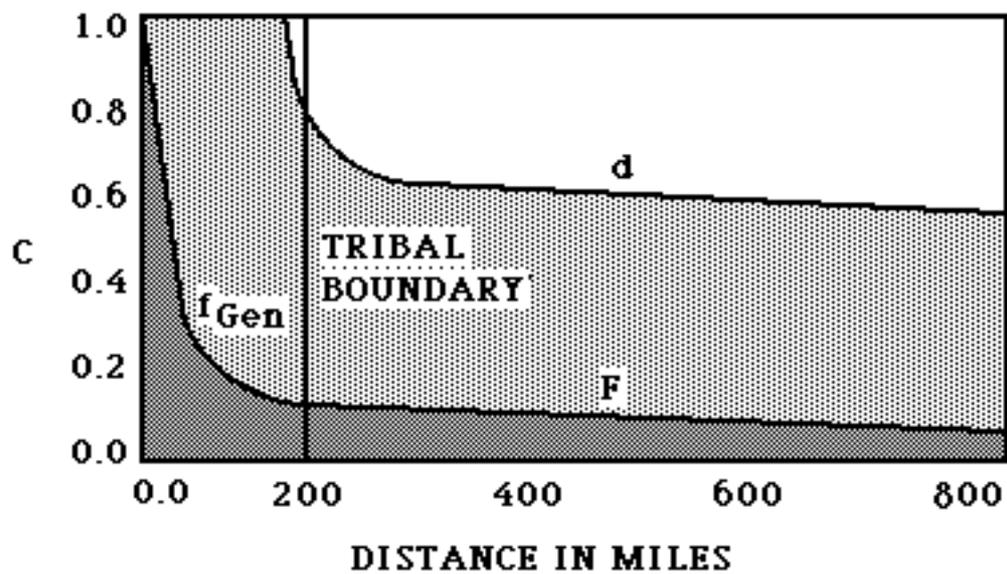
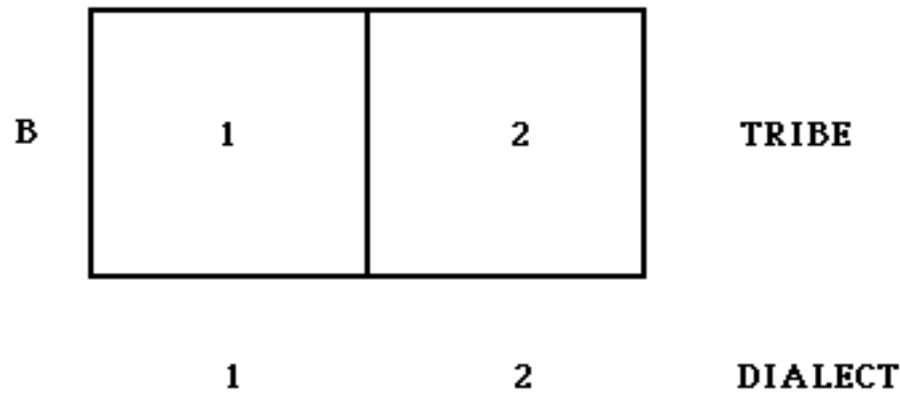


STEP CHART OF INBREEDING COEFFICIENT (F) AND DIALECT COEFFICIENT (d) AGAINST DISTANCE FROM TABLE 17(PPOINTS AT SAME DISTANCE ARE AVERAGED).

conclusion that gene frequency distribution in the region of Bogia, Papua New Guinea are dependent on geographic proximity, not linguistic similarity. Distance, geographic isolation and coarse grain environmental changes do all effect genetic differentiation but so too does linguistic change. An examination of scale can perhaps help discriminate between Kirk's conclusion and my own. Figure 9 represents a number of tribes as might be found along a river or coast line. In diagram A positive correlations would be expected to be found between distance, genetic and linguistic change. As Kirk found, the correlation between distance and genetic differentiation may well be stronger than between distance and linguistic differentiation. Genetic differences between tribe 1 and 10 would be principally due to distance. However if the scale is altered to examine two adjacent tribes then the results are quite different. In diagram B there would be no correlation at all between genetic differences and linguistic change within either tribe 1 or 2 as the dialect within each tribe would not change. Conversely within each tribe there would be a correlation between genetic change and distance due to relatedness attributable to a pedigree or genealogy (f_{Gen}) and slight inbreeding in each subtribe. However between the two tribes there would be a change in dialect and that change would correspond with the difference in the coefficient of consanguinity due to inbreeding within each tribe (Figure 9C). In other words linguistic differences could function as one of the proximate mechanisms to produce a structured megapopulation that bears more resemblance to a stepping stone model than an isolation by distance model.

Thus it is suggested that tribal badges, such as dialect, by influencing mate choice, are one of the proximate mechanisms of tribal genetic differentiation amongst the natural human populations described here. Whether or not these same mechanisms could precipitate other social behaviors is dependent on such behaviors being restricted to the same genetic/badge groups.

FIGURE 9



**GENETIC AND LINGUISTIC DIFFERENTIATION FOR TRIBES
IN A TWO DIMENSIONAL STEPPING STONE MODEL**

Netsilingmiut Prosocial Behavior Within The Badged Population

Beyond close kin, but within the tribe, sharing partnerships may be most easily understood as forms of reciprocal altruism as described by Trivers (1971). However such relationships can only operate successfully providing the beneficiary does not cheat on his or her indebted reciprocity. In the context of kin selection the cost of such cheating to the altruist is lessened when the beneficiary is a close relative but would be very high when the beneficiary is a non-relative. Because of this differential in the cost of being cheated it would be expected that reciprocity would frequently evolve within a certain range of the coefficient of relatedness such as beyond the nuclear or extended family but within the breeding population or tribe. (A general mathematical model of this kind of cost benefit relationship has been developed by Rubenstein, 1982). If this is the case then the proximate mechanisms for tribe identification could also be proximate mechanisms for potential reciprocal altruism pacts.

Eskimo reciprocal altruism is built on the insight that Kako has explained in these words:-

"A greedy person is not smart because a greedy person will end up with nothing some day and then he will end up with no help."

Kako 1980.

The critical difference between the situation the Eskimo found themselves in and the predicament of most other cultures was the certainty with which it could be stated that " a greedy person will end up with nothing some day." This fact necessitated communalism with regard to all resources including food, land and game. This necessity for sharing and cooperation is explained by Williamson in environmental terms as follows:-

"Among a people particularly vulnerable to the vagaries of climate and game availability, a high degree of social interdependency was a basic necessity. No hunter could hope to invariably bring home food for the family. Thus within

the extended family, and in fact beyond, within the camp group, the practice of sharing is highly valued and firmly institutionalized."

Williamson 1974 pp. 30.

Although Kako and Williamson do not specifically limit reciprocity to tribal members, in practice, camp groups are nearly always made up from one tribe (Irwin field notes) and Xenophobia restricted the opportunity to develop intertribal partnerships. Tungriik, a Netsilingmiut from Repulse Bay in Hudson's Bay notes:-

"If a stranger, from a different tribe, came into the camp the people might kill the person from the distant land. That is why life could be frightening in those days."

Tungriik 1982.

In order to substantiate the thesis that communalism for the Eskimo was an environmental necessity, at least within the tribe, it may prove helpful to compare their situation with that of contemporary Western society. Hardin (1978) in "The Tragedy of the Commons" demonstrates why it is essential for resources to be legally regulated and not held in common. He illustrates the inevitable disastrous effects of ethical egoism with the case of shared grazing land. However, it is not necessary to regulate sharing so formally amongst the Eskimo, as they must share or possibly die. If an individual shares he will enjoy the security of the community. If he does not share, the security of the community will be denied him. Weyer sums up these property mores regarding food resources as follows:-

"These mores are basic; for they govern the apportioning of the primary essential of life, sustenance. Naturally, they owe their distinctive character to the unusual life-conditions upon which they have developed....."

(1) Hunting grounds, or rather the privilege of hunting on them, is a communal right, except in some rather rare instances.

(2) The hunter or hunters almost always have the preferential share in the game secured, but part of each catch is

generally divided among the community or among those present at the apportioning.

(3) Stored provisions are normally the property of the family or household; but in time of scarcity there is a tendency toward communalism. Hospitality is stressed under all circumstances."

Weyer 1932 pp. 188.

However, Birket-Smith (1959) adds to this unwritten "Eskimo Constitution" the principle that: "No one may be excused from hunting except in the case of bodily infirmity." This properly recognizes labor as a common resource.

The dominance hierarchy of the extended family regulated the distribution of resources amongst kin (Chapter 3, *The Sociocultural Biology of Netsilingmiut Kinship*). Reciprocal altruism within the tribe was not so rigidly regulated and was therefore strengthened with the cultural institutionalizing of sharing partnerships (for a review see *Alliance In Eskimo Society*, Edt. Guemple 1971), The reciprocal behaviors of seal meat sharing (Franz Van de Velde 1956, Balikci 1970, Trivers 1971), name sharing gift exchange (Guemple 1966, Irwin 1981), wife sharing (Guemple 1961) and various forms of kin extension (Burch 1975) were principally limited to tribal members. Amongst the traditional Netsilingmiut this would minimize the costs of cheating. Given the need for cultural enforcement of partnerships and the limitation of these partnerships to the approximately 200 adults of the tribe' outside an individual's extended family, reciprocal altruism can be seen as a limited biological prosocial mechanism in humans, constrained by the costs and benefits of kin selection. It is probably true of all primitive human societies that the display of tribal badges would indicate a preferred partner for any mutually beneficial enterprise. This conclusion is further supported by contrasting descriptions of behavior between tribes.

Social Behavior Between Badged Populations

The group of Eskimo tribes described here are not totally genetically and socially isolated. Any intertribal marriage will produce intertribal alliances. However given a migration rate of five percent any individual will have 19 kinship alliances within the tribe for each single alliance they have outside. These observations are in turn a manifestation of an underlying genetic reality that produces a significant differential in coefficients of relatedness (r) between tribes. While taking inbreeding into account, this differential is in turn analyzable using formula (3) and (5) for computing r and r . The relationship between the coefficient of relatedness of two individuals and the rest of the population is such that those individuals will be more likely to cooperate providing they are more closely related to each other than they are to the rest of the population. So long as the cost to benefit ratio remains unchanged this relationship would hold true for all groups with the result that prosocial behavior in humans will often be accompanied by an associated indifference or even antisocial behavior. Between tribes this antisocial behavior most frequently manifests itself as the behavior known as war (Bigelow 1969, Eibi-Eibeefeldt 1979).

The physical harshness of the Central Arctic would appear to have provided an environment in which the costs of tribal warfare have come to outweigh the benefits. Thus the Eskimo of this region (in contrast with many Alaskan Eskimo) may be one of the very few peoples who have abandoned the behavior of mass murder organized at a tribal level. Many studies have been devoted to the cross cultural study of warfare (e.g. Otterbein 1970, Nettleship, et. al. 1975, Wilkinson 1980). A detailed analysis of the Central Arctic Eskimo as an example of a people uninvolved with the pursuit of warfare is beyond the scope of this dissertation. However the rareness of a society that does not know the meaning of the word "war" may be reason enough for briefly listing some of the culture traits that may make up a coadaptive culturetype for non-war.

(1) The Netsilingmiut do not possess a cognate for war in their vocabulary so that no special praiseworthy or blameworthy value can be associated with the behavior of mass murder.

(2) The warring Eskimo of South West Alaska have developed the office of chieftain to a higher degree than any other Eskimo (Nelson 1899, Weyer 1932). The Netsilingmiut do not have chiefs (Steenhoven 1959).

(3) The Alaska Eskimo of the Bearing Sea region recognize property rights, such as productive places to set seal and salmon nets (Weyer 1932). The tribes described in this study do not (Irwin field notes). According to some examples of Eskimo ethics such property would be abandoned before a conflict could develop (Hawkes 1916).

(4) Hunting technology and local knowledge specialized to specific animals and terrain restricted the migration of populations. However the recent introduction of the rifle made all hunters generalists and upset these close hunter/niche adaptations (Irwin field notes).

(5) In spite of the tribal limitations on reciprocal altruism highly ritualized partnerships called Itlureet (ritual cousins) existed between some of the dominant members of different tribes in the Central Arctic (Irwin field notes).

Of particular interest to the thesis developed in this chapter is the relationship between badging and antisocial behavior. All Eskimo, from North Alaska to Greenland speak essentially the same language with the result that they can converse with their tribal neighbors. In contrast, this megapopulation is separated from the Indians by a solid linguistic wall. No Eskimo in traditional times could converse with their Indian neighbors who might be only 200 miles distant, while they could have conversed with other Eskimo 2000 miles distant. Accompanying this cultural barrier each of these two megapopulations did not consider the other human. Migration rates were zero and all conflicts between them were particularly bloody. Typically, inter-Eskimo war in Alaska

stopped short of killing women and children (Weyer 1932) while Eskimo-Indian engagements were often genocidal (for a graphic description of such an encounter see Samuel Hearne 1795).

The nations that now make up the East and West blocks would appear to be behaving like two adjacent megapopulations. These behaviors, the proximate mechanisms of deadly competition, can possibly be reversed with cultural exchange, student exchange, inter-marriage, worker exchange and the learning and practice of each other's language and customs. This conclusion is based on the proposition that the proximate mechanisms of competition between modern social groups and cooperation within modern social groups are, to a considerable degree, artifacts of human social evolution. If this thesis is correct then cultural heterogeneity should correlate with human conflict. In *Deadly Quarrels* Wilkinson (1980) analyses 780 wars that took place between 1820 and 1952 in order to test numerous empirical generalizations concerning the nature of war. On the question of heterogeneity he concludes:-

"The propensity of any two groups to fight increases as the differences between them (in language, religion, race, and culture style) increase. A homogeneous world would probably be a more peaceful one"

Wilkinson 1980, pp. 119.

Discussion and Conclusions

The studies of primitive human societies made here leads to a descriptive conclusion that can provide a foundation for numerous other conclusions concerning the nature of human group behavior. This first hypothesis can be summarised as follows:-

(1) Natural human populations are genetically differentiated such that coefficients of relatedness are higher within groups than between groups.

It is suggested that inbreeding has significant effects on the coefficient of relationship in these natural human populations (Wright 1922, Shields 1982 a). By

taking these effects into account when analyzing the behaviors of individuals in such groups, in accordance with the theory of kin selection (Hamilton 1964), it can be concluded that:-

(2) Humans are genetically predisposed to ethnocentrism.

The corollary of ethnocentrism, xenophobia, a fear of strangers, is likewise provided with an evolutionary explanation. Predisposed has a similar meaning to innate and needs to be qualified as the development of ethnocentric behaviors will be greatly effected by the developmental environment of individuals (Bateson 1979, 1983b).

Theories of cultural evolution are often derived from theories of the evolutionary process associated with population genetics. However, if the natural structure of human populations produces demic rather than panmictic interactions then complex genetic models must be looked to as a possible foundation for cultural evolution. Wright's shifting balance theories of evolution provide for many, but not all, of the mechanisms by which such demes will interact to promote or shape the evolutionary process (Wright 1929, 1932, 1956, 1970, 1977). Perhaps the most important conclusion to be drawn from Wright's work for the present thesis is his principle of shifting balance in a structured species:-

"Finally, in a large but subdivided population, there is a continually shifting differentiation among the local races, even under static conditions, which through intergroup selection brings about indefinitely continuing, irreversible, adaptive and much more rapid evolution of the species as a whole."

Wright, 1929.

Inbreeding and inclusive fitness interests provides the key to understanding why ethnocentrism should have evolved in natural human populations. By applying models of cultural evolution developed in the tradition of Wright to such subdivided populations a theory of ethnocentric evolution can be developed. Such a model would go beyond merely explaining ethnicity to defining the structure within which cultural evolution takes place:

(3) The groups of humans formed and maintained by ethnocentrism provides the structure for cultural evolution.

Conclusion (1) is concerned with the genetic makeup of natural human populations. Conclusion (2) and (3) are consequences of that Hypothesis. However both ethnocentrism and structured cultural evolution continue to be operative in ultrasocial societies which have abandoned inbreeding and the altruism that can be associated with it. Therefore altruism, or prosocial behavior, is not simply a product of costs and benefits computed in the context of high coefficients of relatedness but:-

(4) Prosocial behavior is frequently linked to the proximate mechanisms associated with natural human population structure.

This conclusion does not dismiss the importance of reciprocal altruism (Trivers 1971) or other prosocial cultural inventions such as law, religious ethics and moral education (Campbell 1975 & 1983). However the effectiveness of such culture traits may frequently be constrained by the artifacts of human social evolution. The biological processes described here are triggered by proximate mechanisms such as genetic predispositions for the identification of parents, siblings, and tribal members. These genetic predispositions continue to function in post-primitive societies such that another conclusion can be stated as:-

(5) The biological proximate mechanisms of behavior and social structure in natural human populations are manipulated to produce novel behaviors and social structures in ultrasocial populations.

The various theories of ethnocentrism that take the form of empirical generalizations (LeVine & Campbell 1972) or cultural evolution (Boyd & Richerson 1980, Abruzzi 1982) can now be reexamined in the context of the biological thesis developed here. It is not necessary to consider this theory as a competing hypothesis. On the contrary the various models of ethnocentrism are probably all correct and, for the most part, mutually compatible. In this view these theories could be understood as cultural elaborations of a human behavior that has a genetic foundation. This

observation suggests yet another conclusion that has guided the method of enquiry used in this study. From the insight on theory used in the biological sciences provided by Williams (1966) it may be suggested that:-

(6) Human cultural phenomena can be best understood through an inquiry into both their cultural and genetic evolutionary history.

Enquiries in such a paradigm would frequently require a detailed understanding of primitive man as he lived for the greater part of human existence. In this state it has been proposed that:-

(7) Cultural, behavioral and genetic differentiation are interdependent in natural human populations.

Implicitly it follows that this may not be so completely true of modern ultrasocial populations that have lost their demic genetic structure. This observation may add weight to perspectives on cultural evolution (Pulliam & Dunford 1980, Boyd & Richerson 1983) that oppose the gene/culture coevolutionary process suggested by Lumsden & Wilson (1981). However demic social structure has not been abandoned such that cultural evolution presently takes place in a social environment that facilitates the processes of cultural change.

Finally, it can reasonably be asked, what has this study in the evolution of ethnocentrism added to the other descriptions and theories of ethnocentrism? How can a description of the genetic underpinings of this human phenomena facilitate a more useful understanding of ethnocentrism? Although the nature/nurture dichotomy may be essentially false, presumably all that can be said to be genetic in human nature is difficult to change. By comparison all that is learnt or cultural is accessible to manipulation. Knowing that ethnocentric behavior has a genetic component alerts the social scientist to the difficulty of coming to terms with what must necessarily be a pervasive phenomena. The critical parameters of the proximate mechanisms of ethnocentrism may be embedded in the development of badging behavior during childhood and adolescence? Successful pluralistic societies have probably invented

coadaptive culturetypes to partly overcome the problems of ethnocentrism? Studying questions like these will hopefully provide a key with which to disarm this frequently destructive human trait.

Chapter 5

Sociocultural Biology: Toward the Study of Natural Social Engineering

"I believe the case for sociocultural evolution is strong enough so that psychologists and other social scientists, when considering an apparently bizarre, incomprehensible feature of their own social tradition, or that of another culture, should approach it with a similar awe, expecting that when eventually understood, when our theories have caught up with it, that seemingly bizarre superstition will turn out to make an adaptive sense."

Campbell 1975.

Introduction

In contrast to the success of modern medicine in confronting the problems of man's bodily ills social science has failed in its efforts to mend mans social ills. This failure, unlike modern medicine, may be traceable to the rejection of the premise that man is essentially a biological phenomena (Rosenberg 1980). Although the theory, methods and goals of human sociobiology are frequently viewed with suspicion (Alper et al. 1976) it would seem reasonable to suggest that human sociobiologists, like other scholars, only wish to focus the knowledge of their discipline on that most difficult and perennial of questions. "Why aren't humans nicer than they are and why are they frequently so maliciously nasty?" Societies have created social institutions to minimize the misery man inflicts on his fellow man. No doubt all those concerned with attempting to formulate an answer to the question posed by the failings of human nature hope to provide society with the wisdom needed to make these institutions more effective before social disintegration or nuclear winter can render such efforts redundant. However human sociobiologists can not claim to have been any more successful than any other group of social scientist involved in this enterprise.

Niceness and nastiness, virtue and immorality are both difficult to measure and define. Human sociobiologists have adopted terms like altruism, selfishness and spite (Hamilton 1964, Trivers 1971, Wilson 1971, 1975, Alexander 1977). This substitution can raise confusion with the concept of altruism as it is used in moral philosophy (Nagel 1970, Lopreato 1981). In an effort to avoid this difficulty this dissertation concerns itself with prosocial behavior, contributing to the well being of others and antisocial or competitive behavior, detracting from the well being of others.

Cooperative behavior is a problem for sociobiology as evolution theory suggests that organisms should only direct resources toward their own fitness. Beyond the obvious benefits of parental care the benefits of cooperation are frequently obscure (Darwin 1871, Haldane 1932). This difficulty was largely overcome by the theory of kin selection (Hamilton 1964, Maynard-Smith 1964), reciprocal altruism (Trivers 1971), group selection (D. S. Wilson 1975 and 1980) and a profusion of related theories (for example: Alexander 1974, West-Eberhard 1975, Wade 1979, Boorman and Levitt 1980, Eshel and Cavalli-Sforza 1982, for reviews: E. O. Wilson 1975 and Alexander 1979). However many sociobiologists and social scientists still found these theories inadequate to the task of explaining the complexity and extensiveness of human cooperation. By applying the principals of evolutionary epistemology (Campbell 1977) and cultural evolution (Campbell 1975, Pulliam and Dunford 1980, Boyd and Richerson 1983) to this problem it is possible to develop models for the cultural evolution of cooperative behavior (Boyd and Richerson 1980) that can also explain the creation of prosocial institutions and mechanisms associated with religious ethics, politics and law (Campbell 1975 and 1983, Burhoe 1981). This dissertation is directed to ascertaining the degree to which some or all of these theories may contribute to a biological understanding of human cooperation and competition which is in turn dependent on combining a biological understanding of cultural adaptation with human sociobiology.

What is Sociocultural Biology?

A formulation of what sociocultural biology is may best be developed from the premise that the nature/nurture distinction is a false dichotomy (Fox 1974, Durham 1976, Bateson 1982). In this perspective culture, as an aspect of nurture, is not separate to nature but is an elaboration of nature and is therefore essentially a biological phenomena subject to the principals of evolution by natural selection. However unlike some analysis of human sociobiology that place an emphasis on the genetic control of culture (Lumsden and Wilson 1981) the thesis to be developed here promotes the proposition that cultural evolution has evolved as a powerful force for adaptive human behavioral change precisely because it can overcome the limitations of phylogenetic inertia (Campbell 1977, Mason 1979, Burhoe 1981, Pulliam and Dunford 1981, Shields 1982, Boyd and Richerson 1983).

Unfortunately the adoption of this simple hypothesis is limited by the lack of detailed theories of the processes of cultural evolutionary change and absence of empirical substantiation of a thesis that is difficult to falsify (See "The War Between the Words" Eds. Wispe and Thompson 1976). However it should be noted that falsification is a problem for the theory of biological evolution (Rosenberg 1980, 1984) and all science in general (Popper 1935, Nagel 1979). Additionally a theory of sociocultural biology, if it can be developed inspite of its complexity, may be valid for philosophic reasons in as much as culture, as a biological phenomena, would become part of a nomological set of scientific theories (Nagel 1979, Rosenberg 1980).

As it is suggested that one of the major functions of culture is to over come the limitations of phylogenetic inertia it is not surprising that culture is often thought of as opposing the biological process. To accomplish this the means by which culture functions to advance human life, and the mechanisms of cultural change must be very different from the equivalent genetic processes. But so long as culture increases the fitness of an organism, and human populations would appear to be fitter for their cultural adaptations (Boyd and Richerson 1983), then the biological process is

enhanced. Culture, it is suggested, has produced a revolution in the evolutionary process that requires special attention when analyzing human behavior. This thesis will be illustrated with a review of some of the major behavioral adaptations to be found in traditional Netsilingmiut Eskimo society. However it may prove helpful to briefly discuss some central questions basic to an understanding of sociocultural biology before this is done.

Functionalism and tracing the historical evolution of behavior.

Functionalism and functional explanations have a very poor reputation in the social sciences as it is so easy to explain away almost any cultural phenomena as being adaptive. All too frequently many different adaptive explanations can be created to rationalize the same phenomena with equal conviction and persuasion while being completely inconsistent. In an effort to overcome this problem Rudner (1966) details ten steps required to providing a phenomena with a functional explanation. These range from the description of the phenomena through the description of the functional system of which it is a part to the theory that explains the workings of that system. Rudner concludes that these requirements are rarely if ever met in the social sciences principally due to the lack of comprehensive bodies of "respectable" theory. Understanding culture as a biological phenomena in the context of the theory of natural selection hopefully overcomes this problem but determining what are the principal causal events that lead to a given behavior in a complex biocultural functional system remains a very difficult enterprise. However this practical problem of separating relevant function from irrelevant or imagined function can be made more reliable by a method of enquiry that examines the evolutionary history of adaptive function (Pittenbrigh 1958, Williams 1966, Mayer 1974). For example I might try to explain the fingers and thumb of my hand as being part of an adaptive system for the manipulation of objects. But to explain why this is done with four fingers and one opposing thumb requires an examination of the fossil record associated with the evolution of limbs in the vertebrates. In like manner asking a more fundamental question like why I should manipulate at all

requires going deeper into the evolutionary story until, perhaps, the point is reached where animals separated from plants.

Mayer (1974) perceptively understood that explanations of this kind could be applied to the functions of all living organisms and human machines. Machines such as the automobile are designed to enhance locomotion so, for example, the design of the car's controls are directly traceable to the evolution of the human limbs, feet and hands, etc. Cars do not require for more than two foot pedals to be operated at the same time as humans only have two feet. However, from the perspective of sociocultural biology, what is true of the evolution of function in machines is equally true of the evolution of function in culture. Humans cannot learn more than they are able to remember without the aid of learning machines (computers, books, etc.). A human could not jump a 20 foot wall unaided as part of an initiation ceremony. This may sound very obvious but as the historical evolution of human sociocultural behavior is explored it will hopefully become clear that these kinds of facts are far from being trivial but are necessary elements of functional explanations. The importance of this approach to biological questions is summed up by Williams as follows:

"No complete explanation of a biological phenomenon can be achieved without an inquiry into its evolutionary development, and a teleonomic analysis would not proceed far without the use of historical data. The analysis would disclose much that is functionally inexplicable. The inversion of the retina, the crossing of the respiratory and digestive systems, and the use of the urethra for both excretory and male reproductive functions represent errors in the organization of the human body. They have no functional explanation but can be understood as aspects of functional evolution. Historical considerations are also necessary in explaining the many functionally arbitrary limitations that are always apparent in the design of an organism: Why is man a mere biped and not a Centaur?"

Williams 1966 pp. 263

To these questions I wish to add: Why is man so socially limited to the point of being anti-social? However a discrimination will be made between the various theories that seek to explain human social behavior by placing the enquiry in an historical

context with the question: What social evolutionary path have humans most likely gone down as opposed to what paths could humans have gone down? By uncovering the details of human social evolution it is hoped that an understanding of the social institutions and other prosocial cultural inventions can be arrived at. If such a description and explanation is for the most part correct it is further hoped that an adequate foundation can be created for developing some applied solutions to the problems of human behavior.

Social behavior in natural human populations.

An analysis of the evolutionary history of human cooperation could possibly begin with an examination of societies that have not deployed a complex array of cultural institutions for the control of antisocial behavior. Hunter/gatherer societies are frequently referred to as "primitive" because of their lack of sociocultural complexity in terms of, for example, law (Hoebel 1954) or religious ethics (Heard 1929, Bellah 1970, Smith 1970, Irwin 1980). Thus, following Wilson's (1975) suggestion that man can frequently be best understood as a Pleistocene hunter/gatherer, studies in sociocultural evolution should begin by examining the sociogenetic environment of our hunter/gatherer ancestors. In such societies, it is suggested, the comparatively simple cultural elaborations of the genetic aspects of human sociality make these behaviors most accessible to description and analysis. Additionally, as humans lived as hunter/gatherers for hundreds of thousands of years (Lee and DeVore 1968), these aspects of human nature very possibly dominate the behavior of humans in modern populations. Hamilton's (1964) theory of kin selection can make the most basic predictions about the patterns of social behavior that would be a consequence of the genetic structure of hunter/gatherer societies. From this starting point, which will be referred to as primitive behavior, the orderly analysis of more complex social behavior can proceed to other theories of sociobiological and sociocultural evolution. In other words a systematic procedure for the analysis of human social behavior is being

proposed that defines a base line for such behavior as being behavior predicted by the theory of kin selection in a hunter/gatherer society. However biological processes, theory and analysis can frequently be conveniently separated into evolutionary theories of ultimate cause that explain why a behavior occurs in terms of its effects on the organisms fitness and proximate causes that describe the mechanisms that control the adaptive behavior. Characteristically ultimate cause questions are Why ? questions, while proximate cause questions are How ? questions. This dichotomy is not pure as these questions probe the causes of behavior at different points in a continuous chain of cause and effect so that some questions are more, but not exclusively, Why? questions while other questions are more, but not exclusively, How? questions. This distinction may prove helpful as the Why ? of a given behavior is nearly always a question of evolutionary sociobiology while the How ? of many human behaviors in modern ultrasocial populations frequently involves a cultural analysis. The "Why ?" of primitive behavior will be examined first.

Hamilton's theory turns on the concept of inclusive fitness such that a behavior is expected to evolve providing the ratio (K) of gain in fitness, for the beneficiary, to loss in fitness, for the donor, exceeds the reciprocal of the average coefficient of relationship of the interactants (r) :-

$$K > 1/r$$

In the absence of inbreeding r for siblings is a 1/2, for an uncle 1/8 and so on (Wright 1922). Thus, kin selection predicts, any helping or altruistic behavior is more likely to evolve amongst close relatives than distant relatives when the costs and benefits remain constant. This model can possibly account for pro-social behavior between parents and progeny, between siblings and all the kinship relationships that are essentially consanguinial. However it does not account for the altruism that would exist between unrelated parents or other essentially affinial relationships. West Eberhard (1975) overcomes this problem with the formulation:-

$$K > 1/r_{ABy}$$

Where r_{ABy} is the relatedness of the altruist and the young of the beneficiary. In practice the consanguinial and affinial components of relationship become mixed in many cultures when, for example, first cousin marriage is preferred. However this element in the algebra of kin selection is built into West Eberhard's model such that if human behavior is in part determined by coefficients of relationship then altruism should correlate more strongly with r_{ABy} than r_{AB} .

The coefficient of relationship of the other members of a population (West Eberhard 1975) and inbreeding in a population (Hamilton 1975, Breden and Wade 1981, Shields 1982a) can also effect the algebra of kin selection. If a group of relatives inbreed then r would increase (Wright 1922) and the degree and number of interactants with whom altruistic acts could evolve could increase (Shields 1982a). The benefits of such a system would be limited only by the costs of inbreeding. (For a review of the costs and benefits of inbreeding see Shields 1982a). If the costs of inbreeding are very high then kin selection alone would not explain the evolution of extreme altruism in humans beyond the extended family. If inbreeding costs are moderate then a considerable amount of altruism could evolve in a group of relatives. But if the costs of inbreeding are lower than is popularly believed then a large but well defined group of individuals could behave very altruistically to other group members. This would be possible even when the acts of altruism were themselves quite costly to the actor.

West Eberhard (1975) pointed out that the relatedness of the altruist and beneficiary (r_{AB}) must be greater than the average relatedness of A with all other individuals in the breeding population as a whole (\bar{r}), (See also Hamilton 1964 & 1970, Williams 1966). Most authors' examinations of kin selection assume a large panmictic population in which r is small such that r_{AB} is always greater than r . However the human populations examined here are highly structured, to such an extent, that inbreeding should be taken into account when considering questions of the evolution of social behavior. The formulas needed for this analysis are available from the work of Wright (1922, 1943 and 1951) as follows:-

$$r_{AB} = \frac{2f_{AB}}{\sqrt{(1+f_A)(1+f_B)}} \quad (1), \text{ (Wright 1922)}$$

Where f = coefficient of consanguinity.

$$(1-f) = (1-f_{Gen})(1-F) \quad (2), \text{ (Wright 1943, 1951)}$$

Where f_{Gen} = coefficient of consanguinity from a genealogy and F = coefficient of consanguinity due to inbreeding of the population. By using expression (2) to correct f_{AB} , f_A and f_B in expression (1) for inbreeding in the population (F) we can express r_{AB} in terms of f_{Gen} (genealogy) and F (population) as follows:-

$$r_{AB} = \frac{2[1-(1-f_{AB})(1-F)]}{\sqrt{[2-(1-f_A)(1-F)][2-(1-f_B)(1-F)]}} \quad (3)$$

Additionally:-

$$\bar{r} = \frac{1}{n} \sum_{i=1}^n r_{AB} \quad (4)$$

Where n is the size of the population. By substituting (3) in (4) we have:-

$$\bar{r} = \frac{1}{n} \sum_{i=1}^n \left\{ \frac{2[1-(1-f_{AB})(1-F)]}{\sqrt{[2-(1-f_A)(1-F)][2-(1-f_B)(1-F)]}} \right\} \quad (5)$$

From the formulas (3) and (5) it is possible to examine the relationship between r_{AB} and \bar{r} in a structured population. For example in a theoretical population of identical individuals that some how came into being spontaneously \bar{r} would become 0 when $F=1$. Providing such an imaginary population was not in competition with other populations then no altruistic behavior would develop between its genetically identical interactants due to inclusive fitness interests alone. However reciprocal altruism is not generally restricted by coefficients of relatedness (Trivers 1971) and

could develop in these circumstances. This thought experiment may help us better understand the behavioral relationships that exists between populations in the natural world. Pro-social behavior evolves as a function of both the genetic similarity of A and B and the genetic differentiation between A, B and other potential interactants.

The preceding analysis suggests that what is true of individuals is equally true of groups. Social behavior is likely to be structured hierarchically if the groups are genetically structured. Additionally differences between r and \bar{r} could produce a polarizing of hostility between genetically differentiated groups. The hierarchical and polarizing properties of group social behavior predicted here as a consequence of applying the principles of kin selection to inbred groups are consistent with the principal forces of ethnocentrism as described by LeVine and Campbell (1972).

These properties of primitive behavior are illustrated graphically in figure 10 by plotting r_{AB} against \bar{r} . When $r_{AB} - \bar{r} > 0$ then, if costs and benefits remain equal, a genetic predisposition towards cooperation will be expected to evolve (shaded area of the graph). However when $r_{AB} - \bar{r} < 0$ then, if costs and benefits remain the same, a genetic predisposition towards competition will be expected to evolve (unshaded area of graph). The line that separates the two portions of the graph is expressed by the function $r_{AB} - \bar{r} = 0$. This function defines the parameters of primitive behavior and can be illustrated for a hunter/gatherer society by plotting the frequency distribution of the different values of r_{AB} in a hunter/gatherer population.

These populations are typically comprised of tribal demes of approximately 500 individuals (Boas 1907 for the Netsilingmiut; Lee, DeVore, Binford, Birdsell, Damos, Freeman, Hiatt, Sahlins and Washburn 1968 for hunter/gatherers in general, Tindale 1974 for Australian Aboriginals) that are considerably endogamous (Tindale 1953) with the result that these populations are inbred with a theoretical probability of identity by descent for homologous alleles as high as 0.5 (Spielman, Neel and Li 1977). The tribes that make up hunter/gatherer megapopulations may best be understood genetically as being structured along the lines of stepping stone models (Hamilton

Figure 10

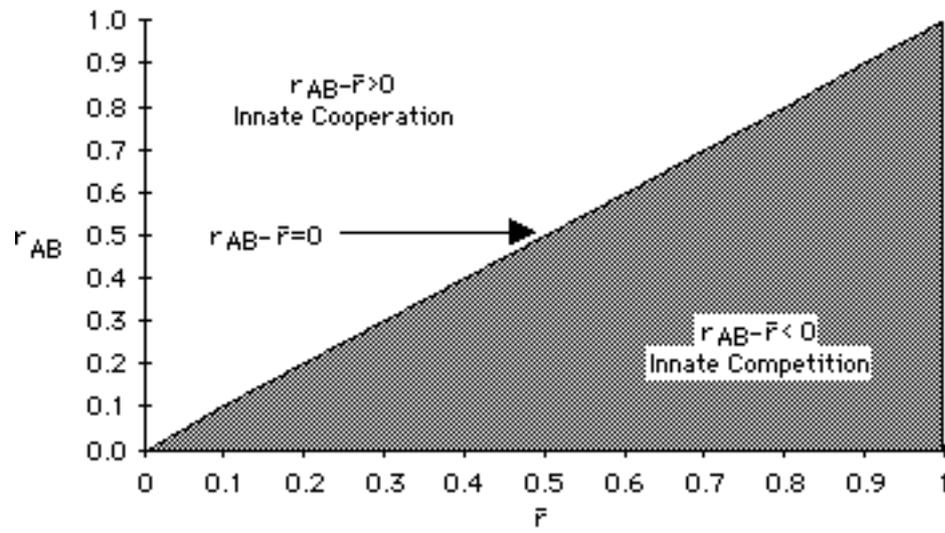


Figure 10 Innate cooperation and innate competition in an inbred population from the function $r_{AB} - F = 0$.

1974, See also Tindale's maps 1974, and Kimura and Weiss 1964, Weiss and Kimura 1965 and Maruyama 1969, 1970, 1971 for the genetic theory). In such a genetic environment an individual would share a certain level of genetic relatedness with their tribal members that would diminish as they were compared with individuals from more distant tribes. Additionally, within each tribe, the patterns of human positive assortative mating that can be associated with the nuclear and extended family will further structure the genetic environment. By combining these effects, using the math developed earlier, the genetic environment for a member of a hunter/gatherer population can be illustrated (figure 11). This curve is a simplification that would frequently be given more precise structure by, for example, low rates of intertribal migration and preferences for first cousin marriage. This has been attempted for the Netsilingmiut Eskimo and their adjacent tribes that live on the west coast of Hudson's Bay. From a frequency distribution of coefficients of consanguinity in a modern Arctic community (Chapter 3, *The Sociocultural Biology of Netsilingmiut Kinship*) and traditional migration rates (Chapter 4, *A Study in the Evolution of Ethnocentrism*) it may be speculated that the traditional Netsilingmiut genetic environment may have looked similar to that illustrated in figure 12. By applying the theory of kin selection to this kind of genetic environment a spectrum of behavior (defined here as primitive behavior) ranging from parental care to ethnocentrism can be analyzed. However modern populations have lost their primitive genetic structure but continue to exhibit modified forms of primitive behavior. For example tribalism may have developed into nationalism. In order to arrive at some understanding of the evolution of contemporary human behavior it may be necessary to combine the preceding analysis with an analysis of the proximate mechanisms of behavior.

Figure 11 & 12

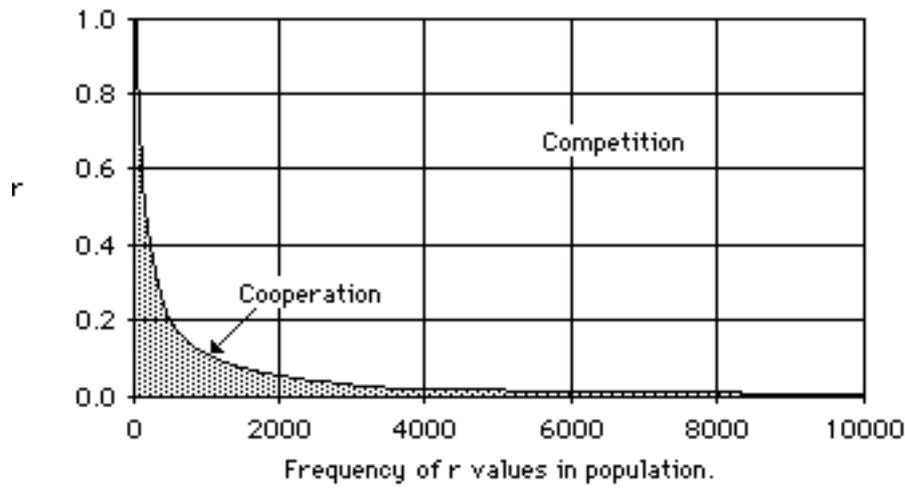


Figure 11 Innate capacity for cooperation and innate capacity for competition in a primitive or natural human population.

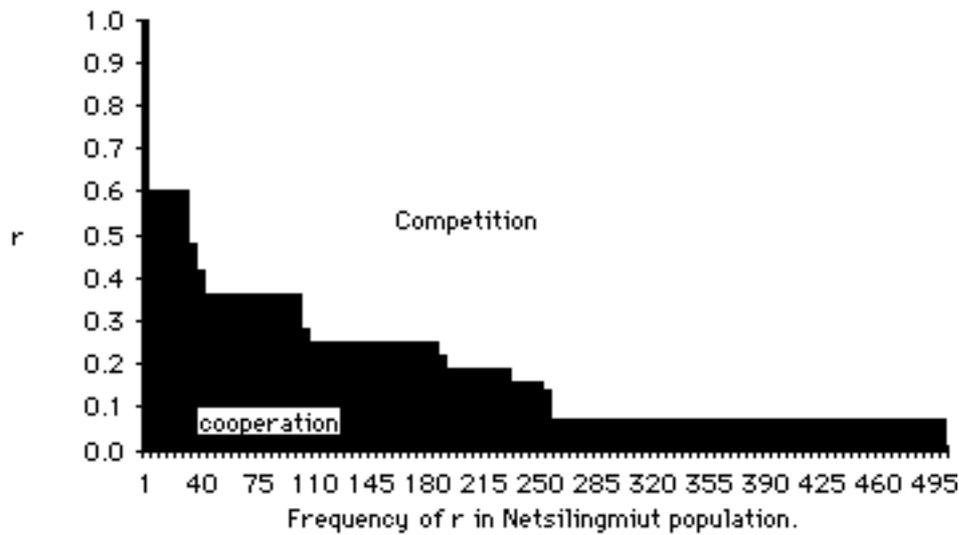


Figure 12 Sociogenetic environment for an individual Eskimo in a traditional Netsilingmiut population.

The Proximate Mechanisms of Social Behavior.

Nearly all sociobiologists are agreed on the impossibility of any organism being able to "read" the true genetic coefficient of relatedness of another conspecific (Holmes & Sherman 1983). Therefore, if societies and populations are to be structured in accordance with degrees of relatedness then the organisms in that society or population must possess mechanisms that at least approximately reflect the kinship of other members of the society or population. Further, in so far as social behavior may be governed by relatedness, then such proximate mechanisms will play an instrumental role in the activation of those behaviors. Given this situation such proximate mechanisms could become the "keys" or "levers and buttons" of genetically based innate social behavior (MacDonald 1984), at least within the parameters of developmental learning (Bateson 1983b). Identifying these mechanisms (For reviews see Holmes & Sherman 1983, Shields 1982a, Lewin 1984) may therefore be an empirical question of considerable importance in developing a better understanding of the evolution of human cooperation and competition. For many animals these mechanisms can function using phenotypic variation such as scent or pheromones (Gilder & Slater 1978, Greenberg 1979, Buckle & Greenberg 1981, Bateson 1980, 1982, Vidal 1982), developmental contact or imprinting (Lorenz 1935, Michener & Sheppard 1972, Hess 1973, Leon 1975, 1978, Porter et al 1978, 1981), learned songs (Marler and Tamura 1962, Nottebohm 1969, 1972) and spacial displacement (Hoogland & Sherman 1976, Holmes & Sherman 1982). Most probably all these mechanisms operate to various degrees in humans particularly within the nuclear family. For example the evidence so far assembled points to a general innate tendency for children raised together not to mate (Shepher 1971, Alexander 1974). However beyond the nuclear family culturally acquired kinship could facilitate the operation of kin selected behaviors in humans with more precision and range than is found in other animals (Campbell 1983).

For example the proximate mechanism of sibling identification in many animals is early developmental contact. This is also true of humans but additionally my parents tell me that a certain individual is my brother or sister. I have additionally been told by my parents that I have a half sister, whom I have never met, in Australia, by my father's deceased first wife. This half sister likewise knows of my existence so if I were to go to Australia or if she were to visit me in America we would naturally stay with each other, we would freely enter into a potentially costly reciprocal altruism pact because we were closely related. But the proximate factor that controlled that behavior was not developmental contact, it was the linguistic report of my parents that this person was my half sister and my acceptance of the belief.

This example illustrates how human culture can extend kin oriented behavior in space and time by mapping aspects of the primitive sociogenetic environment with kinship terminology to provide humans with an improved kin recognition mechanism. However as this mechanism is cultural it is readily available for elaboration, manipulation and sophistication to act as a proximate mechanism for a wide range of adaptive behavior such as reciprocal altruism (Trivers 1971), group cooperation (Campbell 1975, Boyd and Richerson 1980, Abruzzi 1982), optimal mate choice (Shields 1982a and b, Bateson 1983a), parental manipulation (Alexander 1974), dominance (West Eberhard 1975) or exploitation (Betzig 1982). In this perspective the bio/cultural evolutionary history of a complex social behavior is seen as progressing from: (1) The activation of primitive behavior by physiological/developmental proximate mechanisms to: (2) The extension of primitive behavior in space and time through the use of cultural kin recognition mechanisms to: (3) The adaptive elaboration of primitive behavior through the manipulation of cultural kin recognition mechanisms.

It should be noted that this evolutionary process of the cultural mapping and manipulation of primitive behavior is not limited to behavior associated with systems of kinship. For example the proximate mechanisms of tribal behavior could be manipulated to produce tribalistic behavior in a group or population of almost any size.

It may not be too difficult to memorize the individual identities of a limited number of parents, siblings and other frequently contacted relatives. Remembering all the members of a tribe of 500 is a more difficult, but not impossible task. Being certain about who belonged to which tribe or who was not a member of a group of tribes could be very difficult indeed. To deal with this problem, natural selection has repeatedly evolved a proximate mechanism known as badging. Badges can be learned and may be one of the simplest, most rudimentary forms of culture presently known. Nottebohm (1969, 1972) has detailed various bird songs as being learned and identified with particular inbreeding demes (See also Marler and Tamura 1962, and Baker and Cunningham 1985 in press for a review). Of the mechanisms for kin identification originally identified by Hamilton (1964), Holmes and Sherman (1982) consider the possibility of recognition alleles (innate badges) as most problematic. However, this "green beard effect", as Dawkins (1976, 1982) calls it, is essentially what badging is, the only difference being humans (and some song birds) don't grow different colored beards to identify kin, they may wear false beards of different colors in the form of culture. Baker and Cunningham (1985 in press) have suggested that human dialects, like song bird dialects, may also function as population markers. There are many methodological difficulties to the measuring and correlation of genetic and linguistic differences in natural or primitive human populations (For a review see Jorde 1980) however such correlations have been found (White and Parsons 1973, Crawford et al 1981) and therefore could act as proximate mechanisms for ethnocentric tribal behavior. As with kinship this sociocultural mapping of the tribal sociogenetic environment is open to manipulation by cultural evolution to produce ethnocentrism in modern populations that are not inbred.

With regard to how prosocial mechanisms work in ultrasocial societies it may have once been assumed that some form of behaviorism allowed for the conditioning of a malleable, plastic human nature. In contrast to such a thesis it now seem probable that ultrasocial societies stumbled upon the manipulation of the proximate mechanisms of

sociality maintenance inherent in primitive societies. This could be accomplished by manipulating the developmental environment of individuals (Lumsden and Wilson 1983, MacDonald 1984) or, as is suggested here, by manipulation of cultural mappings of the primitive sociogenetic environment, or a combination of these processes and effects.

Perhaps the simplest and most powerful example of this process would be the manipulation of tribal badges to induce altruism amongst individuals sharing the same badges. Nationalism, in this view, would be a cultural extension of the evolved proximate mechanisms associated with tribalism. Shared flag, language, dress, sports, institutions, etc., would all take on the force of badges to help create a population of cooperative individuals. Further, it may be speculated that the restriction of the free movement of individuals across national boundaries is, in part, an artifact of a genetically predisposed behavior whose biological origins are to be found in primitive tribal restrictions on outbreeding (Tindale 1953). All groups who maintain their cooperative force with badges will tend toward group endogamy. Thus religions frequently condemn and restrict marriage between their members and members of other religious groups (Gordon 1959, Besanceney 1970, Johnson 1980). It follows that if nation states and religious boundaries coincide, the one source of group altruism will be piled upon and added to the other. Conversely nations who tolerate pluralism in religion or pluralism in language may divide the loyalties of their subjects and create conflicts of interest. However the costs of such conflicts may be compensated for by the benefits of creating larger nation states. Descriptions of the cultural aspects of ethnocentrism (LeVine and Campbell 1972) and models of the cultural evolution of ethnocentrism (Boyd and Richerson 1980, Abruzzi 1982) may now be understood as cultural elaborations of an innate behavior associated with tribal badging. This cultural manipulation of the genetics of tribalism to produce nationalism, in-group cooperation and out-group conflict is but one example of what may be a general principle of human behavioral evolution, namely: The innate biological proximate mechanisms of behavior

and social structure in primitive human populations are manipulated by culture to produce novel behaviors and social structures in ultrasocial populations.

However, even if a systematic analysis of human behavior were to be completed from this perspective it would still be inadequate to the task of predicting behavior. Behavior, like any phenotype, is effected by its environment, particularly during the growth and development of the organism (Bateson 1979, 1982, 1983). In other words an analysis of the evolutionary history of a behavior would have to be combined with a full understanding of the individual development of that behavior in order to explain the manifestation of the behavior being examined. For example, ethnocentrism may be associated with badging, which may be associated with tribalism, which may be associated with inbreeding and mate choice. If this is correct then it follows that badging should be completed before mating i.e. prior to or during early adolescence making that the critical period for the development of individual ethnocentric attitudes.

Cultural Evolution.

Attempts have been made to model cultural change by drawing analogies from population genetics (Murdock 1960, Alexander 1979, Pulliam and Dunford 1980, Boyd and Richerson 1980, 1983) but unlike the development of the math of population genetics in the 1930's (Fisher 1930, Haldane 1931, Wright 1931) there is no well thought out equivalent of Mendell's Laws upon which to develop a cultural evolution "New Synthesis." Campbell (1974, 1983) considers the process of cultural change to be essentially Darwinian in as much as evolution is shaped by blind variation and selective retention. However the biological evolution of what Churchland (1979) calls epistemic engines and the cultural refinement of human cognition with science, computers and, possibly in the future, artificial intelligence, may render the process of cultural change so efficient that models of such change may be better developed from a Lamarkian understanding of the evolutionary process. In this perspective cultural variation is no

more blind than a person with sight although it is recognized that both epistemic engines and the eye came into being, during their evolutionary history, by a process of blind variation and selective retention. Current developments in biological theory are frequently focused on gaining a more precise understanding of the vehicles, processes of replication and units of selection of biological evolution. One possible set of answers to this question may be genes, meiosis and the individual (for a discussion of these issues see Williams 1966, Dawkins 1976, 1982). However determining the vehicles? (humans, books, televisions, computers, radios, teachers, libraries), the process of replication? (learning, taping, printing, photographing), and the units of selection? (individuals, families, groups, schools of thought, corporations, societies, states, nations, cultures) of cultural evolution has barely begun. Answering questions like these may help provide cultural evolution with an equivalent of Mendel's laws from which a cultural equivalent of population genetics could be developed. However, understanding the details of cultural change may not be an impediment to the study of cultural evolution any more than not knowing the details of genetic change was an impediment to the study of biological evolution prior to the discovery of D. N. A.

In as much as culture may promote fitness, genetic models of fitness could possibly be extended to take the effects of culture into account. For example the topographic models of Wright (1931, 1932, 1942, 1956, 1970, 1977) are developed to combine various aspects of genetic variation to produce an analysis of genetic fitness. Wright's models may be conceptually extended if culture, as another source of variation, is added in as an additional characteristic that contributes to an organisms fitness. Although this exercise is restricted by the inadequate knowledge of the dynamics of cultural variation it may help illustrate some important trends in the relationship between human genetic and cultural evolution.

In Wright's conceptualization of populations, fitness is represented by the elevation of peaks in the adaptive topography and genetic variation is represented by the distance between points on the topography. For example, even in the absence of

culture, the Eskimo are genetically, anatomically and physiologically better adapted to their arctic environment than the members of the Indian population to their south. The Eskimo have improved capillary circulation below the skin which reduces the occurrence of frost bite but increases susceptibility to bruising and they also have shorter legs in relation to their body size which reduces heat loss but also reduces running speed. Figure 13A illustrates this point by plotting what may be the relative fitness of the Eskimo and Indian genotype with respect to annual mean temperature. However cultural variation also improves fitness as different technologies are tailored to survival and foraging in different environments. Figure 13B adds this cultural aspect of fitness to the genetic aspects of fitness plotted in figure 13A. All the culturetraits that make up the coadaptive culturetype for Netsilingmiut cooperation, to be reviewed later in this chapter, would be subject to variation in the Eskimo megapopulation. For example, the culturetraits that control the rate of female infanticide vary with temperature (See Chapter 2, The Sociocultural Biology of Netsilingmiut Female Infanticide). These culturetraits would add to (or detract from if maladaptive) the combined fitness of the Eskimo genotype and culturetype. So long as primitive populations maintained a demic structure genetic and cultural variation and fitness would follow a synchronous pattern as illustrated in figure 14A. In comparison to their hunter/gatherer ancestors, modern ultrasocial societies have abandoned a demic genetic structure so that variations in human fitness are increasingly dominated by the cultural components of fitness, figure 14B. Ethnocentrism, in part an artifact of genetic population structure, continues to structure cultural variation in the contemporary human megapopulation. In this perspective the present convergence of cultures can be seen as the increased dominance of a small group of peaks, figure 14C. This point is also illustrated in figure 13C where contemporary North American culture has increased fitness across a wider temperature range than either the Indian or Eskimo culture.

Figure 13

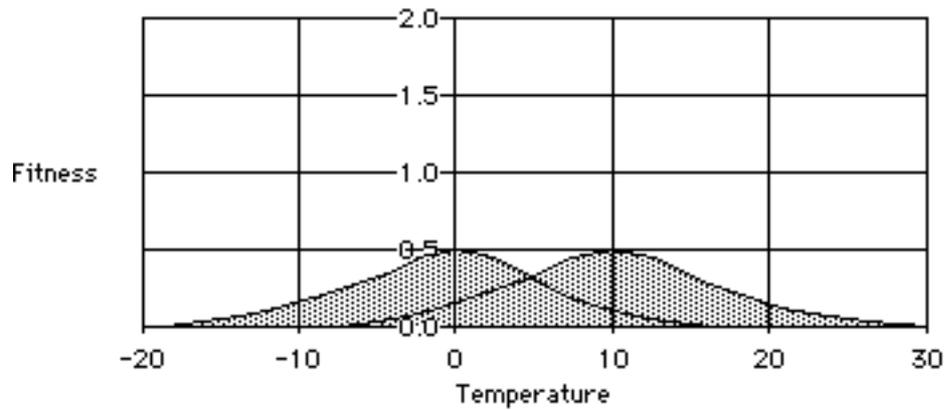


Figure 13a Relative fitness of Eskimo and Indian genotype with respect to annual mean temperature.

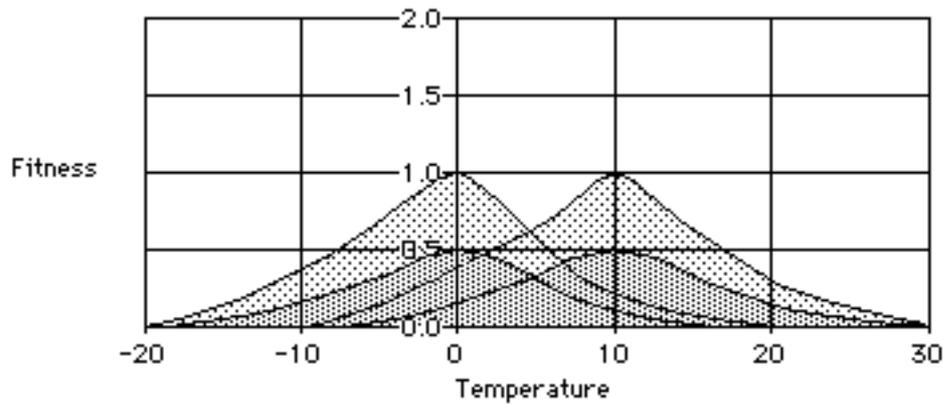


Figure 13b Relative fitness of Eskimo and Indian genotype and culture type with respect to annual mean temperature.

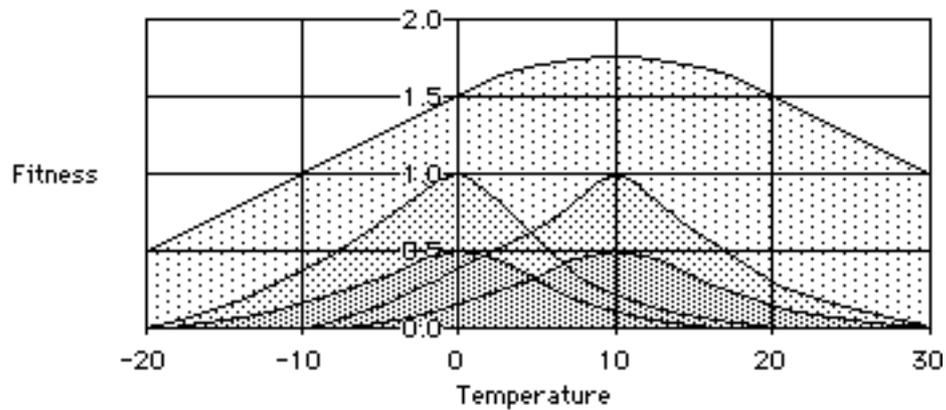


Figure 13c Relative fitness of Eskimo, Indian and modern American genotype and culture type with respect to annual mean temperature.

Figure 14

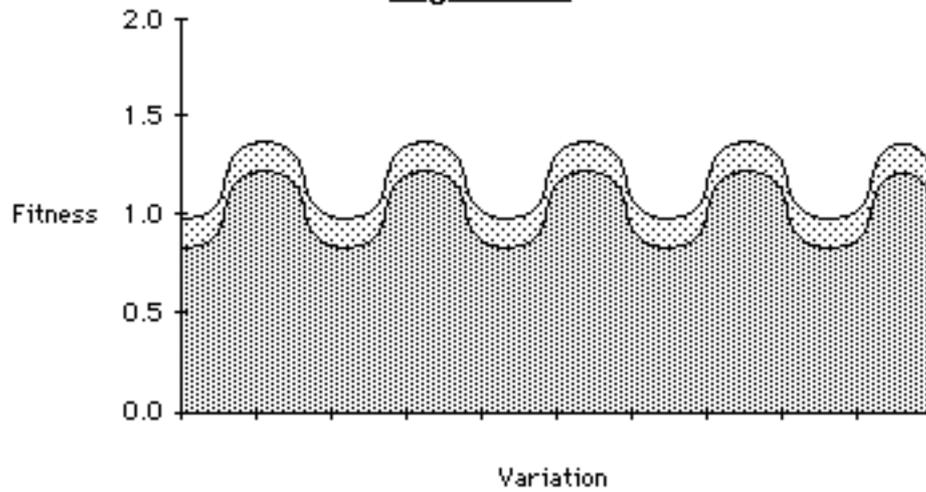


Figure 14a Synchronous cultural and genetic variation in a primitive population.

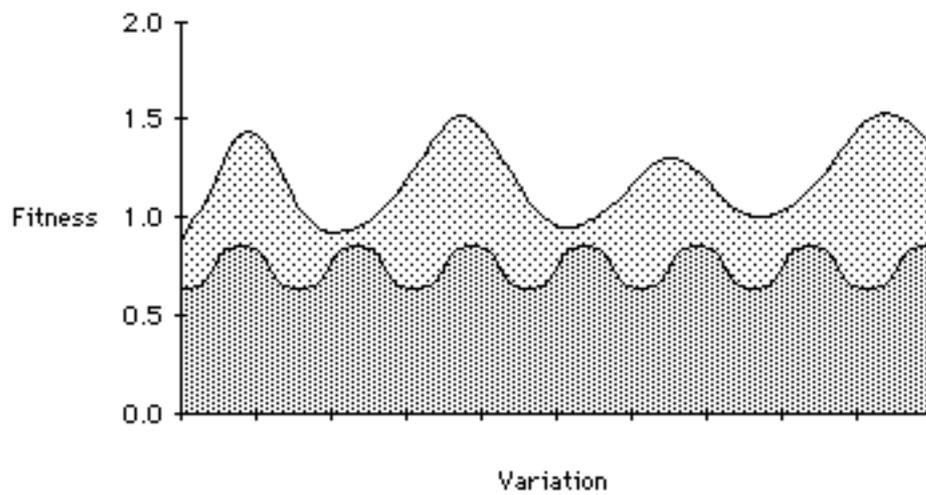


Figure 14b Cultural variation dominating fitness in ultrasocial populations.

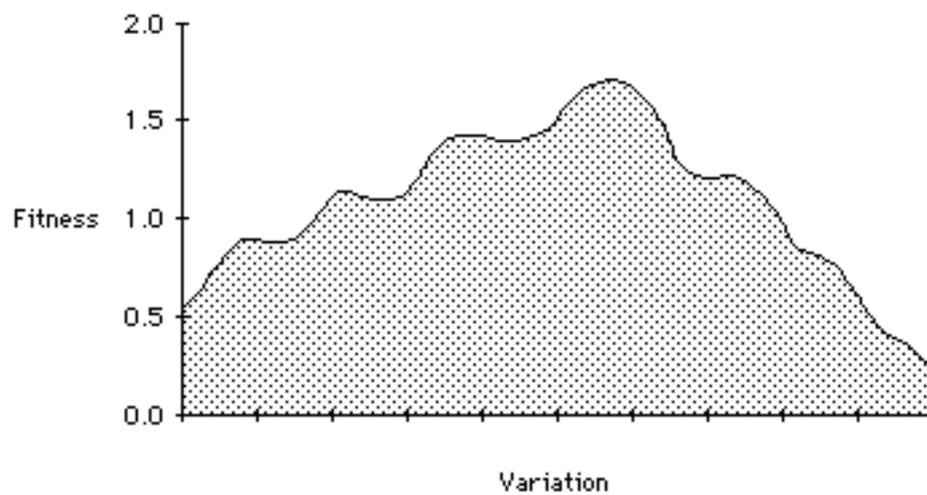


Figure 14c Modern convergence of cultures to produce dominant peaks in culturetype topography.

Between and within the organizational levels of factories and corporations, research centers and scientific disciplines, cities and nation states, the process of cultural change described by Kuhn (1962), Campbell (1969 and 1979), Pulliam and Dunford (1980) and Boyd and Richerson (1980), may now be provided with some additional detail. For example moving from one adaptive peak to another in Wright's model requires traversing a maladaptive valley. Such a reversal of the genetic evolutionary process is extremely difficult (Fisher 1930). The redirection of cultural evolution may not be so completely impossible but this kind of analysis of genetic and cultural inertia could apply to the problems of paradigm shift described by Kuhn (1962). Wright's (1942, 1970) "shifting balance" theory speeds the processes of biological evolutionary change by creating a population structure in which adaptive changes can quickly originate and subsequently spread more effectively through a subdivided population.

For cultural evolution, a comparable process may take place. Groups of individuals sharing similar culturetypes create a protective nurturing environment in which adaptive new culturetypes have an opportunity to flourish. Once refined, such that an adaptive new idea takes over a given group, then Wright's "shifting balance" process of inter-group selection (individual selection within and between structured groups) can quickly spread the adaptive culturetrait. (See also the "cascade principle" of Borman and Levitt, 1980). The highly complex group structure of ultrasocial societies is favorably configured for cultural inter-group selection, providing no impenetrable ideological barriers are created between groups. Group barriers are adaptive so long as they nurture adaptive new culturetraits but may be maladaptive in the long term when they prevent the spread of adaptive new culturetraits. In this sense Wright's model of gene flow may be applicable to a model of the flow of culturetraits and could provide an evolutionary standard by which the environment for the development of adaptive culturetraits can be structured for maximum utility.

The faithful reproduction of an adaptive ideology may be as important for a culture as the faithful reproduction of an adaptive genome is important for an organism (Boyd and Richerson 1980). However a too stringent protection of an ideology in times of rapid environmental change could be dangerous if adaptive cultural evolutionary change is prevented. A case in point may be ideological restrictions on birth control that evolved in an ancient world where infant mortality rates were several times higher than those of the modern world (Edel 1978). Conversely a rapid abandonment of an ultrasocial ideology without first knowing what prosocial functions it performed could be as dangerous as not adapting to change. Given sufficient time adaptive changes may win out over non-adaptive changes. However, this process of a natural evolution of ultrasocial ideology can possibly be greatly enhanced by an evolutionary understanding of the functions of the elements of ultrasocial ideology. This in turn, it is suggested, may be facilitated by analyzing the cultural and genetic evolutionary history of the culturetraits of ideologies.

The Evolution of Netsilingmiut Cooperative Behavior.

Providing some of the major elements of social theory have been identified in their biological and cultural evolutionary forms an empirical study of any sociocultural system should now be possible in which each culturetrait will distinctly correlate with a specific repertoire of adaptive behavior. At least this should be true in principle. In practice, however, the complexity of the bio/cultural system and the existence of some functionally neutral or maladaptive culturetraits will probably render a perfect analysis impossible.

Although a rudimentary human society may have once existed in which most of the social behavior could be explained in terms of primitive genetic relationships probably no such society exists today. To basic primitive behavior other forms of sociality can be added that are to be explained in terms of the various biological theories of cooperation mentioned in the introduction. However this process of

elaboration will be least advanced and therefore most accessible to analysis amongst a "primitive" hunter/gatherer such as the Arctic Netsilingmiut (descriptions and ethnographies of the Netsilingmiut are to be found in Ross 1835, Boas 1901, 1907, Amundson 1908, Rasmussen 1930, 1931, Balikci 1970, Williamson 1974, Irwin 1981). For the Netsilingmiut, and possibly most of the Eskimo from northwest Alaska to Greenland, these additional behaviors are probably understandable as forms of reciprocal altruism in as much as the benefits of these behaviors are even handed. However these different reciprocal behaviors are most often associated with degrees of cooperation that are in turn associated with different values of relationship (r). This may be in part due to the reduced risks of reciprocation with a relative and increased potential costs of reciprocation with a non-relative (Rubenstein 1982). These behaviors, that may be thought of as a cultural synthesis of aspects of kin selection and reciprocal altruism, are illustrated in figure 15 and can be summarized as follows:-

(1) In Netsilingmiut metaphysics a persons name is synonymous with their spirit, soul and personhood so that individuals sharing the same name are metaphysically extensions of themselves and the common ancestor they are named after (Guemple 1966, Irwin 1981). Such persons are required to exchange gifts (Weyer 1932). As name sakes receive their name from a common ancestor they are generally members of the same extended family such that associated reciprocity will generally be retained within the extended family. Personal names may be thought of as primarily being cultural maps of ego ($r=1$). By sharing names the Netsilingmiut introduce an element of ambiguity to the concept of self that may contribute to the cooperation between name sakes.

(2) Wife exchange (Guemple 1961) increases the number of individuals who enjoy levels of cooperation associated with the high coefficients of relatedness found in the nuclear family (for parents $r_{ABy}=0.5$ and for siblings $r_{AB}=0.5$ in the absence of inbreeding). These reciprocal partnerships are generally limited to members of the same tribe who are not close relatives (Irwin field notes). One of the principle proximate

Figure 15

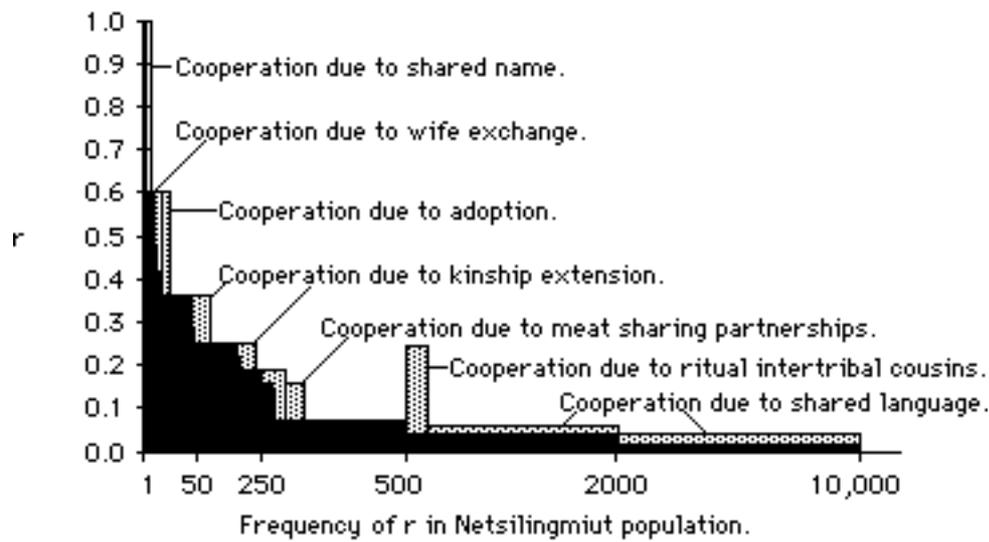


Figure 15a Culturally enhanced sociogenetic environment for an individual Eskimo in a traditional Netsilingmiut population due to cultural manipulation of r .

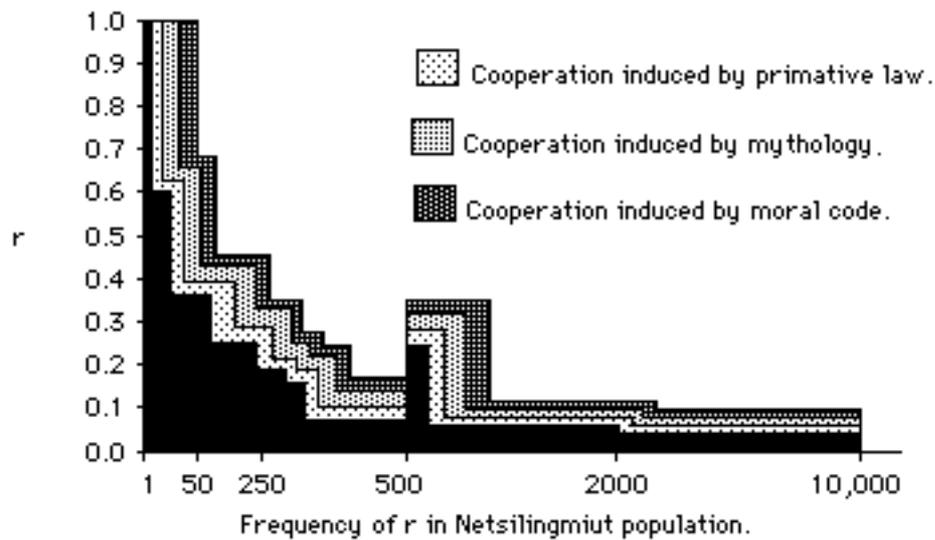


Figure 15b Culturally enhanced sociogenetic environment for an individual Eskimo in a traditional Netsilingmiut population due to cultural manipulation of cost benefit ratio.

mechanisms of cooperation associated with parenting in humans is probably sexual bonding. This aspect of human sociobiology is exploited in Netsilingmiut sociocultural biology by extending this bonding to another nuclear family and culturally mapping such relationships with kinship terminology (Guemple 1961, 1966, Balikci 1970).

(3) The Netsilingmiut practice the systematic adoption of their daughters first son. Infertile couples adopt from their close relatives and the Netsilingmiut culture encourages the adoption of orphans who will generally be from deceased members of the extended family (Rasmussen 1931, Guemple 1966, Balikci 1970, Chapter 3, *The Sociocultural Biology of Netsilingmiut Kinship*). Like wife exchange this behavior effectively increases cooperation at the level of the nuclear family. By using the prefix Tiguark Netsilingmiut kinship terminology can discriminate between the biological members of a nuclear family to reflect the differences between coefficients of relationships for the biological progeny and adopted progeny. This could contribute to a biased distribution of resources in the nuclear family toward the biological kin. However adoption at infancy, of close relatives, by couples that are infertile or past their reproductive prime, maximizes inclusive fitness benefits to those making the adoption and takes full advantage of early bonding processes.

(4) Kinship extension (Guemple 1966, Burch 1975, Chapter 3, *The Sociocultural Biology of Netsilingmiut Kinship*) increases the effective size of the extended family (above $r_{AB}=0.125$ but below $r_{AB}=0.5$ in the absence of inbreeding). As kinship extension allows members from one extended family to "plug in" to another extended family this behavior can be understood as a form of reciprocity between extended families. Netsilingmiut kinship extension terms are generated by the addition of appropriate suffixes to extended family terminology. In this way normative behavior associated with a given kinship extension term can be understood as a manipulation of extended family primitive behavior.

(5) Institutionalized seal meat sharing partnerships (Franz Van de Velde 1956, Balikci 1970, Trivers 1971) draws individuals from the tribe into levels of cooperation

associated with membership in an extended family. As with kinship extension this behavior effectively increases the size of the extended family. These partners refer to each other with specific terms that take precedence over any kinship relationship, and its associated term, that may exist between them. These terms encompass a field of meaning that includes a normative rule for the sharing of specific parts of any seal either partner may catch.

(6) Cooperation established through intertribal marriage is already taken into account by allowing for intertribal migration in the original model of primitive behavior. However intertribal ritual cousins (Chapter 4, A Study in the Evolution of Ethnocentrism) established a small group of pseudokin from outside the tribe. This unusual behavior is the reciprocity to be found between individuals not sharing in the background coefficient of relationship associated with tribal population inbreeding. Unlike kinship extension the term for intertribal ritual cousins, *Itluk*, is actually identical to the kin term for biological cousin in much the same way as uncle can be biological or cultural in American kinship.

(7) Intertribal communication was very good. Unlike most hunter/gatherer megapopulations, the Eskimo tribes spoke dialects of the same language from northwest Alaska to Greenland (Birkett-Smith 1928). If dialects act as cultural markers or badges for differences in intertribal coefficients of relationship (r) then linguistic similarity could raise the effective value of r between adjacent tribes (Chapter 4, A Study in the Evolution of Ethnocentrism). This study and the work of Speilman, Neil and Li (1977) places the value of r attributable to inbreeding in a hunter/gatherer tribe between approximately 0.125 and 0.5. Cooperation associated with tribal badging may therefore be important in terms of both intensity but perhaps more significantly in terms of numbers (approximately 500) in comparison with the extended family (approximately 50 to 100) and nuclear family (approximately 5 to 10).

(8) The Netsilingmiut do not have a written language or institutionalized legal system (Van den Steenhoven 1959) although, like many hunter/gatherers (Hoebel

1954), they do have sets of rules and taboos enforced by the sanction of the shaman (Balikci 1963) and/or community. Typical of such unwritten laws are the mores of property summed up by Weyer as follows:-

"These mores are basic; for they govern the apportioning of the primary essential of life, sustenance. Naturally, they owe their distinctive character to the unusual life-conditions upon which they have developed.....

(1) Hunting grounds, or rather the privilege of hunting on them, is a communal right, except in some rather rare instances.

(2) The hunter or hunters almost always have the preferential share in the game secured, but part of each catch is generally divided among the community or among those present at the apportioning.

(3) Stored provisions are normally the property of the family or household; but in time of scarcity there is a tendency toward communalism. Hospitality is stressed under all circumstances."

Weyer 1932 pp.188.

However, Birket-Smith (1959) adds to this unwritten "Eskimo Constitution" the principle that: "No one may be excused from hunting except in the case of bodily infirmity." This recognizes labor as a common resource. These kinds of rules, and their enforcement, reduce the degree of competition between individuals which reduces the antisocial area of figure 4 and thereby increases the prosocial area by increasing the effective values of r_{AB} and r in the function $r_{AB}-r=0$. As the punishment for breaking Netsilingmiut "law" is reduced cooperation from relatives and tribal members the proximate mechanism of cooperation in this case can be best understood as a change in the cost/benefit ratio of behavior (Shields and Shields 1983) to facilitate the subjugation of individual interests for group interests (Campbell 1975, Alexander 1979).

(9) The Netsilingmiut have a very rich mythology (see Rasmussen 1931 for a collection). Of 36 Netsilingmiut myths recorded during my own field work approximately half deal with the subject of revenge killing for murder. As with legal sanctions against antisocial behavior execution would nearly always make any act of murder more costly than the benefits of murder. However revenge killing would do

little to deter murder if it only occasionally followed the act of murder. Possibly even more important than execution frequently following the act of murder would be the belief that revenge killing always follows the act of murder. From this perspective the emphasis on revenge killing in Netsilingmiut mythology can be understood as an element in the culture type that prevents murder. But unlike law and legal sanctions that actually change the cost benefit ratio of antisocial behavior mythology creates perceived changes in the cost benefit ratio by enforcing the belief that the costs are very high. A recurrent problem in moral philosophy and game theory is the difficulty of coming to terms with a successful cheater. Netsilingmiut mythology, like much religious ethics, can overcome this dilemma by providing metaphysical retribution for wrong doing. This point is illustrated by the following myth that graphically details the perceived costs of abandoning unwanted orphans:-

"There was once a boy and a girl who were brother and sister. They were left behind by the other people in their band because they did not have a mother or a father.

The brother would tell the girl. " What do we want to be? What do we want to be? Do we want to be musk oxen? Do we want to be musk oxen? If we are strong black musk oxen we can fight with our horns."

Again the boy would say to his sister, "What do we want to be? What do we want to be?"

His sister would answer, " We could be polar bears. But if we are polar bears we might fight with each other."

They were sitting inside the rocks of an old tent ring when the little boy asked his sister what they wanted to be.

He said . " Do we want to be thunder?"The girl remained completely silent and began to concentrate on the old tent ring that surrounded them.The boy found two rocks that were tools, that were left behind by their band and had been used for making fire. The girl found a skin and stretched it into a drum. Then the orphan boy started to strike the two rocks together and great sparks leapt from his hands. He had made lightning. The girl started to hit the drum that she had made and it thundered. Each beat on the tight skin made a beat that roared across the land. And so the abandoned children became thunder and lightning. The sister was thunder, the brother was lightning and they went in search of the people that were not kind to them when they lived together in the same camp. The people had been cruel to the boy and girl so they went to their

band's camp and raged a thunderstorm on them. The brother and sister made the thunder and lightning last for many days until the wicked people were all killed. People came to see the destruction from other hunting camps. They found the people there were all dead, killed because they had been so cruel to the little boy and the little girl.

The distant travelers who came to see these wretched people that had been in this first thunderstorm were in the exact same position as when the thunderstorm started. Some people were sitting up, some people were standing up, some people were lying down, some people were working, cooking, some people were playing, children were playing, including the babies, from the eldest to the youngest, the people never moved even when the other people came to see them.

And the dogs, some of them were lying down, some of them were standing up, some of them were under the rocks trying to get away from the thunder. They were all looking, staring vacantly at the same empty open ground.

And one traveler touched a dog and it disintegrated to a pile of ashes. So all the travelers went about and touched all these people that were in the thunderstorm. They all became ashes.

The brother and sister that had become thunder and lightning had done that to them because those thoughtless people were so cruel to the orphans. So that is why my mother and father used to tell me never to be mean to children who do not have parents because children that are not loved by anyone can become anything, an animal, the thunder, anything that could be vengeful and dangerous.

Aupudluk 1977.

(10) Like the Hopi (Brandt 1954) and Navajo (Ladd 1957) the Netsilingmiut have a well developed ethics (Irwin 1981). It is based on the concept of an ideal Eskimo being extremely human which in turn necessitates being intelligent and good. In the Netsilingmiut view an intelligent person will not be bad because, as Kako points out:-

" A greedy person is not smart because a greedy person will end up with nothing some day and then he will end up with no help"

Kako 1980.

However being intelligent, good and human means being Eskimo in the Eskimo language (Irwin 1981) such that Netsilingmiut ethics are restricted to the Eskimo megapopulation. Folk definitions of the ideal Eskimo, Inutsiavumarrearluk, are as follows:-

"Even if you don't know a person very well, it is easy to tell if they are kind, generous, loving and forgiving. It's very easy to tell when you see them. People who are happy, making jokes are also Inutsiavumarrearluk. It is not possible to be such a person without also being very intelligent, thoughtful."

Kugak 1980.

"To me someone who is Inutsiavumarrearluk is someone who never changes his attitude towards people, his personality never changes. Different people have different personalities, but someone who is wise can never be bad."

Samutuk 1980.

Someone who is Inutsiavumarrearluk doesn't say much to anybody. They don't bother other people. They never change. Someone who thinks correctly is always nice."

Ipiak 1980.

Any behavior that tends toward this praiseworthy standard will increase cooperation between adherents of the ethic so that the effective values of r_{AB} and \bar{r} will increase in the function $r_{AB}-\bar{r}=0$. Law also increases the effective value of r_{AB} and \bar{r} but law achieves this by reducing competition, in contrast ethics operates so as to directly increase cooperation. Although a virtuous Netsilingmiut may not receive benefits from the community that fully compensate for his or her benevolent acts a false belief, that greedy people always do get their "just deserts" could possibly evolve by a cultural form of trait group selection (Wilson D. S. 1979, 1980, Boyd and Richerson 1980, Campbell 1983). Additionally it should be noted that benevolence, in a hunter/gatherer society, will nearly always fall to a relative and therefore partly benefit the altruist in inclusive fitness terms. This observation possibly explains the limiting of Netsilingmiut ethics to the Eskimo megapopulation.

All these behaviors effectively increase both the number of individuals a Netsilingmiut cooperates with and the intensity of cooperation. This is illustrated graphically by an increase in the shaded area of the graph and the movement of the effective $r_{AB}-\bar{r}=0$ function to the right and up. By mapping the behaviors in this way it is

possible to gauge the cooperative value of each behavior in terms of how many individuals are effected by it and the effective r value of the behavior.

In the contemporary Arctic name sharing, wife exchange, kinship extension and intertribal ritual cousins are dying culturetraits and their removal from the coadaptive culturetype for prosocial behavior will extinguish those forms of cooperation, figure 16. However this process will be in part compensated for by the deployment of western prosocial culturetraits such as christian religious ethics, more effective law enforcement, a welfare state and the erosion of intertribal differences, figure 17. Interestingly these changes are marked by a trend away from high values of effective r toward greater numbers of individuals, quantity rather than quality.

Ultrasociality

In their paper on the coefficient of relatedness of the Yanomama Indians Spielman, Neil and Li (1977) conclude:-

"While we can speak with some assurance only with respect to the Amerindian, we surmise that aspects of the inferences we have drawn are in the main applicable to man during his tribal days everywhere. If this is correct, then the process of detribalization which has occurred since the advent of civilization some 2000-4000 years ago must have resulted in a marked relaxation of inbreeding....."

Spielman, Neil and Li 1977.

Given the dependent relationship between inbreeding, coefficients of relatedness (Wright 1922) and prosocial behavior (Hamilton 1975, Breden and Wade 1981, Shields 1982) the implications of abandoning tribalism are profound. The critical importance of these aspects of human nature is emphasized by the work of Chagnon (1979). He empirically demonstrates that tribal fission among the primitive Yanomama is causally related to growth in tribe size and a consequent reduction in mean relatedness coefficients. Further, the mean coefficient of relatedness of the individuals within the two new villages formed by the fission is higher than it was among all individuals in the combined village prior to fission. These facts suggest that a gradual

Figure 16 & 17

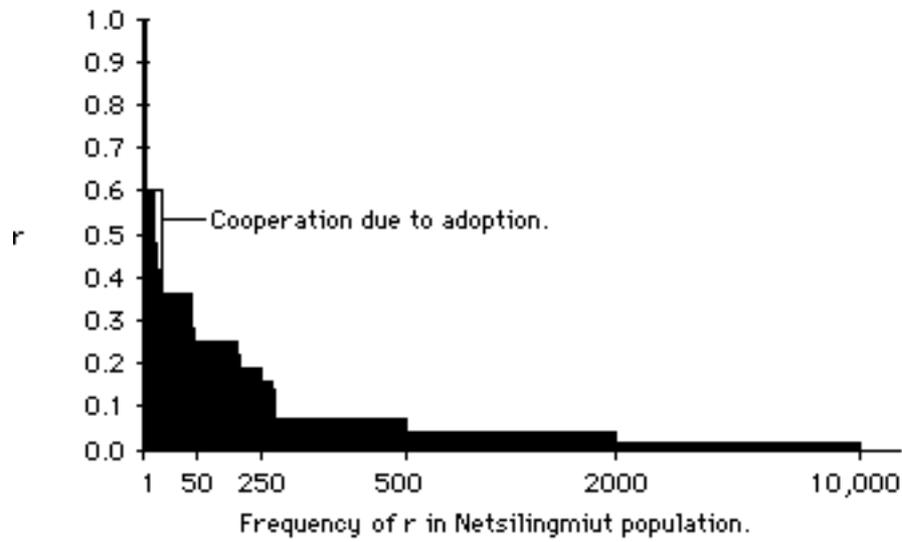


Figure 16 Loss of the majority of cultural prosocial mechanisms in modern Netsilingmiut population.

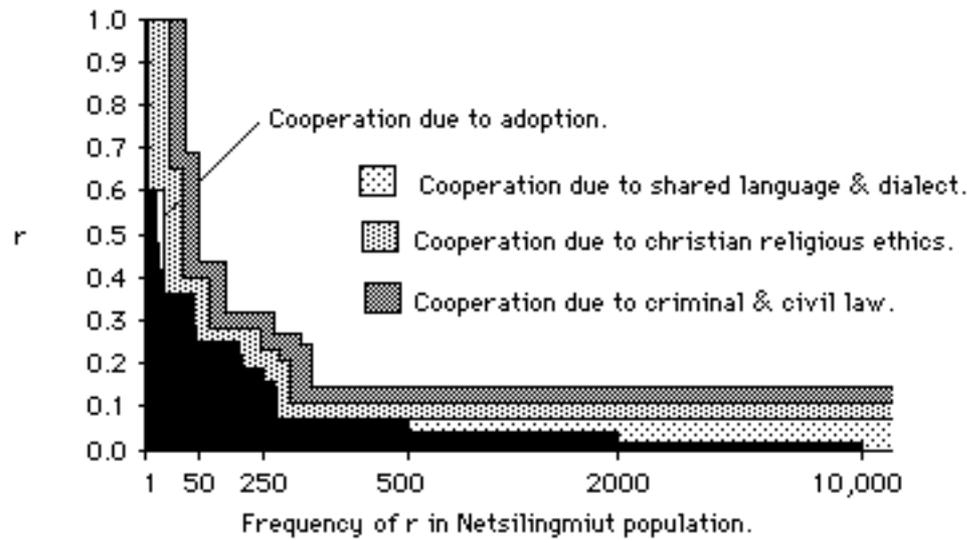


Figure 17 Introduction of modern Western cultural prosocial mechanisms among contemporary Netsilingmiut.

evolution and growth in the population size and density of human social units was sociobiologically impossible (for reviews of gradual perspectives see Wilson 1975 and Alexander 1979).

It is suggested here that nothing short of a revolution in human affairs was required to break what must have been an unending cycle of tribal growth and fission. This conclusion may be supported by the descriptive facts of human social history. Compared to the hundreds of thousands of years of gradual social evolution of hunter/gatherers, the advent of civilization, in just the past 10 thousand years, has been an explosive event in geological and evolutionary terms. In a mere 10 thousand years the human population has increased from approximately 10 million (Lee and DeVore 1968) to five billion, or 500 thousand percent. Most anthropologists and sociobiologists are of the opinion that this turn of events in human history is due to technological innovation, particularly agriculture. It is undoubtedly true that advances in technology occurred correspondent in time with human population increases. However, primitive societies often possess sophisticated technical skills, including agricultural methods, yet they do not frequently grow into city states. Agriculture may be a necessary condition for the creation of complex civilizations, however it is far from being a sufficient condition. City states, such as ancient Egypt and Peru, often occupied desert or mountainous terrain that was agriculturally inferior (Parsons 1977). In these cases a critical necessary condition for the creation of civilizations was not merely new technology but also the innovation and implementation of prosocial mechanisms that could maintain prosociality beyond the level of the primitive tribe.

Humans may be genetically predisposed to inbreeding (Shields 1982, Bateson 1983) and associated tribalism (Chapter 4, A Study in the Evolution of Ethnocentrism). Thus in order to create societies that can grow beyond the limits of a few interacting demes it may not be sufficient to merely relax inbreeding (Spielman, Neil and Li 1977). In order to create societies that had the density of population of the earliest city states it may have been necessary to suppress inbreeding. Of course it follows that as this was

done the coefficients of relatedness of the members of the city state would have correspondingly decreased allowing egoism to run unchecked by tribalistic altruism. Thus concomitant with the suppression of inbreeding, egoism would have to have been brought under the control of society by the deployment of cultural prosocial mechanisms. This, it has been suggested, was accomplished by (1) the manipulation of the developmental environment of the proximate mechanisms of innate social behavior (Lumsden and Wilson 1983, MacDonald 1984); (2) the cultural manipulation of cultural maps of innate social behavior; (3) the cultural evolution of institutions that manipulate the cost benefit ratio of social behavior (Shields and Shields 1983); (4) cultural manipulation of the perceived cost benefit ratio of social behavior or (5) a combination of these processes.

The age old realization that human nature possesses a hubris, or flawed sociality, has been reviewed and given a sociobiological articulation by Campbell (1975, 1983). Unlike the social insects, humans do not possess an innate capacity to live in the large division of labor societies that Campbell refers to as ultrasocial. Ultrasociality, it is suggested, can only be attained with the help of a heavy dose of enculturation to curb innate egoism. By way of contrast Campbell points out that individual egoism is not innate amongst the eusocial insects (Hamilton 1964). This is illustrated in figure 18 by comparing primitive human and eusocial insect coefficients of relationship for their respective, culturally unaltered, populations. In the light of the enormity of this genetic problem, Campbell considers moral, legal, political and in the past, at least, religious enculturation to be indispensable to the maintenance of ultrasocial societies.

Most sociobiologists probably do not conceptualize human nature as being as problematic as Campbell does. For example the process of coevolution described by Lumsden and Wilson (1981) would allow for the embedding of behavior in the genome over a period of approximately 1000 years. This view of the gradual evolution of an innate capacity for ultrasocial behavior stands in contrast to the revolutionary changes

Figure 18

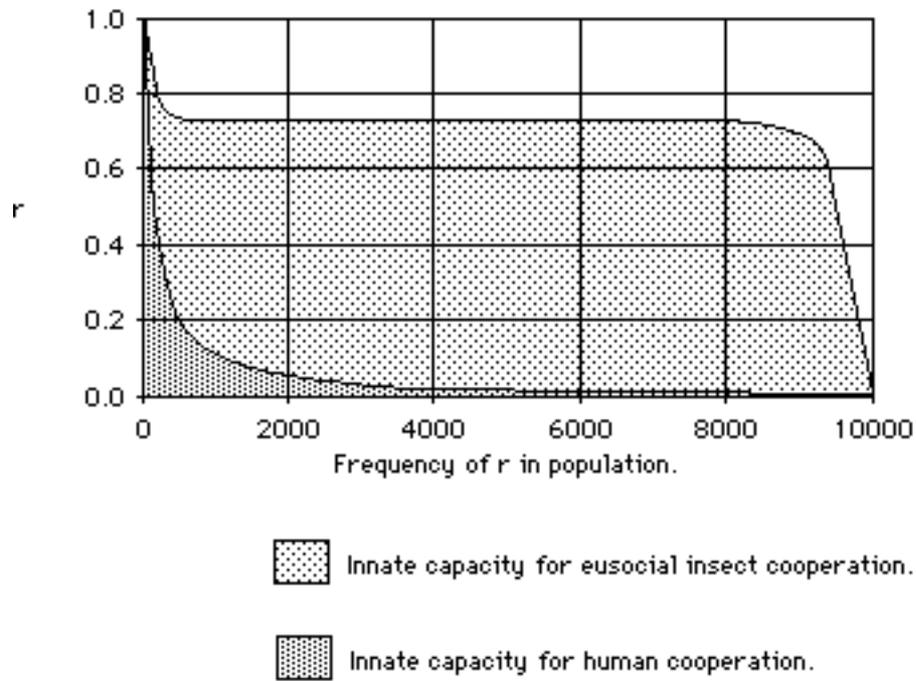


Figure 18 Comparison of a "typical" eusocial insect (from Hamilton 1964, Trivers and Hare 1976, Wilson 1975, Oster and Wilson 1978) and primitive human innate cooperation.

in human population genetics and social structure described here. Lumsden and Wilson fail to take into account the radical changes in the genetic environment of primitive and post-primitive man. The thesis presented here is more similar to Wilson's (1975) earlier view that placed greater emphasis on understanding man as a Pleistocene hunter/gatherer. Figure 19, although over simplified, attempts to illustrate this point. In post-primitive societies the loss of demic genetic structure reduces the efficiency of the genetic evolutionary loop (Wright 1929, 1932, 1956, 1970, 1977) while the cultural evolutionary loop becomes increasingly important for the human evolutionary process as group sociocultural structure continues to be maintained by ethnocentrism.

Tracing and modeling the evolutionary history of Netsilingmiut prosocial culture traits is possibly manageable. However tracing the evolutionary history of an ultrasocial culture trait, from its earliest mapping of a genetically predisposed behavior, through possibly hundreds of generations of elaboration and manipulation to produce ever more adaptive behavior, may be beyond the capacity of a cultural archaeology. However biologists are able to trace the major events of evolutionary change by examining the fossil record and by making extensive comparative studies of species. Similar studies are made of culture but they are generally separated by both discipline, for example, anthropology, political studies, history and religious studies and school, humanities and social science. This institutional separation of the various descriptions of culture is clearly counterproductive to an evolutionary understanding of culture. Studies in cultural evolution will tend to be interdisciplinary. In the absence of an expressly biological perspective examples of such studies could include Marx on politics (1906-1909), Maine on law (1963), Bellah on religion (1970), Parsons on society (1977) and Naroll on values (1983). The scope of cultural evolutionary history is clearly so broad any useful work in such studies will have to focus on specific issues and questions. It has been suggested that megatrends in cultural evolution can be traced by plotting the fitness of culture traits. However discerning the adaptive function of such culture traits may frequently turn on tracing and describing the earliest emergence of the

Figure 19

Figure 19a. Non human genetic kin, kin group and intergroup selection.

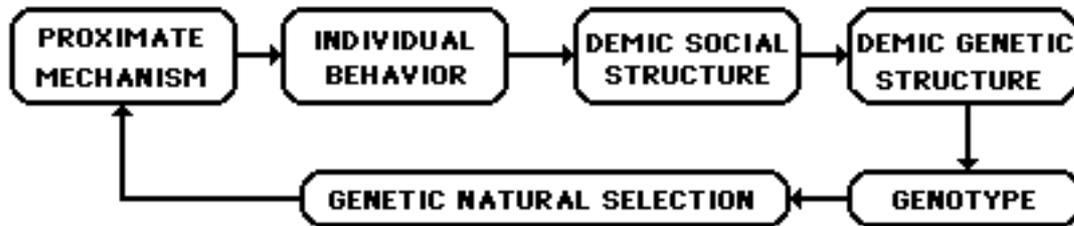


Figure 19b. Primitive human genetic and cultural kin, kin group and intergroup selection.

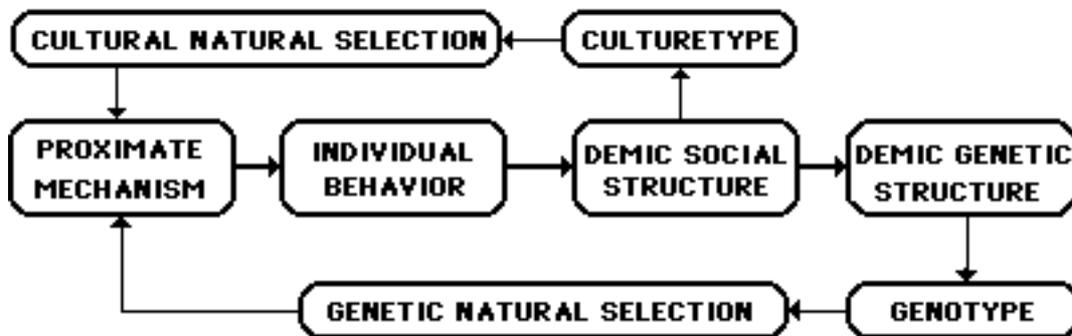


Figure 19c. Ultrasocial cultural intergroup selection in humans.

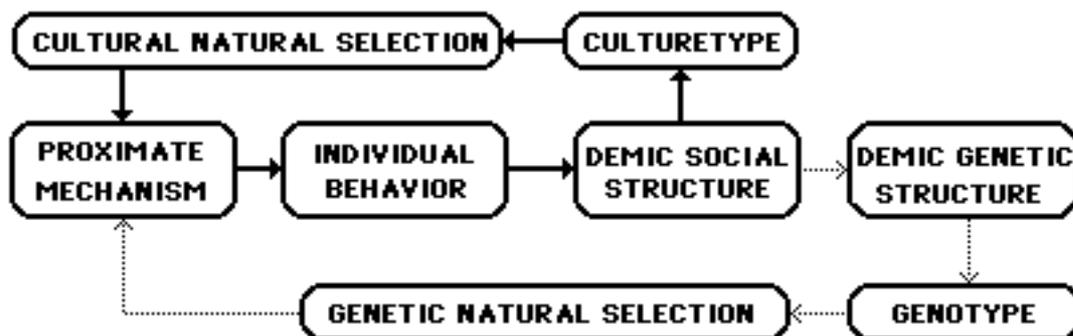


Figure 19. The evolution of the processes of selection for the genetic and cultural proximate mechanisms of behavior in humans.

culturetrait. This point can be illustrated by briefly reviewing what may have been some of the more significant events in the sociocultural biological evolution of ultrasocial prosocial ideology. Future work in this area of cultural analysis could possibly discern changes in the relative importance of such culturetraits by plotting their relative fitness through time.

(1) Primitive behavior has been defined as the behavior predicted by the theory of kin selection in a hunter/gatherer society. These are the behaviors that might be observed in a primitive society if such a society did not possess a capacity to culturally alter behavior.

(2) Hunter/gatherer societies, such as the Netsilingmiut reviewed earlier, do elaborate primitive behavior to produce more adaptive behavior. This natural social engineering improves on the limitations of primitive behavior by culturally manipulating the biologically evolved proximate mechanisms and cost/benefit ratios of primitive behavior. In such societies political order tends to follow the dominance hierarchy established by reproductive maturity and sex (Chapter 3, *The Sociocultural Biology of Netsilingmiut Kinship*). The social sanctioning of behavior by taboos constituted primitive law (Hoebel 1954). Religious ethics were of little importance for the maintenance of prosocial behavior in primitive societies (Heard 1929, Bellah 1970, Smith 1970, Irwin 1981). However what little work has been done on primitive ethics demonstrates a considerable degree of sophistication in the creation and embodiment of moral concepts in language (Brandt 1954, Ladd 1957, Irwin 1981).

(3) "Missing link" societies that were able to move beyond the limitations of tribal growth and fission (Chagnon 1979) must have existed in man's social evolutionary past. Of the 600 Australian aboriginal tribes described by Tindale (1974) three were unusually large. The largest, the Winadjuri, were made up of subpopulations or hordes with their own distinct totems suggesting that the tribe, Winadjuri, might more appropriately be called a supertribe. The evolution of such social units could have been accomplished by the cultural manipulation of tribal badges to produce multiple levels of

ethnocentrism correspondent with several levels of migration rates and several levels of coefficients of relationship. A society, larger than a single tribe, could have also maintained inbreeding and associated primitive ingroup prosociality by being structured along feudal lines. This could have been facilitated by combining many villages within which citizens inbred. The clusters being ruled by an aristocracy that also inbred. Such an aristocracy may have possessed some specialized skills of an agricultural, metallurgical or militaristic nature. As the aristocracy would be the dominant members of each tribal village unit, then villagers might be expected to tend to assimilate the badges of the aristocracy. Thus the badges of tribes ruled by the same aristocracy would tend toward uniformity, inbreeding would be partly relaxed and a city state could possibly emerge.

(4) City states with their shared badges of language, religion, dress, etc., would have naturally retained the weak altruism associated with tribal badging. However any subgroup of individuals in such a city state practicing inbreeding could create an ingroup by virtue of their shared high coefficients of relatedness. Any such group would be disruptive unless they were the ruling class, the aristocracy. Thus it might be expected that an aristocracy would continue to inbreed while encouraging their subjects to mate freely within the city society. This might include fertilizations from male members of the aristocracy, however, females of the aristocracy would be prohibited from any outbreeding. In order to further subjugate their citizens, such an aristocracy could exploit the proximate mechanisms of dominance. A ruler could gain authority by virtue of being male, having numerous wives and living in the largest dwelling. Having his dominance enforced by the submission of other dominant males would further enhance his position, particularly if this was done publicly. In this way the palace and ritual of a god king could be created. The rewards for the dominant male are increased inclusive fitness and the rewards for the god king is metaphysical ultimate fitness. Only the god king would be immortal. In such a society religion, law and political authority

would have all evolved to suppress the egoism of the god king's subjects (for a review of the sociobiology of despotism see Betzig 1982).

(5) The great religious traditions of the axial age (Herskovits 1929, Bellah 1970, Smith 1970) attempted, and partly succeeded, in revolutionizing the political, legal, religious and moral order of nepotistic subjugation. Taoism, Christianity, Hinduism, Jainism, Buddhism, Islam and, more recently, the secular religion of Marxism reject egoism to embrace cosmopolitanism. Max Weber makes this point as follows:-

"The great achievement of ethical religions, above all the ethical and ascetic sects of Protestantism, was to shatter the fetters of the sib. These religions established the superior community of faith and a common ethical way of life in opposition to the community of blood, even to a large extent in opposition to the family."

Weber 1951.

Unfortunately the failure of a religious ethic utopia can be found in part in the strength of the tribalistic urge. The force of cultural differentiation driven by an evolved need to create ingroup badges denied the possibility of a rational fusion of the common wisdoms of the great religious traditions. Christian, Muslim and Hindu fought each other and these religions fissioned into sects to further fight amongst themselves.

(6) In nation states and super powers religious authority has been largely replaced by a separate political, legal and moral order. Exceptions would include some Islamic states and possibly some Marxist states, if Marxism is regarded as being a secular religion. The sociobiological efficiency of the various elements, or culturetraits, that go to make up ultrasocial ideology, or coadaptive culturetype for prosocial behavior, can possibly be analyzed in much the same way as Netsilingmiut prosociality was examined earlier, for example:-

a) The evolutionary history of religion, sketched here, suggests that religious authority was in part built upon the proximate mechanisms of primitive dominance and tribalism. The contemporary failure of religious authority in some societies may

therefore be in part attributed to the usurping of the badges of dominance and tribalism by other institutions, both commercial and political.

b) As humans are able to create badges with symbols and as the ethics of religions are embedded in their symbols then religious ethics become synonymous with the badges that create weak altruism in the religious community. In this way religious morality, through ritual and symbol, can induce morality. Moral philosophy, as it is presently taught, lacks such symbols and therefore can not fully replace religious ethics as an ultrasocial prosocial mechanism. Although not nearly so well developed law, the force of law and justice may be embedded in the symbols of the judiciary. However, unlike a religious community, the members of a community of justice are not required to learn, share and display the symbols of their moral order.

c) Some Fascist societies made use of the proximate mechanisms of social behavior associated with phenotypic variation between megapopulations i.e. race. Western and particularly North American ideology has been successful in exploiting egoism as a means to driving social and economic diversity and growth. In rejecting the individualistic benefits of egoism communism may place more emphasis on cooperation associated with tribalism and dominance. Japanese ideology, by way of contrast, makes effective use of the proximate mechanisms of nepotism (Huse 1975). By manipulating the natural structures of families Japanese society has successfully exploited an important level of primitive organization between the individual and the family.

Primitive behavior associated with egoism, nepotism, tribalism, racism, dominance hierarchies and possibly many other natural proximate mechanisms can be used as a repertoire of agents in the creation of ultrasocial societies. However such agents are sources of competition as much as they are sources of cooperation. Studying the dynamics of these relationships could help illuminate the inadequacies of various ultrasocial structures and by comparative analysis point to possibilities for improvement.

Models of Sociocultural Behavior

The model of primitive behavior developed earlier is based on the function $\overline{r_{AB}-r}=0$ which is described when the value of r_{AB} is plotted against the frequency of r_{AB} in a hunter/gatherer population, figure 11. An example of culturally modified primitive behavior is developed for the Netsilingmiut by plotting the effective function of $\overline{r_{AB}-r}=0$, figure 15. The process of cultural contact and change, with respect to social behavior, is illustrated for the contemporary Netsilingmiut in figures 16 and 17. These models are based on estimates of r_{AB} and effective r_{AB} in the population. The range of error for estimates of effective r_{AB} may be difficult or impossible to calculate so a conceptual model for comparing human social behavior may be easier to work with as it would not require the computation of r_{AB} and effective r_{AB} values. This model, referred to as a moral matrix, is essentially a combination of the model already developed and the models of Sahlins (1965) and Alexander (1975, 1979) so that decreasing values of r_{AB} and the increasing frequency of r_{AB} values in the population are replaced by ego, nuclear family, extended family, village or subtribe, tribe, adjacent group of tribes, and race, figure 20. This substitution also better reflects that part of cooperative behavior attributable to affinal relationships i.e., the coefficient of relationship of an altruist and the young of the beneficiary, r_{ABy} (West Eberhard 1975).

In this diagram each square in the matrix represents a specific set of relationships that in turn represent specific sets of codes or prescriptions for normative behavior that arise from problems of innate capacities for cooperation and competition. In primitive societies there would be no conflict between genetically realized behavior and prescribed behavior. However, as societies became larger, the difference between primitive and society prescribed normative behavior would increase. For a hunter/gatherer society, such as the traditional Netsilingmiut, many of the potential problems suggested by the matrix do not in practice arise. For example, although race strongly competes with race, this may not be perceived as being in the least bit wrong as the traditional Netsilingmiut, like most primitive societies, classified the members of

Figure 20 & 21

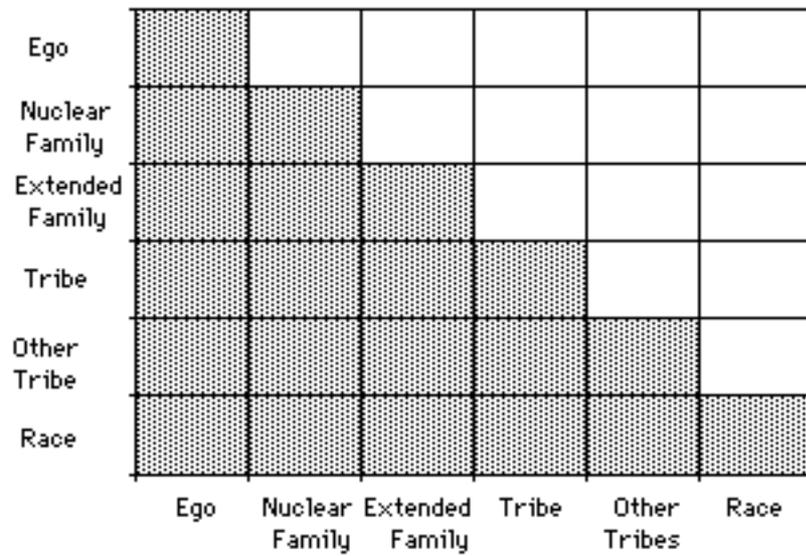


Figure 20 . Moral Matrix. Innate cooperation and competition in a primitive population organized by levels of social structure.

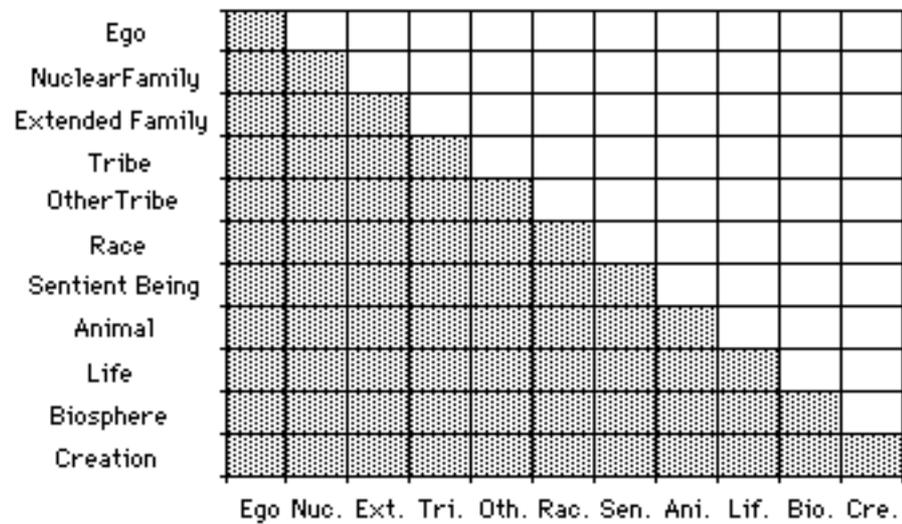


Figure 21 . Extended Moral Matrix.

adjacent megapopulations as non-human. In a similar way competition between different nuclear and extended families within a tribe was equally acceptable as a norm that considered nepotism to be virtuous. In these cases moral codes simply map primitive behavior and like primitive kinship could be referred to as primitive morality.

It should be emphasized that the simple relationships described here, for primitive behavior, kinship, and morality, only hold true so long as the cost/benefit ratio of a behavior remains constant. For example the cost/ benefit ratio changes as an individuals reproductive maturity changes (West Eberhard 1975) so that dominance hierarchies are to be found in primitive societies. This aspect of behavior does not show up in the moral matrix except by making the qualification that the relationships in the matrix hold true only if individuals of the same sex and age are being compared. Other aspects of social behavior associated with changes in the cost/benefit ratio show up as changes in the effective value of r_{AB} . However two Netsilingmiut behaviors not reviewed earlier will help illustrate other adjustments that need to be made to the model:-

(1) The Netsilingmiut keep sled dogs with which they maintain a relationship of reciprocal altruism so that the fitness of both the Eskimo and the dogs are improved by their cooperation. This aspect of Netsilingmiut behavior can be taken into account by extending the moral matrix to include sentient beings, animals, life, biosphere and creation, figure 21.

(2) The fecundity benefits of manipulating the Netsilingmiut sex ratio with the practice of female infanticide (Rasmussen 1931, Balikci 1967, Freeman 1970, 1971) do not show up in the current generation (Chapter 2, The Sociocultural Biology of Netsilingmiut Female Infanticide). As the moral matrix represents a set of social relationships at a point in time, and not through time, it can not take this aspect of changes in the cost/benefit ratio into account. This inadequacy of the model is probably characteristic of the failure of analysis in moral philosophy that do not take the rights of future generations into account (Quine 1978).

In ultrasocial societies the natural genetic order of morality is torn apart. However, the natural moral order is substantially restored by the manipulation of the proximate mechanisms of natural genetic order. This is accomplished by the institution of legal, moral, political, religious and other cultural prosocial mechanisms which in turn are dependent on the proximate mechanisms of natural genetic order for their efficiency. The ideals of morality and the manipulation of the proximate mechanisms of the natural genetic social order can all be represented by changes in the cooperative area of the moral matrix.

For example, figure 22 depicts the moral ideal or golden rule, "do unto others as you would have them do unto you." Figure 23 depicts the slightly less ideal prescription, "treat all men as your brother." Unfortunately these ideals are not fully realizable. However, by manipulating the proximate mechanisms of tribalism cooperativeness of the order depicted in figure 24 can be produced. In a multiethnic society, that has substantially overcome the problems of racism, cooperation may be further improved as shown in figure 25. Unfortunately one substantial and dangerous step remains unaddressed by contemporary ultrasocial societies. The non-cooperative, competitive valley of intertribalism or internationalism. This is depicted in figure 26.

Modeling the prosocial structures of various societies with increasing sophistication may now be possible. This could lead to comparative studies but the simple moral matrix used here would have to be elaborated to incorporate intercepting group loyalties and disloyalties. The increasing complexities of such structures in modern cosmopolitan, eclectic societies very possibly contributes to the weakening of traditional ultrasocial prosocial mechanisms in such societies.

The model of moral behavior used here is not merely the exchanging of one taxonomy for another. The structure of the model is to be found in the genetic nature of all humans. As a methodological tool for studies in comparative descriptive ethics the matrices given in figures 11 and 12 may prove useful as a conceptualization that addresses all questions of conflict. For example any single square can be taken in a

Figure 22 & 23

Ego						
Nuclear Family						
Extended Family						
Tribe						
Other Tribe						
Race						
	Ego	Nuclear Family	Extended Family	Tribe	Other Tribes	Race

Figure 22. Moral Matrix for the perscription "Golden Rule" "treat all men as yourself".

Ego						
Nuclear Family						
Extended Family						
Tribe						
Other Tribe						
Race						
	Ego	Nuclear Family	Extended Family	Tribe	Other Tribes	Race

Figure 23. Moral Matrix for the perscription "treat all men as your brother".

Figure 24 & 25

Ego						
Nuclear Family						
Extended Family						
Tribe						
Other Tribe						
Race						
	Ego	Nuclear Family	Extended Family	Tribe	Other Tribes	Race

Figure 24. Culturally manipulated moral matrix for simple ultrasocial nation state.

Ego						
Nuclear Family						
Extended Family						
Tribe						
Other Tribe						
Race						
	Ego	Nuclear Family	Extended Family	Tribe	Other Tribes	Race

Figure 25. Culturally manipulated moral matrix for multi-racial ultrasocial nation state.

Figure 26

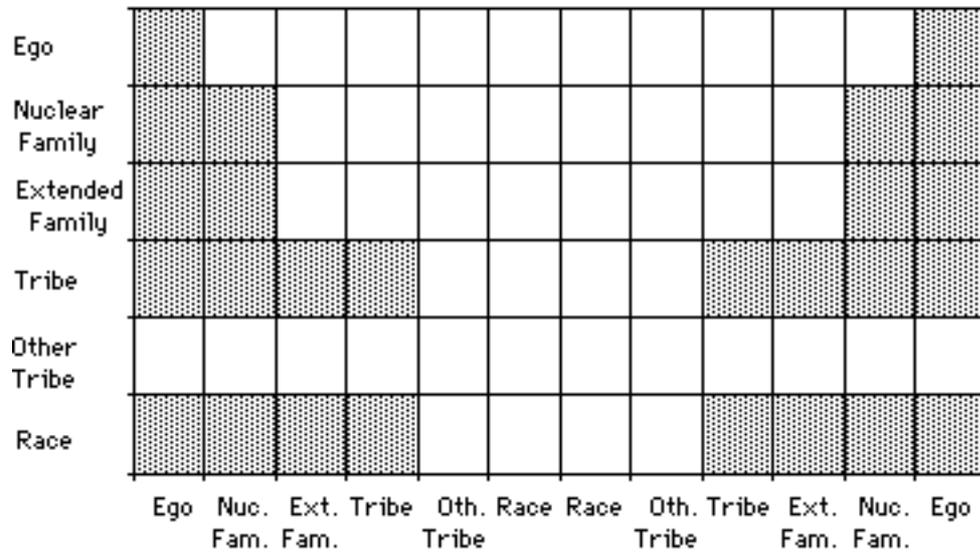


Figure 26 . Culturally manipulated moral matrix for opposed ultrasocial megapopulations.

matrix and the following sets of questions can be asked. Is competition within this square dealt with as a matter of innate cooperativeness? If not does the society in question manipulate the proximate mechanisms of innate cooperation to stimulate cooperation? If so to what extent is this achieved by legal, political, religious and secular educational institutions, and what proximate mechanisms are being exploited to realize their efficiency? Are any squares inadequately dealt with by the society's prosocial mechanisms? If not, does this represent a danger to the society?

Descriptive Morality

The model of human social behavior developed here is compatible with the observation of the moral philosopher Gilbert Harman who suggests that:-

'.....you are subject to a number of different moralities -- the morality of your family, perhaps your school, a professional morality (your "business ethics"), the morality of your neighborhood, the various moralities of various groups of friends, the morality of your country, and finally, perhaps, a limited morality you share with most of humanity.'

Harman 1977 pp. 113.

This description of morality draws attention to the levels of social organization considered to be a universalistic character of all societies by the social anthropologists Evans-Pritchard, Fortes, Colson, Gluckman, and Murphy (LeVine and Campbell 1972). This perspective is summed up by LeVine and Campbell such that, "each individual can correctly regard himself as a member of several units increasing in scope and inclusiveness up to the 'total society' itself."

Comparative and historical studies in the evolution of societies suggests that the prosocial mechanisms of societies become more complex as the societies become larger. These mechanisms can adjust the number of individuals at each level of social organization so as to maximize the fitness of dominant males, an aristocracy, a class, possibly the society at large or a combination of such individuals and groups. However the principal trend, from hunter/gatherer to ultrasocial societies, would seem to be the

maximization of the cooperative, shaded, area of the moral matrix, to move the division between prosocial and antisocial behavior up and to the right. Like most primitive people the traditional Netsilingmiut limited their morality to their race, the Inuit. Many religions and nations likewise limit salvation and welfare to their members.

Contemporary western ethics demonstrates this trend as some moral philosophers begin to consider the interests of future generations (Quine 1978). These descriptive observations suggest that an aspect of the nature of morality could be summarized with an empirical generalization of the form: acting morally is acting so as to maximize benefits to an ever more inclusive group of individuals. These observations on the nature of morality hopefully suggest a considerable advance from the "might is right" perspective of evolutionary ethics (Edel 1955) that was based on a fallacious understanding of what behaviors were most fit for human societies.

"Ethical naturalism" can be divided into the hard variety that considers natural facts to be sufficient to justify a moral claim, or of the weak variety that considers natural facts to be relevant to the justification of a moral claim (Edel 1955, Matten 1978). Donald Campbell (1979) gives a description of what amounts to soft naturalistic ethics in his scientific mediational normative ethics. Here the normative goals of society are mediated or achieved by the implementation of a scientific approach to the problems of ethics founded on an empirical understanding of human nature. For all practical purposes this is the perspective taken here and is essentially the same role given applied human sociobiology by Alexander (1979) and Lumsden and Wilson (1983). However, if it is true that all human cultural phenomena have an adaptive human benefit (as has been suggested here from the perspective of sociocultural biology and by Campbell in the opening quotation) then values and moral norms, as cultural phenomena, would also be open to theoretical explanation. Further if the theory were nomological with the theory of evolutionary natural selection then that explanation would give the values and moral norms being examined a naturalistic foundation. For example if an evolutionary theory of group behavior (eg. Wilson 1968,

1975, Cohen 1971, and Oster and Wilson 1978) could demonstrate the adaptive benefit of continually increasing the size of human groups then, the empirical generalization: acting morally is acting so as to maximize benefits to an ever more inclusive group of individuals, would be given substance in evolution theory. However this "naturalization" of values and moral norms does not necessarily lead to hard naturalistic ethics as evolutionary ethics is conceptually separate to the evolution of ethics (Flew 1968).

Apart from the philosophic difficulties of formulating a naturalistic ethic (For an historical review of the naturalistic fallacy see Edell 1981) the failure of social science theory, method and description continues to prevent any final formulation of an ethics based in fact (Dewey 1939). From this perspective the central problem for an evolutionary ethics is probably defining what adaptive means in terms of human fitness. Netsilingmiut cooperative behavior and the fitness of Netsilingmiut culture traits, reviewed earlier, can very possibly be measured in terms of fecundity. Reproductive success measured in terms of "head counts" is probably an adequate measure of fitness for all primitive societies that follow an essentially primitive genetic/social structure. However it may not be possible to measure the fitness of societies that culturally manipulate the reproductive success of individuals, classes and groups in terms of fecundity alone (Harris 1979). If fitness is considered to be a primitive term in evolution theory then fecundity is merely one of the many effects of fitness (Rosenberg 1985). Fitness may therefore be computed in terms of any of the effects of adaptation that can be measured for example efficiency (MacArthur 1962, Slobodkin 1972), biomass (Carson 1961), competitive ability (Claringbold and Barker 1961), energy flux through all organisms jointly (Lotka 1922) or control of trophic energy (Van Valen 1976).

Human sociocultural biology, and with it the naturalization of morality, may rest or fall on taking a more imaginative approach, than is presently found in main stream biology, to the measurement of fitness. For example if life is to be understood in

terms of the manipulation of the flow of energy (Prigogine 1980) as opposed to a capacity for reproduction then the currency of fitness may well be energy consumed. From this perspective North American society could be considered fitter than Chinese society (See The Red Queen Hypothesis in Energy and Evolution, Van Valen 1976) while from a reproductive point of view Chinese society is presently the fitter. However the success of any life form at a point in time is no guarantee of future success. It may be speculated that in the long term the inefficient use of the limited resources of the planetary biosphere could be maladaptive or tapping into unlimited resources beyond the planetary biosphere, if feasible, could be very adaptive. These most basic issues at present rest on unresolved questions in evolutionary theory which in turn contributes to the failure, in this example, of a naturalized environmental ethics.

Applied Sociocultural Biology

The sociocultural biology of human cooperative behavior, as it is sketched here, is far from complete and thus the epistemological question is raised as to whether sociocultural science or sociocultural tradition should gain ascent to sociocultural truth. Scientists attribute truth to scientific fact through the imperfect authority of their journals. This truth can be winnowed and refined in the testing ground of experimentation. However, sociocultural tradition, such as religious ethics, have been tested and refined through thousands of years of sociocultural evolution. In this case, authority and truth has been with societies that have survived, grown and prospered, principally the surviving societies of the great religious traditions. Therefore, when sociocultural science agrees with religious tradition there is good reason to consider sociocultural science to have it right. But when they do not agree, then there is good reason to be skeptical of the findings of sociocultural science. There is however, one special circumstance when this rule will not hold, namely when there has been a significant physical and/or social environmental change. How then is it possible to know when there has been a significant change that necessitates a change in societies

cultural norms and social practices? As with any question, particularly a new question, there is no way of achieving epistemic certainty. However, competent science can accomplish more as a knowing process in such circumstances than any other knowing process presently in use. Thus an empirically substantiated sociocultural science may be the best tool for dealing with the problems of sociocultural change so long as it is exercised with epistemic humility with regard to the authority of time given religious and other sociocultural tradition. Low infant mortality is a likely example of social and physical environmental change requiring urgent moral change (Edel, 1978). Coming to terms with the problem of an exponential growth of the human population, and all the tragic ills such growth precipitates, may be a prime candidate for a science of morality founded on the sociocultural biology of behavior. Likewise other problems that were not moral issues for the ancient sages may require radical moral solutions that will not be found in the texts of religious revelation. The sociocultural evolution of wisdom has not as yet had an opportunity to be selected around the issues of genetic engineering and contemporary medical ethics.

Given the present inability of sociocultural biology to provide a foundation for morality and given the epistemic limitations of such a science what then are the immediate prospects for an applied human sociocultural biology. If such a science is pursued through an analysis of the appropriate mechanisms of the mind then perhaps, as Wilson (1975) suggests, little advance can be expected in the immediate future. However social scientists interested in the culturally evolved proximate mechanisms of human behavior are fortuitously blessed with being born into an ongoing multidimensional social experiment accessible through archaeology, history and ethnography.

Unlike some perspectives on the biology of human social behavior, sociocultural biology does not diminish the importance of ideology, but on the contrary, emphasizes the possibility that ultrasocial cultures may not be sustainable without ideology (Campbell, 1975). A total abandonment or break down of traditional prosocial

ideologies would be catastrophic, in as much as law or some form of secular religion probably could not be socially engineered to fulfill such roles at the present time.

Malinowsky reached essentially the same conclusion when he wrote:-

"The rationalist and agnostic must admit that even if he himself cannot accept these [religious] truths, he must at least recognize them as indispensable pragmatic figments without which civilization cannot exist."

Malinowsky, 1936 pp. 62.

Sociocultural biology can attempt to edit out irrelevant function and discriminate and isolate pertinent causal function by tracing the sociocultural and genetic historical evolution of function. It is in this functional vein that some of the elements of Netsilingmiut culture, reviewed earlier, can be seen as being tailored to the needs of survival under the most hostile of circumstances. As such Netsilingmiut mores and associated sociocultural practices may represent one of the best examples of a sociocultural system tested to the limits of self destruction in which the necessity of certain culturetraits can be seen to be imperative. The choice of the Netsilingmiut to illustrate the theory of sociocultural biological analysis may have been fortuitous. The Eskimo of all peoples can least afford to carry "excess baggage" in the form of redundant, neutral and obsolete culturetypes. None the less the complexities of ultrasocial sociocultural biology can possibly be unraveled.

Perhaps such an analysis could usefully begin by examining numerous primitive societies to uncover the multiplicity of ways in which biological proximate mechanisms are manipulated by cultural invention to produce enhanced social structure. The Netsilingmiut employ mate-bond manipulation through wife sharing, familial-bond manipulation through adoption and kinship extension and tribal-bond manipulation through similarity of tribal badging. However these are but a few examples of what must be an almost unlimited number of possible combinations of natural biosocial engineering. Every natural joint in primitive social structure likely has its appropriate set of proximate mechanisms. The most popularly discussed such mechanism is early

childhood contact and incest avoidance. But, given a spectrum of behaviors associated with a spectrum of coefficients of relationship, reproductive maturity, and division of sex roles, the repertoire of proximate mechanisms must be at least as elaborate as any primitive kin system. Each mechanism will have its critical period that will range through all the ages of life from the bonding of infant to parent and sibling to the bonding of grand parent to grandchild. Thus in addition to a comparative study of primitive societies to identify the proximate mechanisms of innate social behavior and their potential for manipulation, a parallel study of human development should define the critical parameters of such mechanisms. These parameters would concern mechanisms such as sexual activity, touch, sleep contact, recreational contact, work contact, scent and visual badging. They would also attend to periods such as infantile, childhood, preadolescent, postadolescent and adult, mature and aged. Duration and frequency of stimulation, hourly, daily, weekly and so forth would be analyzed. It might, for example, be expected that ultrasocial surrogate kin bonding would be most successful if it mimicked consanguineal relationships in preadolescents and affinal relationships in postadolescents. It could be further speculated that such bonding would be diminishingly less effective among individuals of the same age as they moved beyond the age of adult maturity. However bonding to children should be effective at any age. The size of a primitive tribe approximates to several hundred members. This fact likely places an upper limitation on the number of individuals any single person is able to establish an individually negotiated relationship of reciprocity with. Institutions as surrogate persons may take up part of such a limited capacity for interaction.

A detailed study of the proximate mechanisms of behavior and social structure in natural human populations may never be exhausted. However this should not represent an impediment to the immediate comparative study of contemporary ultrasocial societies. It has already been suggested that tribal badging has been manipulated to promote the natural social engineering of nations. In a similar way the manipulation of different yet specific sets of kin related proximate mechanisms has

likely been employed to produce religious, secular and military institutions with different behavioral and structural characteristics. A cross cultural analysis of such cultural phenomena will help identify and determine the efficiency of specific proximate mechanisms to perform specific social engineering functions. This dissertation proposes no social engineering applications. For the present, all that is aspired to is an examination of the natural social engineering of primitive sociality.

However, within the strict epistemological limits already set out, improvement of our social fabric, in all its various forms, could eventually take place. Indeed, such advances have already been achieved through deliberate social planning although the theory behind such social change was empirical generalization rather than sociocultural biology. For example architects and urban planners in examining the social failure of high rise development and urban sprawl have returned to establishing neighborhoods along village lines. This intuition is now given substance in the sociocultural biology of human tribes. Malinowsky's 1936 observation on the indispensable nature of religious tradition for the maintenance of civilization is very likely correct. But religion in many societies may now be beyond institutional redemption. If this is so modern man is presently offered the unenviable choice of two secular ideologies that leave a great deal to be desired, Western individualistic materialism and communistic materialism. Hopefully an in-depth study of the functional elements of past and present ultrasocial ideologies would reveal the social benefits of much of traditional religious belief, practice and behavior so that such culturetypes could be incorporated into modern secular institutions. In the absence of such social engineering, law and the force of law may have to fill the void. Such a turn of events could possibly contribute to the precipitation of a police state. If a police state is considered undesirable then a timely development of a science of human sociocultural behavior could possibly help divert such an outcome.

Unfortunately the prospects for improving the quality of life for the members of societies through careful social adjustments will be of no value unless humans first

extinguish or render harmless the causes and instruments of conflict between societies. Numerous studies of the causes and correlates of war have been assembled that establish empirical generalizations with regard to warring behavior. Hopefully the theoretical perspective developed here will provide a vehicle for better distinguishing and thereby circumventing the proximate mechanisms of war. The genetics and biology of ethnocentrism that establishes cultural badges to identify would be competitors, if correct, offers several opportunities for the long term defusing of deadly rivalry.

The sociocultural biology of human ideology and behavior is clearly a vast subject. For the most part inquiries in this area of study will reiterate the common wisdom of religion, philosophy and literature. However, epistemic authority ceases to rest solely with tradition in times of radical change. Knowledge of change can never be knowledge of past worlds. At the present time change may be best understood in terms of science, and the language and methods of science. Thus in order to come to terms with the most pressing of human problems in today's fast changing world a science of sociocultural phenomena, including ethics, may be necessary.

In the past it has always been possible to allow social evolution to follow its natural course in the knowledge that given sufficient time selection would edit out the unfit cultural mutations. However, selection requires a node of selection (Campbell, 1974); a point about which the unfit adapt or die out; a point about which the fit survive and prosper. In human cultural evolution the units of selection have become less numerous and more deadly. From 10 million hunters and gatherers which would have made up some 20,000 tribes we find the present world of nearly five billion polarized about two or three superpowers. From prehistoric until recent times true group selection could take place without endangering humanity. One tribe or nation could extinguish another. This eventuality is no longer possible. Only inter-group selection, as described by Wright (1970), remains a viable vehicle for sociocultural evolution. For true group selection, the node of selection, has moved from the arena of tribes and nations to the arena of worlds. Those worlds of sentient beings that come to terms with the problems

of social behavior will be selected for. Those worlds of sentient beings that fail to come to terms with the problems of social behavior will be selected against. The Sword of Damocles, selection, is presently poised above our world. It will undoubtedly fall. But the devastation of its thrust can be turned from an extinguishing to a creative force if inter-group selection can be instituted in the place of true group selection. If this can be accomplished, then man and a science of human nature will have come of age by cheating selection with its own instruments. In such a circumstance, human fitness is dependent on human enlightenment.

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30100 DATA 201,195,196,301,70,250,154,465,466,293,294,377,378,320,321
30200 DATA 202,203,355,195,196,527,528,301,70,250,154,985,986,987,988
30300 DATA 203,195,196,301,70,250,154,465,466,293,294,377,378,320,321
30400 DATA 204,262,263,387,388,399,400,728,729,730,502,731,732,733,734
30500 DATA 205,257,61,387,388,285,286,400,728,729,730,437,438,439,440
30600 DATA 206,135,356,262,263,529,530,387,388,399,400,989,990,991,992
30700 DATA 207,204,357,262,263,16,260,387,388,399,400,258,259,393,394
30800 DATA 208,204,357,262,263,16,260,387,388,399,400,258,259,393,394
30900 DATA 209,257,61,387,388,285,286,400,728,729,730,437,438,439,440
31000 DATA 210,358,359,531,532,533,534,881,882,883,884,885,886,887,888
31100 DATA 211,157,158,483,484,325,326,493,494,377,378,499,500,501,502
31200 DATA 212,360,361,598,599,606,607,608,609,610,611,612,613,614,615
31300 DATA 213,212,211,360,361,157,158,598,599,606,607,483,484,325,326
31400 DATA 214,362,211,535,536,157,158,919,920,921,922,483,484,325,326
31500 DATA 215,363,364,537,538,539,540,873,874,875,876,877,878,879,880
31600 DATA 216,365,366,541,542,543,544,861,862,863,864,865,866,867,868
31700 DATA 217,215,216,363,364,365,366,537,538,539,540,541,542,543,544
31800 DATA 218,367,368,545,546,547,548,853,854,855,856,857,858,859,860
31900 DATA 219,222,16,373,374,258,259,557,558,559,560,389,390,391,392
32000 DATA 220,369,370,549,550,551,552,923,924,925,926,927,928,929,930
32100 DATA 221,21,22,262,263,264,265,387,388,399,400,401,402,403,404
32200 DATA 222,220,221,369,370,21,22,549,550,551,552,262,263,264,265
32300 DATA 223,375,376,561,562,563,564,845,846,847,848,849,850,851,852
32400 DATA 224,10,11,255,256,257,61,385,386,387,388,387,388,285,286

Individuals, taken from genealogies of Nunatsiaqput, who play cards together See Chapter 4 for explanation.

Number of Groups: 2

Group 1: 6, 11, 17, 53, 62, 78, 101, 143, 147, 205, 211

Group 2: 17, 11, 22, 31, 61, 62, 73, 106, 119, 158, 205, 210, 211

Adult females, taken from genealogies of Nunatsiaqput, who visit. See Chapter 4 for explanation.

Number of Groups: 41

Group 1: 2, 56, 73, 85, 115, 154, 155, 185, 191, 196,

Group 2: 8, 11, 167, 205

Group 3: 11, 8, 22, 38, 53, 61, 62, 106, 147, 154, 205, 211

Group 4: 17, 11, 22, 53, 61, 62, 73

Group 5: 22, 61

Group 6: 31, 205

Group 7: 38, 11, 158

Group 8: 47, 154, 155, 158

Group 9: 53, 11, 101

Group 10: 56, 2, 73, 154, 155, 211

Group 11: 60, 131, 137, 143, 177

Group 12: 61, 11, 22, 70, 137, 154, 155, 158, 205, 210

Group 13: 62, 11, 17, 205, 210

Group 14: 68, 124, 154, 155, 185

Group 15: 70, 61, 96, 124, 137, 154, 155

Group 16: 73, 2, 17, 85

Group 17: 78, 11, 22, 61, 62, 106, 119, 124, 154, 155, 158, 205, 21, 211

- Group 18: 85, 2, 56, 73, 154, 155
- Group 19: 90, 70, 154, 155, 196
- Group 20: 97, 8, 101, 106, 154, 155, 167
- Group 21: 101, 53, 97, 147, 167
- Group 22: 106, 11, 147, 154, 155
- Group 23: 115, 2, 73, 154, 155, 185
- Group 24: 119, 11, 22, 61, 62, 97, 154, 155, 167, 205
- Group 25: 124, 70, 154, 155
- Group 26: 131, 124, 137, 143, 177
- Group 27: 137, 61, 70, 147, 154, 155, 177, 191
- Group 28: 143, 53, 60, 97, 101, 137, 147, 154, 155
- Group 29: 147, 137
- Group 30: 154, 70, 137, 158
- Group 31: 155, 2, 47, 96, 185, 191, 196, 211
- Group 32: 158, 61, 70, 106, 154, 167, 211
- Group 33: 167, 97, 101, 106, 154, 155, 158
- Group 34: 177, 131, 137, 154, 155
- Group 35: 185, 68, 115, 154, 155
- Group 36: 191, 2, 11, 47, 124, 137, 154, 155, 158, 185
- Group 37: 196, 124, 154, 155
- Group 38: 205, 8, 11, 22, 61, 62, 119, 210, 211
- Group 39: 210, 11, 22, 53, 60, 61, 62, 119, 131, 205, 211
- Group 40: 216, 68
- Group 41: 211, 11, 56, 106, 124, 155, 158, 205

Individuals, taken from genealogies of Nunatsiaqput, who live in the same house. See Chapter 4 for explanation.

Number of Groups: 39

Group 1: 1, 2, 3, 4, 5, 6

Group 2: 7, 8, 9

Group 3: 10, 11, 12, 13, 15, 223, 224

Group 4: 16, 17, 18, 19, 20

Group 5: 21, 22, 23, 24, 25, 26, 27, 28, 29, 220, 221, 222

Group 6: 30, 31, 32, 33, 34, 35, 36

Group 7: 37, 38, 39, 40, 41, 42, 43, 44, 45, 46

Group 8: 47, 48

Group 9: 50, 51

Group 10: 52, 63, 54

Group 11: 55, 56, 57, 58

Group 12: 59, 60

Group 13: 61, 62, 63, 64, 65, 66

Group 14: 67, 68, 69

Group 15: 72, 73, 74, 75, 76

Group 16: 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88

Group 17: 89, 90, 91, 92, 93, 94, 95

Group 18: 96, 97, 98, 99

Group 19: 100, 101, 102, 103, 104

Group 20: 105, 106, 107, 108, 109, 110, 111, 112, 113

Group 21: 114, 115, 116, 117

Group 22: 118, 119, 120, 121, 122, 123

Group 23: 124, 125, 126, 127, 128, 129

Group 24: 130, 131, 132, 133

Group 25: 134, 135, 136

Group 26: 137, 138, 139

Group 27: 142, 143, 144, 145

Group 28: 146, 147, 148, 149, 150, 151, 152, 153

Group 29: 154, 155, 156

Group 30: 157, 158, 159, 160, 161, 162, 163, 164, 165

Group 31: 166, 167, 168, 169, 170, 171, 172, 173, 174, 175

Group 32: 176, 177, 178, 179, 180, 181, 182, 183

Group 33: 184, 185, 186, 187, 188, 189

Group 34: 190, 191, 192, 193, 194

Group 35: 195, 196, 197, 198, 199, 200, 201, 202, 203

Group 36: 204, 205, 206, 207, 208

Group 37: 209, 210,

Group 38: 211, 212, 213, 214

Group 39: 215, 216, 217

Males, taken from genealogies of Nunatsiaqput, who hunt together. See Chapter 4 for explanation.

Number of Groups: 33

Group 1: 1, 4, 84, 71, 105

Group 2: 4, 1, 84

Group 3: 7, 105, 1, 195, 100

Group 4: 10, 195, 146

Group 5: 16, 72, 19

Group 6: 21, 209, 72, 204, 29

- Group 7: 176, 184, 139, 130
Group 8: 30, 49, 39, 142, 146, 40
Group 9: 32, 159, 30
Group 10: 49, 30, 166, 197
Group 11: 50, 195
Group 12: 52, 100
Group 13: 55, 1, 84, 105, 16, 71
Group 14: 77, 21, 105, 1, 30, 37, 204, 81, 146
Group 15: 84, 55, 1, 105, 16, 71
Group 16: 89, 1, 195, 114, 197
Group 17: 100, 146, 150, 30
Group 18: 105, 146, 10, 1, 77, 159, 157, 212, 109
Group 19: 114, 89, 1, 195, 197
Group 20: 118, 105, 166, 77, 21, 173, 49
Group 21: 139, 130, 146, 176
Group 22: 142, 146, 30, 130, 142
Group 23: 159, 146, 10, 1, 77, 159, 157, 212, 109
Group 24: 166, 1, 77, 118, 146, 105, 7, 195, 190
Group 25: 176, 130, 139, 10, 180
Group 26: 190, 195, 1, 105, 166, 194
Group 27: 194, 190,
Group 28: 197, 114, 89, 195, 49
Group 29: 204, 77, 40, 37, 21, 10, 209
Group 30: 209, 204, 77, 40, 37, 21, 10
Group 31: 223, 10, 105, 159
Group 32: 139, 130, 190, 32, 39

Group 33: 84, 89, 114

Children, taken from genealogies of Nunatsiaqput, who play together in cooperative groups.

See Chapter 4 for explanation.

Number of Groups: 25

Group 1: 45, 63, 148, 80, 33, 12

Group 2: 14, 42, 189, 171, 94

Group 3: 192, 140

Group 4: 126, 187, 133, 125

Group 5: 5, 182

Group 6: 150, 74

Group 7: 194, 151

Group 8: 92, 186, 199, 91

Group 9: 128, 110, 169, 213

Group 10: 4, 188, 93

Group 11: 168, 193, 156, 200

Group 12: 138, 95, 102, 111, 218

Group 13: 198, 173

Group 14: 83, 66, 43

Group 15: 161, 107

Group 16: 201, 127, 86, 87

Group 17: 39, 81, 40, 44

Group 18: 64, 208, 65, 66

Group 19: 48, 163, 174, 103, 75, 35

Group 20: 23, 18

Group 21: 24, 13, 122

Group 22: 121, 206, 82, 41, 29

Group 23: 108, 162, 141, 214, 25

Group 24: 180, 139

Group 25: 109, 160, 165

Children, taken from genealogies of Nunatsiaqput, who play together in cooperative groups.

See Chapter 4 for explanation.

Number of Groups: 12

Group 1: 18, 45, 194, 148, 33, 12, 23

Group 2: 180, 139, 140, 4, 188, 194, 151

Group 3: 44, 40, 81, 39

Group 4: 128, 110, 169

Group 5: 150, 74, 93, 201, 127, 86, 87

Group 6: 83, 66, 43, 64, 208, 65

Group 7: 24, 13, 122, 29, 41, 82, 121, 206

Group 8: 92, 186, 199, 91, 126, 187, 133, 125

Group 9: 138, 95, 102, 111, 218, 48, 163, 174, 103, 75, 35

Group 10: 160, 165, 14, 42, 189, 171, 94, 109, 182, 5

Group 11: 141, 108, 162, 214, 25, 107, 161, 213, 192

Group 12: 168, 193, 200, 156, 6, 149, 170, 198, 173

Children, taken from genealogies of Nunatsiaqput, who play together in cooperative groups.

See Chapter 4 for explanation.

Number of Groups: 7

Group 1: 44, 40, 81, 39, 18, 45, 63, 148, 80, 33, 12, 23

Group 2: 180, 139, 140, 4, 188, 194, 151, 92, 186, 199, 91, 126, 187, 133, 125

Group 3: 65, 66, 64, 208, 43, 83, 24, 13, 122, 29, 41, 82, 121, 206

Group 4: 138, 95, 102, 111, 218, 48, 163, 174, 103, 75, 35

Group 5: 160, 165, 14, 42, 189, 171, 94, 109, 182, 5

Group 6: 141, 108, 162, 214, 25, 107, 161, 213, 192, 169, 110, 128

Group 7: 173, 198, 170, 149, 6, 156, 200, 193, 168, 87, 86, 127, 201, 93, 74, 150

Children, taken from genealogies of Nunatsiaqput, who play together in cooperative groups.

See Chapter 4 for explanation.

Number of Groups: 3

Group 1: 18, 44, 40, 81, 39, 65, 66, 64, 208, 43, 83, 206, 121, 82, 41, 29, 122, 13, 24,
23, 12, 33, 80, 148, 63, 45

Group 2: 180, 139, 140, 4, 188, 194, 151, 92, 186, 199, 91, 126, 187, 133, 125, 150, 74,
93, 201, 127, 86, 87, 168, 193, 200, 156, 6, 149, 170, 198, 173

Group 3: 138, 95, 102, 111, 218, 48, 163, 174, 103, 75, 35, 160, 165, 42, 189, 171, 94,
109, 182, 5, 128, 110, 169, 192, 213, 161, 107, 25, 214, 162, 108, 141

Children, taken from genealogies of Nunatsiaqput, who play together in cooperative groups.

See Chapter 4 for explanation.

Number of Groups: 2

Group 1: 18, 44, 40, 81, 39, 65, 66, 64, 208, 43, 83, 206, 121, 82, 41, 29, 122, 13, 24,
23, 12, 33, 80, 148, 63, 45

Group 2: 180, 139, 140, 4, 188, 194, 151, 92, 186, 199, 91, 126, 187, 133, 125, 150, 74,
93, 201, 127, 86, 87, 168, 193, 200, 156, 6, 149, 170, 198, 173, 138, 95, 102, 111, 218,
48, 163, 174, 103, 75, 35, 160, 165, 42, 189, 171, 94, 109, 182, 5, 128, 110, 169, 192,
213, 161, 107, 25, 214, 162, 108, 141

Children, taken from genealogies of Nunatsiaqput, divided into those who regularly attend school and those who have dropped out. See Chapter 4 for explanation.

Number of Groups: 2

Group 1: 93, 4, 162, 42, 127, 121, 174, 170, 198, 214, 25, 48, 65, 103, 126, 6, 24, 168, 180, 208, 194, 122, 149, 133, 125, 74, 139, 199, 151, 41, 102, 35, 201, 150, 189, 171, 83, 111, 218, 43, 156, 138, 163, 193, 13, 187, 43, 206, 182, 213, 87, 95, 127, 128, 173, 94, 14, 200

Group 2: 12, 33, 29, 64, 34, 66, 160, 109, 161, 169, 107, 82, 18, 165

Programs used for analysis of data in Chapter 3.*

```

00100 REM CALCULATION OF INBREEDING
00150 FILE #1,"FMATRI"
00175 SCRATCH #1
00200 REM DIMENSIONS FOR THE "NAMES OF INDIVIDUALS"
00300 REM CLEAR
00400 PRINT "NUMBER OF INDIVIDUALS--->"
00500 INPUT N
00600 DIM P(225),P1(450),P2(900),P3(1800)
00700 REM DIMENSIONS FOR THE STORAGE LOCATIONS OF INDIVIDUALS
00800 DIM K(2),L(2),K1(2,2),L1(2,2),K2(2,2,2),L2(2,2,2)
00900 REM DIMENSIONS FOR F-MATRIX
01000 DIM F(225,225)
01100 REM INPUT DATA
01200 GOSUB 8400
01300 PRINT "DATA IN"
01400 REM LOOP THROUGH ALL PAIRS
01500 FOR I=1 TO N
01600 FOR J=1 TO N
01800 CF=0
01900 IF I=J THEN GO TO 6200
02000 REM STORAGE LOCATIONS FOR PARENTS,ETC.
02100 FOR G=1 TO 2
02200 K(G)=(I-1)*2+G
02300 L(G)=(J-1)*2+G
02400 NEXT G
02500 FOR M=1 TO 2
02600 FOR G=1 TO 2
02700 K1(M,G)=(K(M)-1)*2+G
02800 L1(M,G)=(L(M)-1)*2+G
02900 NEXT G
03000 NEXT M
03100 FOR Q=1 TO 2
03200 FOR M=1 TO 2
03300 FOR G=1 TO 2
03400 K2(Q,M,G)=(K1(Q,M)-1)*2+G
03500 L2(Q,M,G)=(L1(Q,M)-1)*2+G
03600 NEXT G
03700 NEXT M
03800 NEXT Q
03900 REM F FOR I VERSUS J
04000 FOR M=1 TO 2
04100 FOR G=1 TO 2
04200 D=P1(K(M))
04300 E=P1(L(G))
04400 IF D=E THEN GO TO 6700
04500 FOR MM=1 TO 2
04600 FOR GG=1 TO 2
04700 D=P2(K1(M,MM))
04800 E=P2(L1(G,GG))
04900 IF D=E THEN GO TO 7800

```

```
05000 FOR MQ=1 TO 2
05100 FOR GQ=1 TO 2
05200 D=P3(K2(M,MM,MQ))
05300 E=P3(L2(G,GG,GQ))
05400 IF D=E THEN GOSUB 8100
05500 NEXT GQ
05600 NEXT MQ
05700 NEXT GG
05800 NEXT MM
05900 NEXT G
06000 NEXT M
06050 GOSUB 33100
06100 REM STORE VALUE OF F
06200 F(I,J)=CF
06300 PRINT I,J,CF
06400 NEXT J
06500 NEXT I
06600 GO TO 32600
06700 REM SUBROUTINE FOR SAME P1
06800 VV=1
06900 FOR WQ=1 TO 2
07000 FOR WX=1 TO 2
07100 D=P3(K2(M,1,WQ))
07200 E=P3(K2(M,2,WX))
07300 IF D=E THEN VV=VV+1/8
07400 NEXT WX
07500 NEXT WQ
07600 CF=CF+VV/8
07700 GO TO 5900
07800 REM SUBROUTINE FOR SME P2
07900 CF=CF+1/32
08000 GO TO 5700
08100 REM SUBROUTINE FOR SAME P3
08200 CF=CF+1/128
08300 RETURN
08400 REM DATA INPUT "SET UP INSIDE"
08500 FOR I=1 TO N
08600 U=(I-1)*2+1
08700 V=(I-1)*2+2
08800 U1=(I-1)*4+1
08900 U2=(I-1)*4+2
09000 V1=(I-1)*4+3
09100 V2=(I-1)*4+4
09200 W1=(I-1)*8+1
09300 W2=(I-1)*8+2
09400 W3=(I-1)*8+3
09500 W4=(I-1)*8+4
09600 X1=(I-1)*8+5
09700 X2=(I-1)*8+6
09800 X3=(I-1)*8+7
09900 X4=(I-1)*8+8
10000 READ
```

```
P(I),P1(U),P1(V),P2(U1),P2(U2),P2(V1),P2(V2),P3(W1),P3(W2),P3(W3),P
3(W4),P3(X1),P3(X2),P3(X3),P3(X4)
10050 NEXT I
10100 DATA 1,250,154,377,378,320,321,600,601,602,603,604,605,493,494
32400 DATA 224,10,11,255,256,257,61,385,386,387,388,387,388,285,286
32500 RETURN
32600 PRINT #1,N
32650 FOR I=1 TO N
32700 FOR J=1 TO N
32800 PRINT #1,F(I,J)
32900 NEXT J
33000 NEXT I
33100 REM COMPARE I,J-->P1,P2,P3
33200 T1=P1(K(1))
33300 T2=P1(K(2))
33400 S1=P1(L(1))
33500 S2=P1(L(2))
33600 T3=P2(K1(1,1))
33700 T4=P2(K1(1,2))
33800 T5=P2(K1(2,1))
33900 T6=P2(K1(2,2))
34000 S3=P2(L1(1,1))
34100 S4=P2(L1(1,2))
34200 S5=P2(L1(2,1))
34300 S6=P2(L1(2,2))
34400 D1=P(I)
34500 D2=P(J)
34600 FOR M1=1 TO 2
34700 E1=P1(L(M1))
34800 E2=P1(K(M1))
34850 DN=1/4
34900 IF D1=E1 GO TO 50000
35000 IF D2=E2 GO TO 50200
35100 FOR M2=1 TO 2
35200 F1=P2(L1(M1,M2))
35300 F2=P2(K1(M1,M2))
35350 DN=1/8
35400 IF D1=F1 GO TO 50400
35500 IF D2=F2 GO TO 50600
35600 MH=1
35650 DN=1/16
35700 IF T1=F1 GO TO 51200
35702 IF S1=F2 GO TO 51600
35704 MH=2
35706 IF T2=F1 GO TO 51200
35728 IF S2=F2 GO TO 51600
35730 FOR M3=1 TO 2
35732 G1=P3(L2(M1,M2,M3))
35734 G2=P3(K2(M1,M2,M3))
35735 DN=1/16
35736 IF D1=G1 GO TO 50800
35738 IF D2=G2 GO TO 51000
```

```
35740 MH=1
35741 DN=1/32
35742 IF T1=G1 GO TO 52000
35744 IF S1=G2 GO TO 52400
35746 MH=2
35748 IF T2=G1 GO TO 52000
35750 IF S2=G2 GO TO 52400
35752 IF T3=G1 THEN CF=CF+1/64
35754 IF T4=G1 THEN CF=CF+1/64
35756 IF T5=G1 THEN CF=CF+1/64
35758 IF T6=G1 THEN CF=CF+1/64
35760 IF S3=G2 THEN CF=CF+1/64
35762 IF S4=G2 THEN CF=CF+1/64
35764 IF S5=G2 THEN CF=CF+1/64
35766 IF S6=G2 THEN CF=CF+1/64
35768 NEXT M3
35770 NEXT M2
35772 NEXT M1
35774 RETURN
35800 REM P1(K(M1)) SAME AS P2(L1(M2,M3))
35900 REM FIND F OF P1,CF=CF+FP*DN
36000 FF=1
36100 REM COMPARE P2(K1(M1,1-2)~P3(K2(M1,1-2,1-2))
36200 REM COMPARE P3(K2(M1,1-2,1-2)~P3(K2(M1,1-2,1-2))
36300 X1=P2(K1(MH,1))
36400 X2=P2(K1(MH,2))
36500 FOR Q2=1 TO 2
36600 Y1=P3(K2(MH,1,Q2))
36700 Y2=P3(K2(MH,2,Q2))
36800 IF X1=Y2 THEN FF=FF+1/4
36900 IF X2=Y1 THEN FF=FF+1/4
37000 NEXT Q2
37200 FOR Q1=1 TO 2
37300 FOR Q2=1 TO 2
37400 D=P3(K2(MH,1,Q1))
37500 E=P3(K2(MH,2,Q2))
37600 IF D=E THEN FF=FF+1/8
37700 NEXT Q2
37800 NEXT Q1
37900 FP=FP+FF*DM
38000 RETURN
38200 REM P1(L(MH)) ETC
38300 REM FIND F OF P1, ETC
38400 FF=1
38500 REM COMPARE P2(L1 ETC
38600 REM COMPARE P3(L2 ETC
38700 X1=P2(L1(MH,1))
38800 X2=P2(L1(MH,2))
38900 FOR Q2=1 TO 2
39000 Y1=P3(L2(MH,1,Q2))
39100 Y2=P3(L2(MH,2,Q2))
39200 IF X1=Y2 THEN FF=FF+1/4
```

```
39300 IF X2=Y1 THEN FF=FF+1/4
39400 NEXT Q2
39600 FOR Q1=1 TO 2
39700 FOR Q2=1 TO 2
39800 D=P3(L2(MH,1,Q1))
39900 E=P3(L2(MH,2,Q2))
40000 IF D=E THEN FF=FF+1/8
40100 NEXT Q2
40200 NEXT Q1
40300 FP=FP+FF*DM
40400 RETURN
50000 GOSUB 60000
50100 GO TO 35772
50200 GOSUB 80000
50300 GO TO 35772
50400 GOSUB 60000
50500 GO TO 35770
50600 GOSUB 80000
50700 GO TO 35770
50800 GOSUB 60000
50900 GO TO 35768
51000 GOSUB 80000
51100 GO TO 35768
51200 REM
51300 GOSUB 35800
51400 CF=CF+FF*DN
51500 GO TO 35770
51600 REM
51700 GOSUB 38200
51800 CF=CF+FF*DN
51900 GO TO 35770
52000 REM
52100 GOSUB 35800
52200 CF=CF+FF*DN
52300 GO TO 35768
52400 REM
52500 GOSUB 38200
52600 CF=CF+FF*DN
52700 GO TO 35768
52800 MH=1
52900 GOSUB 35800
53000 CF=CF+FP*DN
53100 GO TO 61775
53200 MH=2
53300 GOSUB 35800
53400 CF=CF+FP*DN
53500 GO TO 61775
53600 MH=1
53700 GOSUB 35800
53800 CF=CF+FP*DN
53900 GO TO 61750
54000 MH=2
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```
54100 GOSUB 35800
54200 CF=CF+FP*DN
54300 GO TO 61750
54400 FP=FP+1/8
54600 GO TO 68000
55800 MH=1
55900 GOSUB 38200
56000 CF=CF+FP*DN
56100 GO TO 81775
56200 MH=2
56300 GOSUB 38200
56400 CF=CF+FP*DN
56500 GO TO 81775
56600 MH=1
56700 GOSUB 38200
56800 CF=CF+FP*DN
56900 GO TO 81750
57000 MH=2
57100 GOSUB 38200
57200 CF=CF+FP*DN
57300 GO TO 81750
57400 FP=FP+1/8
57600 GO TO 88000
60000 FF=0
60100 FP=1
60200 H1=P1(K(1))
60300 H2=P1(K(2))
60400 FOR Q1=1 TO 2
60500 J1=P2(K1(2,Q1))
60600 J2=P2(K1(1,Q1))
60700 DM=1/4
60800 IF H1=J1 THEN GO TO 52800
60900 IF H2=J2 THEN GO TO 53200
61000 DM=1/8
61100 FOR Q2=1 TO 2
61200 R1=P3(K2(2,Q1,Q2))
61300 R2=P3(K2(1,Q1,Q2))
61400 IF H1=R1 THEN GO TO 53600
61500 IF H2=R2 THEN GO TO 54000
61600 IF J2=R1 THEN FP=FP+1/16
61700 IF J1=R2 THEN FP=FP+1/16
61750 NEXT Q2
61775 NEXT Q1
61800 FOR Q5=1 TO 2
61900 FOR Q6=1 TO 2
62000 H1=P2(K1(1,Q5))
62100 H2=P2(K1(2,Q6))
62200 IF H1=H2 THEN GO TO 54400
62300 FOR Q3=1 TO 2
62400 FOR Q4=1 TO 2
62500 H1=P3(K2(Q5,1,Q3))
62600 H2=P3(K2(Q6,2,Q4))
```

```
62700 IF H1=H2 THEN FP=FP+1/32
63100 NEXT Q4
63200 NEXT Q3
68000 NEXT Q6
68100 NEXT Q5
68200 CF=CF+FP*DN
70200 RETURN
80000 FF=0
80100 FP=1
80200 H1=P1(L(1))
80300 H2=P1(L(2))
80400 FOR Q1=1 TO 2
80500 J1=P2(L1(2,Q1))
80600 J2=P2(L1(1,Q1))
80700 DM=1/4
80800 IF H1=J1 THEN GO TO 52800
80900 IF H2=J2 THEN GO TO 53200
81000 DM=1/8
81100 FOR Q2=1 TO 2
81200 R1=P3(L2(2,Q1,Q2))
81300 R2=P3(L2(1,Q1,Q2))
81400 IF H1=R1 THEN GO TO 53600
81500 IF H2=R2 THEN GO TO 54000
81600 IF J2=R1 THEN FP=FP+1/16
81700 IF J1=R2 THEN FP=FP+1/16
81750 NEXT Q2
81775 NEXT Q1
81800 FOR Q5=1 TO 2
81900 FOR Q6=1 TO 2
82000 H1=P2(L1(1,Q5))
82100 H2=P2(L1(2,Q6))
82200 IF H1=H2 THEN GO TO 54400
82300 FOR Q3=1 TO 2
82400 FOR Q4=1 TO 2
82500 H1=P3(L2(Q5,1,Q3))
82600 H2=P3(L2(Q6,2,Q4))
82700 IF H1=H2 THEN FP=FP+1/32
83100 NEXT Q4
83200 NEXT Q3
88000 NEXT Q6
88100 NEXT Q5
88200 CF=CF+FP*DN
90200 RETURN
90300 END
```

GROUPF.BAS

```
00100 REM CROSS GROUP COMPARISONS
00200 DIM G(50,100),F(224,224),CG(50)
00300 FILE #1,"FMATRI"
00400 INPUT #1,N
00500 FOR I=1 TO N
00600 FOR J=1 TO N
```

```
00700 INPUT #1,F(I,J)
00800 NEXT J
00900 NEXT I
01000 REM INPUT GROUPS
01100 PRINT "NUMBER OF GROUPS--->"
01200 INPUT NG
01300 FOR GI=1 TO NG
01350 L=0
01400 PRINT "ENTER INDIVIDUALS OF GROUP"GI
01500 INPUT K
01600 IF K=999 GO TO 2100
01700 REM INPUT 999 TO QUIT
01800 L=L+1
01900 G(GI,L)=K
02000 GO TO 1500
02100 CG(GI)=L
02200 NEXT GI
02300 REM WITHIN COMPARISONS
02350 X=0
02375 X2=0
02400 FOR GI=1 TO NG
02500 SX=0
02600 SX2=0
02700 SN=0
02800 FOR P=1 TO CG(GI)-1
02900 FOR Q=P+1 TO CG(GI)
03000 I=G(GI,P)
03100 J=G(GI,Q)
03200 SX=SX+F(I,J)
03300 SX2=SX2+F(I,J)*F(I,J)
03400 SN=SN+1
03500 NEXT Q
03600 NEXT P
03700 GOSUB 6000
03750 PRINT
03800 PRINT "GROUP"GI"MEAN F-->"MEAN"VARIANCE-->"VAR"PAIRS-->"SN
03850 X=X+MEAN
03875 X2=X2+(MEAN)*(MEAN)
03900 NEXT GI
03950 PRINT
03955 SX=X
03960 SX2=X2
03965 SN=NG
03970 GOSUB 6000
03974 PRINT
03975 PRINT "MEAN F WITHIN GROUPS--->"MEAN
03976 PRINT
03980 PRINT "VARIANCE WITHIN GROUPS FOR F====>"VAR
03981 PRINT
03985 PRINT "STANDARD ERROR FOR WITHIN GROUPS F====>"SE
03986 PRINT
03990 M1=MEAN
```

```
03995 S1=SE
04000 REM BETWEEN GROUP COMPARISONS
04050 X=0
04075 X2=0
04100 FOR GI=1 TO NG-1
04200 FOR GJ=GI+1 TO NG
04300 SX=0
04400 SX2=0
04500 SN=0
04600 FOR P=1 TO CG(GI)
04700 FOR Q=1 TO CG(GJ)
04800 I=G(GI,P)
04900 J=G(GJ,Q)
05000 SX=SX+F(I,J)
05100 SX2=SX2+F(I,J)*F(I,J)
05200 SN=SN+1
05300 NEXT Q
05400 NEXT P
05500 GOSUB 6000
05600 PRINT "GROUPS"GI"AND"GJ"MEAN
F-->"MEAN"VARIANCE-->"VAR"PAIRS-->"SN
05650 PRINT
05675 X=X+MEAN
05687 X2=X2+(MEAN)*(MEAN)
05700 NEXT GJ
05800 NEXT GI
05810 SX=X
05820 SX2=X2
05830 SN=NG*(NG-1)/2
05840 GOSUB 6000
05845 PRINT
05850 PRINT "MEAN F BETWEEN GROUPS--->"MEAN
05855 PRINT
05860 PRINT "VARIANCE BETWEEN GROUPS FOR F--->"VAR
05865 PRINT
05870 PRINT "STANDARD ERROR FOR BETWEEN GROUPS F--->"SE
05875 PRINT
05880 GOSUB 6300
05900 REM CALCULATE MEAN & VARIANCE
06000 MEAN=SX/SN
06100 VAR=(SX2-(SX)*(SX)/SN)/(SN-1)
06150 SE=SQR(VAR/SN)
06200 RETURN
06300 D=M1-MEAN
06400 VD=SE*SE+S1*S1
06500 T=D/(SQR(VD))
06600 DF=(NG-1)+(NG*(NG-1)/2)-1
06700 PRINT
06800 PRINT "T===>"T"D.F.===>"DF"FOR WITHIN/BETWEEN GROUP
COMPARISONS"
06900 RETURN
07000 END
```

```
MEANF.BAS
00100 DIM F(224,224)
00200 FILE #1, "FMATRI"
00300 INPUT #1,N
00400 FOR I=1 TO N
00500 FOR J=1 TO N
00600 INPUT #1,F(I,J)
00700 NEXT J
00800 NEXT I
00900 SUMF=0
01000 FOR I=1 TO N
01100 FOR J=1 TO N
01200 SUMF=SUMF+F(I,J)
01300 NEXT J
01400 NEXT I
01500 PRINT "POPULATION MEAN F====>"SUMF/((N-1)*(N-1))
01600 END
```

*Note: These programs were developed in Applesoft Basic and then rewritten in Dec10 Basic to run on that computer. Some of these programs have now been rewritten to run in Microsoft Basic on the Apple Macintosh with run times comparable to the Dec10. The listings given here are in Dec10 Basic.

Programs used for analysis of data in Chapter 4.*

```

ESKIMO.BAS
00100 DIM NSV(6),NIV(6,3),G1V(6,3,500),G2V(6,3,500),G3V(6,3,500),G4V(6,3,500)
00200 REM POPULATION STRUCTURE
00300 D$ = CHR$(4)
00400 DEF MOD(X) = INT((X/2 - INT(X/2)) * 2 + .05) * SGN(X/2)
00500 PRINT "INPUT SIZE OF POPULATIONS"
00600 PRINT
00700 PRINT "NUMBER OF POPULATIONS--> ";
00800 INPUT NV
00900 PRINT
01000 PRINT "MAXIMUM # OF SUBPOPULATIONS --> ";
01100 INPUT RV
01200 PRINT
01300 PRINT "MAXIMUM # OF IND. IN A SUBPOP --> ";
01400 INPUT IV
01600 FOR I = 1 TO NV
01700 PRINT
01800 PRINT "# OF SUBPOPULATIONS IN "I
02000 INPUT CX
02050 NSV(I)=CX
02100 FOR J = 1 TO NSV(I)
02200 PRINT " # OF INDIV. IN SUB "J
02400 INPUT CX
02450 NIV(I,J)=CX
02500 NEXT J
02550 NEXT I
02600 PRINT
02700 PRINT "OK? (Y/N)"
02800 INPUT A$
02900 IF A$ = "Y" THEN GO TO 3100
03000 GO TO 1600
03100 REM SET UP MIGRATION MATRICES
03200 DIM MV(6,6),MSV(6,3,3),MAV(6,6),MBV(6,3,3)
03300 PRINT "MIGRATION BETWEEN POPULATIONS"
03400 FOR I = 1 TO NV
03500 FOR J = 1 TO NV
03600 IF I = J THEN 4100
03700 PRINT
03800 PRINT "% MIGRATION FROM ";I;" TO ";J;
03900 PRINT "--> ";
04000 INPUT MV(I,J)
04100 NEXT J,I
04200 PRINT
04300 PRINT "OK? (Y/N)"
04400 INPUT A$
04500 IF A$ = "Y" THEN GO TO 4700
04600 GO TO 3300
04700 PRINT
04800 PRINT "MIGRATION WITHIN POPULATIONS"
04900 FOR I = 1 TO NV

```

```
05000 PRINT
05100 PRINT
05200 PRINT
05300 PRINT "POPULATION #";I
05400 FOR J = 1 TO NSV(I)
05500 FOR K = 1 TO NSV(I)
05600 IF J = K THEN 6100
05700 PRINT
05800 PRINT "% MIGRATION FROM ";J;" TO ";K;
05900 PRINT "--> ";
06000 INPUT MSV(I,J,K)
06100 NEXT K,J,I
06200 PRINT
06300 PRINT "OK? (Y/N)"
06400 INPUT A$
06500 IF A$ = "Y" THEN GO TO 6700
06600 GO TO 4700
06700 REM CREATE INITIAL GENOTYPES
06800 CV = 1
06900 FOR I = 1 TO NV
07000 FOR J = 1 TO NSV(I)
07100 FOR K = 1 TO NIV(I,J)
07200 G1V(I,J,K) = CV
07300 CV = CV + 1
07400 G2V(I,J,K) = CV
07500 CV = CV + 1
07600 NEXT K,J,I
07700 REM MAIN GENERATION LOOP
07800 PRINT "HOW MANY GENERATION? ";
07900 PRINT "--> ";
08000 INPUT NGV
08100 PRINT
08200 PRINT "DETERMINE F ?? GEN--> ";
08300 INPUT Z
08400 DEF PMC(Y) = INT ((Y / Z - INT (Y / Z)) * Z + .05) * SGN (Y / Z)
08500 FOR ML = 1 TO NGV
08600 IF ML = 1 THEN GO TO 16300
08700 REM
08800 IF ML = 1 THEN GO TO 16300
08900 REM MIGRATE BETWEEN POPULATIONS
09000 FOR I = 1 TO NV
09100 PNV = 0
09200 FOR J = 1 TO NSV(I)
09300 PNV = PNV + NIV(I,J)
09400 NEXT J
09500 FOR II = 1 TO NV
09600 IF I = II THEN GO TO 9800
09700 MAV(I,II) = MV(I,II) * PNV / 100
09800 NEXT II,I
09900 FOR I = 1 TO NV
10000 PNV = 0
10100 FOR J = 1 TO NSV(I)
```

```
10200 PNV = PNV + NIV(I,J)
10300 NEXT J
10400 FOR II = 1 TO NV
10500 IF I=II THEN GO TO 11900
10550 PV=MAV(I,II)
10600 IF PV = 0 THEN GO TO 11900
10700 FOR IM = 1 TO PV
10800 MNV = INT((RND(1)*PNV))+1
10900 HNV = 0
11000 FOR J = 1 TO NSV(I)
11100 HNV = HNV + NIV(I,J)
11200 IF MNV<=HNV THEN GO TO 11400
11300 NEXT J
11400 REM
11500 MNV=1
11600 GOSUB 15300
11700 GOSUB 14600
11800 NEXT IM
11900 NEXT II,I
12000 FOR I = 1 TO NV
12100 FOR J = 1 TO NSV(I)
12200 FOR JJ = 1 TO NSV(I)
12300 IF J = JJ THEN GO TO 12500
12400 MBV(I,J,JJ) = MSV(I,J,JJ) * NIV(I,J) / 100
12500 NEXT JJ,J,I
12600 REM
12700 FOR I = 1 TO NV
12800 FOR J = 1 TO NSV(I)
12900 FOR JJ = 1 TO NSV(I)
13000 IF J=JJ THEN GO TO 13800
13100 PV = MBV(I,J,JJ)
13200 IF PV = 0 THEN GO TO 13800
13300 FOR IM = 1 TO PV
13400 MNV=1
13500 GOSUB 15300
13600 GOSUB 14000
13700 NEXT IM
13800 NEXT JJ,J,I
13900 GO TO 16300
14000 REM ARRIVE #2
14100 NIV(I,JJ) = NIV(I,JJ) + 1
14200 QV = NIV(I,JJ)
14300 G1V(I,JJ,QV) = H1V
14400 G2V(I,JJ,QV) = H2V
14500 RETURN
14600 REM ARRIVE
14700 SPV = INT ( RND (1) * NSV(II)) + 1
14800 NIV(II,SPV) = NIV(II,SPV) + 1
14900 QV = NIV(II,SPV)
15000 G1V(II,SPV,QV) = H1V
15100 G2V(II,SPV,QV) = H2V
15200 RETURN
```

```
15300 REM LEAVE
15400 H1V = G1V(I,J,MNV)
15500 H2V = G2V(I,J,MNV)
15600 NIV(I,J) = NIV(I,J) - 1
15700 PNV = PNV - 1
15800 FOR K = MNV TO NIV(I,J)
15900 G1V(I,J,K) = G1V(I,J,K + 1)
16000 G2V(I,J,K) = G2V(I,J,K + 1)
16100 NEXT K
16200 RETURN
16300 REM CHOOSE MATES
16400 REM
16500 FOR I = 1 TO NV
16600 FOR J = 1 TO NSV(I)
16700 FOR K = 1 TO NIV(I,J)
16800 IF NIV(I,J) < = 1 THEN GO TO 17000
16900 GO TO 17300
17000 PRINT "POP WENT EXTINCT"
17100 NIV(I,J) = 0
17200 GO TO 19300
17300 LV = INT ( RND (1) * NIV(I,J)) + 1
17400 MV = INT ( RND (1) * NIV(I,J)) + 1
17500 LLV = MOD(LV)
17600 MMV = MOD(MV)
17700 IF LLV = MMV THEN GO TO 17400
17800 RN = RND (1)
17900 IF RN < .25 THEN GO TO 18500
18000 IF RN < .50 THEN GO TO 18800
18100 IF RN < .75 THEN GO TO 19100
18200 G3V(I,J,K) = G2V(I,J,LV)
18300 G4V(I,J,K) = G2V(I,J,MV)
18400 GO TO 19300
18500 G3V(I,J,K) = G1V(I,J,LV)
18600 G4V(I,J,K) = G1V(I,J,MV)
18700 GO TO 19300
18800 G3V(I,J,K) = G1V(I,J,LV)
18900 G4V(I,J,K) = G2V(I,J,MV)
19000 GO TO 19300
19100 G3V(I,J,K) = G2V(I,J,LV)
19200 G4V(I,J,K) = G1V(I,J,MV)
19300 NEXT K,J,I
19400 REM
19500 FOR I = 1 TO NV
19600 FOR J = 1 TO NSV(I)
19700 FOR K = 1 TO IV
19800 G1V(I,J,K) = G3V(I,J,K)
19900 G2V(I,J,K) = G4V(I,J,K)
20000 NEXT K,J,I
20100 Q1 = PMC(ML)
20200 IF Q1 = 0 THEN GO TO 20400
20300 GO TO 20700
20400 REM
```

```
20500 GOSUB 28800
20600 GO TO 20800
20700 GO TO 30300
20800 IF NV = 1 THEN GO TO 23100
20900 FOR I = 1 TO NV - 1
21000 FOR II = I + 1 TO NV
21100 FSUM = 0
21200 C = 0
21300 FOR J = 1 TO NSV(I)
21400 FOR K = 1 TO NIV(I,J)
21500 A1V=G1V(I,J,K)
21550 A2V=G2V(I,J,K)
21600 FOR JJ = 1 TO NSV(II)
21700 FOR KK = 1 TO NIV(II,JJ)
21800 A3V = G1V(II,JJ,KK)
21900 A4V = G2V(II,JJ,KK)
22000 GOSUB 28000
22100 FSUM = FSUM + F
22200 C = C + 1
22300 NEXT KK
22400 NEXT JJ
22500 NEXT K
22600 NEXT J
22700 AVEF = FSUM / C
22800 PRINT SPACES(4);I;SPACES(12);II;SPACES(8);AVEF
22900 NEXT II
23000 NEXT I
23100 PRINT
23200 PRINT
23300 REM CALCULATE F BETWEEN SUBPOPULATIONS
23400 GOSUB 29500
23500 FOR I = 1 TO NV
23600 IF NSV(I) = 1 THEN GO TO 25400
23700 FOR J = 1 TO NSV(I) - 1
23800 FOR JJ = J + 1 TO NSV(I)
23900 FSUM = 0
24000 C = 0
24100 FOR K = 1 TO NIV(I,J)
24200 A1V = G1V(I,J,K)
24300 A2V = G2V(I,J,K)
24400 FOR KK = 1 TO NIV(I,JJ)
24500 A3V = G1V(I,JJ,KK)
24600 A4V = G2V(I,JJ,KK)
24700 GOSUB 28000
24800 FSUM = FSUM + F
24900 C = C + 1
25000 NEXT KK,K
25100 AVEF = FSUM / C
25200 PRINT SPACES(4);I;SPACES(9);J;SPACES(6);JJ;SPACES(4);AVEF
25300 NEXT JJ,J
25400 NEXT I
25500 PRINT
```

```

25600 PRINT
25700 REM CALCULATE F FOR INDIVIDUALS WITHIN SUBPOPS
25800 GOSUB 29900
25900 FOR I = 1 TO NV
26000 FOR J = 1 TO NSV(I)
26100 FSUM = 0
26200 C = 0
26300 FOR K = 1 TO NIV(I,J) - 1
26400 FOR KK = K + 1 TO NIV(I,J)
26500 A1V = G1V(I,J,K)
26600 A2V = G2V(I,J,K)
26700 A3V = G1V(I,J,KK)
26800 A4V = G2V(I,J,KK)
26900 GOSUB 28000
27000 FSUM = FSUM + F
27100 C = C + 1
27200 NEXT KK,K
27300 AVEF = FSUM / C
27400 PRINT SPACES(4);I;SPACES(13);J;SPACES(7);AVEF
27500 NEXT J,I
27600 PRINT
27700 PRINT
27800 GOSUB 30500
27900 GO TO 30300
28000 REM COMPARE ALLELES & CALCULATE F
28100 IC = 0
28200 IF A1V = A3V THEN IC = IC + 1
28300 IF A1V = A4V THEN IC = IC + 1
28400 IF A2V = A3V THEN IC = IC + 1
28500 IF A2V = A4V THEN IC = IC + 1
28600 F = IC / 4
28700 RETURN
28800 REM HEADING FOR OUTPUT
28900 PRINT "AVERAGE COEFFICIENT OF CONSANGUINITY"
29000 PRINT "GENERATION---> "ML
29100 PRINT "    BETWEEN"
29200 PRINT "POPULATION POPULATION" SPACES(4)"AVERAGE F"
29300 PRINT "-----"
29400 RETURN
29500 PRINT "-----"
29600 PRINT "POPULATION SUBPOP SUBPOP AVERAGE F"
29700 PRINT "-----"
29800 RETURN
29900 PRINT "-----"
30000 PRINT "POPULATION WITHIN SUBPOP AVERAGE F"
30100 PRINT "-----"
30200 RETURN
30300 NEXT ML
30400 GO TO 31700
30500 REM OUTPUT FINAL POP SIZES
30600 PRINT "-----"
30700 PRINT "POPULATION SUBPOPULATION SIZE"

```

```

30800 PRINT "-----"
30900 FOR I = 1 TO NV
31000 PRINT
31100 FOR J = 1 TO NSV(I)
31200 PRINT SPACES(4);I;SPACES(14);J;SPACES(8);NIV(I,J)
31300 NEXT J,I
31400 PRINT
31500 PRINT
31600 RETURN
31700 END

```

WORDS.BAS

```

00100 REM COEFICIENT OF LINGUISTIC CORRELATION
00200 REM INPUT DATA
00300 DIM CH$(10,10,10)
00400 PRINT "MAXIMUM # OF CHARACTERS PER WORD--->"
00500 INPUT MCC
00600 PRINT "HOW MANY DIALECTS--->"
00700 INPUT NDD
00800 PRINT "HOW MANY DIFFERENT WORDS--->"
00900 INPUT NWW
01000 FOR WW=1 TO NWW
01100 FOR DD=1 TO NDD
01200 FOR CC=1 TO MCC
01300 PRINT "WORD "WW" DIALECT " DD " CHARACTER "CC
01400 INPUT C$
01450 CH$(WW,DD,CC)=C$
01500 NEXT CC
01600 NEXT DD
01700 NEXT WW
01800 REM COMPARE DIALECTS
01900 SUMXX=MCC*NWW
02000 SUMYY=0
02100 FOR DD=1 TO NDD
02200 FOR DDD=1 TO NDD
02300 FOR WW=1 TO NWW
02500 FOR CC=1 TO MCC
02600 W1$=CH$(WW,DD,CC)
02700 W2$=CH$(WW,DDD,CC)
02800 IF W1$=W2$ THEN SUMYY=SUMYY+1
02900 NEXT CC
03100 NEXT WW
03200 PRINT "FOR DIALECT" DDD "AND DIALECT" DD
"COEFICIENT====>"100*SUMYY/SUMXX
03300 SUMYY=0
03400 NEXT DDD
03500 NEXT DD
03600 END

```

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