A DERMATOGLYPHIC ANALYSIS OF FOUR INDIAN POPULATIONS

IN BRITISH COLUMBIA

by

JAMES COLTON HAGGARTY

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ABSTRACT

Supervisor: Professor Richard Shutler, Jr.

This thesis comprises a dermatoglyphic study of four linguistic samples from indigenous Northwest Coast populations. A purpose of the study was to contribute to an understanding of the dermatoglyphic (biological) relationships that exist between each sample. A further purpose was to examine the usefulness of linguistic classification as operational units for biological investigation.

A total of 323 individual sets of prints have been analyzed; 174 from the collection of prints belonging to the Department of Pediatrics, University of British Columbia, and 149 obtained at the Anaham Reserve in central British Columbia during the month of October, 1969. The collection was assembled to form four linguistic samples of the following sizes: Nootka 74, Kwakiutl 65, Tsimshian 35, and Athapaskan 149.

The analysis of finger, palmar, and plantar dermatoglyphic data by both quantitative and qualitative measures showed that, in general, for males and females, the Nootka were most divergent from the Kwakiutl and Tsimshian samples while the Athapaskan sample was almost consistently intermediate between these two extremes. Further, the results clearly indicate that linguistic samples are only of limited use as operational units in physical anthropological studies.

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CHAPTER I

THE PROBLEM AND THE DERMATOGLYPHIC METHOD

The Problem

At the time of contact, the geographical area that is now British Columbia was not characterized by a heavy concentration of people but it has been estimated by Duff (1964:8) that approximately one-third of Canada's native population lived in this area. These people exhibited a high degree of linguistic diversity (twenty-four languages representing seven of the eleven language families in Canada: Duff 1964:8) and, for those populations occupying the relatively few areas along the rugged shoreline suitable for year-round habitation, a number of fundamental cultural patterns that, in combination, make it possible to distinguish the Northwest Coast or any other culture area from surrounding culture areas. In turn, it is possible to sub-divide this larger Northwest Coast unit into smaller regional divisions or cultural provinces on the basis of a "detailed plotting of the distributions of the various local specializations" (Drucker 1965:112). However, none of these units is completely uniform and all are characterized by indistinct boundaries. Drucker (1965:111-113) has also suggested that "the historic Indian population consisted of several distinct physical types" and that these are correlated with linguistic divisions and cultural provinces. Duff (1964:12) similarly states:

> On an ethnological map which attempts to reduce the complexity of Indian groupings to a workable number of descriptive units, the major ethnic groups can theoretically be drawn on the basis of physical type, culture, or language.

Of these three, the linguistic criterion (primarily as a result of its higher discriminatory power) is the most widely used for the purpose of classification. Language, in many cases, can be used to differentiate between populations that otherwise exhibit a high degree of similarity, both culturally and biologically. As such, the criterion of language must be treated independently until such time as sufficient evidence has accumulated for each of the other criteria so as to facilitate comparative analysis. There is a need to examine in depth the interrelationships, if any, that exist between the various linguistic, cultural, and biological groupings within limited geographical areas on the basis of as many factors as possible. This thesis is an attempt to contribute to the understanding of the biological relationships that exist among four native linguistic groupings in British Columbia on the basis of dermatoglyphic data.

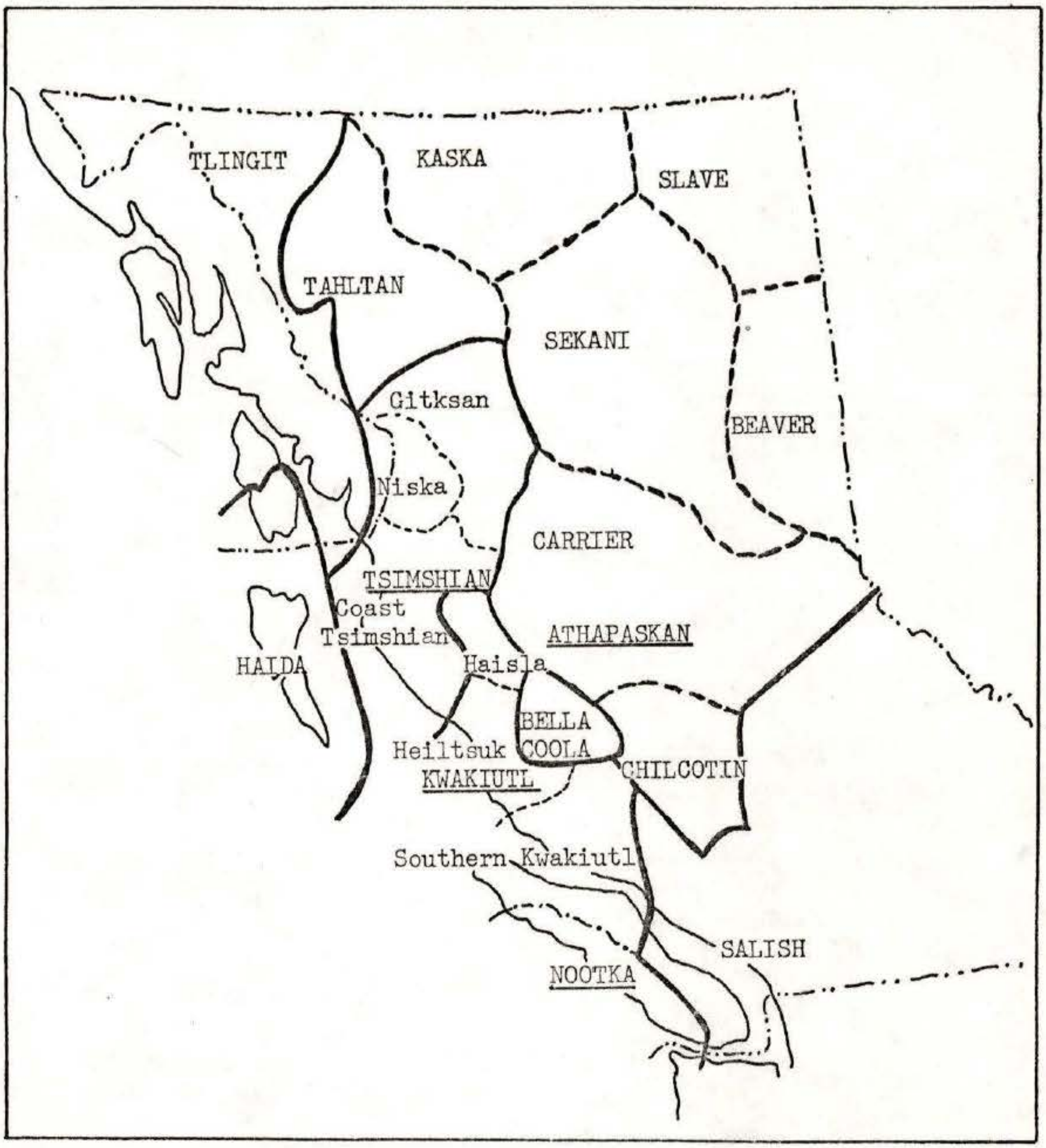
The classification of Indian groups used in this study follows that outlined in Duff (1964:15). Of the ten major ethnic divisions that comprise this classification, four are of concern here. Table 1 presents the four major ethnic divisions and subsequent language and dialect subdivisions. This broad, primarily linguistic classification (factors such as the occupation of a continuous territory and cultural similarities have also been taken into account) is, like most classificatory systems, somewhat arbitrary and, to some extent, inconsistent, i.e., the groups are not linguistically equivalent in all respects (Duff 1964:12, 15). The geographical location of

TABLE I: Linguistic Subdivisions of the Four Major Ethnic Groups Sampled

Ethnic Divisions	Language	Dialect
Tsimshian	Tsimshian	Tsimshian Gitksan Niska
Kwakiutl	Kwakiutl	Haisla Heiltsuk Southern Kwakiutl
Nootka	Nootka	Northern Nootka Southern Nootka
Athapaskan	Chilcotin Carrier Sekani Tahltan Kaska Slave Beaver	

each of the four ethnic divisions sampled, as well as language and dialect subdivisions, are presented in Map 1. This system, nevertheless, does provide the investigator with descriptive units with which to work. It should also be noted that none of these groups were "functioning social or political units, although their members usually recognized that they all shared the same language, culture, and territory" (Duff 1964:15). For a more detailed discussion of some of the problems involved in attempting to define smaller (less gross) or more refined units for analysis, see Duff (1964:16, 17).

Physical Anthropology in British Columbia is distinguished by the fact that so far as contemporary research with population genetics models, it is minimal. Drucker (1965:111) states: "The data on anthropometry of the North Pacific Coast leave much to be desired." Similar statements could well be made for other methods of analysis within the discipline. The data on anthropometry of Northwest Coast populations dates back to the early work of Franz Boas in the late 1880's and early 1890's. The only anthropometric data collected since that time has been done very recently (1968 on) by Drs. Melvin Lee, Braxton Alfred, John Birkbeck and colleagues of the University of British Columbia. As yet these data have not been published. Concerning interior populations of British Columbia, Grant (1936) published a small monograph on the anthropometry of the Beaver, Sekani, and Carrier Indians. Blood group studies of native populations have been both limited and sporadic. Gates and Darby (1934) and Ride (1935) were the first to contribute and work since then has been done by Hulse (1955, 1957), Allen (1959), Thomas, Stuckey, Robinson, Goffon, Anderson and Bell (1964) and Alfred, Stout, Birkbeck, Lee, and Petrakis (1969, 1970). Studies involving the analysis of skeletal material have also been very sporadic: Dorsey (1897a, 1897b), Robinson (1935), Leechman (1944), and recent unpublished work by Jerome Cybulski, University of California, Santa Barbara and Michael Finnegan of the University of Colorado. Much, if not all of the earlier work in all fields (up to 1950 or so) is of little use to contemporary researchers as a result of the development of more stringent methodological requirements; requirements that are simply not met by the earlier works. With respect to dermatoglyphic analysis, no research other than this thesis has been done in this area although studies have been conducted among the Eskimo to the



Map 1. Geographical location of the four ethnic divisions sampled including language and dialect subdivisions.
(After Duff 1964:14)

north (Jenness 1923, Midlo and Cummins 1931, Abel 1934, Cummins 1935, Cummins and Hansen 1946, Auer 1950, Popham 1953, and Meier 1966) and Comanches (Cummins and Goldstein 1932), Navahos (Spuhler 1950), and Seminoles (Rife 1968) to the south (see also Cummins 1941).

The Dermatoglyphic Method

The term "Dermatoglyphics" (derma, meaning SKIN plus glyphē, meaning CARVE) was first proposed by H. Cummins and C. Midlo (1926) as a collective name for the study of integumentary and anatomical features of the fingers, toes, palms, and soles. The peculiar patternings of the skin in these areas (commonly referred to as "friction skin") have long been recognized but their scientific value or at least the recognition of such is of much shorter duration. In this respect Sir Francis Galton and H. H. Wilder stand out as the two most prominent of the early proponents of dermatoglyphic research in terms of scientific value. Galton was primarily concerned with morphology, classification, inheritance and racial variation; Wilder with morphology, the methodology of plantar and palmar dermatoglyphics, inheritance and racial differences. A detailed account of the history of dermatoglyphics, scientific and otherwise, is provided in Cummins and Midlo (1961).

Any trait (such as those in dermatoglyphics) used in a biological study of human populations for classificatory purposes should meet several requirements:

(a) The criteria must be sufficiently objective so that individuals will be classified identically by different investigators. Dermatoglyphic methodology has progressed to the point where this requirement is satisfactorily met and, consequently, the terminology used which undoubtedly reflects the degree of objectivity attained has also become highly standardized. There is, however, a continuing need for further refinement and clarification of specific terms. Penrose (1968) provides a current account of approved terms and alternatives as well as an outline of accepted methods in dermatoglyphic analysis; Cummins and Midlo (1961) also provide a detailed discussion of both nomenclature and methods.

(b) The traits used must not be subject to extensive environmental modification. This requirement is fully met as dermatoglyphic features are fixed during the third month of foetal life and do not undergo any post-natal modification.

(c) Ideally, a criterion chosen for analysis should be one that is controlled by a simple and known genetic process. Dermatoglyphic features are controlled or regulated by a complex and incompletely understood genetic mechanism but the traits are highly heritable (Holt 1968).

(d) To eliminate the effects of natural selection, the traits chosen should be non-adaptive. It is highly improbable that any selective value exists between two pattern types or between a pattern and a patternless configuration although the possibility does exist that there may be genetic linkage with other traits that do have some selective value. Chai (1967:183, 184) in his summary discussion of bimanual and sexual differences clearly states that "As most people are right-handed, the greater frequencies of whorl and radial loops and more transversal of the main line alignments in right hands are a consequence of evolution." The resultant effect of this on the ultimate performance of the individual is, as he suggests, difficult to visualize. Additional information from other areas is most certainly required before this statement can be considered anything but tentative. Nevertheless, it is known that dermatoglyphic features are not correlated with either standard anthropometric measures or blood group systems.

(e) The criterion should not be subject to a high rate of mutation. Although actual mutation rates have not yet been documented, the high heritability of dermatoglyphic features indicates that this criterion is at least satisfactorily met.

In summary, dermatoglyphic analysis does have a real potential for classification in human populations. This potential is perhaps best viewed in a comparison of dermatoglyphics with other methods of analysis currently in use. Anthropometric characteristics, like dermatoglyphic ones, have a polygenic basis but the phenotypic expression of anthropometric traits is in part nongenic. As previously noted, this is not true of dermatoglyphic traits. Environmental modification tends to mask biological differences and hence interferes with the expression of genetic differences. Further, in comparison with monogenic traits, polygenic traits have certain advantages in classificatory studies. As Birdsell (1952:358) points out:

> It is becoming clear that genetically simple characters, such as are now the only materials available for use in human population genetics, and which are most useful for studying certain evolutionary processes, may on the other hand give biased and blurred impressions of population relationships distant in time and space. For the latter type of analysis, genetically complex traits may serve better even though they offer little hope of detailed genetic definition.

Until quite recently, it was believed that the monogenic traits of the various blood group systems were immune to natural selection, and if their frequencies changed at all, it was an extremely slow process. In an excellent paper reviewing certain basic theorems of population genetics, Brues (1969:293) states:

> This comfortable hypothesis (that A - B - O blood group genes were neutral in respect to the survival of their bearers) became untenable in 1947, when Waterhouse and Hoghen clearly demonstrated that there were maternal-fetal incompatibility reactions involving the A - B - O blood group system . . . . Numerous later investigations have confirmed this finding. This discovery might at first glance appear to be only a minor exception to the theory that the blood groups were immune to natural selection. However, it immediately necessitated recasting our entire concept of the manner in which blood group gene frequencies are maintained at relatively stable levels.

Newman (1960:55), citing various blood group studies carried out in Middle America, states that:

> . . . analysis of single gene traits exemplified by the blood group systems may too strongly reflect any recent gene frequency alterations to discern older and more basic biological relationships . . . .

Further, Newman (1960:56) suggests that this might not be as pronounced for dermatoglyphics as it is for blood groups, claiming that "There is no internal evidence whatsoever of European admixture in the dermatoglyphic configurations." He suggests, in fact, that on two counts (1. hypothenar and thenar/first interdigital patterns and 2. mainline indices) there is strong "evidence that European admixture has had no appreciable effect" (1960:56). This suggestion, however, must simply remain as just another possible advantage of dermatoglyphics with respect to monogenic traits. At present, it must not be accepted as a positive advantage as it has yet to be precisely documented. Similarly, and previously noted, judgment concerning the effects of natural selection on dermatoglyphic features must also be reserved until further evidence can be brought to bear on the subject. It is clear that the dermatoglyphic method, in relation to other methods of analyses currently in use, does offer the investigator certain potentialities, particularly in the area of classification of human populations.

CHAPTER II

THE COLLECTION, COMPOSITION AND LINGUISTIC RELATIONSHIPS OF THE FOUR SAMPLES

Collection and Composition

The individual prints that make up the four samples used in this study (Nootka, Kwakiutl, Tsimshian, and Athapaskan) have been derived from a larger collection of prints obtained by members of the Department of Pediatrics, University of British Columbia. I was personally involved only in the collection of prints from the Anaham Reserve, the majority of which constitute the Athapaskan sample. As the purpose of their research was to establish a reliable control sample for a large heterogeneous Indian population and thus differed from mine, the same data could be used for both purposes. However, in order to use these data in this study, more information about each of the individuals printed was required than that for the control sample study. The major problem encountered in this respect concerned the lack of classificatory information for all individuals printed. The collection of prints was simply designated as "Indian"; sufficient for their purpose. It was necessary to sort and assign the individuals whose prints make up this collection, first by band affiliation, second by language group, and finally by major ethnic division. The first task was accomplished by tracing individuals by means of the various Indian Agency Band Lists. Any individual that could not be located was excluded. Once the individuals had been assigned to various bands, the next step was to assemble these bands into language groupings and, finally, these language groupings into major ethnic divisions. A total of 323 individuals, comprising 1292 separate prints (four per individual), have been analyzed. A complete listing of the number of individuals by band, language group and ethnic division is presented in Table II.

All "Indian" prints obtained by members of the Department of Pediatrics, University of British Columbia, with the exception of the Anaham study, were collected on the basis of one individual per nuclear family, as given in the Indian Agency Band Lists. These prints, comprising the Nootka, Kwakiutl, and Tsimshian samples, were obtained on field trips to various residential schools in the province such as Tofino, Alert Bay, Le Jac, and Port Alberni. The three above samples, therefore, are composed solely of school children between the ages six and sixteen.

The dermatoglyphic material that was obtained on the Anaham project and which eventually became the Athapaskan sample was collected in a somewhat different manner, primarily as a result of its inclusion as a part of another project being conducted by Dr. Melvin Lee, Director of the School of Home Economics, University of British Columbia. Instead of selecting individuals to be printed on the basis of one per nuclear family in the field, as was previously done, it was simply more convenient to print all individuals as they progressed through our station in the study and leave the final selection of prints until after the fieldwork was completed. A total of 265 individuals were printed and, of these, 149 were selected for analysis as a result of the one individual per nuclear family requirement. The majority of these selected prints are of school children between the

TABLE II: Listing of Individuals by Band, Language Group, and Ethnic Division

Ethnic Division	Language Group	Dialect and Regional Groups	Present Band Name
Nootka (74)	Nootka (74)	Northern Nootka (18)	Kyuquot (5)
			Ehattesaht (2)
			Nuchatlaht (6)
			Nootka (5)
		Central Nootka (47)	Hesquiaht (16)
			Ahousaht (19)
			Uchucklesaht (4)
			Opetchesaht (2)
			Ohiet (6)
		Southern Nootka (9)	Nitinat (9)
Kwakiutl (65)	Kwakiutl (65)	Heiltsuk (Northern Kwakiutl along with Haisla) (35)	Bella Bella (26)
			Oweekano (9)
		Southern Kwakiutl (30)	Gilford Island (4)
			Tsawataineuk (5)
			Mamalillikulla (10)
			Turnour Island (5)
			Kwawkewlth (3)
			Campbell River (3)
Tsimshian (35)	Tsimshian (35)	Tsimshian (7)	Kitkatla (2)
			Port Simpson (5)
		Gitksan (22)	Kitwanga (3)
			Kitwancool (1)
			Hazelton (8)
			Kispiox (8)
			Glen Vowell (2)
		Niska (6)	Kincolith (6)
Athapaskan (149)	Chilcotin (68)	Chilcotin (68)	Anaham (64)
			Alexis Creek (1)
			Nemiah Valley (3)
	Carrier (67)	Upper Carrier (64)	Stoney Creek (5)
			Cheslatta (3)
			Necoslie (3)
			Stuart-Trembleur Lake (32)
			Fraser Lake (2)
			Stellaquo (11)
			Takla Lake (8)
		Babines (3)	Lake Babine (3)
	Sekani (14)	Sasuchan (5)	Finlay River (5)
		Yutuwichan (9)	McLeod Lake (9)

ages of six to sixteen. In cases where the selection involved a choice between two or more siblings, a number of factors were considered: (1) age--birth date closest to 1957 (approximately the middle of the desired age-range), (2) sex--attempt to balance the sex ratio within the sample where possible, and (3) clarity and completeness of print--the criterion was used only in the case of extremely poor reproductions. A few prints have been included in the sample that do not fall within the six to sixteen age-range. However, in these cases care was exercised to ensure that no direct descendants or siblings had previously been included. This was difficult to determine beyond the level of the nuclear family as genealogies were not collected and Indian Agency Band Lists do not specify consanguinity. Consequently, I relied exclusively upon the nuclear family arrangements given in the 1968 Band Lists that listed offspring in the six to sixteen age-range.

The composition of the four samples used in this study are presented in Tables III and IV. Referring to Table III, the Central Nootka of the Nootka sample are found to be highly represented (63.5%) and the Gitksan (62.9%) highly represented in the Tsimshian sample. The Heiltsuk (53.8%) and Southern Kwakiutl (46.2%) of the Kwakiutl sample and the Chilcotin (45.6%) and Carrier (45.0%) of the Athapaskan sample are of approximately equal representation. The Haisla, northernmost of the Kwakiutl speakers, are not represented in the Kwakiutl sample. The total composition of the four major ethnic divisions sampled are presented in Table IV. In terms of the total number of individuals printed (Table IV), the Athapaskans comprise almost half (46.2%) while the Tsimshian constitute only 10.8%. The

TABLE III: Composition of the Linguistic and Regional Groups Sampled in Each of the Four Major Ethnic Divisions

Ethnic Division	Language Groups	Dialect and Regional Groups	Percentage of Ethnic Division	Total No. of Families in Bands Sampled	Percentage of Families Sampled
Nootka	Nootka	Northern	24.3	90	20.0
		Central	63.5	195	24.1
		Southern	12.2	32	28.1
Kwakiutl	Kwakiutl	Heiltsuk	53.8	181	19.3
		Southern	46.2	197	15.2
Tsimshian	Tsimshian	Coast Tsimshian	20.0	257	2.7
		Gitksan	62.9	249	8.8
		Niska	17.1	109	5.5
Athapaskan	Chilcotin		46.6	169	40.2
	Carrier		45.0	286	23.4
	Sekani		9.4	186	7.5

TABLE IV.: Total Composition of the Four Major Ethnic Divisions Sampled

Ethnic Division	Male	Female	Total	Percentage of Total	Total No. of Families in Bands Sampled	Percentage of Families Sampled
Nootka	42	32	74	22.9	317	23.3
Kwakiutl	40	25	65	20.1	378	17.2
Tsimshian	20	15	35	10.8	615	5.7
Athapaskan	81	68	149	46.2	641	23.2
Totals	183	140	323	100.0		

percentage of families sampled in each of the bands represented in this study is highest among the Nootka (23.3%) and Athapaskan (24.2%) samples and lowest among the Tsimshian (5.7%). The percentage recorded for the Kwakiutl is also relatively high (17.2%). The total number of families for each of the ethnic divisions sampled was calculated by totaling the number of nuclear family units listed in the 1968 Indian Agency Band Lists for each of the Indian bands represented in this study. To obtain the percentage of families sampled, the total number of individuals in each of the four ethnic divisions was divided by the total number of families in each of the bands sampled.

Linguistic Relationships of the Four Samples

General linguistic relationships of the four major ethnic divisions sampled are discussed both by Duff (1964:15) and Drucker (1965:103-109). The terminology, system of classification, etc., of various Indian terms follows that of Duff (1964). A number of points concerning the linguistic classification should be made explicitly clear. The terms Tsimshian, Kwakiutl, and Nootka denote both language and major ethnic division while the term Athapaskan refers only to ethnic division. Under the heading Athapaskan, there are nine languages listed by Duff (1964:15), two of which are now extinct (Tsetsault and Nicola). Three of these language divisions are of concern in this study: Chilcotin, Carrier, and Sekani, none of which can apparently be divided into dialects. The Tsimshian and Kwakiutl languages, however, can both be further divided into three dialects: Tsimshian: Coast Tsimshian, Gitksan, and Niska; and Kwakiutl: Haisla (not represented in this study), Heiltsuk, and Southern Kwakiutl. Speakers of the Nootka language can also be differentiated on the basis of dialect: Northern and Southern Nootka. According to Duff (1964:15), these linguistic groupings are both "somewhat arbitrary and inconsistent" but, nevertheless, do provide the investigator with useful descriptive units. Duff (1964:15) further states:

> Nor were these groups functioning social or political units, although their members usually recognized that they all shared the same language, culture, and territory.

More to the point is a statement by Hulse (1955:99, 100):

> For anyone with social pretensions, marriage outside of one's village has been preferred among Northwest Coast Indians, and we find that it was in fact very common. Not a single one of the settlements, reservations, or even linguistic groups forms a breeding isolate, or anything

> like it: perhaps outbreeding has been even more prevalent in recent times, as travel has become easier, but it is traditional in any case.

It is clear that these groupings can only be used as descriptive units, not biological populations. The four samples that comprise this thesis then are samples of both ethnic and linguistic groupings in British Columbia. The geographical locations of each of the groupings are presented in Map 1.

As stated previously in Chapter I, one concern of this thesis is to examine the interrelationship between linguistic and biological realms of four native groupings in British Columbia. As such, various cultural factors other than language are of limited importance. Similarly, the biological realm is represented solely by dermatoglyphic data and therefore any extrapolation of the results of this study beyond these inherent limitations must be viewed as extremely tentative. Undoubtedly, the need to understand the operation of a number of factors simultaneously within a definable population area rather than simply one or two is indeed very great. The development of a suitable method capable of performing such a task is discussed by Howells (1966).

The linguistic distributions of the native populations of British Columbia have varied both temporally and spatially since the time of arrival of the first inhabitants. Major shifts in linguistic boundaries undoubtedly took place during much of the prehistoric period but these changes will remain largely undocumented except for some indirect evidence supplied by further and much needed archaeological investigation. However, there is, according to Drucker (1965:105), some "evidence of minor changes in linguistic boundaries in late prehistoric times." A brief summary of a number of minor changes in linguistic boundaries that occurred on the Northwest Coast during late prehistoric and early historic times can be found in Drucker (1965:103-108).

The Athapaskan speakers of British Columbia, represented by seven language divisions, occupy a sizeable portion of the province (see Map 1). Along with the speakers of Tlingit and Haida of the Northwest Coast and the Eyak of Southeastern Alaska, they combine to form the Na Déné linguistic stock. The second major linguistic grouping is the Tsimshian, a member of the Macro-Penutian linguistic stock, with its three dialects: Niska, Coast Tsimshian, and Gitksan. The Niska have traditionally occupied the area adjacent to the Nass River; the Coast Tsimshian, the outer coast area at the mouths of the Nass and Skeena Rivers as well as the lower reaches of the Skeena; and the Gitksan, the upper reaches (above the canyon) of the Skeena (Drucker 1965:105). In late prehistoric and early historic times, according to Drucker (1965:105, 106) there appears to have been a considerable movement of various populations:

> The Niska division was augmented, apparently in late prehistoric times, by a Tlingit group forced from their northern home by population pressure, who were given tracts on the lower Nass, and who soon became Niska in speech and custom. In the early historic period, this same group became the chief aggressors in a campaign with other Tlingit--and Tsimshian--speaking units against some Tahltan bands who spoke Athapascan. When they captured and enslaved the last survivors of the Tahltan bands, they also claimed their victims' lands along the western shores of Portland Canal, thus extending the boundaries of their newly acquired Niska speech. South of the Skeena, a Coast Tsimshian division, the Kitisu, waged a bitter war against their neighbors to the south, but the extent of their gains has not been recorded.
>
> According to both Tlingit and Tsimshian traditions, ancient linguistic distributions were quite different: Tlingit-speaking groups held the lower Skeena and the

> adjacent coasts, and were pushed out by the ancestors of the Coast Tsimshian, who presumably split off from their Gitksan relatives upstream long ago. In defeat the Tlingit retired northward to the panhandle region, which, traditions indicate, these early Tlingit found unoccupied.

Each of these two major linguistic divisions are represented by the Athapaskan and Tsimshian samples, respectively. The two remaining samples, Nootka and Kwakiutl, belong to the same major linguistic division, namely, Wakashan. Wakashan is one of six major divisions of the Macro-Algonkian major linguistic stock. Of the three dialects of Kwakiutl, only the Heiltsuk and Southern Kwakiutl varieties are represented in this study. The third dialect, Haisla, is referred to by Drucker (1965:104) as Northern Heiltsuk stating that the "differentiation of Haisla from Heiltsuk is more properly cultural than linguistic" (1965:106). Heiltsuk speakers occupied territory in the vicinity of Milbanke Sound, Rivers Inlet and Wikeno Lake. Speakers of Southern Kwakiutl ranged from Smith Sound to the vicinity of Surge Narrows on the mainland side as well as the northern tip of Vancouver Island from Cape Scott to Quatsino Sound and across to Seymour Narrows (Drucker 1965:106). The Nootka of British Columbia occupy a vast area on the west coast of Vancouver Island stretching from Cape Cook in the north to the shore of Juan de Fuca Strait in the south. According to Drucker (1965:107), Nootka "has long been recognized as related to Kwakiutl, the two forming the Wakashan stock."

In general terms, the four samples analyzed in this study represent four of the ten major ethnic divisions outlined by Duff (1964:15) for the Indian population of British Columbia. None of the samples, in relation to the others, are equally representative of their respective ethnic divisions. Further, not all bands listed under a specific ethnic division have been sampled. The composition of each of the samples is clearly defined in Tables II, III and IV. The linguistic relationships in terms of classification can be described as follows: three major linguistic stocks are represented by the four samples: Na Déné (Athapaskan), Macro-Penutian (Tsimshian), and Macro-Algonkian (Nootka and Kwakiutl). Only the Nootka and Kwakiutl samples are linguistically related--both are grouped under the Wakashan linguistic division of the major Macro-Algonkian linguistic stock. The remaining two samples are not linguistically related at any classificatory level as each is a member of an entirely different major linguistic stock. Whether or not, or more specifically, the degree to which the results of the following analysis of dermatoglyphic data coincide with the Linguistic model outlined above is of primary concern. What are the interrelationships, if any, that exist between the above linguistic classification and one that results from an analysis of genetically transmitted traits?

CHAPTER III

ANALYSIS OF DATA AND DISCUSSION

Technical Aspects

All prints analyzed in this study were collected by means of Faurot Inkless materials. For details of the inkless technique the reader is referred to Walker (1957). The procedure consists of applying a special chemical fluid (re-sensitizing fluid) to the friction skin surface in moderate quantity by means of a soft cloth pad. The surface is then pressed to a sheet of sensitized paper, producing instantly a very clear black and white reproduction of the ridge and furrow systems. Initially, some practice is necessary in order to determine the right amount of fluid to use and pressure to apply to consistently ensure maximum results. It is equally important to make sure that all peripheral regions of the various configurational areas have been adequately supplied with fluid so that a complete print is possible. For example, some digital triradii are located at the side of a pattern and could possibly remain unprinted if care is not taken to ensure their reproduction. Similarly, patterns that occur in the hypothenar area of the palm often extend beyond the flattened palmar surface and again care must be taken if a complete print is to be obtained. It is essential that each digit be rolled once to ensure complete printing and usually digit I (thumb) must be reprinted separately as it is difficult to roll with the subject's hand in a normal printing position. Finally, the investigator should systematically check each print for clarity, completeness, etc., while the subject is still available in case any reprinting is desired.

The analysis of data by computer was done at the Computing Center, University of Victoria. The machine used for the major computations was an IBM 360, model 44. The following three programs from the BMD Bio-medical Computer Program series and developed by the Health Services Computing Facility, UCLA were used in this study:

1. BMD06D : Description of Strata
2. BMD08D : Cross-Tabulation with Variable Stacking
3. BMD01V : Analysis of Variance for One-Way Design

See Dixon (1967) for a detailed description of these three programs.

Before turning to the analysis of the data, I would like to mention briefly some of the problems encountered as a result of the nature of dermatoglyphic data. The fact that dermatoglyphic analysis, at present, primarily involves the use of qualitative measures (pattern types) precludes the use of multivariate techniques. The few quantitative measures currently available in this dermatoglyphic analysis are insufficient in number to support multivariate analysis. There is a need for the development of multivariate or similar techniques capable of analyzing data that uses either nominal or ordinal scales of measurement. Another approach equally worthwhile would be to constructively quantify, i.e., devise new measures, a large enough portion of dermatoglyphic data so that existing multivariate techniques might be used. Using univariate analyses (student's statistic for the quantitative measures and the chi-square statistic for qualitative measures) posed the standard problem of interpreting each of the measures independently.

The reader is referred to Appendix II for an account of the method used in coding the dermatoglyphic data for computer application and to Appendix I for a definition of all technical terms used in the body of this thesis.

The following section involving the analysis of dermatoglyphic data is divided into three major subsections: (1) Finger Dermatoglyphics, (2) Palmar Dermatoglyphics, and (3) Plantar Dermatoglyphics.

Finger Dermatoglyphics

Of the various dermatoglyphic areas open to examination, fingerprints outnumber all others in terms of the amount of information available. Undoubtedly, one of the major underlying reasons is their widespread application in personal identification. Many anthropological studies of dermatoglyphics are concerned principally with the analysis of digital configurations. Both the relative ease with which fingerprints can be obtained and their highly standardized format for analysis, coupled with reliable scientific value, are undoubtedly contributing factors in terms of their popularity. See Cummins and Midlo (1961:56-83) for a comprehensive survey of finger dermatoglyphics.

In any analysis of finger dermatoglyphics, there are a number of standard measures that are consistently used by most investigators, including physical anthropologists. A combination of quantitative and qualitative measures is commonly used. The quantitative measure that has received widespread application is ridge counting; the qualitative measure of equal importance is pattern type (see Figure 1) and its three associated indices: pattern intensity, arch/whorl, and whorl/loop. Although there do exist other measures, they are of little importance concerning the nature of the problem undertaken by this study. It is these three measures that are of primary concern in the analysis of finger dermatoglyphics.

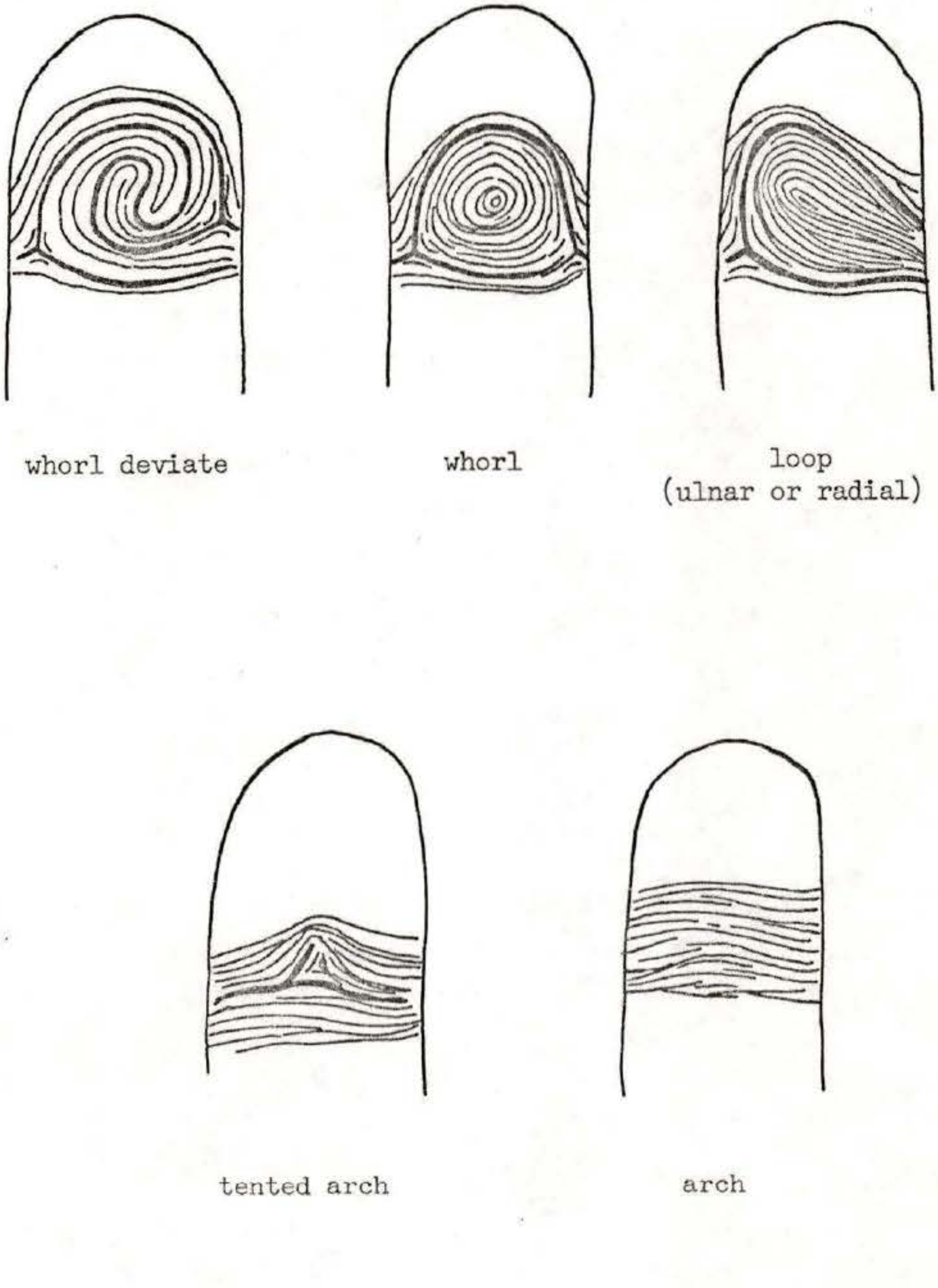


Figure 1. Digital pattern types.

Ridge Counts

Ridge counts on individual digits are obtained by counting the number of ridges that intersect a straight line connecting the outer triradius of a pattern with its inner core. In the case of true whorls and whorl deviates where there are two triradii present and, therefore, further rules must be applied. For true whorls, it is the larger of the two counts (from each triradius to the core) that is recorded by the investigator. In whorl deviates the situation is a little more complex. Besides having two triradii, this particular pattern also has two cores; one associated with each triradius. To obtain a total ridge count for this particular pattern type, the investigator must first determine the larger of the two counts from each triradius to its respective core. A count must then be made between the two cores and divided by two; this count is then added to the larger of the two initial counts to yield a total count for the pattern itself. Ridge counts for ulnar and radial loops are very straightforward in that there can only be one triradius and one core per pattern. There can be no ridge counts for tented arches or plain arches as these pattern types do not contain a triradius. In all counts made, neither the triradial point nor the point of core are included in the count. Besides these general rules for ridge counting there are also a number of specific rules. For a thorough discussion of the many rules involved in ridge counting see Cummins and Midlo (1961:74-76).

The total ridge count for each individual in each of the four groups was obtained by adding the ridge counts obtained for each of the ten digits. Similarly, totals for smaller groupings, i.e., left hand, were obtained by adding the ridge counts of only those digits in the

the desired category. Ridge count totals have been grouped according to hand, separately as well as combined, and sex.

The distribution of total ridge counts (left and right hands combined) for both males and females is shown graphically in Figures 2 and 3 (Nootka males and females respectively), 4 and 5 (Kwakiutl), 6 and 7 (Tsimshian), and 8 and 9 (Athapaskan). The range of variation for both sexes in each of the four groups is as follows: Nootka males (30 - 229), females (49 - 220); Kwakiutl males (75 - 232), females (87 - 289); Tsimshian males (81 - 240), females (16 - 207); Athapaskan males (37 - 236), females (52 - 236).

Intra-group Differences

Mean ridge count, variance, standard deviation and standard error for left hands in both sexes of the four groups are presented in Table V. The same data for right hands are presented in Table VI and for right and left hands combined, in Table VII. In all three tables, the male mean ridge counts for each of the four groups are consistently larger than their female counterparts. This tendency, in part, reflects a further tendency concerning the distribution of pattern types. As noted in Cummins and Midlo (1961:272), " . . . females almost universally differ from males in having more arches, and usually they differ also in having fewer whorls." The distributional tendency of these two specific pattern types in part explains the generally larger ridge count among males, for whorls typically yield larger counts than most other patterns while arches yield a zero ridge count. However, not all of the differences in means between males and females of the same population are statistically significant (see Table VIII). Although three of the groups do exhibit significant differences (0.05 level) for left

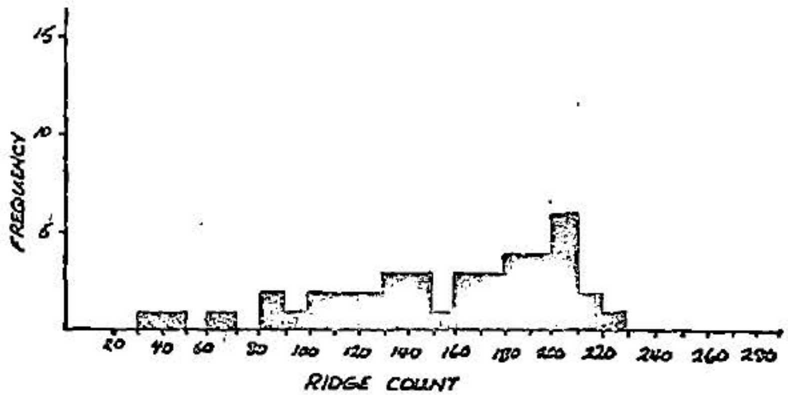


Figure 2. Distribution of total ridge counts for Nootka males (n = 42).

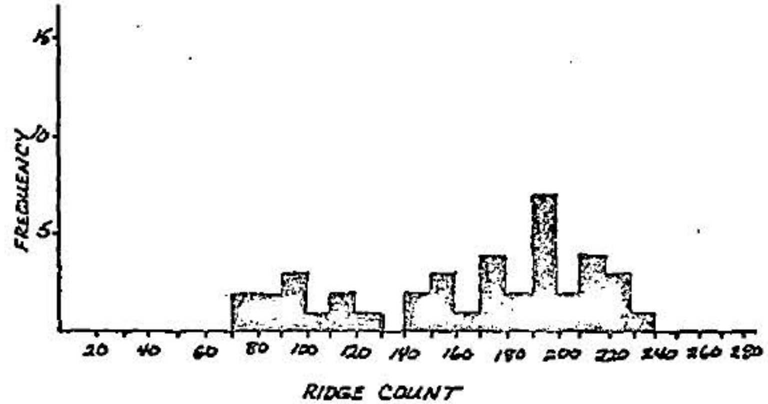


Figure 4. Distribution of total ridge counts for Kwakiutl males (n = 40).

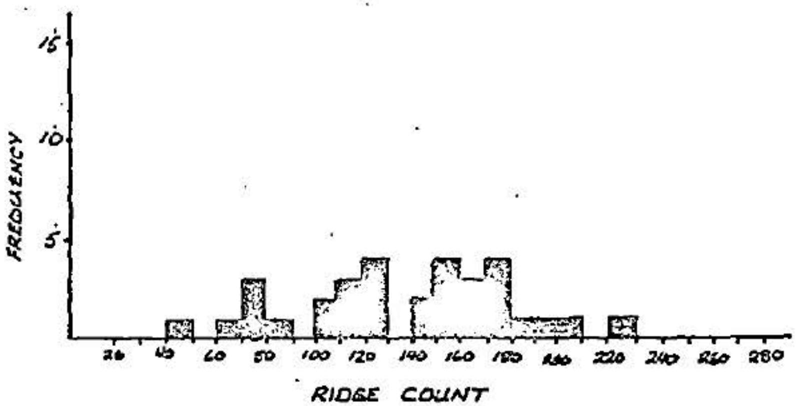


Figure 3. Distribution of total ridge counts for Nootka females (n = 32).

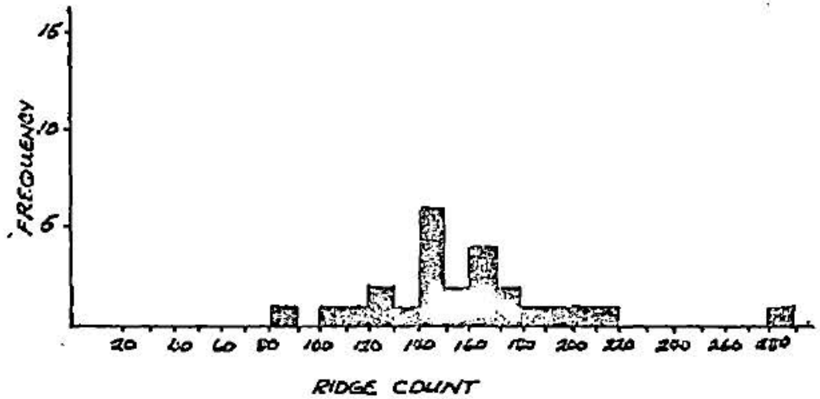


Figure 5. Distribution of total ridge counts for Kwakiutl females (n = 25).

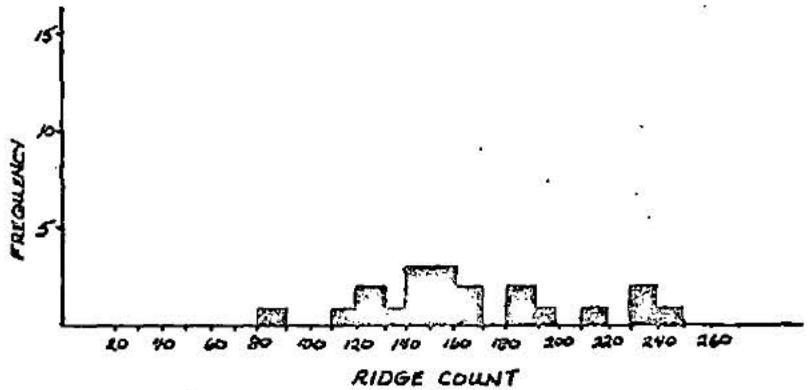


Figure 6. Distribution of total ridge counts for Tsimshian males (n = 20).

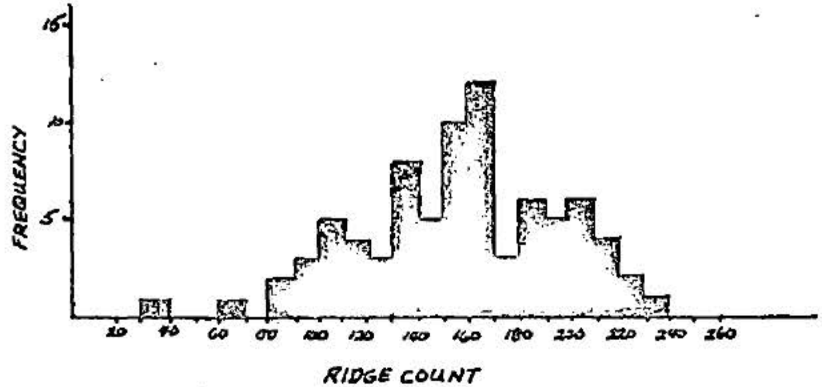


Figure 8. Distribution of total ridge counts for Athapaskan males (n = 81).

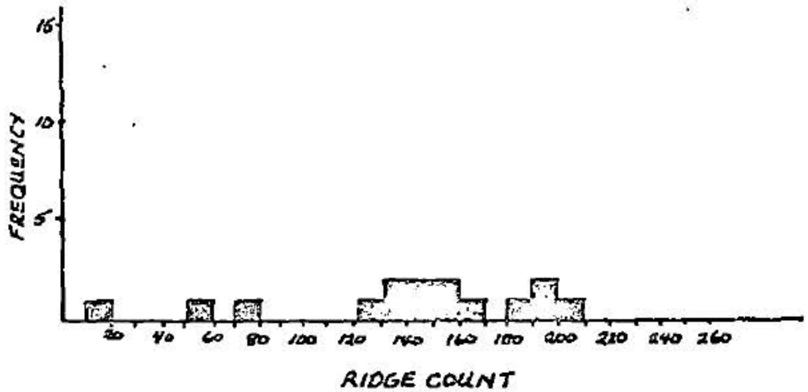


Figure 7. Distribution of total ridge counts for Tsimshian females (n = 15).

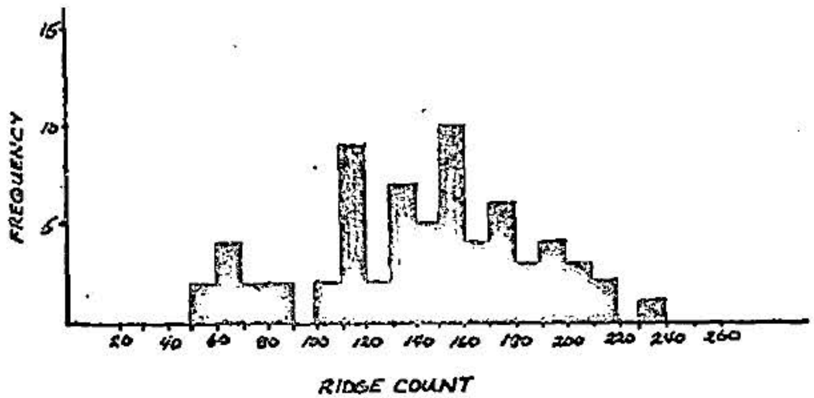


Figure 9. Distribution of total ridge counts for Athapaskan females (n = 68).

TABLE V: Mean Ridge Count, Variance, Standard Deviation, and Standard Error by Sex and Sample for Left Hands

Sample	Sex	Frequency	Mean	Variance	Standard Deviation	Standard Error
Nootka	M	42	78.1	663.6	25.8	4.0
	F	32	67.6	495.5	22.2	3.9
Kwakiutl	M	40	83.4	615.7	24.8	3.9
	F	25	81.2	415.0	20.4	4.1
Tsimshian	M	20	82.4	459.6	21.4	4.8
	F	15	67.9	763.6	27.6	7.1
Athapaskan	M	81	78.0	438.7	20.9	2.3
	F	68	70.1	576.0	24.0	2.9

TABLE VI: Mean Ridge Count, Variance, Standard Deviation, and Standard Error by Sex and Sample for Right Hands

Sample	Sex	Frequency	Mean	Variance	Standard Deviation	Standard Error
Nootka	M	42	76.7	618.1	24.9	3.8
	F	32	68.9	498.1	22.3	3.9
Kwakiutl	M	40	81.4	543.2	23.3	3.7
	F	25	77.8	438.4	20.9	4.2
Tsimshian	M	20	82.1	518.2	22.8	5.1
	F	15	70.9	718.4	26.8	6.9
Athapaskan	M	81	77.0	412.0	20.3	2.2
	F	68	72.8	424.4	20.6	2.5

TABLE VII: Mean Ridge Count, Variance, Standard Deviation, and Standard Error by Sex and Sample for Left and Right Hands Combined

Sample	Sex	Frequency	Mean	Variance	Standard Deviation	Standard Error
Nootka	M	42	154.8	2415.3	49.1	7.6
	F	32	136.5	1875.0	43.3	7.6
Kwakiutl	M	40	164.8	2250.5	47.4	7.5
	F	25	159.0	1621.4	40.3	8.0
Tsimshian	M	20	164.5	1866.8	43.2	9.7
	F	15	138.7	2844.4	53.3	13.8
Athapaskan	M	81	155.1	1609.9	40.1	4.4
	F	68	142.9	1897.0	43.6	5.3

TABLE VIII: Values of t and Chance Probabilities for Intra-Group Differences by Sex in Mean Ridge Counts

Variable	Samples Compared	Degrees of Freedom	t	Levels of Significance 0.10	0.05	0.01
Left Hand	N-N	72	1.836		*	
	K-K	63	0.367			
	T-T	33	1.707		*	
	A-A	147	2.191		*	
Right Hand	N-N	72	1.392	*		
	K-K	63	0.626			
	T-T	33	1.304	*		
	A-A	147	1.264			
Combined Hands	N-N	72	1.952		*	
	K-K	63	0.573			
	T-T	33	1.538			
	A-A	147	1.796		*	

TABLE IX: Values of t and Chance Probabilities for Intra-Group Differences by Hand in Mean Ridge Counts

Sex	Samples Compared	Degrees of Freedom	t	Levels of Significance 0.10	0.05	0.01
M	N-N	82	0.256			
	K-K	78	0.376			
	T-T	38	0.041			
	A-A	160	0.314			
F	N-N	62	-0.228			
	K-K	48	0.538			
	T-T	28	-0.293			
	A-A	134	-0.733			

hand mean ridge counts, the Kwakiutl do not. For right hand mean ridge counts the situation is almost completely reversed as none of the four groups exhibit significant differences. When right and left hands are combined and these differences in means are analyzed, both the Nootka and Athapaskan groups again exhibit differences that are significant at the 0.05 level. These conflicting results obviously make generalizations about male-female differences hazardous.

None of the eight groupings exhibit statistically significant differences (see table IX). Also important, unlike the differences in means between the sexes of the same group, there is only partial supporting evidence of the tendency, observed by Cummins and Midlo (1961:194), for right digits to possess a higher quantitative value than that of their left counterparts. Referring to Tables V and VI, the results indicate that while three of the four female groups exhibit higher mean ridge counts on right hands (the Kwakiutl group is the only exception), none of the male groups do. Instead, all male groupings and the female Kwakiutl grouping possess higher mean ridge counts on the left hand than on the right; however, none of the differences are statistically significant. It is apparent that sex differences in mean ridge counts are statistically more important than bimanual differences. For the purpose of analysis, in these populations it appears unnecessary to separate data by hands.

Inter-group Differences

Table X presents the results obtained from an analysis of variance of the four samples by sex for the three ridge count categories. None of the differences between groups compared are statistically significant.

TABLE X: Analysis of Variance of the Four Samples by Sex and Hand (Separately as well as Combined) for Ridge Counts

Variable	Samples Compared	Degrees of Freedom	F Ratio	Levels of Significance 0.10	0.05	0.025	0.01
Left Hand	Males	3; 179	0.6510				
	Females	3; 136	1.9362				
Right Hand	Males	3; 179	0.6053				
	Females	3; 136	0.8152				
Combined Hands	Males	3; 179	0.6522				
	Females	3; 136	1.3620				

A further evaluation of the statistical significance of inter-group differences in mean ridge counts is presented in the following three tables. Table XI gives results for left hand mean ridge counts; Table XII, right hand mean ridge counts; and Table XIII for the combined left and right hand mean ridge counts. Only a very few of the inter-group differences are statistically significant at the 0.05 level. For left hand mean ridge counts, three of the female inter-group differences (N-K, K-T, and K-A) are significant while none of the male differences are. Of the three significant female differences, none are significant at the 0.01 level. For right hand mean ridge counts, none of the male or female inter-group differences are significant at the 0.05 level. As expected, for combined left and right hand mean ridge counts, none of the male differences are significant, but two of the female differences are (N-K and K-A). The N-K (female) difference in means is significant at the 0.01 level.

Although there exist no statistically significant inter-group differences among the male groupings, apparently some clustering of groups is taking place. In all three categories examined, the Nootka and Athapaskan mean ridge counts are virtually identical. The same thing is true for the Kwakiutl and Tsimshian groups. Unfortunately, not much weight can be given this apparent clustering as none of the differences are even close to being significant.

Among the female groupings, there are not only a number of significant inter-group differences, but also a consistent sequence for the groups when arranged on a scale according to ridge count means. In all three categories, the ranking of groups from lowest mean ridge count to highest is as follows: Nootka, Tsimshian, Athapaskan, and

TABLE XI: Values of t and Chance Probabilities for Inter-Group Differences by Sex in Left Hand Mean Ridge Counts

Sex	Samples Compared	Degrees of Freedom	t	Levels of Significance		
				0.10	0.05	0.01
M	N-K	80	-0.953			
	N-T	60	-0.641			
	N-A	121	0.011			
	K-T	58	0.158			
	K-A	119	1.248			
	T-A	99	0.821			
F	N-K	55	-2.345		*	
	N-T	45	-0.036			
	N-A	98	-0.497			
	K-T	38	1.714		*	
	K-A	91	2.059		*	
	T-A	81	-0.314			

TABLE XII: Values of t and Chance Probabilities for Inter-Group Differences by Sex in Right Hand Mean Ridge Counts

Sex	Samples Compared	Degrees of Freedom	t	Levels of Significance 0.10	0.05	0.01
M	N-K	80	-0.880			
	N-T	60	-0.814			
	N-A	121	-0.084			
	K-T	58	-0.108			
	K-A	119	1.054			
	T-A	99	0.968			
F	N-K	55	-1.506	*		
	N-T	45	-0.262			
	N-A	98	-0.876			
	K-T	38	0.885			
	K-A	91	1.011			
	T-A	81	-0.154			

TABLE XIII: Values of t and Chance Probabilities for Inter-Group Differences by Sex for Mean Ridge Counts, Combined Left and Right Hands

Sex	Samples Compared	Degrees of Freedom	t	Levels of Significance 0.10	0.05	0.01
M	N-K	80	-0.938			
	N-T	60	-0.747			
	N-A	121	-0.036			
	K-T	58	0.027			
	K-A	119	1.180			
	T-A	99	0.919			
F	N-K	55	-3.823			*
	N-T	45	-0.201			
	N-A	98	-0.794			
	K-T	38	1.658	*		
	K-A	91	1.764		*	
	T-A	81	-0.323			

Kwakiutl. The Kwakiutl have by far the largest ridge count means in all three categories, especially for the combined left and right hand category. For left hand ridge counts, the differences in means between the Kwakiutl and each of the other three groups are significant at the 0.05 level. None of the mean differences is significant for the right hand but when left and right hands are combined and means calculated, the differences in means between the Kwakiutl and the Nootka and Athapaskan groups are again significant. Why the Tsimshian mean does not also differ significantly is probably due to its relatively large standard deviation (53.3). For the female groups, it would appear that the Kwakiutl are distinct from the other three groups with respect to mean ridge counts.

Pattern Types

The classification of pattern types, like most systems of classification, can be subdivided into finer and finer groupings, depending upon the specific aims of individual researchers and their specific research requirements. There has developed for dermatoglyphics a system of classification that seems to fit the specific needs of most of the researchers most of the time. The arch-loop-Whorl classification of Galton is certainly the most basic classification in dermatoglyphics and still receives wide usage among various researchers. There is, however, a further system, the Henry classification, that, according to Cummins and Midlo (1961:60), is not only more widely used than any other but also provides the foundation for the modified systems as well. In this system there are four main types of patterns: arches, loops, (true) whorls and composites (whorl deviates). Both the Galton and Henry systems of classification (with, at times, slight modification) have been used in this study.

The analysis of digital pattern types in accordance with standard procedure is divided into three basic sections: (1) analysis of individual digits, (2) analysis of the hands separately as well as combined, and (3) analysis of the index of pattern intensity and other indices. The sexes of each group are treated separately.

Analysis of Pattern Types by Single Digits

Percentage frequencies of pattern types on single digits in each of the four groups are presented in Tables XIV and XV (Nootka), XVI and XVII (Kwakiutl), XVIII and XIX (Tsimshian) and XX and XXI (Athapaskan). These data are condensed in Tables XXII (males and XXIII (females), for easier comparative analysis. In Tables XXII and XXIII,

TABLE XIV: Percentage Frequencies of Finger Pattern Types on Individual Digits in Nootka Males (n = 42)

Digit	Side	Pattern Types						Number of Digits
		Whorl Deviate	Whorl	Ulnar Loop	Radial Loop	Tented Arch	Arch	
	L	45.2	26.2	23.8	2.4	-	2.4	42
I	R	33.3	45.2	19.1	2.4	-	-	42
	L + R	39.3	35.7	21.4	2.4	-	1.2	84
	L	19.1	26.2	23.8	11.9	14.3	4.8	42
II	R	14.3	33.3	26.2	14.3	7.1	4.8	42
	L + R	16.7	29.8	25.0	13.1	10.7	4.8	84
	L	14.3	11.9	59.5	-	2.4	11.9	42
III	R	9.5	19.1	69.1	-	-	2.4	42
	L + R	11.9	15.5	64.3	-	1.2	7.1	84
	L	11.9	61.9	21.4	-	-	4.8	42
IV	R	4.8	59.5	35.7	-	-	-	42
	L + R	8.3	60.7	28.6	-	-	2.4	84
	L	9.5	9.5	80.9	-	-	-	42
V	R	4.8	19.1	73.8	-	-	2.4	42
	L + R	7.1	14.3	77.4	-	-	1.2	84
	L	20.0	27.1	41.9	2.9	3.3	4.8	210
I-V	R	13.3	35.2	44.8	3.3	1.4	1.9	210
	L + R	16.7	31.2	43.3	3.1	2.4	3.3	420

TABLE XV: Percentage Frequencies of Finger Pattern Types on Individual Digits in Nootka Females (n = 32)

Digit	Side	Pattern Types						Number of Digits
		Whorl Deviate	Whorl	Ulnar Loop	Radial Loop	Tented Arch	Arch	
	L	21.9	43.7	34.4	-	-	-	32
I	R	15.6	59.4	25.0	-	-	-	32
	L + R	18.7	51.6	29.7	-	-	-	64
	L	21.9	18.7	31.3	18.7	-	9.4	32
II	R	9.4	28.1	43.7	9.4	3.1	6.3	32
	L + R	15.6	23.4	37.5	14.1	1.6	7.8	64
	L	3.1	12.5	68.7	-	6.3	9.4	32
III	R	-	3.1	90.6	-	-	6.3	32
	L + R	1.6	7.8	79.7	-	3.1	7.8	64
	L	9.4	37.5	43.7	3.1	-	6.3	32
IV	R	-	40.6	50.0	3.1	-	6.3	32
	L + R	4.7	39.1	46.9	3.1	-	6.3	64
	L	-	6.3	93.7	-	-	-	32
V	R	-	9.4	90.6	-	-	-	32
	L + R	-	7.8	92.2	-	-	-	64
	L	11.3	23.7	54.4	4.4	1.2	5.0	160
I-V	R	5.0	28.1	60.0	2.5	0.6	3.8	160
	L + R	8.1	25.9	57.2	3.4	0.9	4.4	320

TABLE XVI: Percentage Frequencies of Finger Pattern Types on Individual Digits in Kwakiutl Males (n = 40)

Digit	Side	Pattern Types: Whorl Deviate	Whorl	Ulnar Loop	Radial Loop	Tented Arch	Arch	Number of Digits
	L	17.5	62.5	20.0	-	-	-	40
I	R	5.0	77.5	17.5	-	-	-	40
	L + R	11.3	70.0	18.7	-	-	-	80
	L	10.0	47.5	22.5	12.5	7.5	-	40
II	R	20.0	42.5	20.0	17.5	-	-	40
	L + R	15.0	45.0	21.3	15.0	3.7	-	80
	L	7.5	37.5	50.0	-	5.0	-	40
III	R	12.5	37.5	47.5	-	-	2.5	40
	L + R	10.0	37.5	48.7	-	2.5	1.3	80
	L	5.0	70.0	25.0	-	-	-	40
IV	R	5.0	72.5	20.0	2.5	-	-	40
	L + R	5.0	71.3	22.5	1.3	-	-	80
	L	17.5	32.5	50.0	-	-	-	40
V	R	7.5	47.5	42.5	2.5	-	-	40
	L + R	12.5	40.0	46.3	1.3	-	-	80
	L	11.5	50.0	33.5	2.5	2.5	-	200
I-V	R	10.0	55.5	29.5	4.5	-	0.5	200
	L + R	10.7	52.7	31.5	3.5	1.3	0.2	400

TABLE XVII: Percentage Frequencies of Finger Pattern Types on Individual Digits in Kwakiutl Females (n = 25)

Digit	Side	Whorl Deviate	Whorl	Ulnar Loop	Radial Loop	Tented Arch	Arch	Number of Digits
		Pattern Types						
	L	24.0	60.0	16.0	-	-	-	25
I	R	20.0	52.0	28.0	-	-	-	25
	L + R	22.0	56.0	22.0	-	-	-	50
	L	12.0	40.0	40.0	4.0	4.0	-	25
II	R	24.0	28.0	40.0	4.0	-	4.0	25
	L + R	18.0	34.0	40.0	4.0	2.0	2.0	50
	L	8.0	24.0	68.0	-	-	-	25
III	R	4.0	16.0	80.0	-	-	-	25
	L + R	6.0	20.0	74.0	-	-	-	50
	L	4.0	60.0	36.0	-	-	-	25
IV	R	4.0	60.0	36.0	-	-	-	25
	L + R	4.0	60.0	36.0	-	-	-	50
	L	4.0	20.0	76.0	-	-	-	25
V	R	4.0	12.0	84.0	-	-	-	25
	L + R	4.0	16.0	80.0	-	-	-	50
	L	10.4	40.8	47.2	0.8	0.8	-	125
I-V	R	11.2	33.6	53.6	0.8	-	0.8	125
	L + R	10.8	37.2	50.4	0.8	0.4	0.4	250

TABLE XVIII: Percentage Frequencies of Finger Pattern Types on Individual Digits in Tsimshian Males (n = 20)

Digit	Side	Pattern Types: Whorl Deviate	Whorl	Ulnar Loop	Radial Loop	Tented Arch	Arch	Number of Digits
	L	30.0	55.0	15.0	-	-	-	20
I	R	30.0	65.0	5.0	-	-	-	20
	L + R	30.0	60.0	10.0	-	-	-	40
	L	10.0	45.0	25.0	15.0	5.0	-	20
II	R	10.0	35.0	30.0	25.0	-	-	20
	L + R	10.0	40.0	27.5	20.0	3.0	-	40
	L	10.0	30.0	55.0	-	5.0	-	20
III	R	5.0	35.0	55.0	-	-	5.0	20
	L + R	7.5	32.5	55.0	-	2.5	2.5	40
	L	5.0	70.0	25.0	-	-	-	20
IV	R	-	80.0	20.0	-	-	-	20
	L + R	2.5	75.0	22.5	-	-	-	40
	L	-	40.0	60.0	-	-	-	20
V	R	-	45.0	55.0	-	-	-	20
	L + R	-	42.5	57.5	-	-	-	40
	L	11.0	48.0	36.0	3.0	2.0	-	100
I-V	R	9.0	52.0	33.0	5.0	-	1.0	100
	L + R	10.0	50.0	34.5	4.0	1.0	0.5	200

TABLE XIX: Percentage Frequencies of Finger Pattern Types on Individual Digits in Tsimshian Females (n = 15)

		Pattern Types						
Digit	Side	Whorl Deviate	Whorl	Ulnar Loop	Radial Loop	Tented Arch	Arch	Number of Digits
	L	20.0	60.0	20.0	-	-	-	15
I	R	20.0	53.3	26.7	-	-	-	15
	L + R	20.0	56.7	23.3	-	-	-	30
	L	13.3	26.7	20.0	26.7	6.7	6.7	15
II	R	20.0	26.7	40.0	6.7	-	6.7	15
	L + R	16.7	26.7	30.0	16.7	3.3	6.7	30
	L	6.7	26.7	53.3	-	-	13.3	15
III	R	-	33.3	60.0	-	-	6.7	15
	L + R	3.3	30.0	56.7	-	-	10.0	30
	L	-	66.7	26.7	-	-	6.7	15
IV	R	-	66.7	26.7	-	-	6.7	15
	L + R	-	66.7	26.7	-	-	6.7	30
	L	-	33.3	53.3	-	-	13.3	15
V	R	-	20.0	73.3	-	-	6.7	15
	L + R	-	26.7	63.3	-	-	10.0	30
	L	8.0	42.7	34.7	5.3	1.3	8.0	75
I-V	R	8.0	40.0	45.3	1.3	-	5.3	75
	L + R	8.0	41.3	40.0	3.3	0.7	6.7	150

TABLE XX: Percentage Frequencies of Finger Pattern Types on Individual Digits in Athapaskan Males (n = 81)

		Pattern Types						
Digit	Side	Whorl Deviate	Whorl	Ulnar Loop	Radial Loop	Tented Arch	Arch	Number of Digits
	L	30.7	38.3	30.7	-	-	-	81
I	R	22.2	60.5	17.3	-	-	-	81
	L + R	26.5	49.4	24.1	-	-	-	162
	L	7.4	40.7	35.8	8.6	3.7	3.7	81
II	R	13.6	40.7	33.3	9.9	-	2.5	81
	L + R	10.5	40.7	34.6	9.3	1.9	3.1	162
	L	12.3	33.3	53.1	-	-	1.2	81
III	R	7.4	34.6	55.6	-	1.2	1.2	81
	L + R	9.9	33.9	54.3	-	0.6	1.2	162
	L	12.3	59.3	28.4	-	-	-	81
IV	R	6.2	70.4	23.5	-	-	-	81
	L + R	9.3	64.8	25.9	-	-	-	162
	L	6.2	23.5	70.4	-	-	-	81
V	R	3.7	30.9	65.4	-	-	-	81
	L + R	4.9	27.2	67.9	-	-	-	162
	L	13.8	39.0	43.7	1.7	0.7	1.0	405
I-V	R	10.6	47.4	39.0	2.0	0.3	0.7	405
	L + R	12.2	43.2	41.4	1.9	0.5	0.9	810

TABLE XXI: Percentage Frequencies of Finger Pattern Types on Individual Digits in Athapaskan Females (n = 68)

		Pattern Types						
Digit	Side	Whorl Deviate	Whorl	Ulnar Loop	Radial Loop	Tented Arch	Arch	Number of Digits
	L	29.4	26.5	44.1	-	-	-	68
I	R	27.9	38.2	33.8	-	-	-	68
	L + R	28.7	32.4	40.0	-	-	-	136
	L	13.2	26.5	39.7	10.3	2.9	7.3	68
II	R	13.2	32.4	44.1	4.4	-	5.9	68
	L + R	13.2	29.4	41.9	7.4	1.5	6.6	136
	L	5.9	23.5	67.6	-	1.5	1.5	68
III	R	7.3	25.0	66.2	-	-	1.5	68
	L + R	6.6	24.3	66.9	-	0.7	1.5	136
	L	1.5	57.4	41.2	-	-	-	68
IV	R	1.5	57.4	41.2	-	-	-	68
	L + R	1.5	57.4	41.2	-	-	-	136
	L	4.4	19.1	75.0	-	-	1.5	68
V	R	4.4	13.2	82.4	-	-	-	68
	L + R	4.4	16.2	78.7	-	-	0.7	136
	L	10.9	30.6	53.5	2.1	0.9	2.1	340
I-V	R	10.9	33.2	53.5	0.9	-	1.5	340
	L + R	10.9	31.9	53.5	1.5	0.4	1.8	680

TABLE XXII: Percentage Frequencies of Finger Pattern Types on Individual Digits in Males (Nootka - 42; Kwakiutl - 40; Tsimshian - 20; Athapaskan - 81)

			Pattern Types				
				Loops			Number of
Digit	Side	Sample	Whorls	Ulnar	Radial	Arches	Digits
I	L	NOO	71.4	23.8	2.4	2.4	42
		KWAK	80.0	20.0	-	-	40
		TSIM	85.0	15.0	-	-	20
		ATHA	69.0	30.7	-	-	81
	R	NOO	88.5	19.1	2.4	-	42
		KWAK	82.5	17.5	-	-	40
		TSIM	95.0	5.0	-	-	20
		ATHA	82.7	17.3	-	-	81
	L + R	NOO	75.0	21.4	2.4	1.2	84
		KWAK	81.3	18.7	-	-	80
		TSIM	90.0	10.0	-	-	40
		ATHA	75.9	24.1	-	-	162
II	L	NOO	45.3	23.8	11.9	19.1	42
		KWAK	57.5	22.5	12.5	7.5	40
		TSIM	55.0	25.0	15.0	5.0	20
		ATHA	48.1	35.8	8.6	7.4	81
	R	NOO	47.6	26.2	14.3	11.9	42
		KWAK	62.5	20.0	17.5	-	40
		TSIM	45.0	30.0	25.0	-	20
		ATHA	54.3	33.3	9.9	2.5	81
	L + R	NOO	46.5	25.0	13.1	15.5	84
		KWAK	60.0	21.3	15.0	3.7	80
		TSIM	50.0	27.5	20.0	3.0	40
		ATHA	51.2	34.6	9.3	5.0	162

TABLE XXII (continued)

III	L	NOO	26.2	59.5	-	14.3	42
		KWAK	45.0	50.0	-	5.0	40
		TSIM	40.0	55.0	-	5.0	20
		ATHA	45.6	53.1	-	1.2	81
	R	NOO	28.6	69.1	-	2.4	42
		KWAK	50.0	47.5	-	2.5	40
		TSIM	40.0	55.0	-	5.0	20
		ATHA	42.0	55.6	-	2.4	81
	L + R	NOO	27.4	64.3	-	8.3	84
		KWAK	47.5	48.7	-	3.8	80
		TSIM	40.0	55.0	-	5.0	40
		ATHA	43.8	54.3	-	1.8	162
IV	L	NOO	73.8	21.4	-	4.8	42
		KWAK	75.0	25.0	-	-	40
		TSIM	75.0	25.0	-	-	20
		ATHA	71.6	28.4	-	-	81
	R	NOO	64.3	35.7	-	-	42
		KWAK	77.5	20.0	2.5	-	40
		TSIM	80.0	20.0	-	-	20
		ATHA	76.6	23.5	-	-	81
	L + R	NOO	69.0	28.6	-	2.4	84
		KWAK	76.3	22.5	1.3	-	80
		TSIM	77.5	22.5	-	-	40
		ATHA	74.1	25.9	-	-	162
V	L	NOO	19.0	80.9	-	-	42
		KWAK	50.0	50.0			40
		TSIM	40.0	60.0	-	-	20
		ATHA	29.7	70.4	-	-	81
	R	NOO	23.9	73.8	-	2.4	42
		KWAK	55.0	42.5	2.5	-	40
		TSIM	45.0	55.0	-	-	20
		ATHA	34.6	65.4	-	-	81
	L + R	NOO	21.4	77.4	-	1.2	84
		KWAK	52.5	46.3	1.3	-	80
		TSIM	42.5	57.5	-	-	40
		ATHA	32.1	67.9	-	-	162

TABLE XXIII: Percentage Frequencies of Finger Pattern Types on Individual Digit in Females (Nootka - 32; Kwakiutl - 25; Tsimshian - 15; Athapaskan - 68)

Digit	Side	Sample	Pattern Types				Number of Digits
			Whorls	Loops Ulnar	Loops Radial	Arches	
I	L	NOO	65.6	34.4	-	-	32
		KWAK	84.0	16.0	-	-	25
		TSIM	80.0	20.0	-	-	20
		ATHA	55.9	44.1	-		68
	R	NOO	75.0	25.0	-	-	32
		KWAK	72.0	28.0	-	-	25
		TSIM	73.3	26.7	-	-	20
		ATHA	66.1	33.8	-	-	68
	L + R	NOO	70.3	29.7	-	-	64
		KWAK	78.0	22.0	-	-	50
		TSIM	76.7	23.3	-	-	40
		ATHA	61.1	40.0	-	-	136
II	L	NOO	40.6	31.3	18.7	9.4	32
		KWAK	52.0	40.0	4.0	4.0	25
		TSIM	40.0	20.0	26.7	13.4	20
		ATHA	39.7	39.7	10.3	10.3	68
	R	NOO	37.5	43.7	9.4	9.4	32
		KWAK	52.0	40.0	4.0	4.0	25
		TSIM	46.7	40.0	6.7	6.7	20
		ATHA	45.6	44.1	4.4	5.9	68
	L + R	NOO	39.0	37.5	14.1	9.4	64
		KWAK	52.0	40.0	4.0	4.0	50
		TSIM	43.4	30.0	16.7	10.0	40
		ATHA	42.6	41.9	7.4	8.1	136

TABLE XXIII (continued)

III	L	NOO	15.6	68.7	-	15.7	32
		KWAK	32.0	68.0	-	-	25
		TSIM	33.4	53.3	-	13.3	20
		ATHA	29.4	67.6	-	3.0	68
	R	NOO	3.1	90.6	-	6.3	32
		KWAK	20.0	80.0	-	-	25
		TSIM	33.3	60.0	-	6.7	20
		ATHA	32.3	66.2	-	1.5	68
	L + R	NOO	9.4	79.7	-	10.9	64
		KWAK	26.0	74.0	-	-	50
		TSIM	33.3	56.7	-	10.0	40
		ATHA	30.9	66.9	-	2.2	136
IV	L	NOO	46.9	43.7	3.1	6.3	32
		KWAK	64.0	36.0	-	-	25
		TSIM	66.7	26.7	-	6.7	20
		ATHA	58.9	41.2	-	-	68
	R	NOO	40.6	50.0	3.1	6.3	32
		KWAK	64.0	36.0	-	-	25
		TSIM	66.7	26.7	-	6.7	20
		ATHA	58.9	41.2	-	-	68
	L + R	NOO	43.8	46.9	3.1	6.3	64
		KWAK	64.0	36.0	-	-	50
		TSIM	66.7	26.7	-	6.7	40
		ATHA	58.9	41.2	-	-	136
V	L	NOO	6.3	93.7	-	-	32
		KWAK	24.0	76.0	-	-	25
		TSIM	33.3	53.3	-	13.3	20
		ATHA	23.5	75.0	-	1.5	68
	R	NOO	9.4	90.6	-	-	32
		KWAK	16.0	84.0	-	-	25
		TSIM	20.0	73.3	-	6.7	20
		ATHA	17.6	82.4	-	-	68
	L + R	NOO	7.8	92.2	-	-	64
		KWAK	20.0	80.0	-	-	50
		TSIM	26.7	63.3	-	10.0	40
		ATHA	20.6	78.7	-	0.7	136

true whorls and whorl deviates have been combined to form a single whorl category; and true arches and tented arches have been combined to form a single category. Loop categories have remained unchanged. This classification, therefore, closely resembles that devised by Galton.

In general, for both the male and female groupings, right and left hands, whorls occur more frequently than ulnar loops on digits I, II, and IV. Conversely, ulnar loops occur more frequently than whorls on digits III and V. There are, however, a few exceptions (see Table XXII). Further, radial loops and arches are characteristically more abundant on digit II than on any other digit. The distribution of radial loops for both males and females certainly verifies this statement while for arches it is not nearly so clear (see Tables XXII and XXIII). The distribution of arches is spread over a greater number of digits than is the case for radial loops, especially among the female groupings, and not all groups exhibit the highest percentage of arches on digit II.

Many of the differences exhibited by various pattern types on a single digit are indeed quite small and consequently, little weight, if any at all, can or should be given them separately concerning their significance. Nevertheless, I will discuss each of the digits in turn, with a view to tentatively establishing some possible relationships between each of the four groups.

This discussion will involve only those percentage frequencies listed for left and right hands combined, an average of the recorded percentages for the left and right hands separately (see Tables XXII and XXIII. Groupings based on sex will be retained and discussed separately. For males, digit I category, the Nootka and Athapaskan groups have approximately the same percentage of whorls (75.0% and 75.9% respectively) while the Tsimshian have a substantially higher percentage (90.0%), and subsequently fewer ulnar loops (10.0%). The Kwakiutl are essentially in an intermediate position with respect to both percentages of whorls (81.3%) and ulnar loops (18.7%). In female groupings, the Kwakiutl and Tsimshian have similar percentage of both whorls (78.0% and 76.7% respectively) and ulnar loops (22.0% and 23.3% respectively). The Athapaskan are distinguished from the other three groups by having the lowest percentage of whorls (61.1%) and the highest percentage of ulnar loops (40.0%). The Nootka occupy an intermediate position in this category. Of the eight groupings only the Nootka males possess percentages for either radial loops or arches on digit I.

For digit II, males, the Kwakiutl possess the highest percentage of whorls (60.0%) and the lowest percentage of ulnar loops (21.3%). The percentages exhibited by the other three groups with respect to these two pattern types are quite similar although the Athapaskan do have a fairly high percentage of ulnar loops (34.6%). Of further notice is the extremely high percentage of arches exhibited by the Nootka (15.5%). The distribution of radial loops shows the Athapaskan with the lowest percentage (9.3%) and the Tsimshian the highest (20.0%). In the female groupings, the Kwakiutl possess a relatively high percentage of both whorls (52.0%) and ulnar loops (40.0%). Both the Nootka and Tsimshian exhibit relatively high percentages of radial loops (14.1% and 16.7% respectively) and arches (9.4% and 10.0% respectively). The Athapaskan also possess a relatively high percentage of arches (8.1%).

Of note for the male groupings for digit III, is the low percentage of whorls (27.4%) exhibited by the Nootka and their correspondingly high percentage of ulnar loops (64.3%) and arches (8.3%). For female groupings, the Nootka are again characterized by a low whorl percentage (9.4%) and a high arch percentage (10.9%). The Tsimshian also have a high percentage of arches (10.0%).

The tendency noted for Nootka males in digit III also appears to be present in digit IV, although not of the same magnitude. The Nootka possess the lowest percentage of whorls (69.0%) and the highest percentage of ulnar loops (28.6%). The Athapaskan (the next closest group) are not very different in terms of whorl and ulnar loop percentages (74.1% and 25.9% respectively). The Nootka are also the only group with arches on this digit (2.4%). The same pattern is also apparent among the female groupings. The Nootka again exhibit the lowest percentage of whorls (43.8%) and the highest percentage of ulnar loops (46.9%) of any of the four groups. They also exhibit a high percentage of arches (6.3%), along with the Tsimshian (6.7%), and are the only group possessing radial loops on this digit (3.1%).

For digit V, Nootka males and females have the lowest whorl percentages (7.8% and 21.4% respectively) and the highest ulnar loop percentages (92.2% and 77.4% respectively) in their respective groupings. No other group possesses similar percentages for these two pattern types. Also of note, the Tsimshian males possess a high percentage of arches (10.0%).

In summary, I think it can be said that the Nootka, particularly the males for the whorl and arch categories, possess sufficiently distinct percentages in relation to the other three groups to warrant their possible separation. For example, Nootka males consistently exhibit the lowest percentage of whorls and the highest percentage of arches on each of the five digits. The females are not as consistent as the males in this respect although they do exhibit the lowest percentage of whorls for all four groups on all digits except digit I. Further, Nootka males and females exhibit the highest percentage of ulnar loops on digits III, IV, and V; the Athapaskan, in both cases, exhibit the highest percentages on digits I and II.

Some general statements can also be made for groups other than the Nootka. Kwakiutl males tend to have the highest percentage of whorls (except digits I and IV) and the lowest percentage of ulnar loops (except digit I) of all four groups. Tsimshian males replace them in the three exceptions noted above. This pattern is not present for female groups. Instead the Tsimshian tend to have the highest percentage of whorls (except digits I and II) and the lowest percentage of ulnar loops (except digit I). In the three above exceptions, the Tsimshian are replaced by the Kwakiutl. It will be noted that the pattern for females in the ulnar loop category with respect to lowest percentages is exactly opposite that found for males. The fact that Athapaskan males and females have received very little comment in this discussion is primarily a result of their tendency to consistently occupy an intermediate position with respect to the distribution of pattern types on single digits.

It is now possible to make a few tentative generalizations concerning the inter-relationships that possibly exist between each of the four samples. First, I think it is fairly clear that the Nootka possess certain characteristics that differentiate them from the remaining three groups with perhaps the possible exception of the Athapaskan. Second, it appears that the Kwakiutl and Tsimshian, in terms of percentages exhibited for specific pattern types (with the exception of arches), together occupy a somewhat similar position. These two groups consistently exhibit percentages of specific pattern types (particularly whorls and ulnar loops) that are directly opposite those exhibited by the Nootka. For example, the Nootka consistently exhibit a low percentage of whorls and a high percentage of ulnar loops while the Kwakiutl and Tsimshian groups exhibit an opposing pattern characterized by a high percentage of whorls and a low percentage of ulnar loops. It should also be noted that while the Nootka males exhibit a high percentage of arches, their female counterparts must share this distinction with Tsimshian females. Third, both the Athapaskan males and females consistently occupy what might best be described as an intermediate position between the Nootka and Kwakiutl/Tsimshian extremes. Further, it appears that the males of this group have a tendency toward the Nootkan pattern while the females, conversely, have a tendency toward the Kwakiutl/Tsimshian situation. As a result there appears to be no clear-cut affinity with either of these two groupings. The Athapaskans, therefore, are best described at this point in the analysis as an intermediate group residing somewhere between the Nootka and Kwakiutl/Tsimshian extremes.

Analysis of Pattern Types by Hand

The foregoing section was concerned with the analysis of pattern types on individual digits. In this section the percentage of specific pattern types will be examined by hand, separately as well as combined (see Table XXIV). The sexes will again be treated separately. These data are presented graphically in Figures 10 and 11 (male left

TABLE XXIV: Percentage Frequencies of Pattern Types in Each of the Four Samples by Hand (Separately as well as Combined) and Sex

Sample	Sex	Side	Pattern Types: Whorl Deviate	Whorl	Ulnar Loop	Radial Loop	Tented Arch	Arch	Number of Digits
Nootka	M	L	20.0	27.1	41.9	2.9	3.3	4.8	210
(74)	(42)	R	13.3	35.2	44.8	3.3	1.4	1.9	210
		L + R	16.7	31.2	43.3	3.1	2.4	3.3	420
	F	L	11.3	23.8	54.4	4.4	1.3	5.0	160
	(32)	R	5.0	28.1	60.0	2.5	0.6	3.8	160
		L + R	8.1	25.9	57.2	3.4	0.9	4.4	320
Kwakiutl	M	L	11.5	50.0	33.5	2.5	2.5	-	200
(65)	(40)	R	10.0	55.5	29.5	4.5	-	0.5	200
		L + R	10.8	52.8	31.5	3.5	1.3	0.3	400
	F	L	10.4	40.8	47.2	0.8	0.8	-	125
	(25)	R	11.2	33.6	53.6	0.8	-	0.8	125
		L + R	10.8	37.2	50.4	0.8	0.4	0.4	250
Tsimshian	M	L	11.0	48.0	36.0	3.0	2.0	-	100
(35)	(20)	R	9.0	52.0	33.0	5.0	-	1.0	100
		L + R	10.0	50.0	34.5	4.0	1.0	0.5	200
	F	L	8.0	42.7	34.7	5.3	1.3	8.0	75
	(15)	R	8.0	40.0	45.3	1.3	-	5.3	75
		L + R	8.0	41.3	40.0	3.3	0.7	6.7	150
Athapaskan	M	L	13.8	39.0	43.7	1.7	0.7	1.0	405
(149)	(81)	R	10.6	47.4	39.0	2.0	0.3	0.7	405
		L + R	12.2	43.2	41.4	1.9	0.5	0.9	810
	F	L	10.9	30.6	53.5	2.1	0.9	2.1	340
	(68)	R	10.9	33.2	53.5	0.9	-	1.5	340
		L + R	10.9	31.9	53.5	1.5	0.4	1.8	680

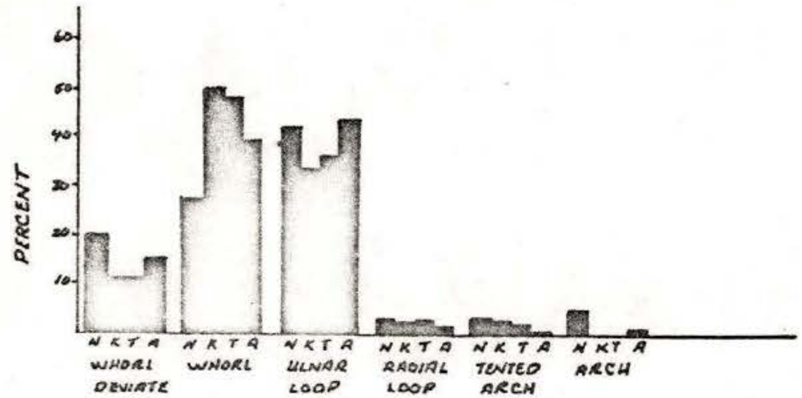


Figure 10. Distribution of digital pattern types for males left hand.

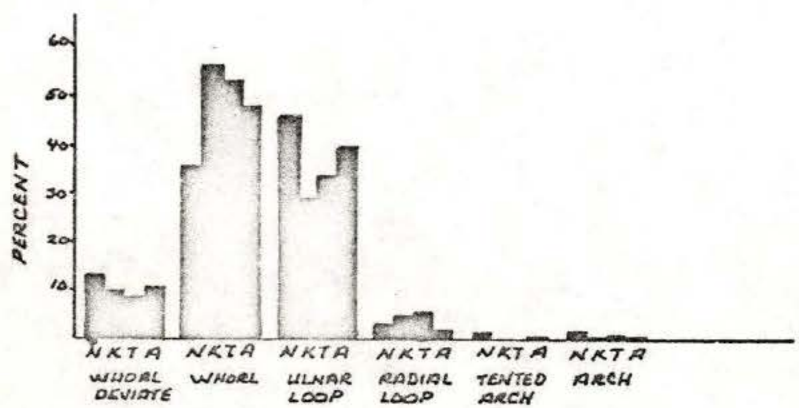


Figure 11. Distribution of digital pattern types for males right hand.

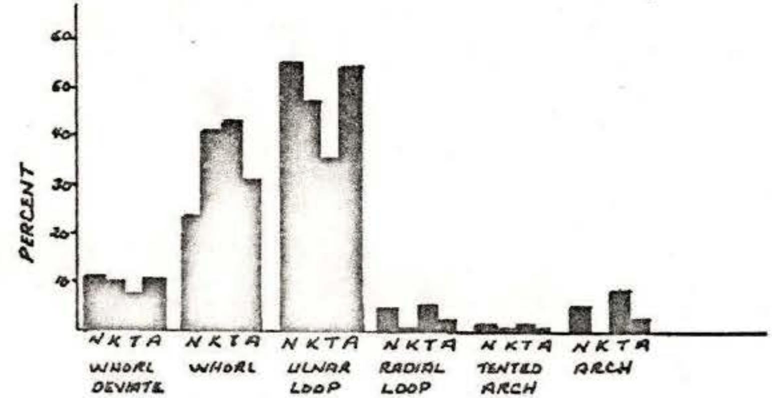


Figure 12. Distribution of digital pattern types for females left hand.

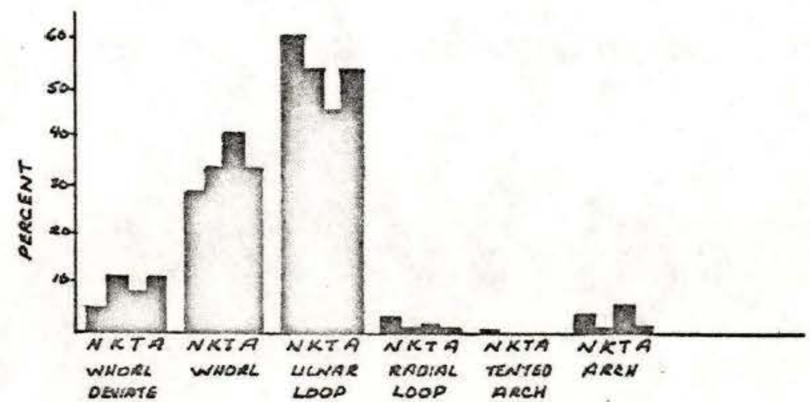


Figure 13. Distribution of digital pattern types for females right hand.

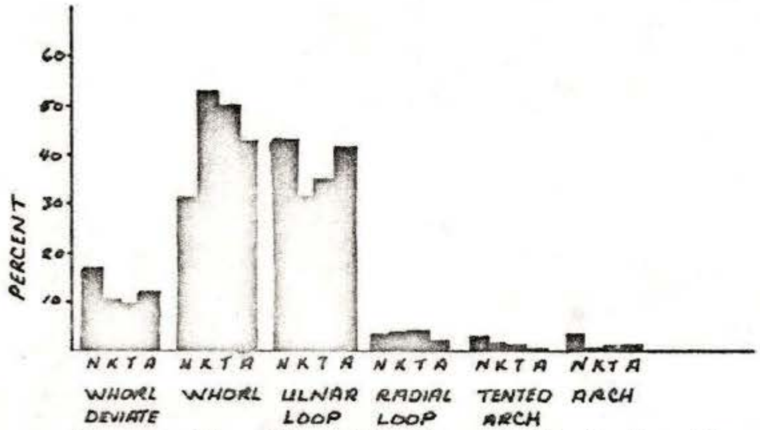


Figure 14. Distribution of digital pattern types for males left and right hands combined.

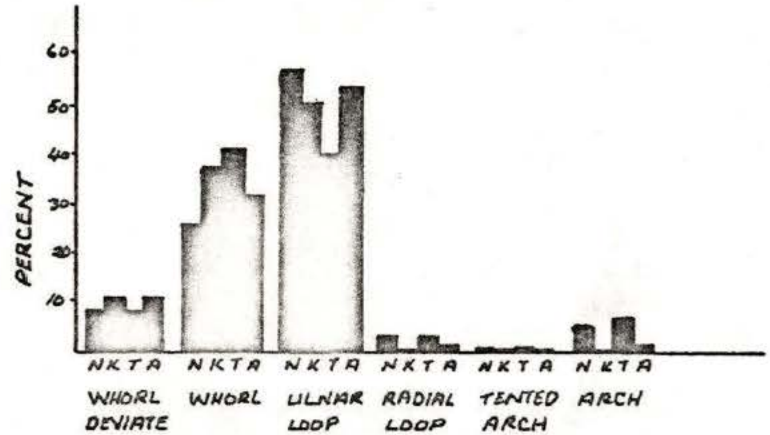


Figure 15. Distribution of digital pattern types for females left and right hands combined.

and right hands respectively), 12 and 13 (female left and right hands), and 14 and 15 (male left and right hands combined, and female left and right hands combined). Table XXV presents the same data but in a condensed form so as to facilitate comparative analysis. Similarly, the data presented in Table XXVI have been condensed from Table XXV. This has been done for two reasons: (1) for the purpose of comparative analysis with respect to the total frequencies recorded for the category left and right hands combined; and (2) to bring together the percentage frequencies used in the calculation of the pattern indices. These indices will be dealt with in the following section. It will also be noted that Tables XXV and XXVI are a condensed version of Table XXIV: whorl deviates and true whorls have been combined, as they were in the foregoing section, to form a single whorl category; and true arches and tented arches have been combined to form a single arch category. Loop categories have again remained unchanged. As before, the classification used here closely approximates that devised by Galton.

A consideration of the distribution of pattern types by hand in each of the four groups (see Table XXV) shows that, for males, whorls are more abundant than ulnar loops on both right and left hands, separately and combined. Among females this is generally not the case except for the Tsimshian (all three categories) and the Kwakiutl (left hand only). All other female groups and subsequent categories exhibit an opposite pattern: ulnar loops being more abundant than whorls. This apparent reversal in percentage frequencies of these two pattern types can be explained to some extent by the fact that females generally exhibit a lower frequency of whorls than do males (Cummins and Midlo 1961:272). This generalization is consistent with the results of this

TABLE XXV: Percentage Frequencies of Condensed Pattern Types in Each of the Four Samples by Hand (Separately as well as Combined) and Sex

Sample	Sex	Side	Pattern Types: Whorls	Loops: Ulnar	Loops: Radial	Arches	Number of Digits
Nootka	M	L	47.1	41.9	2.9	8.1	210
	(42)	R	48.6	44.8	3.3	3.3	210
		L + R	47.9	43.3	3.1	5.7	420
	F	L	35.0	54.4	4.4	6.3	160
	(40)	R	33.1	60.0	2.5	4.4	160
		L + R	34.1	57.2	3.4	5.3	320
Kwakiutl	M	L	61.5	33.5	2.5	2.5	200
	(40)	R	65.5	29.5	4.5	0.5	200
		L + R	63.5	31.5	3.5	1.5	400
	F	L	51.2	47.2	0.8	0.8	125
	(25)	R	44.8	53.6	0.8	0.8	125
		L + R	48.0	50.4	0.8	0.8	250
Tsimshian	M	L	59.0	36.0	3.0	2.0	100
	(20)	R	61.0	33.0	5.0	1.0	100
		L + R	60.0	34.5	4.0	1.5	200
	F	L	50.7	34.7	5.3	9.3	75
	(15)	R	48.0	45.3	1.3	5.3	75
		L + R	49.3	40.0	3.3	7.3	150
Athapaskan	M	L	52.8	43.7	1.7	1.7	405
	(81)	R	58.0	39.0	2.0	1.0	405
		L + R	55.4	41.4	1.9	1.4	810
	F	L	41.5	53.5	2.1	2.9	340
	(68)	R	44.1	53.5	0.9	1.5	340
		L + R	42.8	53.5	1.5	2.2	680

TABLE XXVI: Percentage Frequencies of Pattern Types in Each of the Four Samples (Left and Right Hands Combined) and Values for Pattern Intensity, Furuhata's and Dankmeijer's Indices

		Pattern Types						
			Loops					
Sex	Sample	Whorls	Ulnar	Radial	Arches	Index of Pattern Intensity[1]	Furuhata's Index[2]	Dankmeijer's Index[3]
M	NOO	47.9	43.3	3.1	5.7	14.21	103.08	11.94
	KWAK	63.6	31.5	3.5	1.4	16.20	181.43	2.36
	TSIM	60.0	34.5	4.0	1.5	15.85	155.84	2.50
	ATHA	55.4	41.4	1.8	1.4	15.41	128.29	2.45
F	NOO	34.0	57.2	3.4	5.3	12.88	56.19	15.60
	KWAK	48.0	50.4	0.8	0.8	14.72	93.75	1.67
	TSIM	49.3	40.0	3.3	7.4	14.20	113.85	14.86
	ATHA	42.8	53.5	1.5	2.2	14.06	77.81	5.16

(1) ([Whorls x 2] + Loops) divided by 10 (using percentage frequencies as shown in this Table)

(a) divided by 10 when using percentage frequencies, and
(b) divided by N (total number of individuals) when using absolute frequencies

(2) (Whorls divided by Loops) x 100

(3) (Arches divided by Whorls) x 100

study. Equally consistent is the fact that females exhibit a higher frequency of ulnar loops than their male counterparts with the only exception being the Tsimshian (left hand only). It has also been noted by Cummins and Midlo (1961:272) that females " . . . almost universally differ from males in having more arches . . . ." This was found to be true only among the Tsimshian and Athapaskan groups. However, the differences in percentage of arches for males and females in the Nootka and Kwakiutl groups are indeed quite small for the combined hands category (0.4% and 0.7% respectively).

Distribution of pattern types by hand (see Table XXV) indicates that for males, whorls and radial loops are more abundant on the right hand than the left in each of the four groups. However, for females this situation is almost completely reversed, with whorls and radial loops being more abundant on the left hand than the right (the Athapaskan being the only exception). It should also be noted that the Kwakiutl females exhibit identical percentages for radial loops on both the left and right hands. With respect to ulnar loops it was found that percentages for males are higher on the left hand than the right (the Nootka being the only exception), and for females, the reverse is true: higher percentages are found on the right hand (Athapaskan exhibiting identical percentages). In arches, both males and females exhibit higher percentages on the left hand than the right (Kwakiutl females exhibit identical percentages).

As would be expected, many of the same generalizations that were previously noted concerning the distribution of specific pattern types on single digits apply to the analysis by hand. The Nootka, both males and females, possess the lowest percentage of whorls and the highest percentage of ulnar loops. Conversely, the Kwakiutl and Tsimshian exhibit the highest percentage of whorls and the lowest percentage of ulnar loops in both male and female groupings. The Athapaskan appear to be more closely associated with the Nootka than either of the other two groups with respect to these two pattern types. Because of the generally low frequency of radial loops in all of the four groups, it is difficult to differentiate the groups on the basis of this pattern type. However, for males, the Athapaskan consistently exhibit the lowest percentage and the Tsimshian the highest while for females, the Kwakiutl exhibit the lowest percentages and the Nootka the highest. For arches, the Nootka exhibit the higher percentages for males and the Athapaskan the lowest, while for females the Tsimshian possess the highest percentages and the Kwakiutl the lowest. The analysis of pattern types by hand provides little in the way of new discriminatory evidence. Cummins and Midlo (1961:273) state that "Analysis of individual fingers is of further interest in sexual comparison, since the contrasts are more discriminative." It appears that individual digits are more informative for other kinds of discrimination also.

Chi-square values were calculated for the frequency distributions of digital pattern types in each of the four samples, keeping the hands and sexes separate. It was necessary to condense the pattern type categories into a threefold Galton classification (whorl-loop-arch) in order to increase the observed frequencies in certain cells, particularly those in the arch category. The results obtained for males are presented in Tables XXVII (left hand), XXVIII (right hand), and XXIX (left and right hands combined); and for females in Tables XXX (left hand), XXXI (right hand), and XXXII (left and right hands combined). The symbol [a] after certain chi-square values in each of the above tables (and in all such tables in this study) indicates that the "Yates' correction for continuity" has been used to adjust the chi-square value. This method should be used when the observed frequency in any cell is ten or less as small frequencies tend to yield lower probabilities than they should and when the total frequency, N, is greater than forty. The correction for continuity results in a lower chi-square value and thus a higher probability. Although this correction method has been extensively used for coping with small samples, " . . . recent work has shown that in many cases it is worse than no adjustment at all" (Simpson *et al*. 1960:189). However, it is sufficient for the purpose in which it is used in this study.

The total chi-square values obtained for males (see Tables XXVII, XXVIII and XXIX) from the frequency distributions of digital pattern types indicate that the differences between these samples are statistically significant at the 0.05 level. The Nootka in all cases contribute most to the total chi-square, specifically in the arch category, and the Tsimshian contribute least. The Kwakiutl total chi-square is also relatively high particularly for the left and right hand category. For females (see Tables XXX, XXXI and XXXII), the left hand and combined hand frequency distributions are statistically significant at the 0.05 level while the right hand distribution is not. The Tsimshian females unlike that found for the males, contribute most to the total chi-square except for the right hand category. The Nootka and the Kwakiutl (except for the right hand category) also contribute substantially. Of the three pattern types, arches, in all three

TABLE XXVII: Frequency Distributions of Digital Pattern Types and Values of χ^2 for Males Left Hand

Sample	Frequency	Whorl	Loop	Arch	Total
Nootka	o	99	94	17	210
	e	113.6	89.3	7.1	
	χ^2	1.876	0.247	13.804	15.927
Kwakiutl	o	123	72	5	200
	e	108.1	85	6.8	
	χ^2	2.054	1.988	0.248a	4.290
Tsimshian	o	59	39	2	100
	e	54.1	42.5	3.4	
	χ^2	0.444	0.288	0.238a	0.970
Athapaskan	o	214	184	7	405
	e	219.1	172.2	13.7	
	χ^2	0.119	0.809	2.805a	4.205
Total	o	495	389	31	915
	χ^2	4.493	3.332	17.095	24.920

[a] Yates' correction for continuity used

$\chi^2 = 24.920$
d.f. = 6
$P < 0.001$

TABLE XXVIII: Frequency Distributions of Digital Pattern Types and Values of χ^2 for Males Right Hand

Sample	Frequency	Whorl	Loop	Arch	Total
Nootka	o	102	101	7	210
	e	121.5	85.6	3.0	
	χ^2	3.13	2.771	4.083a	9.984
Kwakiutl	o	131	68	1	200
	e	115.7	81.5	2.8	
	χ^2	2.023	2.236	0.603a	4.862
Tsimshian	o	61	38	1	100
	e	57.8	40.8	1.4	
	χ^2	0.177	0.192	0.007a	0.376
Athapaskan	o	235	166	4	405
	e	234.1	165.1	5.8	
	χ^2	0.003	0.005	0.291a	0.299
Total	o	529	373	13	915
	χ^2	5.333	5.204	4.984	15.521

[a] Yates' correction for continuity used

$\chi^2 = 15.521$
d.f. = 6
$P < 0.02$

TABLE XXIX: Frequency Distributions of Digital Pattern Types and Values of χ^2 for Males Left and Right Hands Combined

Sample	Frequency	Whorl	Loop	Arch	Total
Nootka	o	201	195	24	420
	e	235	174.9	10.1	
	χ^2	4.919	2.31	19.13	26.359
Kwakiutl	o	254	140	6	400
	e	223.8	166.6	9.6	
	χ^2	4.075	4.247	1.001a	9.323
Tsimshian	o	120	77	3	200
	e	112	83.3	4.8	
	χ^2	0.571	0.476	0.352a	1.399
Athapaskan	o	449	350	11	810
	e	453.3	337.3	19.5	
	χ^2	0.041	0.478	3.705	4.224
Total	o	1024	762	44	1830
	χ^2	9.606	7.511	24.188	41.305

[a] Yates' correction for continuity used

$\chi^2 = 41.305$
d.f. = 6
$P < 0.001$

TABLE XXX: Frequency Distributions of Digital Pattern Types and Values of χ^2 for Females Left Hand

Sample	Frequency	Whorl	Loop	Arch	Total
Nootka	o	56	94	10	160
	e	68.3	85.3	6.4	
	χ^2	2.215	0.887	1.501a	4.603
Kwakiutl	o	64	60	1	125
	e	53.4	66.6	5	
	χ^2	2.104	0.654	2.45a	5.208
Tsimshian	o	38	30	7	75
	e	32	40	3.0	
	χ^2	1.125	2.5	4.083a	7.708
Athapaskan	o	141	189	10	340
	e	145.2	181.2	13.6	
	χ^2	0.121	0.336	0.706a	1.163
Total	o	299	373	28	700
	χ^2	5.565	4.377	8.74	18.682

[a] Yates' correction for continuity used

χ^2 = 18.682
d.f. = 6
P < 0.01

TABLE XXXI: Frequency Distributions of Digital Pattern Types and Values of χ^2 for Females Right Hand

Sample	Frequency	Whorl	Loop	Arch	Total
Nootka	o	53	100	7	160
	e	67.5	88.7	3.9	
	χ^2	3.115	1.439	1.733a	6.287
Kwakiutl	o	56	68	1	125
	e	52.7	69.3	3	
	χ^2	0.207	0.024	0.75a	0.981
Tsimshian	o	36	35	4	75
	e	31.6	41.6	1.8	
	χ^2	0.613	1.047	1.605a	3.265
Athapaskan	o	150	185	5	340
	e	143.3	188.5	8.3	
	χ^2	0.313	0.065	0.944a	1.322
Total	o	295	388	17	700
	χ^2	4.248	2.575	5.032	11.855

[a] Yates' correction for continuity used

$\chi^2 = 11.855$
d.f. = 6
$P < 0.10$

TABLE XXXII: Frequency Distributions of Digital Pattern Types and Values of χ^2 for Females Left and Right Hands Combined

Sample	Frequency	Whorl	Loop	Arch	Total
Nootka	o	109	194	17	320
	e	135.8	173.9	10.3	
	χ^2	5.289	2.323	4.358	11.97
Kwakiutl	o	120	128	2	250
	e	106.0	135.9	8.0	
	χ^2	1.849	0.459	3.781a	6.089
Tsimshian	o	74	65	11	150
	e	63.7	81.5	4.8	
	χ^2	1.665	3.34	8.008	13.013
Athapaskan	o	291	374	15	680
	e	288.5	369.6	21.9	
	χ^2	0.022	0.052	2.174	2.248
Total	o	594	761	45	1400
	χ^2	8.825	6.174	18.321	33.320

[a] Yates' correction for Continuity used

$\chi^2 = 33.320$
d.f. = 6
$P < 0.001$

categories, produce the highest total chi-square values. This was generally true for males as well. The chi-square values in each category are consistently larger for males than for those obtained for their female counterparts. This would indicate that the differences in the distributions of digital pattern types for the male samples are, therefore, greater than the differences exhibited by their female counterparts.

Analysis of the Index of Pattern Intensity and Furuhata's and Dankmeijer's Indices

There are three widely used indices in the analysis of digital pattern types: (1) the index of pattern intensity, (2) Dankmeijer's arch/whorl index, and (3) Furuhata's whorl/ loop index.

The index of pattern intensity is a rough measure of pattern complexity. Patterns increase in complexity and are graded accordingly: arches, 0, loops, 1; and whorls, 2. The numerical values correspond to the number of triradii present in each of the pattern types. It is, therefore, possible for an individual to have a pattern index within the range from 0 (ten arches to 20 (ten whorls). The index then is an approximation (as some composite whorls have more than two triradii) of the number of triradii per individual and can be calculated by adding the frequency of loops to twice the frequency of whorls and dividing this total by the number of individuals (N) when using absolute frequencies or by ten when using percent frequencies.

The Dankmeijer or arch/whorl index is an indicator of the reciprocal relationship that exists between arches and whorls. That is, an increase in the frequency of whorls corresponds with a decrease in the frequency of both loops and arches. Arches are used instead of loops because they are far less numerous, and thus a more sensitive indicator of the inverse relationship. The index is calculated by dividing the total frequency of arches by the total frequency of whorls and multiplying the quotient by 100.

The Furuhata or whorl/loop index was designed to indicate proportionate representation of the two pattern types involved. For calculation, the total frequency of whorls is divided by the total frequency of loops (ulnar and radial combined) and the quotient multiplied by 100 to give a whole number index value. The Furuhata and Dankmeijer indices, according to Cummins and Setzler (1960:204), " . . . are unlike in the selected ratios for the reason that the respective authors differ in their views on which one of these relations is the more significant." As a result, both indices are usually given if either is given.

The index values obtained for both sexes of the four groups are presented in Table XXVI of the preceding section. The index of pattern intensity and Furuhata's whorl/loop index are, without exception, higher in males than females. The arch/whorl index of Dankmeijer is almost universally higher in females (Cummins and Midlo 1961:272). This generalization is adhered to by all groups except the Kwakiutl, although the difference in index values for this group is not very large (0.69). For males, the order of increasing complexity is as follows: Nootka (14.21), Athapaskan (15.41), Tsimshian (15.85), and Kwakiutl (16.20). The same order is found for females. The index values obtained and the subsequent ordering of the groups are explained by the percentage summaries previously mentioned. Thus, the Nootka, at the low end of the scale, possess the lowest percentage of whorls and a high percentage of arches; and the Kwakiutl, at the other end of the scale, possess the highest percentage of whorls and a low percentage of arches.

The four groups exhibit essentially the same order when the values obtained using Furuhata's whorl/loop index are compared. There is no difference in the male sector and only the Tsimshian and Kwakiutl have changed position in the female sector. The Tsimshian possess the highest index value (113.85), rather than the Kwakiutl (93.75) as was the case with both the male and female values for the index of pattern intensity and the males values for Furuhata's index. There is remarkable variation both within sex groupings and between sexes of the same group.

Although the ordering of values from low to high for Dankmeijer's arch/whorl index is the same for both sexes, it nevertheless differs from the order found for the other two indices. Both sexes of the Nootka and Kwakiutl have interchanged their positions on the scale. The values obtained for both sexes of the Nootka are now the highest for the four groups whereas in the two previous indices their values were the lowest, and vice versa for the Kwakiutl. The position of the Athapaskan and Tsimshian groups has remained unchanged.

In general, the results obtained here for pattern type analysis are in direct accordance with the results obtained for the ridge count analysis. As the two are related (i.e., are not independent) this result was expected.

Palmar Dermatoglyphics

As a rule, palmar dermatoglyphics involves both quantitative and qualitative analysis. The two quantitative measures that will be used in the following analysis are: (1) the atd angle--the angle at t, between straight lines drawn from t to a and t to d; and (2) height of the t triradius--the distance between the t triradius and the most distal wrist crease is expressed as a percentage (height of t) of the axis length (the distance between the most distal wrist crease and the most proximal crease on digit III). See Figure 16 for a presentation of the anatomical landmarks referred to in this section. Qualitative analysis involves the examination of pattern types in the five configurational areas of the palm: interdigital areas II, III and IV, hypothnar, and thenar/interdigital I area (see Figure 16). Each of these measures will be dealt with at length in subsequent sections.

One frequently used measure, the main-line index, has not been used in this study. An account of the symbols employed in formulating the terminations of main lines A and D and their equivalents as values in the main-line index is presented in Cummins and Midlo (1961: 114). It is defined by Newman (1960:49) as " . . . an arbitrary expression of the proximal terminations of the triradii at the base of the second and fifth fingers, known as mainlines." Certainly, the main problem with this index, at least as far as statistical analysis is concerned, is that the same formulation (e.g., 7) can be obtained by combining two totally different sets of the arbitrary values assigned to specific palmar areas (e.g., 6 + 1 = 7; and 4 + 3 = 7). As Newman (1960:49-50) rightly points out, the fact that the same score for individual formulations can result from different sets of values not

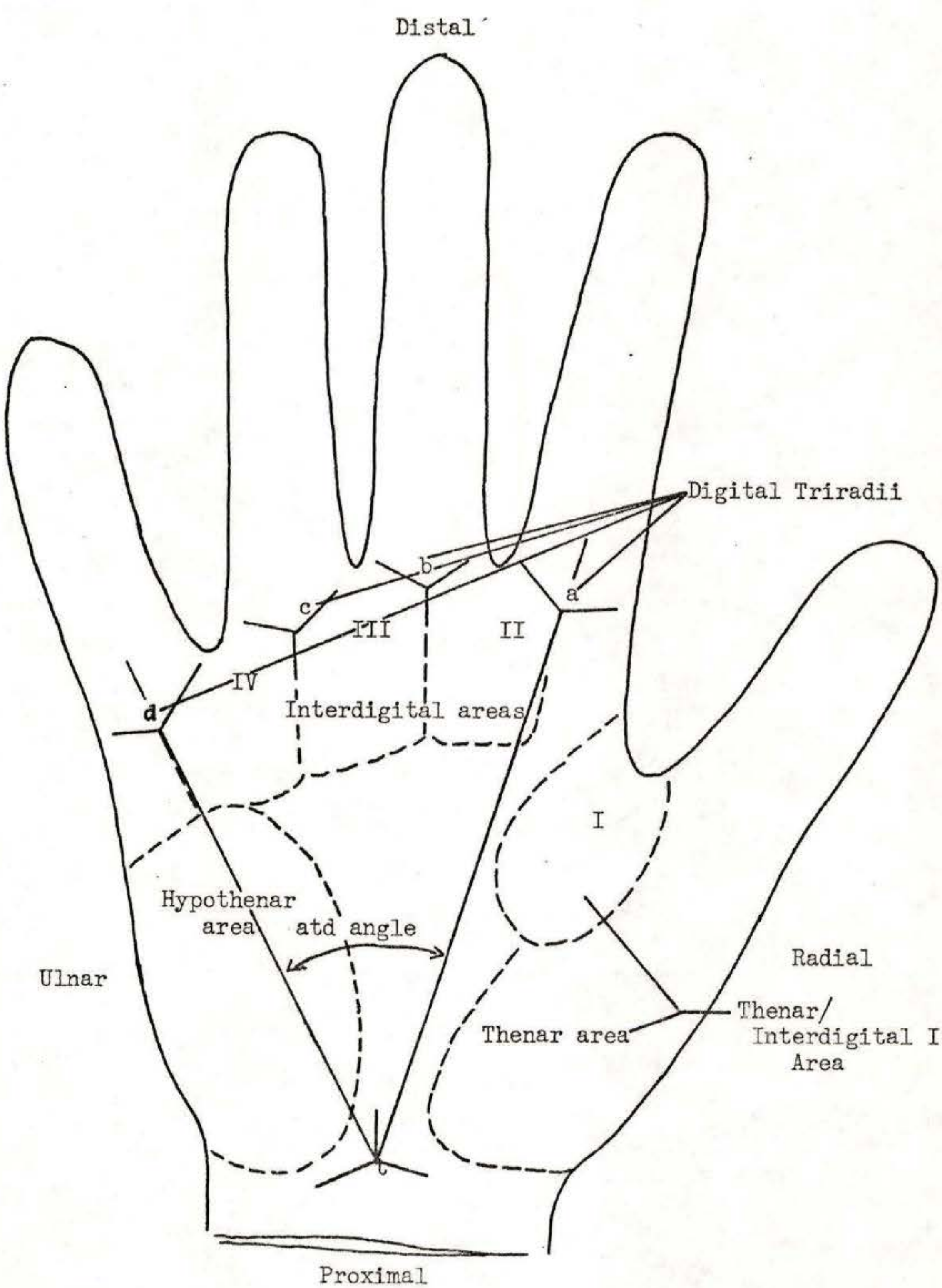


Figure 16. Anatomical landmarks in palmar dermatoglyphics.
(After Cummins and Midlo 1961:84)

only tends to violate statistical usage, but must also critically impair the ultimate interpretation of the results obtained. Undoubtedly, this index has some limited meaning, as it does indicate the generalized ridge direction of the palm, either transverse or longitudinal. For example, if the sum of two numbers corresponding to the exists of D and A mainlines is small, a tendency toward vertical or longitudinal ridge alignment is indicated; if the sum is large a tendency toward horizontal or transverse alignment is indicated. I doubt that this quasi-quantitative measure has any meaning beyond that described above. I fully agree with Newman when he states that "Future research for the purpose of developing more sensitive dermatoglyphic tools should more closely adhere to the tenets of good statistical procedures than they have in the past" (1960:49-50). I think we can begin by casting aside those tools currently in use which fail to meet present day statistical requirements.

atd Angle

The atd angle is the angle formed by two straight lines radiating out from the axial triradius t; one line bisecting triradius a and the other line bisecting triradius d (see Figure 16). In the case where there is more than one axial or hypothenar triradius, the more distal of the triradii is used and thus a maximal reading is obtained. There is, however, one important objection concerning the use of this measure; it is an age-dependent parameter and, therefore, should not be used in comparative studies without correcting for age. Unfortunately, I became aware of this objection only after the coding and computational analysis had already been done. To date, it is one of a very few dermatoglyphic measures that is known not to be independent of the age of the subject. As a result, this measure is not as powerful as it might otherwise be. Some compensation for this omission can be derived from the fact that the majority of subjects printed in this study fall within the ten to sixteen year age-range; only the Athapaskan group has had subjects drawn from the adult population and their percentage in terms of the total number of subjects is very small.

It has been suggested that the atd angle is another method of estimating the height of the t triradius since the larger the angle the more distal the position of the t triradius. This, however, is only partially correct since the atd angle is controlled by three variables (the positions of the three triradii involved) and as such the angle size will be affected by lateral displacement of any one of these three triradii. The angle can also be influenced by the spread of the digits, and thus care must be taken to ensure that the digits are only normally spread during printing. At best, these two measures are only roughly equivalent to one another. One advantage of the atd parameter is that it can usually be measured with a higher degree of precision than the height of the t triradius parameter since, in the latter, the points of measurement at the wrist and at the base of the third digit are oftentimes poorly printed, resulting in somewhat arbitrary designations. In the angle parameter, the three points of measurements are only infrequently unclear.

In the following analysis, atd angles have been grouped according to hand, separately as well as combined, and sex. The range of variation by hand (in degrees) in each of the four groups is as follows: left hand: Nootka males (37-67), females (35-73); Kwakiutl males (36-61), females (33-64); Tsimshian males (39-56), females (40-58); and Athapaskan males (30-70), females (35-75); right hand: Nootka males (35-55), females (36-56); Kwakiutl males (36-62), females (35-54); Tsimshian males (39-54), females (39-70); and Athapaskan males (32-65), females (32-74).

The distribution of individual atd angle means (left and right hands combined) for both males and females is shown graphically in Figures 17 and 18 (Nootka males and females respectively), 19 and 20 (Kwakiutl), 21 and 22 (Tsimshian), and 23 and 24 (Athapaskan). The range of variation (in degrees) is as follows: Nootka males (36-59), females (36-58); Kwakiutl males (36-58), females (34-57); Tsimshian males (39-55), females (40-72); and Athapaskan males (33-62), females (34-70).

Intra-group Differences

Mean atd angle, variance, standard deviation and standard error for left hands in both sexes of the four groups are presented in

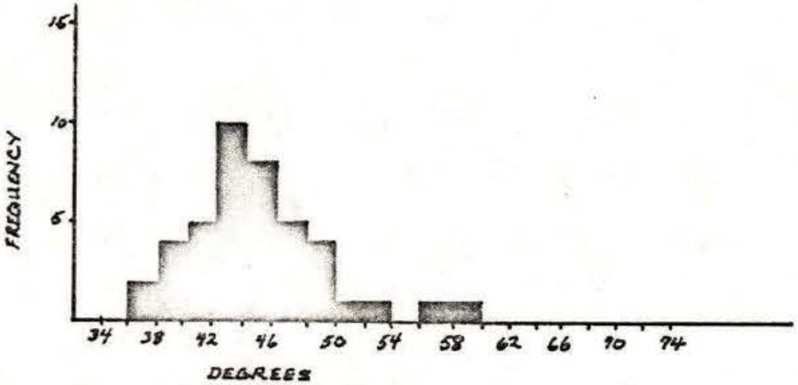


Figure 17. Distribution of mean atd angles for Nootka males (n = 42).

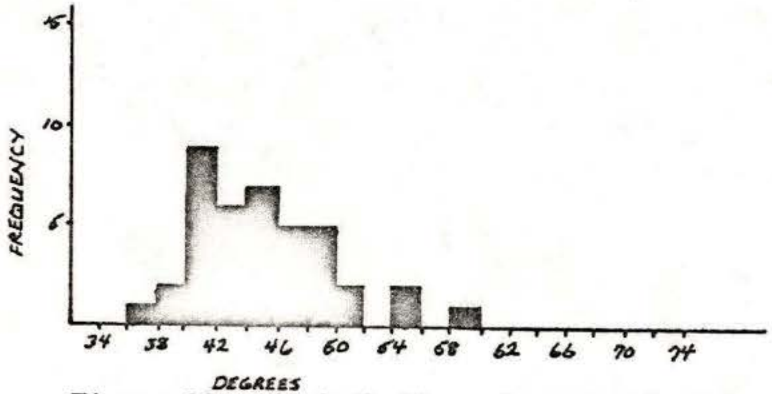


Figure 19. Distribution of mean atd angles for Kwakiutl males (n = 40).

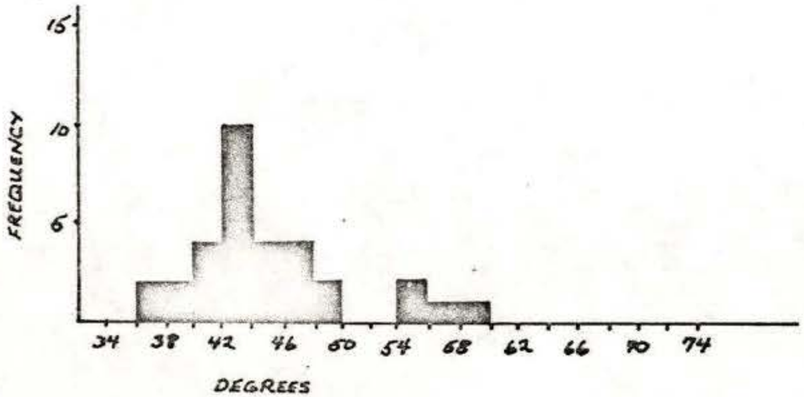


Figure 18. Distribution of mean atd angles for Nootka females (n = 32).

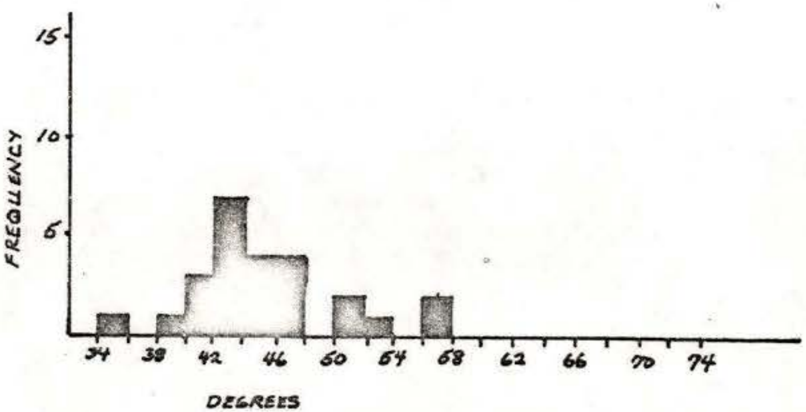


Figure 20. Distribution of mean atd angles for Kwakiutl females (n = 25).

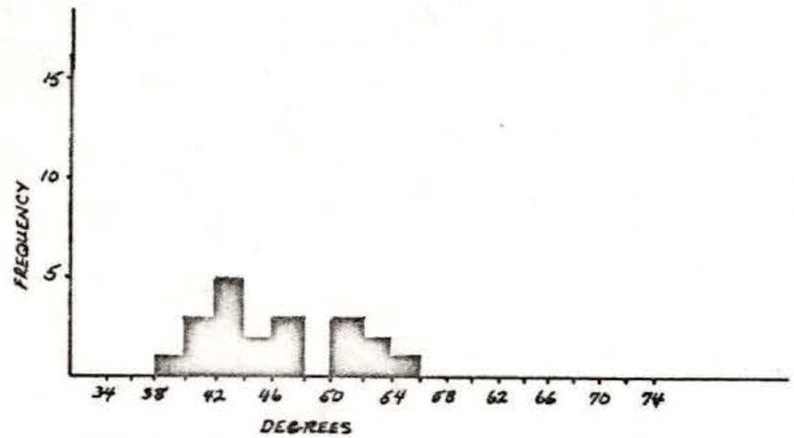


Figure 21. Distribution of mean atd angles for Tsimshian males (n = 20).

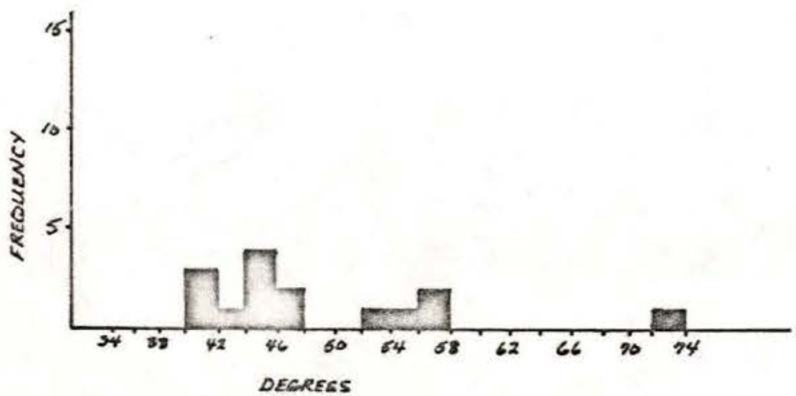


Figure 22. Distribution of mean atd angles for Tsimshian females (n = 15).

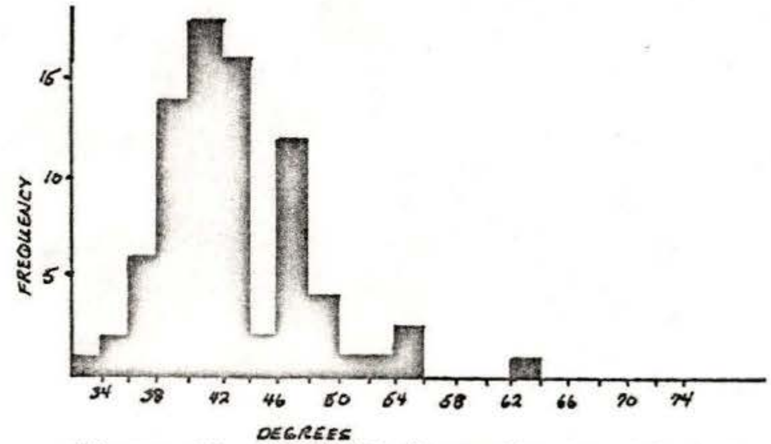


Figure 23. Distribution of mean atd angles for Athapaskan males (n = 81).

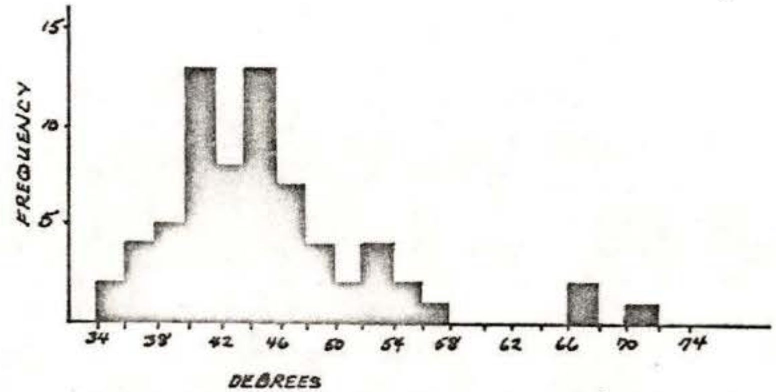


Figure 24. Distribution of mean atd angles for Athapaskan females (n = 68).

Table XXXIII. The same data for right hands are presented in Table XXXIV, and for right and left hands combined, in Table XXXV. In general, females tend to possess larger atd angle means than their male counterparts. There are, however, two minor exceptions. For left hand means (Table XXXIII), Nootka males exhibit a slightly larger mean than the females, but the difference (0.051 degrees) is negligible; and for right hand means (Table XXXIV), Kwakiutl males have a larger mean than the females but again the difference (0.375 degrees) is slight. When left and right hands are combined (averaged) and their means calculated, these slight discrepancies are no longer present. Neither of these differences is statistically significant at the 0.05 level. In fact, the only significant sexual difference in means is that for the Athapaskan in all three categories (see Table XXXVI).

It can be seen from Table XXXVII that none of the eight groupings exhibit statistically significant bimanual differences in means. However, in a comparison of left and right hand means (Tables XXXIII and XXXIV), there appears to be a slight tendency towards larger left hand means. While only two of the male groupings (Nootka and Tsimshian) exhibit larger left hand means, all of the female groupings do. As noted above, the differences in means between right and left hands for the Kwakiutl and Athapaskan groups are not significant at the 0.05 level. As with ridge counts, none of the bimanual differences in atd angle means are significant, while at least some of the sexual differences in means are (more so for ridge counts than atd angles).

Inter-group Differences

The results obtained for an analysis of variance of atd angles of the four samples by sex and hand are presented in Table

TABLE XXXIII: Mean atd Angle, Variance, Standard Deviation, and Standard Error by Sex and Sample for Left Hands

Sample	Sex	Frequency	Mean	Variance	Standard Deviation	Standard Error
Nootka	M	42	44.7	34.7	5.9	0.9
	F	32	44.7	52.5	7.2	1.3
Kwakiutl	M	40	44.3	21.8	4.7	0.7
	F	25	45.2	44.9	6.7	1.3
Tsimshian	M	20	45.4	31.9	5.6	1.3
	F	15	48.5	86.8	9.3	2.4
Athapaskan	M	81	42.2	34.6	5.9	0.6
	F	68	44.6	50.4	7.1	0.9

TABLE XXXIV: Mean atd Angle, Variance, Standard Deviation, and Standard Error by Sex and Sample for Right Hands

Sample	Sex	Frequency	Mean	Variance	Standard Deviation	Standard Error
Nootka	M	42	43.0	19.7	4.4	0.7
	F	32	43.8	24.3	4.9	0.9
Kwakiutl	M	40	44.6	27.0	5.2	0.8
	F	25	44.2	20.3	4.5	0.9
Tsimshian	M	20	45.4	18.7	4.3	1.0
	F	15	47.9	71.4	8.4	2.2
Athapaskan	M	81	42.3	29.9	5.5	0.6
	F	68	44.6	65.2	8.1	1.0

TABLE XXXV: Mean atd Angle, Variance, Standard Deviation, and Standard Error by Sex and Sample for Left and Right Hands Combined

Sample	Sex	Frequency	Mean	Variance	Standard Deviation	Standard Error
Nootka	M	42	44.0	23.0	4.8	0.7
	F	32	44.2	29.0	5.4	0.9
Kwakiutl	M	40	44.5	21.7	4.7	0.7
	F	25	44.6	26.7	5.2	1.0
Tsimshian	M	20	45.4	22.2	4.7	1.0
	F	15	48.1	76.6	8.7	2.3
Athapaskan	M	81	42.2	25.7	5.1	0.6
	F	68	44.7	49.1	7.5	0.8

TABLE XXXVI: Values of t and Chance Probabilities for Intra-Group Differences by Sex in Mean atd Angles

Variable	Samples Compared	Degrees of Freedom	t	Levels of Significance 0.10	0.05	0.01
Left Hand	N-N	72	0.032			
	K-K	63	-0.655			
	T-T	33	-1.180			
	A-A	147	-2.306		*	
Right Hand	N-N	72	-0.693			
	K-K	63	0.297			
	T-T	33	-1.123			
	A-A	147	-2.061		*	
Combined Hands	N-N	72	-0.251			
	K-K	63	-0.111			
	T-T	33	-1.128			
	A-A	147	-2.421			*

TABLE XXXVII: Values of t and Chance Probabilities for Intra-Group Differences by Hand in Mean atd Angles

Sex	Samples Compared	Degrees of Freedom	t	Levels of Signifiance 0.10	0.05	0.01
M	N-N	82	1.494	*		
	K-K	78	-0.250			
	T-T	38	0.030			
	A-A	160	-0.135			
F	N-N	62	0.561			
	K-K	48	0.631			
	T-T	28	0.179			
	A-A	134	0.023			

XXXVIII. The variation among male groups in all three categories is statistically significant; for left hand and combined categories at the 0.025 level and for the right hand category, at the 0.05 level. Variation among females is not significant in any of the three categories.

A further evaluation of the statistical significance of inter-group differences in mean atd angles is presented in Tables XXXIX, XL and XLI. Table XXXIX evaluates the differences in left hand means for both sexes; Table XL, right hand means; and Table XLI, combined left and right hand means. For left hand mean atd angles, two of the male inter-group differences (K-A and T-A) and one of the female (T-A) are significant at the 0.05 level. None of these differences are significant at the 0.01 level. For right hand mean atd angles, three of the male (N-T, K-A and T-A) and one of the female (K-T) inter-group differences are significant at the 0.05 level. None are significant at the 0.01 level. When left and right hand atd angles are combined (averaged) and means calculated, it is found that three of the male differences in means (N-A, K-A and T-A) are significant at the 0.05 level. One of the female differences in means (N-T) is also significant at this level. Further, two of the three male differences in means (K-A and T-A) are significant at the 0.01 level.

In summation, on the basis of mean atd angles, the Athapaskan males show fairly strong divergent tendencies with respect to the Kwakiutl and Tsimshian groups certainly, and to some lesser extent with the Nootka. This conclusion is based on the fact that in all three categories examined (left hand, right hand, and hands combined) the difference in means between the Athapaskan and the Kwakiutl and

TABLE XXXVIII: Analysis of Variance of the Four Samples by Sex and Hand (Separately as well as Combined) for atd Angles

Variable	Samples Compared	Degrees of Freedom	F Ratio	Levels of Significance 0.10	0.05	0.025	0.01
Left Hand	Males	3; 179	3.1867			*	
	Females	3; 136	1.2297				
Right Hand	Males	3; 179	3.0232		*		
	Females	3; 136	1.2974				
Combined Hands	Males	3; 179	3.5321			*	
	Females	3; 136	1.2932				

TABLE XXXIX: Values of t and Chance Probabilities for Inter-Group Differences by Sex for Left Hand Mean atd Angles

Sex	Samples Compared	Degrees of Freedom	t	Levels of Significance 0.10	0.05	0.01
M	N-K	80	0.372			
	N-T	60	-0.445			
	N-A	121	1.623	*		
	K-T	58	-0.823			
	K-A	119	1.964		*	
	T-A	99	2.215		*	
F	N-K	55	-0.289			
	N-T	45	-1.515	*		
	N-A	98	0.045			
	K-T	38	-1.265			
	K-A	91	0.377			
	T-A	81	1.810		*	

TABLE XL: Values of t and Chance Probabilities for Inter-Group Differences by Sex for Right Hand Mean atd Angles

Sex	Samples Compared	Degrees of Freedom	t	Levels of Significance 0.10	0.05	0.01
M	N-K	80	-1.431	*		
	N-T	60	-1.946		*	
	N-A	121	0.753			
	K-T	58	-0.596			
	K-A	119	2.168		*	
	T-A	99	2.329		*	
F	N-A	55	-0.302			
	N-T	45	0.504			
	N-A	98	-0.504			
	K-T	38	-1.778		*	
	K-A	91	-0.227			
	T-A	81	1.432	*		

TABLE XLI: Values of t and Chance Probabilities for Inter-Group Differences by Sex for Mean atd Angles, Combined Left and Right Hands

Sex	Samples Compared	Degrees of Freedom	t	Levels of Significance 0.10	0.05	0.01
M	N-K	80	-0.524			
	N-T	60	-1.107			
	N-A	121	1.844		*	
	K-T	58	-0.690			
	K-A	119	2.382			*
	T-A	99	2.529			*
F	N-K	55	-0.271			
	N-T	45	-1.805		*	
	N-A	98	-0.298			
	K-T	38	-1.526	*		
	K-A	91	-0.030			
	T-A	81	1.528	*		

Tsimshian groups are significant at the 0.05 level and at the 0.01 level for the hands combined category. The significant difference in means between the Athapaskan and Nootka is present only for the hands combined category (0.05 level). Nootka and Tsimshian males in the right hand category also show a significant difference in means (0.05 level). It can be seen from Tables XXXIII, XXXIV and XXXV that the Athapaskan males exhibit the lowest means of the four groups in all three categories of this parameter and the Tsimshian the highest with the Kwakiutl and Nootka intermediate. On the basis of this evidence, I think it can be suggested that a possible ranking for male groups would take the following order: Athapaskan - Nootka - Kwakiutl - Tsimshian.

Significant inter-group differences in means were found between the following female groups: T-A (left hands), K-T (right hands), and N-T (hands combined). In all three categories, the Tsimshian mean atd angles are noticeably higher than those of the other three female groups (see Tables XXXIII, XXXIV and XXXV). The remaining three groups tend to cluster.

Height of the t Triradius

The height of the t triradius is expressed as a percentage of the axis length (see Figure 9). The procedure involves two measurements: (1) axis length—the distance between the most distal wrist crease and the most proximal crease on digit III; and (2) t triradius distance--the distance between the triradius t and the most distal wrist crease. This latter measurement is then expressed as a percentage of the axis length to give the height of the t triradius. In the case where there is more than one axial or t triradius, the most distal of the triradii is used. One major difficulty in using this measure is that creases are not easily printed, particularly the wrist crease or creases. Another difficulty is that creases, unlike triradii, are not very exact structures from which to measure. These problems are greatly reduced if care is taken during the printing process.

In the following analysis, this measure has been categorized by hand, separately as well as combined, and sex. The range of variation by hand (in percent) in each of the four groups is as follows: left hand: Nootka males (9-34), females (9-47); Kwakiutl males (7-36), females (10-37); Tsimshian males (10-38), females (12-47); and Athapaskan males (7-52), females (11-46); right hand: Nootka males (8-30), females (10-31); Kwakiutl males (10-40), females (12-35); Tsimshian males (11-39), females (13-46); and Athapaskan males (8-51), females (9-70).

This distribution of individual means (left and right hands combined) for both sexes is shown graphically in Figures 25 and 26 (Nootka males and females respectively), 27 and 28 (Kwakiutl), 29 and

30 (Tsimshian), and 31 and 32 (Athapaskan). The range of variation (in percent) is as follows: Nootka males (10-26), females (10-34); Kwakiutl males (8-38), females (11-32); Tsimshian males (10-38), females (13-46); and Athapaskan males (8-48), females (10-54).

Intra-group Differences

The mean, variance, standard deviation, and standard error for left hands in both sexes of the four groups are presented in Table XLII. The same data for right hands are presented in Table XLIII, and for left and right hands combined in Table XLIV. As was the case with the atd parameter, females possess larger mean values than their male counterparts. There is one exception; the Nootka left hand mean for males is slightly higher than the corresponding female mean. However, the actual difference in the means (less than 1%) is so slight that when left and right hands are combined and their means calculated, this minor exception is no longer present. In fact, only the Athapaskan exhibit (in all three categories) a significant sexual difference in means (see Table XLV). This same situation was found for the atd angle parameter.

Turning to a consideration of the bimanual differences in means (see Table XLVI), it will be observed that none of the differences are significant at the 0.05 level. However, it should be noted that three of the four male groups (the Nootka is the exception) and one of the four female groups (Athapaskan) exhibit larger means for the right hand than the left. The Nootka and Tsimshian females exhibit larger left hand means than right, while the Kwakiutl possess identical left and right hand means.

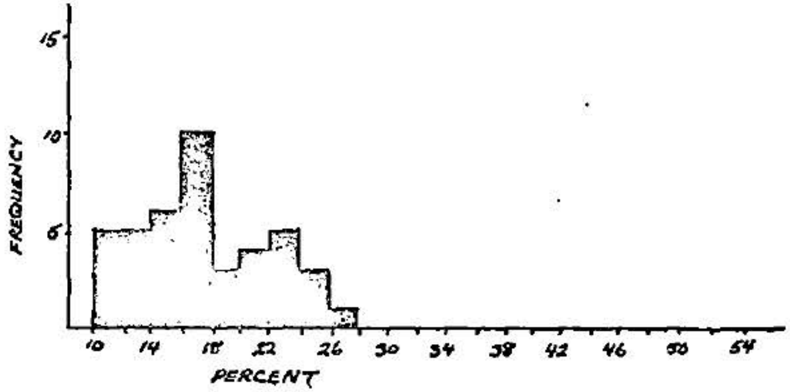


Figure 25. Distribution of the mean height of the t triradius for Nootka males (n = 42).

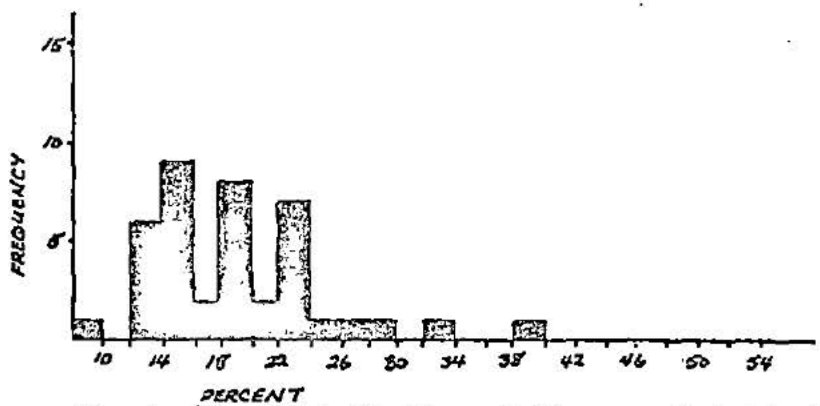


Figure 27. Distribution of the mean height of the t triradius for Kwakiutl males (n = 40).

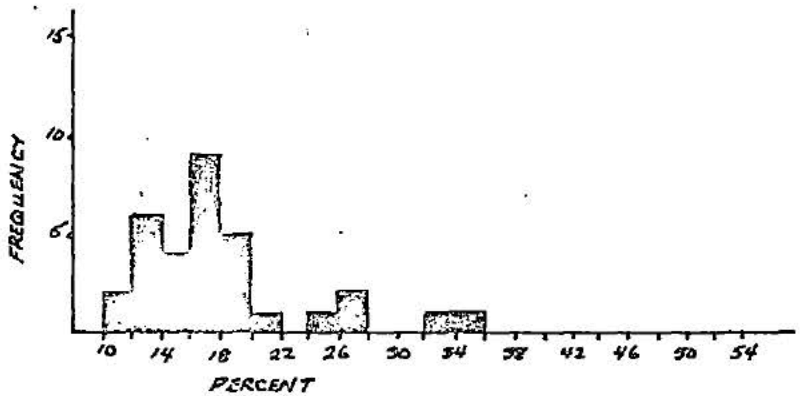


Figure 26. Distribution of the mean height of the t triradius for Nootka females (n = 32).

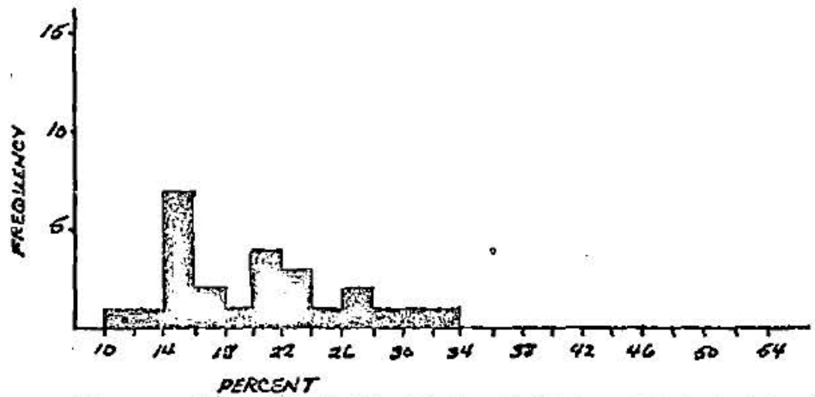


Figure 28. Distribution of the mean height of the t triradius for Kwakiutl females (n = 25).

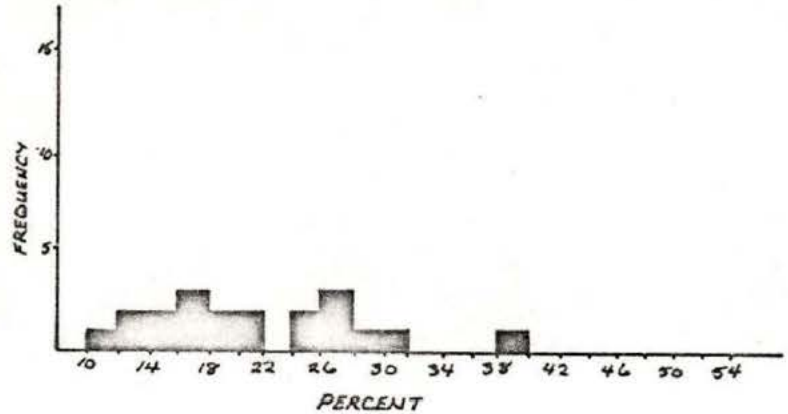


Figure 29. Distribution of the mean height of the t triradius for Tsimshian males (n = 20).

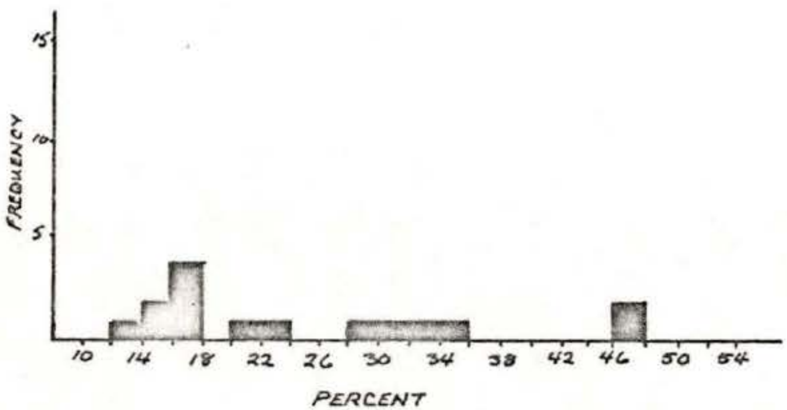


Figure 30. Distribution of the mean height of the t triradius for Tsimshian females (n = 15).

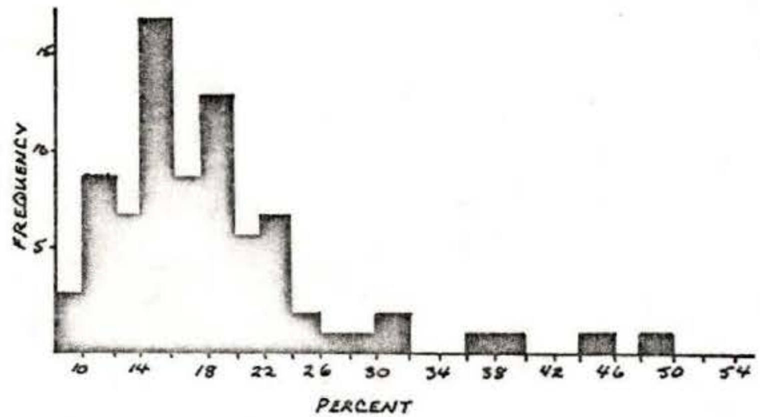


Figure 31. Distribution of the mean height of the t triradius for Athapaskan males (n = 81).

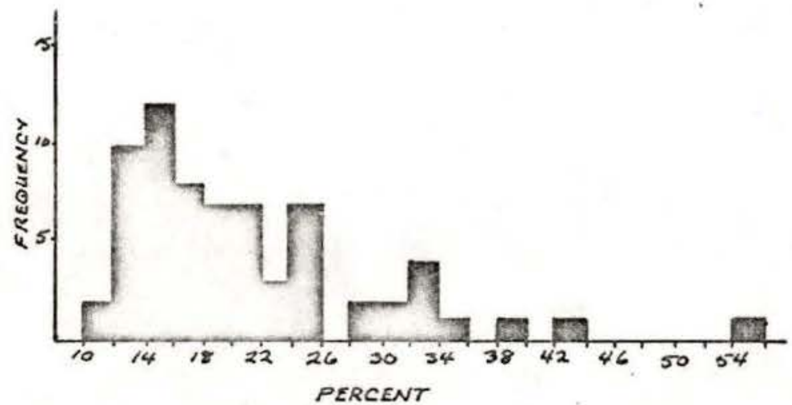


Figure 32. Distribution of the mean height of the t triradius for Athapaskan females (n = 68).

TABLE XLII: Mean Height of t, Variance, Standard Deviation, and Standard Error by Sex and Sample for Left Hands

Sample	Sex	Frequency	Mean	Variance	Standard Deviation	Standard Error
Nootka	M	42	17.9	34.6	5.9	0.9
	F	32	17.4	64.4	8.0	1.4
Kwakiutl	M	40	17.7	36.8	6.1	1.0
	F	25	19.5	44.4	6.7	1.3
Tsimshian	M	20	20.5	53.2	7.3	1.6
	F	15	24.9	131.3	11.5	3.0
Athapaskan	M	81	17.5	58.3	7.6	0.8
	F	68	19.6	56.0	7.5	0.9

TABLE XLIII: Mean Height of t, Variance, Standard Deviation, and Standard Error by Sex and Sample for Right Hands

Sample	Sex	Frequency	Mean	Variance	Standard Deviation	Standard Error
Nootka	M	42	16.0	23.0	4.8	0.7
	F	32	17.2	20.3	4.5	0.8
Kwakiutl	M	40	19.1	38.7	6.2	1.0
	F	25	19.5	35.1	5.9	1.2
Tsimshian	M	20	20.9	62.6	7.9	1.8
	F	15	24.0	125.1	11.2	2.9
Athapaskan	M	81	17.9	56.2	7.5	0.8
	F	68	20.4	101.5	10.1	1.2

TABLE XLIV: Mean Height of t, Variance, Standard Deviation, and Standard Error by Sex and Sample for Left and Right Hands Combined

Sample	Sex	Frequency	Mean	Variance	Standard Deviation	Standard Error
Nootka	M	42	16.9	20.2	4.5	0.7
	F	32	17.3	31.4	5.6	1.0
Kwakiutl	M	40	18.4	36.2	6.0	0.9
	F	25	19.4	34.7	5.9	1.2
Tsimshian	M	20	20.6	49.7	7.0	1.6
	F	15	24.5	124.1	11.1	2.9
Athapaskan	M	81	17.7	53.9	7.3	0.8
	F	68	20.0	68.2	8.3	1.0

TABLE XLV: Values of t and Chance Probabilities for Intra-Group Differences by Sex in Mean Height of t Triradius

Variable	Samples Compared	Degrees of Freedom	t	Levels of Significance		
				0.10	0.05	0.01
Left Hand	N-N	72	0.338			
	K-K	63	-1.093			
	T-T	33	-1.358	*		
	A-A	147	-1.661		*	
Right Hand	N-N	72	-1.054			
	K-K	63	-0.227			
	T-T	33	-0.935			
	A-A	147	-1.773		*	
Combined Hands	N-N	72	-0.324			
	K-K	63	-0.685			
	T-T	33	-1.241			
	A-A	147	-1.849		*	

TABLE XLVI: Values of t and Chance Probabilities for Intra-Group Differences by Hand in Mean Height of t Triradius

Sex	Samples Compared	Degrees of Freedom	t	Levels of Significance 0.10	0.05	0.01
M	N-N	82	1.655	*		
	K-K	78	-1.022			
	T-T	38	-0.162			
	A-A	160	-0.254			
F	N-N	62	0.133			
	K-K	48	0.000			
	T-T	28	0.218			
	A-A	134	-0.522			

Inter-group Differences

The results obtained for an analysis of variance of the four samples by sex and hand for the height of the t triradius are presented in Table XLVII. Variation among females is statistically significant at the 0.05 level for left hand and combined categories although the right hand category has a probability of greater than 0.10. For males, the only significant variation was found in the right hand category.

Significance of the inter-group differences in mean height of the t triradius was tested by the student's t statistic; the results are presented in Tables XLVIII (left hand), XLVIX (right hand), and L (combined left and right hands). For left hand means, none of the male but three of the female (N-T, K-T and T-A) differences are significant at the 0.05 level. The N-T difference is also significant at the 0.01 level. For right hand means, two of both the male (N-K and N-T) and female (N-T and N-A) differences are significant (0.05 level). Both of the male combinations and the N-T female combination are significant at the 0.01 level. For combined left and right hand means, one of the male (N-T) and four of the female (N-T, N-A, K-T and T-A) differences in means are significant (0.05 level). Of these, only the male and female N-T combinations are significant at the 0.01 level.

In view of this evidence and that presented in Tables XLII, XLIII, and XLIV, what can now be said concerning the possible inter-relationships between each of the four groups? For males, I think it is clear that the Nootka differ significantly from the Tsimshian and possibly the Kwakiutl as well, with respect to this parameter. Certainly the Tsimshian are at one end of the scale and the Nootka at the other. I think it is also apparent that the Athapaskan are closer to

TABLE XLVII: Analysis of Variance of the Four Samples by Sex and Hand (Separately as well as Combined) for Height of the t Triradius

Variable	Samples Compared	Degrees of Freedom	F Ratio	Levels of Significance 0.10	0.05	0.025	0.01
Left Hand	Males	3; 179	1.0129				
	Females	3; 136	3.0651		*		
Right Hand	Males	3; 179	2.8440		*		
	Females	3; 136	2.3212	*			
Combined Hands	Males	3; 179	1.5772				
	Females	3; 136	3.0502		*		

TABLE XLVIII: Values of t and Chance Probabilities for Inter-Group Differences by Sex for Left Hand Mean Height of t Triradius

Sex	Samples Compared	Degrees of Freedom	t	Levels of Significance 0.10	0.05	0.01
M	N-K	80	0.173			
	N-T	60	-1.452	*		
	N-A	121	0.299			
	K-T	58	-1.550	*		
	K-A	119	0.100			
	T-A	99	1.544	*		
F	N-K	55	-1.038			
	N-T	45	-2.561			*
	N-A	98	-1.352	*		
	K-T	38	-1.861		*	
	K-A	91	-0.070			
	T-A	81	2.231		*	

TABLE XLVIX: Values of t and Chance Probabilities for Inter-Group Differences by Sex for Right Hand Mean Height of t Triradius

Sex	Samples Compared	Degrees of Freedom	t	Levels of Significance 0.10	0.05	0.01
M	N-K	80	-2.540			*
	N-T	60	-2.984			*
	N-A	121	-1.473	*		
	K-T	58	-0.936			
	K-A	119	0.915			
	T-A	99	1.595	*		
F	N-K	55	-1.655	*		
	N-T	45	-2.934			*
	N-A	98	-1.731		*	
	K-T	38	-1.632	*		
	K-A	91	-0.419			
	T-A	81	1.230			

TABLE L: Values of t and Chance Probabilities for Inter-Group Differences by Sex for Mean Height of t Triradius, Combined Left and Right Hands

Sex	Samples Compared	Degrees of Freedom	t	Levels of Significance 0.10	0.05	0.01
M	N-K	80	-1.266			
	N-T	60	-2.484			*
	N-A	121	-0.653			
	K-T	58	-1.249			
	K-A	119	0.506			
	T-A	99	1.584	*		
F	N-K	55	-1.390	*		
	N-T	45	-2.919			*
	N-A	98	-1.709		*	
	K-T	38	-1.846		*	
	K-A	91	-0.326			
	T-A	81	1.777		*	

the Nootkan pattern on the basis of simple numerical ranking or means in Tables XLII, XLIII, and XLIV. The Kwakiutl appear to be intermediate between the Athapaskan and the Tsimshian.

On the basis of the numerical ranking of means, the female groups are highly consistent. On a low to high scale, the ranking in all three categories yields the following order: Nootka - Kwakiutl - Athapaskan - Tsimshian. It is clear, as it is for the males, that the Nootka and Tsimshian are again at opposite ends of the continuum and that the Kwakiutl and Athapaskan are intermediate. Only this time, the Kwakiutl exhibit mean values that more closely approximate the Nootka than do the Athapaskan.

Pattern Areas

By convention (Cummins and Midlo 1961) the palm is divided into five main areas: (1) hypothenar, (2) thenar/interdigital I, (3) interdigital area II, (4) interdigital area III, and (5) interdigital area IV (see Figure 16). There can occur in each of these five areas " . . . particularized configurations, local specific patterns rather than expanses of straight or only gently arciform systems of ridges . . . ." (Cummins and Setzler 1960:210). In general, the configurations in these areas are similar in principle to the whorls and loops found on digits, but the classification of these patternings can take many forms. For example: (1) Cummins and Setzler (1960) distinguish between patterns and vestiges in each of the five areas; (2) Glanville and Poelking (1964) initially distinguish eight pattern types for the hypothenar area but later collapse these categories into two (true pattern and no true pattern). They list four categories (three pattern types and no true pattern) for the thenar/interdigital I area, and examine only loops in interdigital areas II, III and IV; (3) Newman (1960) and Rife (1970) choose only to distinguish patterns from patternless configurations (Rife includes vestiges in his pattern category for all five areas and Newman, concerned only with the hypothenar and thenar/interdigital I areas, does not mention vestiges); (4) Chai (1967) is not concerned with the distribution of pattern types in the five palmar areas.

After devising and using a system of three categories for the hypothenar and thenar/interdigital I area and six for the three interdigital areas and examining the results, it became apparent that a twofold classification was adequate for describing data in this study, for many of the categories contained extremely small frequencies. Therefore, in each of the five areas, patterns (including vestiges) are distinguished from patternless configurations (open fields) in each of the four groups. Further information concerning the formulation or analysis of configurational areas of the palm can be found in Cummins and Midlo (1961:100-107).

Hypothenar and Thenar/Interdigital I Areas

Presented in Table LI are the percentages found for patterns, as opposed to patternless configurations, in the hypothenar and thenar/interdigital I areas of the palm. The percentages for each of the four groups are categorized by hand (separately as well as combined) and sex. Percentage frequencies of patterns and open fields in each of the four groups are shown graphically by hand and sex in Figures 33 and 34 (hypothenar area) and 35 and 36 (thenar/interdigital I area).

In the hypothenar area, right hands tend to have larger percentages of patterns than left hands and females tend to have larger percentages of patterns than males. For males, the Tsimshian exhibit the largest percentage of patterns in all three categories and the Athapaskan, on the average, the lowest. The Nootka also possess a relatively low percentage of patterns while the Kwakiutl appear intermediate between the Tsimshian and Nootka/Athapaskan percentages. For females, the Nootka consistently exhibit the lowest percentage of patterns and the Kwakiutl, on the average, the highest. The Athapaskan and Tsimshian also tend to possess relatively high percentages in all categories.

In the thenar/interdigital I area (see Table LI), left hand percentages are consistently larger than those for right hands. With

TABLE LI: Percentage Frequencies of Patterns (Including Vestiges) for Each of the Four Samples in the Hypothenar and Thenar/Interdigital I Area of the Palm by Hand (Separately as well as Combined) and by Sex

Palmar Area	Sex	Sample	Patterns Left	Patterns Right	Patterns Combined	Open Fields Combined	Number of Palms Left	Number of Palms Right	Number of Palms Combined
Hypothenar	M	NOO	9.5	11.9	10.7	89.3	42	42	84
		KWAK	10	20	15.0	85.0	40	40	80
		TSIM	20	20	20.0	80.0	20	20	40
		ATHA	12.3	6.1	9.2	90.8	81	81	162
	F	NOO	9.4	15.6	12.5	87.5	32	32	64
		KWAK	16.0	36.0	25.0	74.0	25	25	50
		TSIM	20.0	26.7	23.4	76.7	15	15	30
		ATHA	20.6	20.6	20.6	79.4	68	68	136
Thenar/ Interdigital I	M	NOO	71.4	21.4	46.4	53.6	42	42	84
		KWAK	35.0	17.5	26.3	73.8	40	40	80
		TSIM	15.0	5.0	10.0	90.0	20	20	40
		ATHA	39.5	16.0	27.8	72.3	81	81	162
	F	NOO	50.0	28.1	39.1	60.9	32	32	64
		KWAK	28.0	16.0	22.0	78.0	25	25	50
		TSIM	40.0	26.7	33.4	66.7	15	15	30
		ATHA	55.9	27.9	41.9	58.1	68	68	136

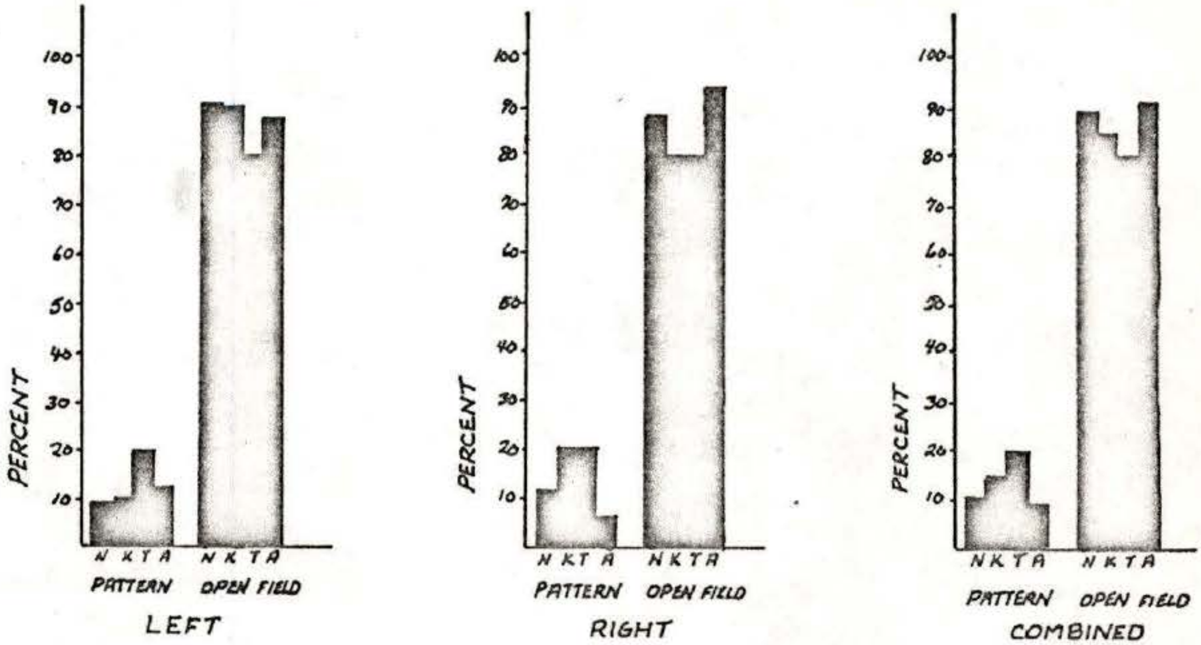


Figure 33. Distribution of patterns and open fields for males by group and hand (separately as well as combined) in the hypothenar area of the palm.

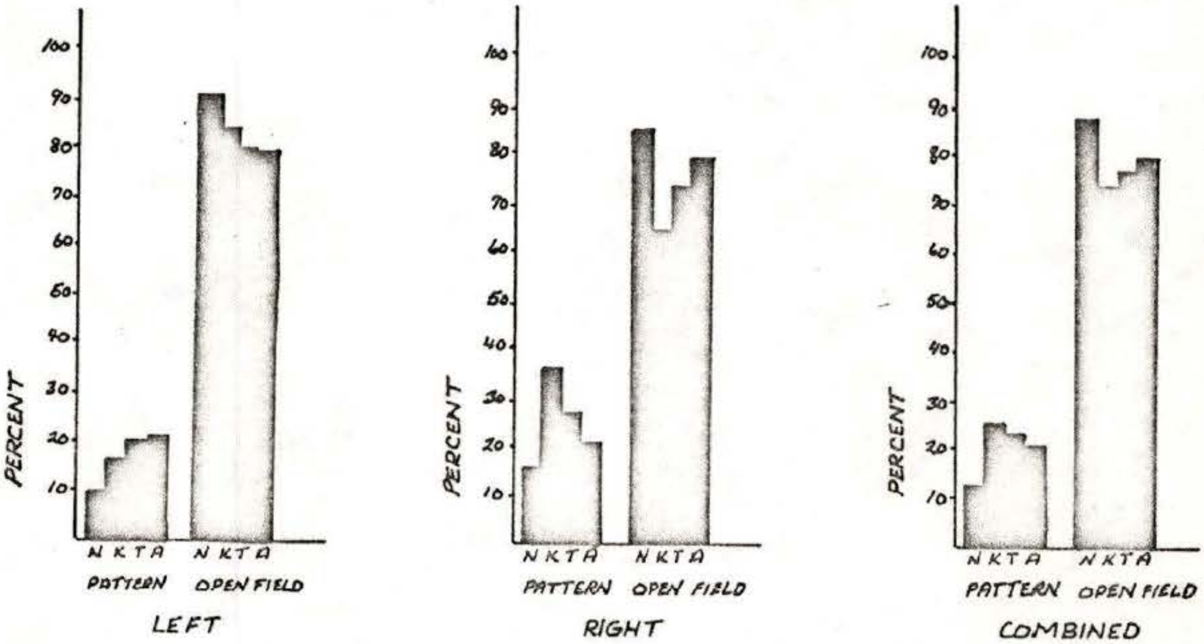


Figure 34. Distribution of patterns and open fields for females by group and hand (separately as well as combined) in the hypothenar area of the palm.

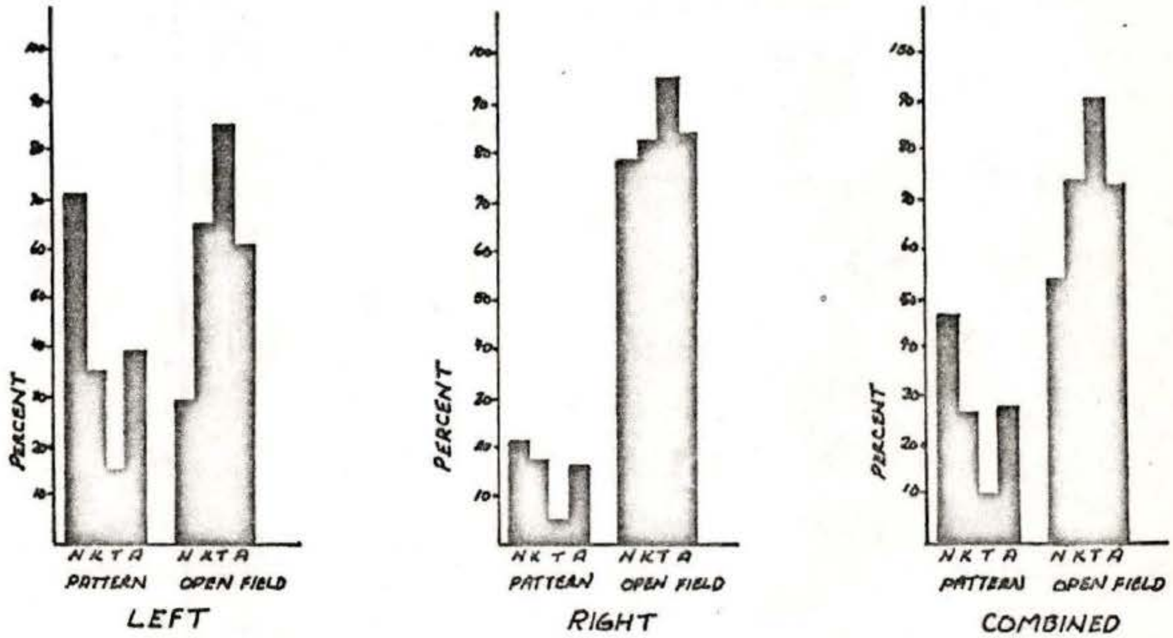


Figure 35. Distribution of patterns and open fields for males by group and hand (separately as well as combined) in the thenar/ interdigital I area of the palm.

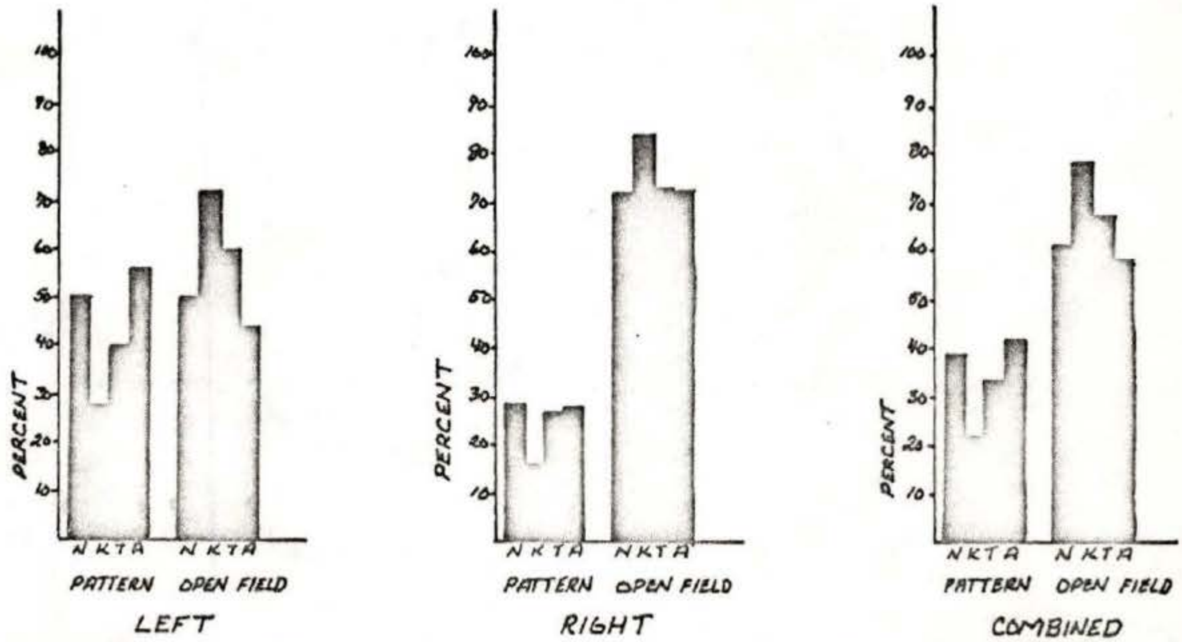


Figure 36. Distribution of patterns and open fields for females by group and hand (separately as well as combined) in the thenar/ interdigital I area of the palm.

respect to pattern percentages for the sexes, no definite pattern emerges. For example, Nootka and Kwakiutl males tend to possess larger percentages than their female counterparts while Tsimshian and Athapaskan males do not. Among the males, the Tsimshian consistently exhibit the lowest percentages and the Nootka the highest. Both the Kwakiutl and Athapaskan exhibit very similar percentages and lie intermediate between the Nootka and Tsimshian extremes. For females, the Kwakiutl consistently exhibit the lowest percentages and the Athapaskan, on the average, the highest. The Nootka as well show a high percentage of patterns while the Tsimshian percentages are intermediate between those of Nootka and Kwakiutl.

Interdigital Areas II, III, and IV

Table LII presents percentage frequencies of patterns both by hand (separately as well as combined) and sex for each of the three interdigital areas of the palm. These data are presented graphically in Figures 37 and 38 (interdigital area II, males and females respectively), 39 and 40 (interdigital area III), and 41 and 42 (interdigital area IV). Interdigital area II is characterized by an extremely low percentage of patterns for all groups; the Tsimshian males and the Nootka, Kwakiutl and Athapaskan females show no patterns in this area at all. As such, this area has little, if any comparative value.

In interdigital area III, right hands have consistently larger percentages of patterns than left hands and females tend to have larger percentages than their male counterparts. However, for this latter comparison, it will be noted that the Kwakiutl males in two of the three categories and the Athapaskan in all categories exhibit larger percentages of patterns than their female counterparts. For males, the

TABLE LII: Percentage Frequencies of Patterns (Including Vestiges) for Each of the Four Samples in the Three Interdigital Areas of the Palm by Hand (Separately as well as Combined) and by Sex

Interdigital Area	Sex	Sample	Patterns Left	Patterns Right	Patterns Combined	Open Fields Combined	Number of Palms Left	Number of Palms Right	Number of Palms Combined
II	M	NOO	-	4.8	2.4	97.6	42	42	84
		KWAK	2.5	2.5	2.5	97.5	40	40	80
		TSIM	-	-	-	100.0	20	20	40
		ATHA	-	2.5	1.3	98.7	81	81	162
	F	NOO	-	-	-	100.0	32	32	64
		KWAK	-	-	-	100.0	25	25	50
		TSIM	-	6.7	3.4	96.6	15	15	30
		ATHA	-	-	-	100.0	68	68	136
III	M	NOO	14.3	42.9	28.6	71.4	42	42	84
		KWAK	17.5	40.0	28.8	71.2	40	40	80
		TSIM	15.0	30.0	22.5	77.5	20	20	40
		ATHA	29.6	56.8	43.2	56.8	81	81	162
	F	NOO	28.1	50.0	39.1	60.9	32	32	64
		KWAK	20.0	32.0	26.0	74.0	25	25	50
		TSIM	38.3	53.3	43.3	56.7	15	15	30
		ATHA	25.0	45.6	35.3	64.7	68	68	136
IV	M	NOO	73.8	61.9	67.9	32.1	42	42	84
		KWAK	67.5	47.5	57.5	42.5	40	40	80
		TSIM	70.0	50.0	60.0	40.0	20	20	40
		ATHA	63.0	33.3	48.2	51.8	81	81	162
	F	NOO	59.4	43.7	51.6	48.4	32	32	64
		KWAK	64.0	52.0	58.0	42.0	25	25	50
		TSIM	60.0	26.7	43.4	56.6	15	15	30
		ATHA	60.3	47.1	53.7	46.3	68	68	136

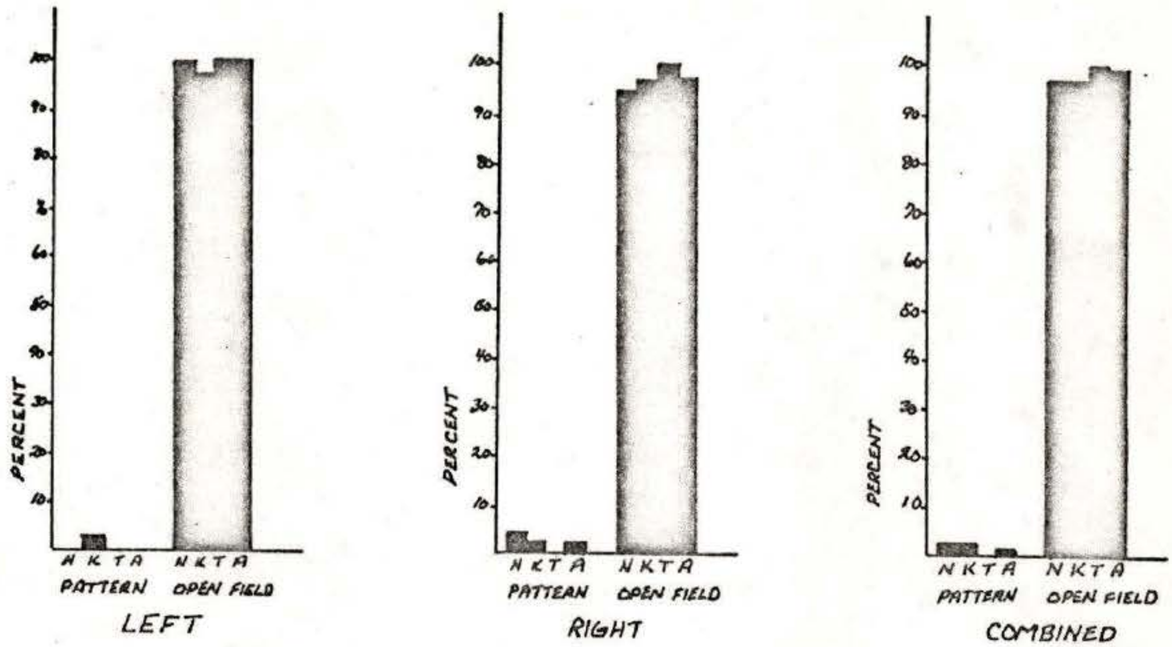


Figure 37. Distribution of patterns and open fields for males by group and hand (separately as well as combined) in the interdigital area II of the palm.

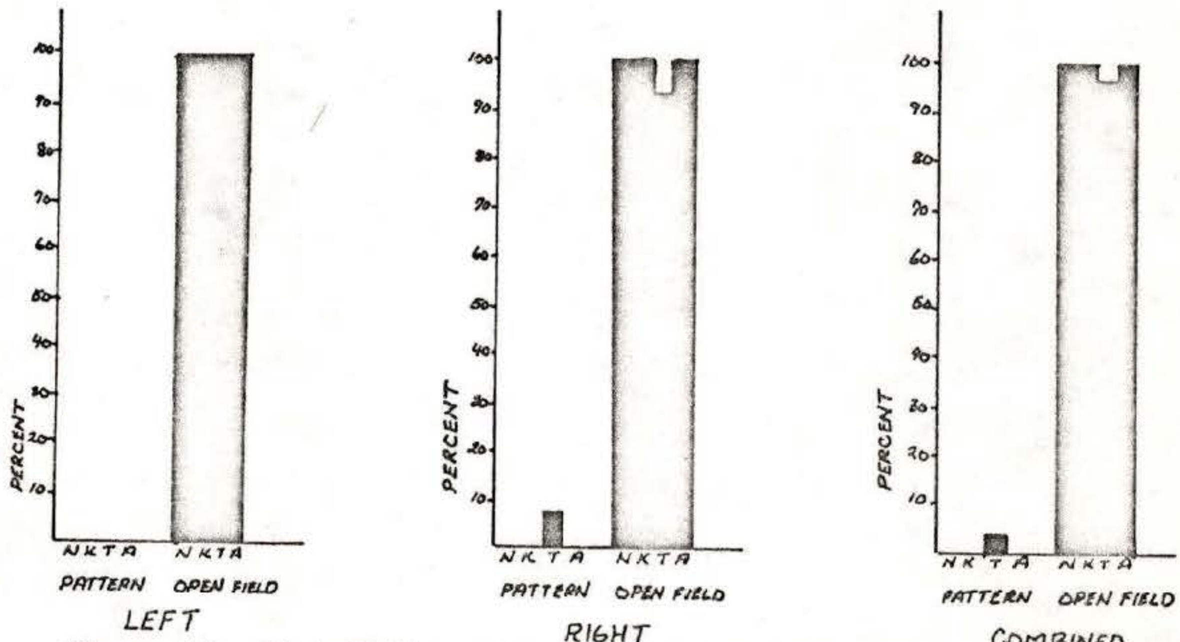


Figure 38. Distribution of patterns and open fields for females by group and hand (separately as well as combined) in the interdigital area II of the palm.

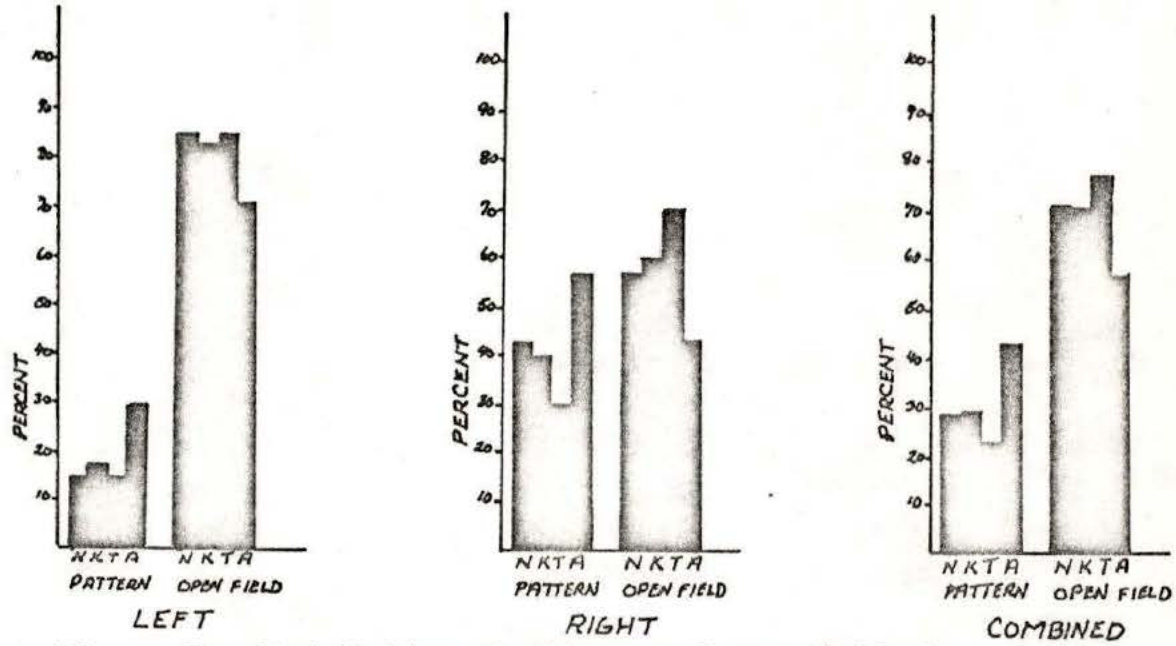


Figure 39. Distribution of patterns and open fields for males by group and hand (separately as well as combined) in the interdigital area III of the palm.

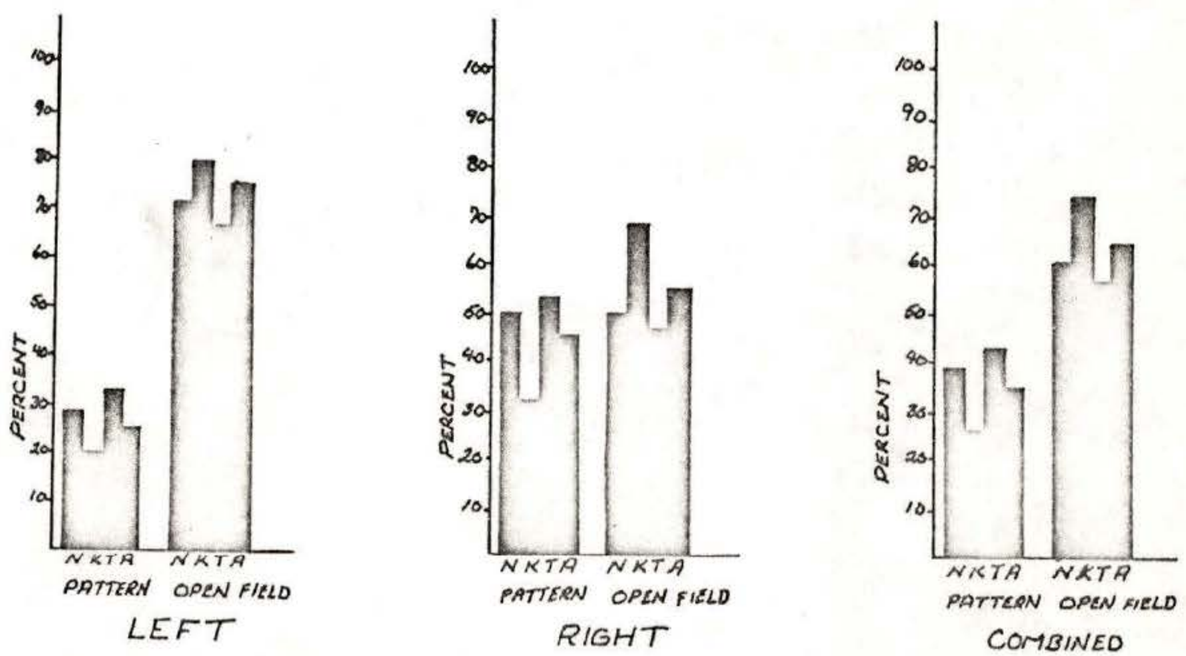


Figure 40. Distribution of patterns and open fields for females by group and hand (separately as well as combined) in the interdigital area III of the palm.

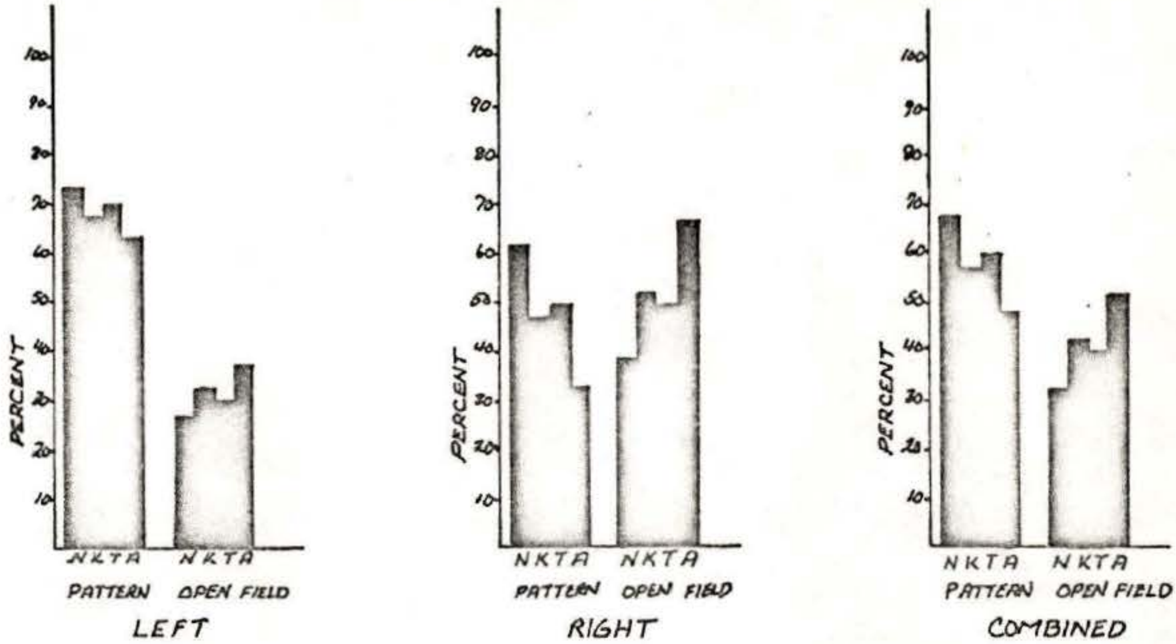


Figure 41. Distribution of patterns and open fields for males by group and hand (separately as well as combined) in the interdigital area IV of the palm.

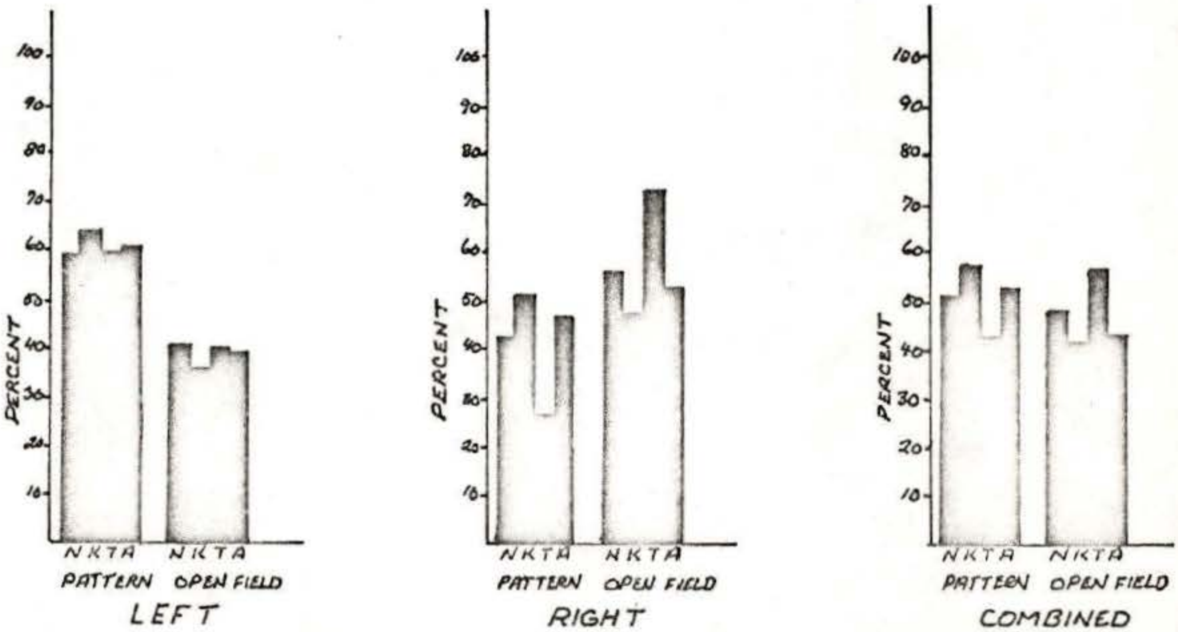


Figure 42. Distribution of patterns and open fields for females by group and hand (separately as well as combined) in the interdigital area IV of the palm.

Tsimshian, on the average, exhibit the lowest percentage of patterns and the Athapaskan the highest. The Nootka and Kwakiutl possess very similar percentages in all three categories, although they are closer to the Tsimshian than to the Athapaskan. For females, the Kwakiutl exhibit the lowest percentage of patterns and the Tsimshian the highest. The Athapaskan and Nootka possess similar percentages and occupy a position intermediate between the Kwakiutl and Tsimshian extremes.

In interdigital area IV, left hands have consistently larger percentages than right hands, a situation directly opposite that found in area III. Further, there is a slight tendency for males to exhibit larger percentages of patterns than their female counterparts. There are exceptions, but they correspond directly with those noted in area III. Again, the Kwakiutl and Athapaskan males are the exception. Both of these groups exhibit lower percentages than their female counterparts in two of the three categories. Although the general relationship between males and females for these two areas is reversed, the exceptions noted in both cases involve precisely the same to groups. Further peculiarities appear when the interrelationships of the four groups are examined. For males, the Athapaskan consistently exhibit the lowest percentage of patterns (highest in area III) and the Nootka the highest. The Kwakiutl and Tsimshian possess similar percentages in all three categories and lie intermediate between the Nootka and Athapaskan extremes, although their percentages are more closely associated with those of the Nootka than with those of the Athapaskan. For females, the Tsimshian, on the average, exhibit the lowest percentages of patterns (highest in area III) and the Kwakiutl the highest (lowest in area III). The Nootka and Athapaskan are again intermediate in terms of percentages expressed for each of the four groups.

Total chi-squares were calculated for the frequency distributions of patterns and open fields in four of the five configurational areas of the palm (no chi-square value was calculated in interdigital area I). This area, as previously noted, is characterized by its almost total lack of patterns, particularly among the female samples, and is, therefore, excluded. The frequency distributions analyzed for each of the four samples involve only those for the combined hand category. The sexes are once again treated separately.

Of the various palmar area frequency distributions only two yield total chi-square values that are statistically significant: male distributions for thenar/interdigital area I (see Table LV) and interdigital area III (see Table LVII). Although none of the other distributions are significant, females in the thenar/interdigital I area approach significance at the 0.05 level (see Table LVI). The Nootka again contribute substantially, as do the Kwakiutl, to the highly significant chi-square for the distribution of patterns and open fields in the thenar/interdigital I area. For the distribution in interdigital area III, it is the Athapaskan that contribute most to the total chi-square. In both areas, the differences in the distribution of patterns are greater than those of open fields. In all areas, the chi-square values for males are larger than those for the females, indicating that the males exhibit a greater degree of difference in the distribution of patterns and open fields than do the females. The same observation was made concerning the distribution of specific pattern types for digits.

Within the five palmar areas, there is very little in the way of evidence that might prove useful in the elucidation of possible

TABLE LIII: Frequency Distributions of Patterns and Open Fields in the Hypothenar Area of the Palm and Values of χ^2 for Males Left and Right Hands Combined

Sample	Frequency	Patterns	Open Fields	Total
Nootka	o	9	75	84
	e	10.1	73.9	
	χ^2	0.035a	0.016	0.051
Kwakiutl	o	12	68	80
	e	9.6	70.4	
	χ^2	0.6	0.082	0.682
Tsimshian	o	8	32	40
	e	4.8	35.2	
	χ^2	1.518a	0.291	1.809
Athapaskan	o	15	147	162
	e	19.5	142.5	
	χ^2	1.038	0.142	1.180
Total	o	44	322	366
	χ^2	3.191	0.531	3.722

[a] Yates' correction for continuity used

χ^2 = 3.722
d.f. = 3
P $<$ 0.30

TABLE LIV: Frequency Distributions of Patterns and Open Fields in the Hypothenar Area of the Palm and Values of χ^2 for Females Left and Right Hands Combined

Sample	Frequency	Patterns	Open Fields	Total
Nootka	o	8	56	64
	e	12.8	51.2	
	χ^2	1.444a	0.45	1.894
Kwakiutl	o	13	37	50
	e	10	40	
	χ^2	0.9	0.225	1.125
Tsimshian	o	7	23	30
	e	6	24	
	χ^2	0.041a	0.042	0.083
Athapaskan	o	28	108	136
	e	27.2	108.8	
	χ^2	0.024	0.006	0.03
Total	o	56	224	280
	χ^2	2.409	0.723	3.132

[a] Yates' correction for continuity used

$\chi^2 = 3.132$
d.f. = 3
$P < 0.50$

TABLE LV: Frequency Distributions of Patterns and Open Fields in the Thenar/Interdigital I Area of the Palm and Values of χ^2 for Males Left and Right Hands Combine

Sample	Frequency	Patterns	Open Fields	Total
Nootka	o	39	45	84
	e	25.0	59	
	χ^2	7.84	3.322	11.162
Kwakiutl	o	21	59	80
	e	23.8	56.2	
	χ^2	0.329	0.139	0.468
Tsimshian	o	4	36	40
	e	11.9	28.1	
	χ^2	4.601a	2.221	6.822
Athapaskan	o	45	117	162
	e	48.2	113.8	
	χ^2	0.212	0.09	0.302
Total	o	109	257	366
	χ^2	12.982	5.772	18.754

[a] Yates' correction for continuity used

χ^2 = 18.754
d.f. = 3
P $<$ 0.001

TABLE LVI: Frequency Distributions of Patterns and Open Fields in the Thenar/Interdigital I Area of the Palm and Values of χ^2 for Females Left and Right Hands Combined

Sample	Frequency	Patterns	Open Fields	Total
Nootka	o	25	39	64
	e	23.5	40.5	
	χ^2	0.096	0.056	0.152
Kwakiutl	o	11	39	50
	e	18.4	31.6	
	χ^2	2.976	1.733	4.709
Tsimshian	o	10	20	30
	e	11	19	
	χ^2	0.022a	0.053	0.075
Athapaskan	o	57	79	136
	e	50	86	
	χ^2	0.98	0.57	1.55
Total	o	103	177	280
	χ^2	4.074	2.412	6.486

[a] Yates' correction for continuity used

χ^2 = 6.486
d.f. = 3
$P < 0.10$

TABLE LVII: Frequency Distributions of Patterns and Open Fields in Interdigital Area III of the Palm and Values of χ^2 for Males Left and Right Hands Combined

Sample	Frequency	Patterns	Open Fields	Total
Nootka	o	24	60	84
	e	28.7	55.3	
	χ^2	0.77	0.399	1.169
Kwakiutl	o	23	57	80
	e	27.3	52.7	
	χ^2	0.677	0.432	1.109
Tsimshian	o	9	31	40
	e	13.7	26.3	
	χ^2	1.287a	0.84	2.127
Athapaskan	o	69	93	162
	e	55.3	106.7	
	χ^2	3.394	1.759	5.153
Total	o	125	241	366
	χ^2	6.128	3.43	9.558

[a] Yates' correction for continuity used

$\chi^2 = 9.558$
d.f. = 3
$P < 0.05$

TABLE LVIII: Frequency Distributions of Patterns and Open Fields in Interdigital Area III of the Palm and Values of χ^2 for Females Left and Right Hands Combined

Sample	Frequency	Patterns	Open Fields	Total
Nootka	o	25	39	64
	e	22.6	41.4	
	χ^2	0.255	0.139	0.394
Kwakiutl	o	13	37	50
	e	17.7	32.3	
	χ^2	1.248	0.684	1.932
Tsimshian	o	13	17	30
	e	10.6	19.4	
	χ^2	0.543	0.297	0.84
Athapaskan	o	48	88	136
	e	48.1	87.9	
	χ^2	0.000	0.000	0.000
Total	o	99	181	280
	χ^2	2.046	1.12	3.166

$\chi^2 = 3.166$
d.f. = 3
$P < 0.50$

TABLE LIX: Frequency Distributions of Patterns and Open Fields in Interdigital Area IV of the Palm and Values of χ^2 for Males Left and Right Hands Combined

Sample	Frequency	Patterns	Open Fields	Total
Nootka	o	57	27	84
	e	47	37	
	χ^2	2.128	2.703	4.831
Kwakiutl	o	46	34	80
	e	44.8	35.2	
	χ^2	0.032	0.041	0.073
Tsimshian	o	24	16	40
	e	22.4	17.6	
	χ^2	0.114	0.145	0.259
Athapaskan	o	78	84	162
	e	90.7	71.3	
	χ^2	0.08	0.102	0.182
Total	o	205	161	366
	χ^2	2.354	2.991	5.345

$\chi^2 = 5.345$
d.f. = 3
$P < 0.20$

TABLE LX: Frequency Distributions of Patterns and Open Fields in Interdigital Area IV of the Palm and Values of χ^2 for Females Left and Right Hands Combined

Sample	Frequency	Patterns	Open Fields	Total
Nootka	o	33	31	64
	e	33.8	30.2	
	χ^2	0.019	0.021	0.04
Kwakiutl	o	29	21	50
	e	26.4	23.6	
	χ^2	0.256	0.286	0.542
Tsimshian	o	13	17	30
	e	15.9	14.1	
	χ^2	0.529	0.596	1.125
Athapaskan	o	73	63	136
	e	71.9	64.1	
	χ^2	0.017	0.019	0.036
Total	o	148	132	280
	χ^2	0.821	0.922	1.743

$\chi^2 = 1.743$
d.f. = 3
$P < 0.70$

relationships between any of the four groups. Although the results are generally of an ambiguous nature, a number of points can be made. In the following areas, the Nootka and Athapaskan are more closely associated with one another in terms of percentage frequencies than either is to the Kwakiutl or Tsimshian groups: hypothenar: males and females; thenar/interdigital I: females only; interdigital area III: females only; and interdigital area IV: females only. Similarly, the Kwakiutl and Tsimshian are more closely associated with one another than either is to the Nootka or Athapaskan in the following areas: hypothenar: males and females; thenar/interdigital I: females only; and interdigital area IV: males only. Associations other than these also are apparent. In the thenar/interdigital I area, the Athapaskan and Kwakiutl males exhibit very similar percentages, neither one associated with either the Tsimshian or Nootka. In interdigital area III, the Kwakiutl and Nootka exhibit similar percentages. From these associations, there emerges some support for the associations previously noted with other measures that suggest relationships between the Kwakiutl and Tsimshian and between the Nootka and Athapaskan. In a later section of this chapter the evidence will be summarized and evaluated.

Plantar Dermatoglyphics

The sole is commonly divided into seven configurational areas (Cummins and Midlo 1961:121, 122): thenar, calcar, hallucal (distal and thenar and first interdigital combined), and interdigital areas II, III and IV (see Figure 43). All seven areas were examined. Only the calcar area was found to be patternless in all individuals examined and, hence, no purpose is served by its inclusion in the analysis. As with the configurational areas of the palm, there can occur particularized configurations as opposed to patternless configurations (open fields) in the sole. For five of the six plantar areas analyzed (hypothenar, thenar, and interdigital areas II, III and IV), a twofold classification, identical to the one used for all palmar areas, has been employed, i. e., patterns as opposed to open fields. I originally devised and used in the computational analysis of interdigital areas II, III and IV a sixfold classification of specific configurations but condensed it to simply patterns and open fields after examining the results, i.e., many of the categories contained such small frequencies that comparative analysis was virtually impossible. The hypothenar and thenar/interdigital I areas with respect to categories have not been modified in any way (see Appendix II). Categories for the hallucal area have been slightly modified; two loop categories have been combined to form a single loop category (see Appendix II). A classification of four categories has been employed in the analysis of the hallucal area. For a more complete discussion of plantar dermatoglyphics, see Cummins and Midlo (1961:120-132).

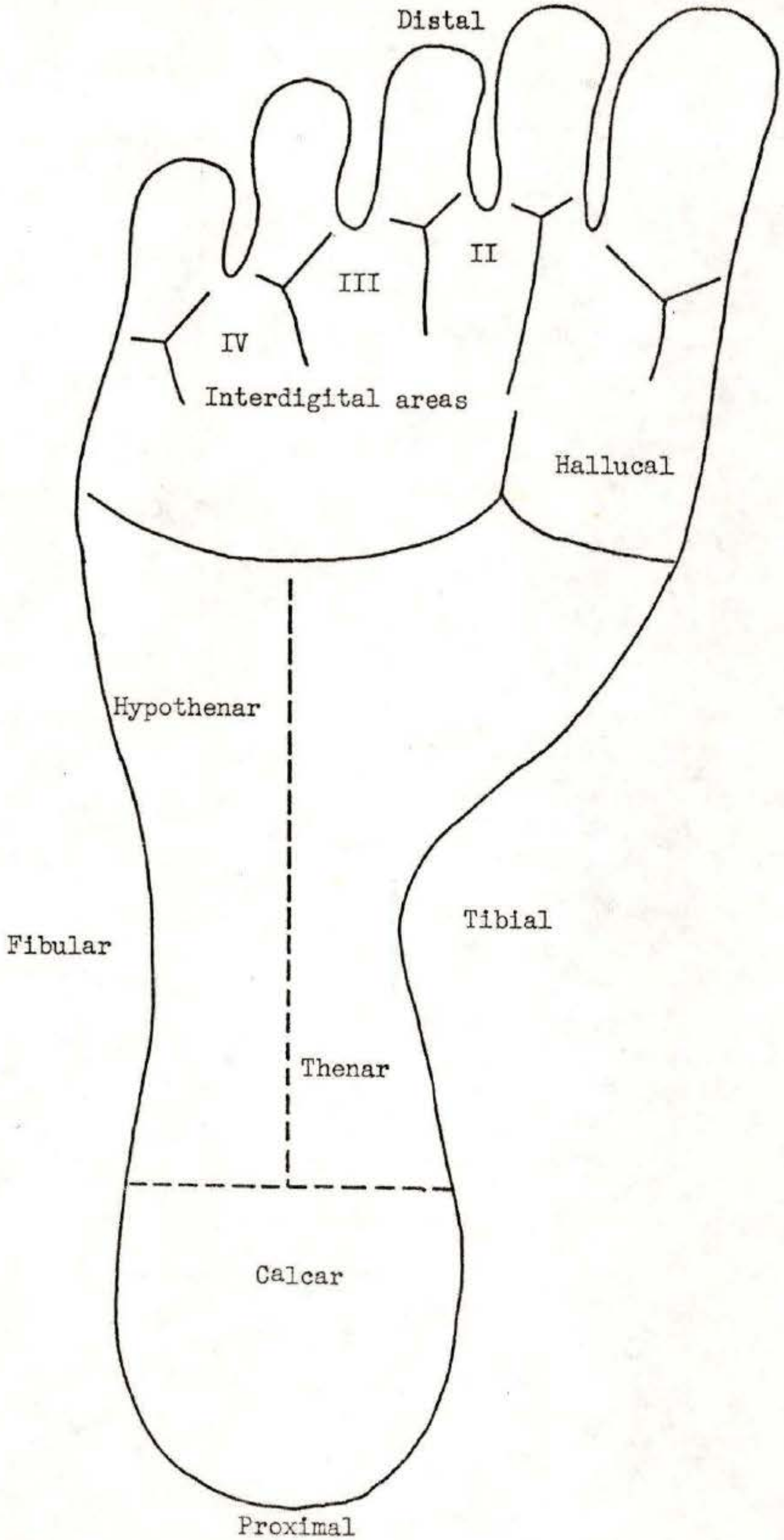


Figure 43. Topography of plantar configurational areas.
(After Cummins and Midlo 1961:120)

Pattern Areas

Hallucal Area

The percentage frequencies of specific pattern types in the hallucal area by both feet (separately as well as combined) and sex is presented in Table LXI. These data are presented graphically in Figures 44 (male: feet separately), 45 (male: feet combined), 46 (female: feet separately), and 47 (female: feet combined). It will be noted that loops are far more abundant than whorls in all groups and that whorls, in turn, are more abundant than arches except in the right foot category for Nootka females (see Table LXI). Arches and whorls tend to be more abundant on left feet than right, while loops tend to be more abundant on right feet than left. Concerning the distribution of pattern types by sex, it will be noted that Nootka females have a larger percentage of arches and loops, and males a larger percentage of whorls. The Kwakiutl females have a larger percentage of loops and their male counterparts a larger percentage of arches and whorls (except for the right foot category). Both the Tsimshian and Athapaskan males have larger percentages of arches and loops while their female counterparts possess larger percentages of whorls.

In a general way the relative positions of certain groups with respect to the distribution of hallucal pattern types can be noted (see Table LXI). For example, the Tsimshian (both males and females) exhibit the highest percentage of whorls and the lowest percentage of loops in all categories except for the male left foot category. For males, the lowest percentage of whorls is exhibited by the Athapaskan (on the average) and for females by the Nootka. The Nootka and Kwakiutl males are intermediate as are the Athapaskan and Kwakiutl females. The

TABLE LXI: Percentage Frequencies of Pattern Types for Each of the Four Samples in Hallucal Area of the Sole by Feet (Separately as well as Combined) and Sex

		Pattern Types													Number of Soles		
		Whorls			Loops			Arches			Other						
Sex	Sample	Left	Right	Combined	Left	Right	Combined	Left	Right	Combined	Left	Right	Combined	L	R	C
M	NOO	16.7	14.3	15.5	69.1	73.8	71.5	2.4	7.1	4.8	11.9	4.8	8.4	42	42	84
	KWAK	27.5	7.5	17.5	67.5	82.5	75.0	5.0	10.0	7.5	-	-	-	40	40	80
	TSIM	25.0	25.0	25.0	70.0	65.0	67.5	5.0	10.0	7.5	-	-	-	20	20	40
	ATHA	18.5	8.6	13.6	72.8	80.3	76.6	7.4	9.9	8.7	1.2	1.2	1.2	81	81	162
F	NOO	9.4	9.4	9.4	78.1	78.1	78.1	3.1	12.5	7.8	9.4	-	4.7	32	32	64
	KWAK	16.0	16.0	16.0	80.0	80.0	80.0	4.0	-	2.0	-	4.0	2.0	25	25	50
	TSIM	33.3	40.0	36.7	66.7	60.0	63.4	-	-	-	-	-	-	15	15	30
	ATHA	25.0	13.2	19.1	69.1	79.4	74.3	2.9	4.4	3.7	2.9	2.9	2.9	68	68	136

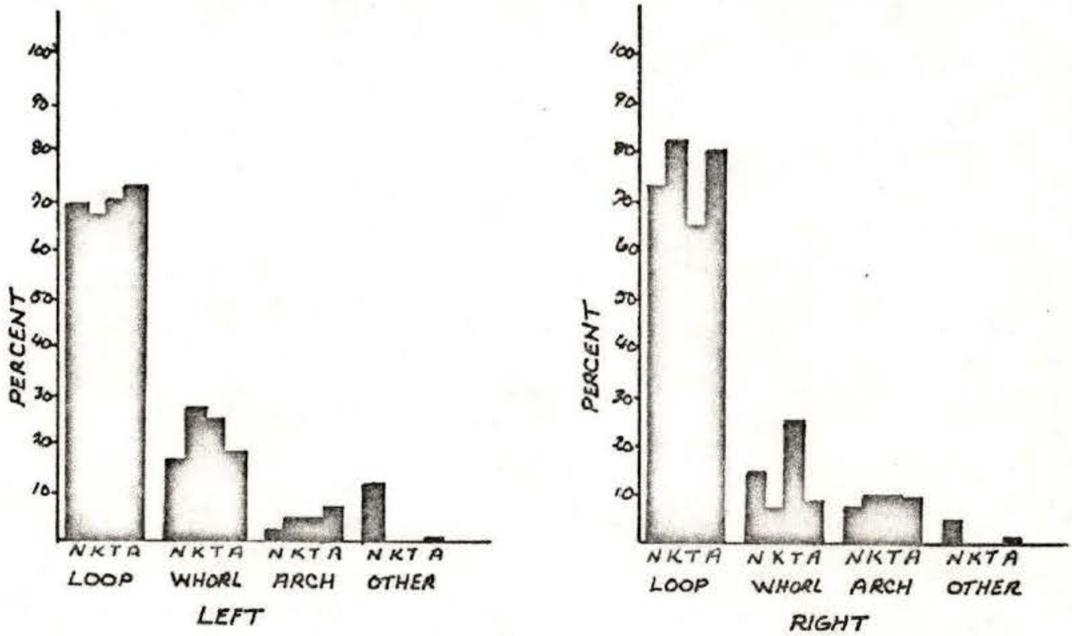


Figure 44. Distribution of pattern types for males by group and feet (left and right) in the hallucal area of the sole.

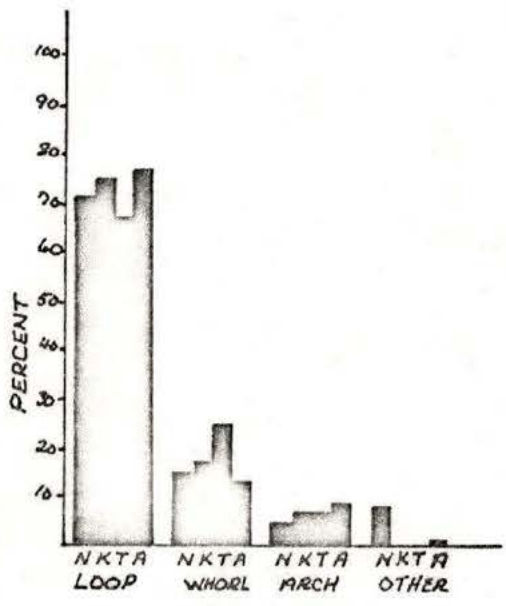
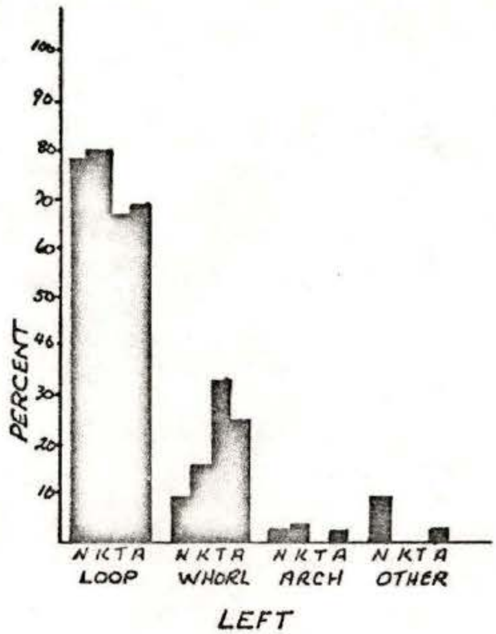


Figure 45. Distribution of pattern types for males by group and feet (combined) in the hallucal area of the sole.



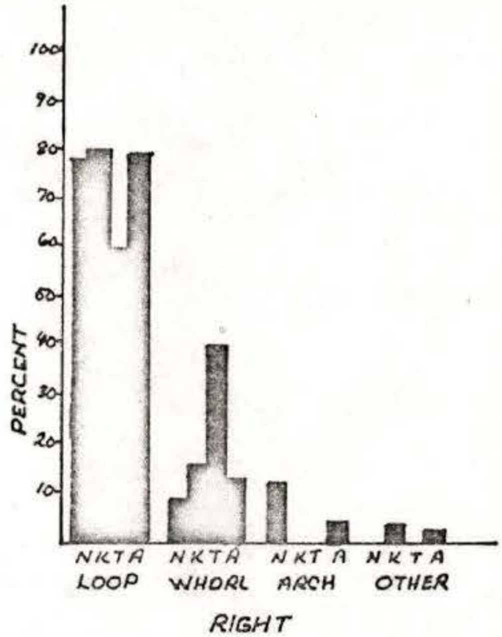


Figure 46. Distribution of pattern types for females by group and feet (left and right) in the hallucal area of the sole.

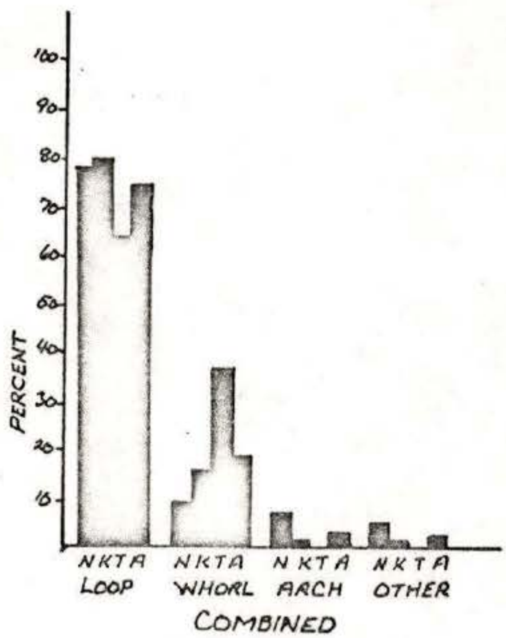


Figure 47. Distribution of pattern types for females by group and feet (combined) in the hallucal area of the sole.

highest percentage of loops for males (on the average) is exhibited by the Athapaskan and for females by the Kwakiutl. For males, the Nootka and Kwakiutl are intermediate (on the average) and for females, the Nootka and Athapaskan. In the arch category for males, the Nootka exhibit the lowest percentage and the Athapaskan (on the average) the highest. For females, the Tsimshian exhibit the lowest percentage and the Nootka (on the average) the highest. The Tsimshian and Kwakiutl are intermediate for the males and for the females, Kwakiutl and Athapaskan.

Interdigital Areas II, III, and IV

Table LXII presents the percentage frequencies of patterns (including vestiges) and open fields in the three interdigital areas of the sole. The data are categorized according to feet (separately as well as combined) and sex for each of the four groups. The distribution of patterns and open fields in each of the four groups is shown graphically by feet and sex in Figures 48 and 49 (area II), 50 and 51 (area III), and 52 and 53 (area IV). In interdigital area II, left feet tend to possess larger percentages than right. A comparison of sexual differences indicates that the Nootka and Athapaskan males possess larger pattern percentages than their female counterparts and conversely, Kwakiutl and Tsimshian females possess larger percentages than the two corresponding male groups. Among males, the Tsimshian, due to the absence of patterns, consistently exhibit the lowest percentages while the Nootka exhibit the highest. The Athapaskan and the Kwakiutl are intermediate between the Tsimshian and Nootka extremes. For females, the group order is very nearly the reverse of that found for the males: the Nootka (on the average) exhibit the lowest percentage of patterns and the Kwakiutl the highest. Again, the Athapaskan are intermediate

TABLE LXII: Percentage Frequencies of Patterns (Including Vestiges) and Open Fields for Each of the Four Samples in the Three Interdigital Areas of the Sole by Feet (Separately as well as Combined) and Sex

Interdigital Area	Sex	Sample	Patterns			Open Fields	Number of Soles		
			Left	Right	Combined	Combined	Left	Right	Combined
II	M	NOO	33.3	26.2	29.8	70.2	42	42	84
		KWAK	12.5	15.0	13.8	86.2	40	40	80
		TSIM	-	-	-	100.0	20	20	40
		ATHA	23.5	22.2	22.9	77.1	81	81	162
	F	NOO	3.1	12.5	7.8	92.2	32	32	64
		KWAK	24.0	20.0	22.0	78.0	25	25	50
		TSIM	13.3	6.7	10.0	90	15	15	30
		ATHA	17.6	13.2	15.4	84.6	68	68	136
III	M	NOO	66.7	61.9	64.3	35.7	42	42	84
		KWAK	65.0	67.5	66.3	33.7	40	40	80
		TSIM	75.0	70.0	72.5	27.5	20	20	40
		ATHA	81.5	86.4	83.9	16.1	81	81	162
	F	NOO	71.9	68.7	70.3	29.7	32	32	64
		KWAK	52.0	52.0	52.0	48.0	25	25	50
		TSIM	46.7	60.0	53.4	46.6	15	15	30
		ATHA	63.2	67.6	65.4	34.6	68	68	136
IV	M	NOO	26.2	26.2	26.2	73.8	42	42	84
		KWAK	27.5	17.5	22.5	77.5	40	40	80
		TSIM	10.0	25.0	17.5	82.5	20	20	40
		ATHA	12.3	21.0	16.7	83.3	81	81	162
	F	NOO	12.5	15.6	14.1	85.9	32	32	64
		KWAK	16.0	12.0	14.0	86.0	25	25	50
		TSIM	6.7	-	3.4	96.6	15	15	30
		ATHA	7.4	13.3	10.4	89.6	68	68	136

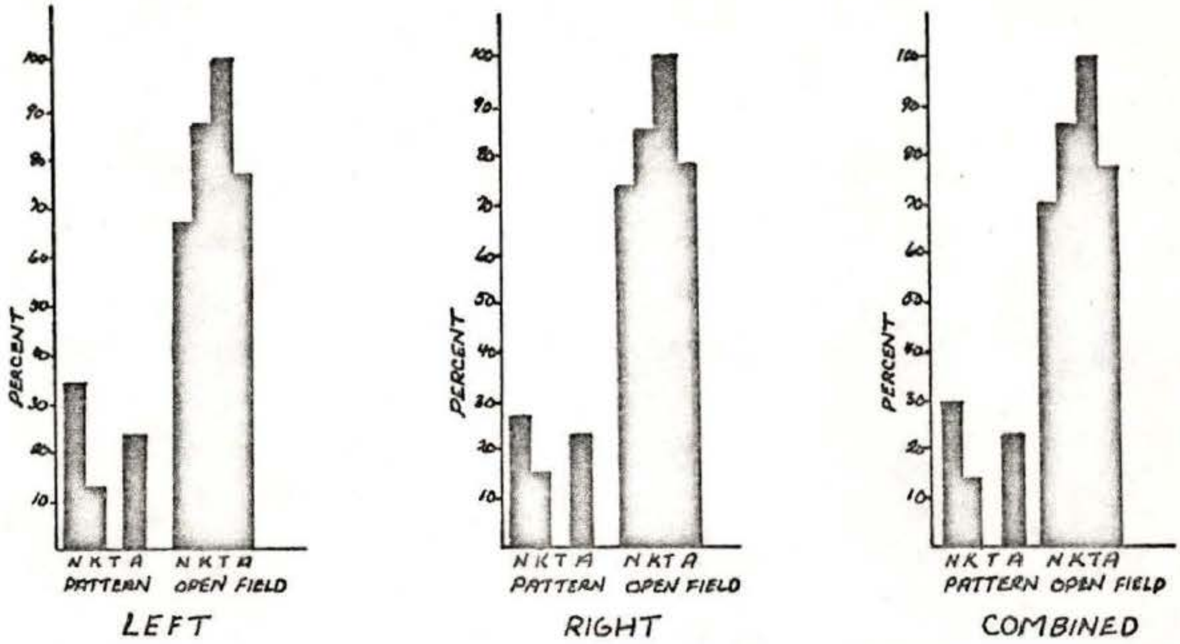


Figure 48. Distribution of patterns and open fields for males by group and feet (separately as well as combined) in interdigital area II of the sole.

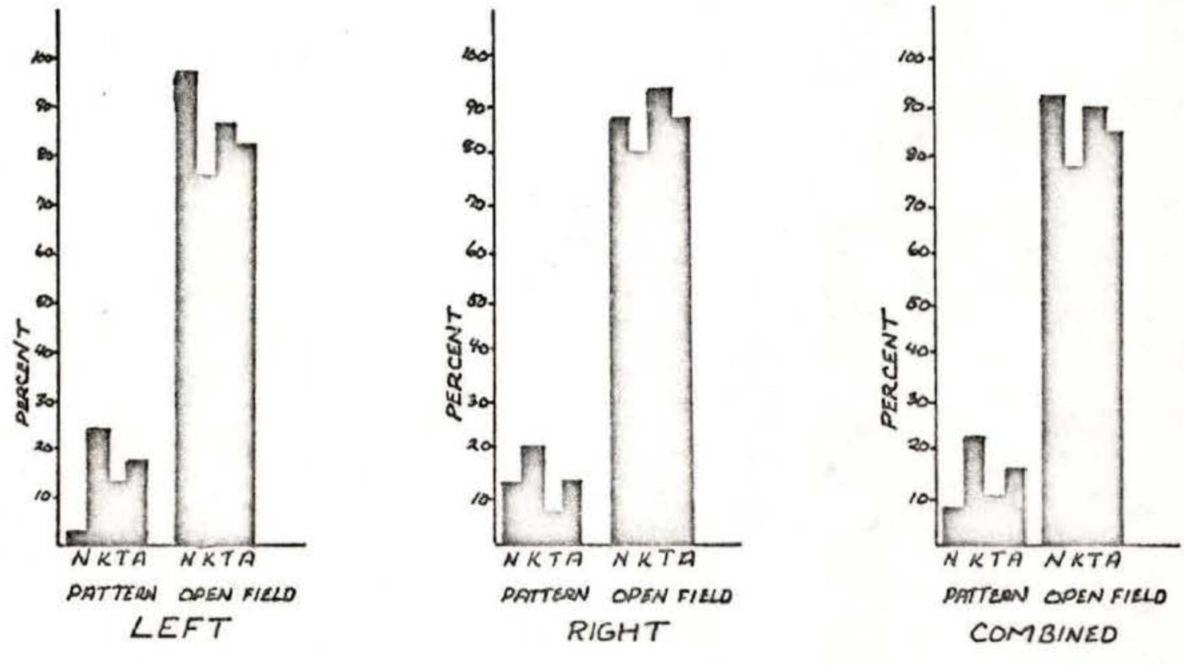


Figure 49. Distribution of patterns and open fields for females by group and feet (separately as well as combined) in interdigital area II of the sole.

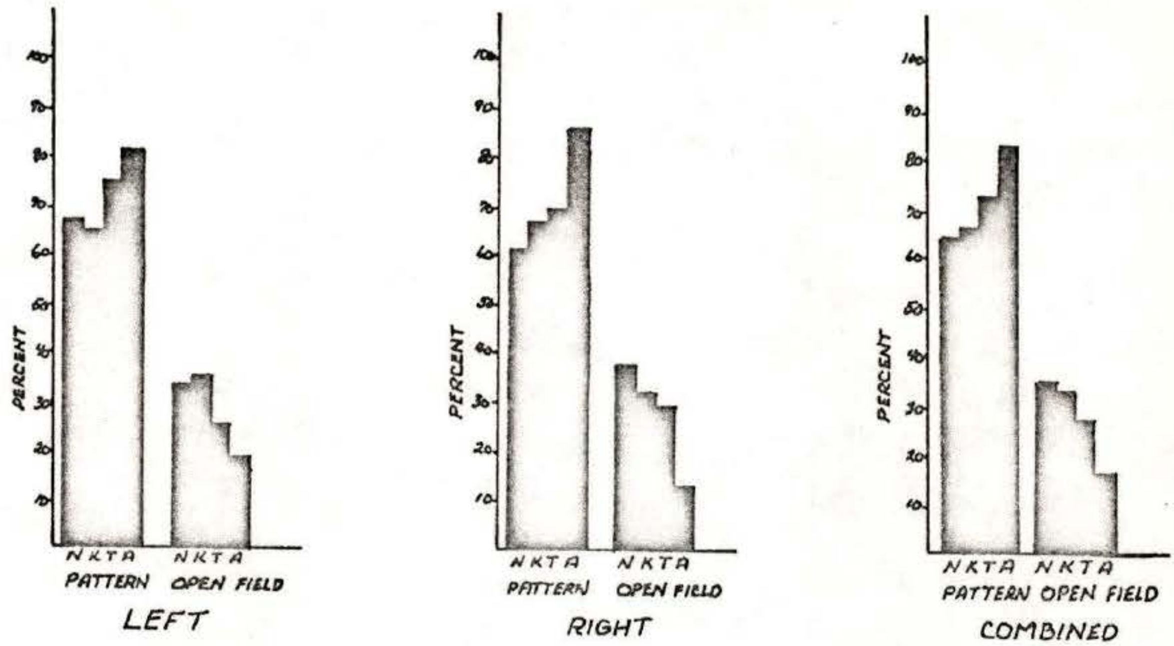


Figure 50. Distribution of patterns and open fields for males by group and feet (separately as well as combined) in interdigital area III of the sole.

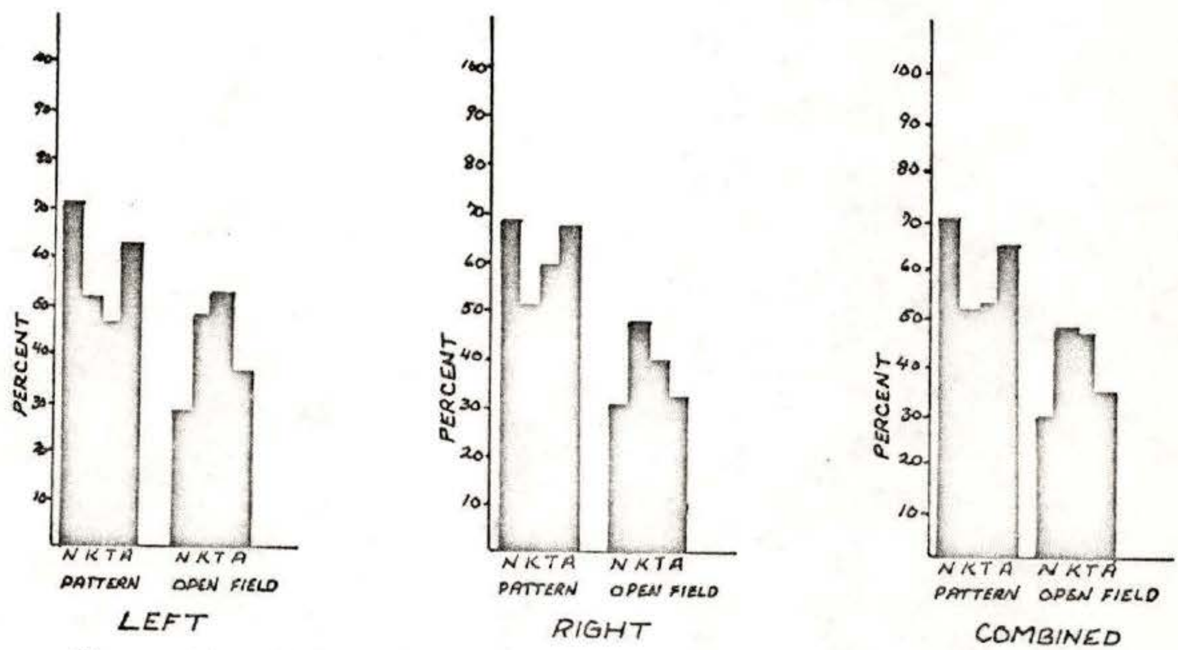


Figure 51. Distribution of patterns and open fields for females by group and feet (separately as well as combined) in interdigital area III of the sole.

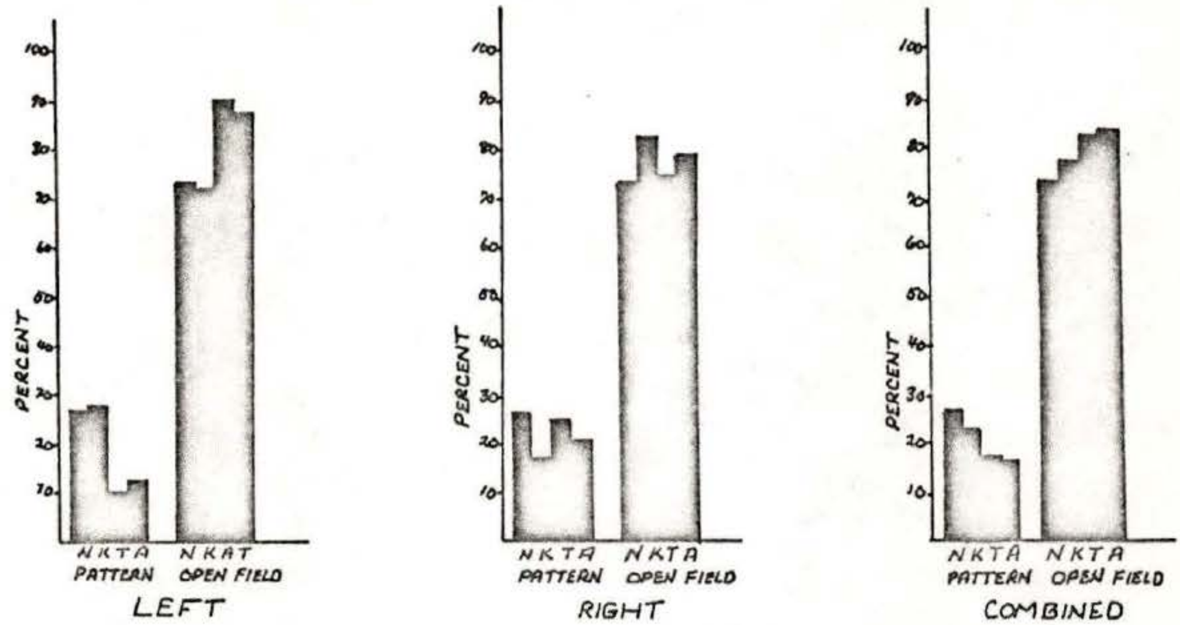


Figure 52. Distribution of patterns and open fields for males by group and feet (separately as well as combined) in interdigital area IV of the sole.

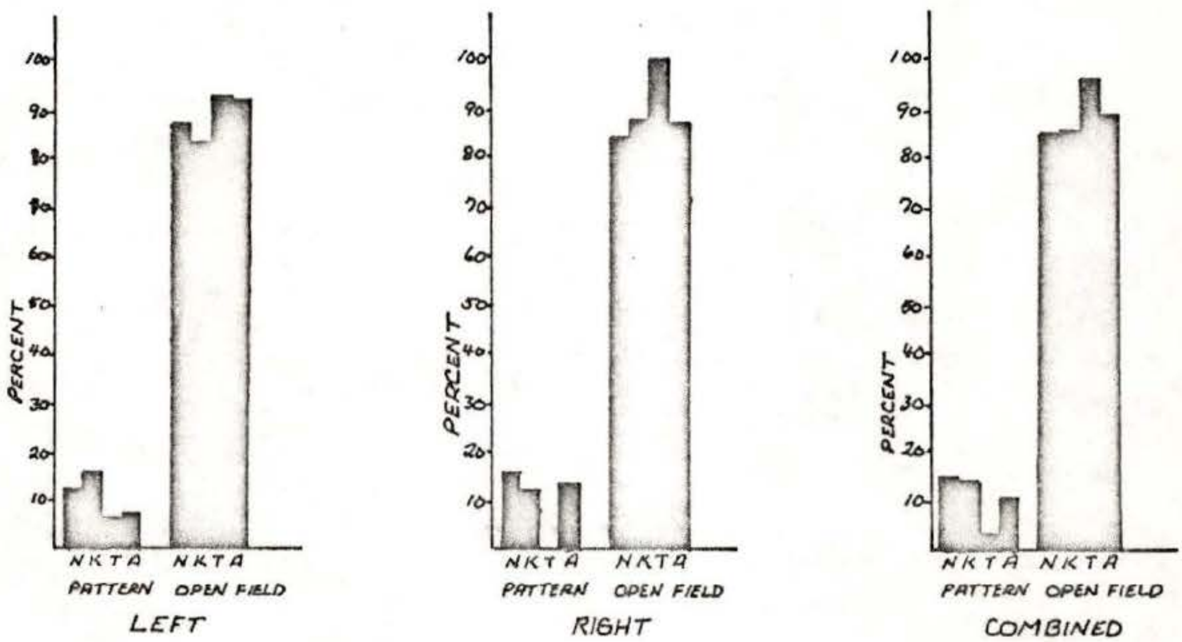


Figure 53. Distribution of patterns and open fields for females by group and feet (separately as well as combined) in interdigital area IV of the sole.

as are the Tsimshian.

In interdigital area III, there is a slight tendency for right feet to possess a larger percentage of patterns than the left. However, this is not true for the Nootka (males and females) or Tsimshian males. Further, it was found that males possess larger percentages of patterns than females in all groups except the Nootka. Among males, the Nootka (on the average) possess the lowest percentages of patterns and the Athapaskan the highest; the Tsimshian and Kwakiutl are intermediate. For females, the Kwakiutl (on the average) exhibit the lowest percentages and the Nootka the highest with the Athapaskan and Tsimshian intermediate.

In interdigital area IV, there is again a slight tendency for right feet to exhibit larger percentages than left feet. The Kwakiutl males are again an exception along with the Kwakiutl and Tsimshian females. Males, in a comparison of sexual differences, consistently exhibit larger percentages than their female counterparts. Among males, the Athapaskan (on the average) exhibit the lowest percentages of patterns of the four groups while the Nootka, (on the average) exhibit the highest. For females, the Nootka again exhibit the highest percentages (on the average) and the Tsimshian the lowest.

The relative positioning of groups with respect to the percentage frequencies of patterns exhibited in each of the three interdigital areas is by no means clear (see Table LXII). No clear pattern emerges for any of the interdigital areas either by sex or area when each is examined separately or when all three are examined as a unit. Consistent clustering of two or more groups is also conspicuously absent.

Thenar and Hypothenar Areas

The percentage frequencies of patterns (including vestiges) and open fields, in the thenar and hypothenar areas of the sole and presented in Table LXIII, are categorized by group, feet (separately as well as combined) and sex. The distribution of these data are shown graphically by group, feet and sex in Figures 54 and 55 (thenar area) and 56 and 57 (hypothenar area).

The thenar area is characterized by either an extremely low percentage of patterns or absent entirely and, as such is of little or no comparative value. For the left foot, only the Kwakiutl and Athapaskan (both males and females) exhibit patterns and for the right only the Athapaskan females.

There is a definite increase in the percentages of patterns in the hypothenar area. Patterns tend to be slightly more abundant on left feet than right, and females tend to exhibit larger percentages than their male counterparts. For males, the Nootka consistently exhibit the lowest percentages of patterns and the Athapaskan (on the average) the highest; for females, the Nootka again exhibit the lowest percentages and the Kwakiutl the highest. The Athapaskan females and Kwakiutl males are consistently intermediate, along with the Tsimshian (males and females) in their respective sex categories. There is no apparent clustering of groups in this plantar area.

Total chi-squares were calculated for five of the six plantar configurational areas and the results obtained are presented in Tables LXIV and LXV (hallucal: males and females respectively), LXVI and LXVII (interdigital area II), LXVIII and LXIX (interdigital area II), LXX and LXXI (interdigital area IV), and LXXII and LXXIII (hypothenar).

TABLE LXIII: Percentage Frequencies of Patterns (Including Vestiges) and Open Fields for each of the Four Samples in Thenar and Hypothenar Areas of the Sole by Feet (Separately as well as Combined) and Sex

Area	Sex	Sample	Patterns			Open Fields	Number of Soles		
			Left	Right	Combined	Combined	Left	Right	Combined
Thenar	M	NOO	-	-	-	100.0	42	42	84
		KWAK	2.5	-	1.3	98.7	40	40	80
		TSIM	-	-	-	100.0	20	20	40
		ATHA	2.5	-	1.3	98.7	81	81	162
	F	NOO	-	-	-	100.0	32	32	64
		KWAK	4.0	-	2.0	98.0	25	25	50
		TSIM	-	-	-	100.0	15	15	30
		ATHA	1.5	1.5	1.5	98.5	68	68	136
Hypothenar	M	NOO	11.9	19.1	15.5	84.5	42	42	84
		KWAK	27.5	20.0	23.8	76.2	40	40	80
		TSIM	20.0	25.0	22.5	77.5	20	20	40
		ATHA	30.9	24.7	27.8	72.2	81	81	162
	F	NOO	12.5	9.4	10.9	89.1	32	32	64
		KWAK	40.0	40.0	40.0	60.0	25	25	50
		TSIM	20.0	26.7	23.4	76.6	15	15	30
		ATHA	22.1	16.2	19.2	80.8	68	68	136

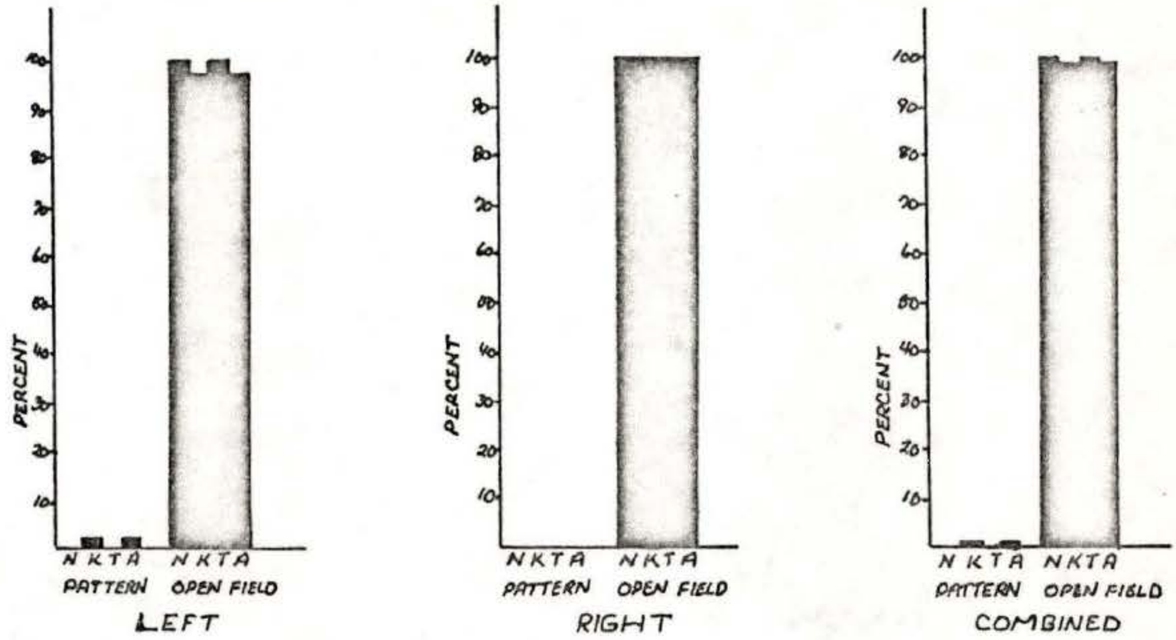


Figure 54. Distribution of patterns and open fields for males by group and feet (separately as well as combined) in the thenar area of the sole.

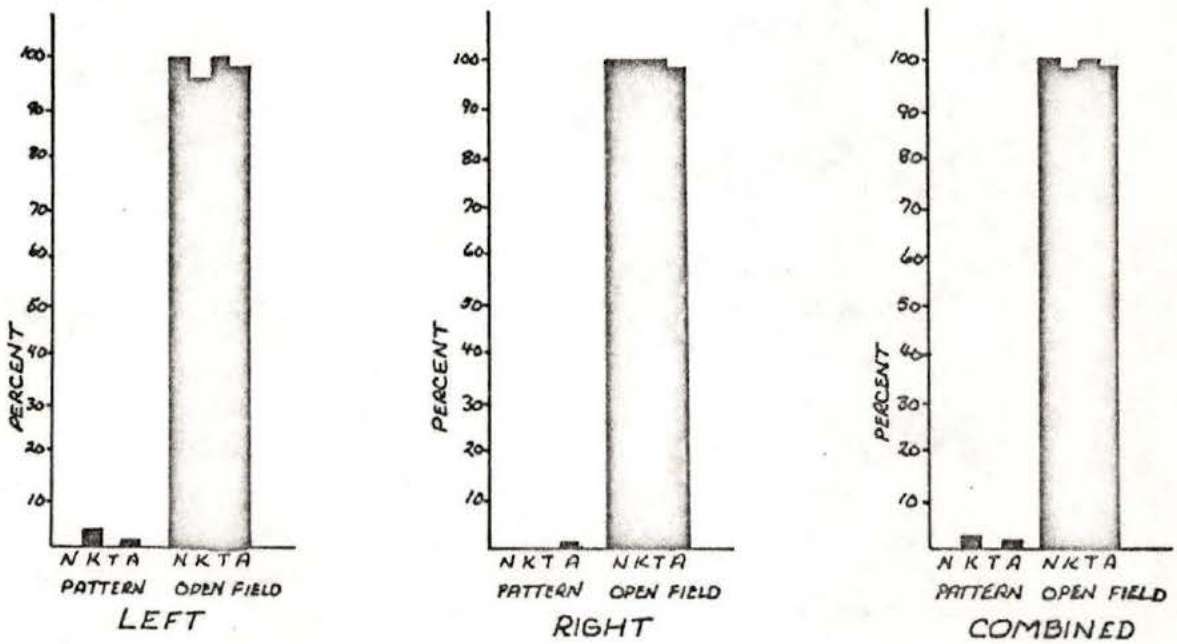


Figure 55. Distribution of patterns and open fields for females by group and feet (separately as well as combined) in the thenar area of the sole.

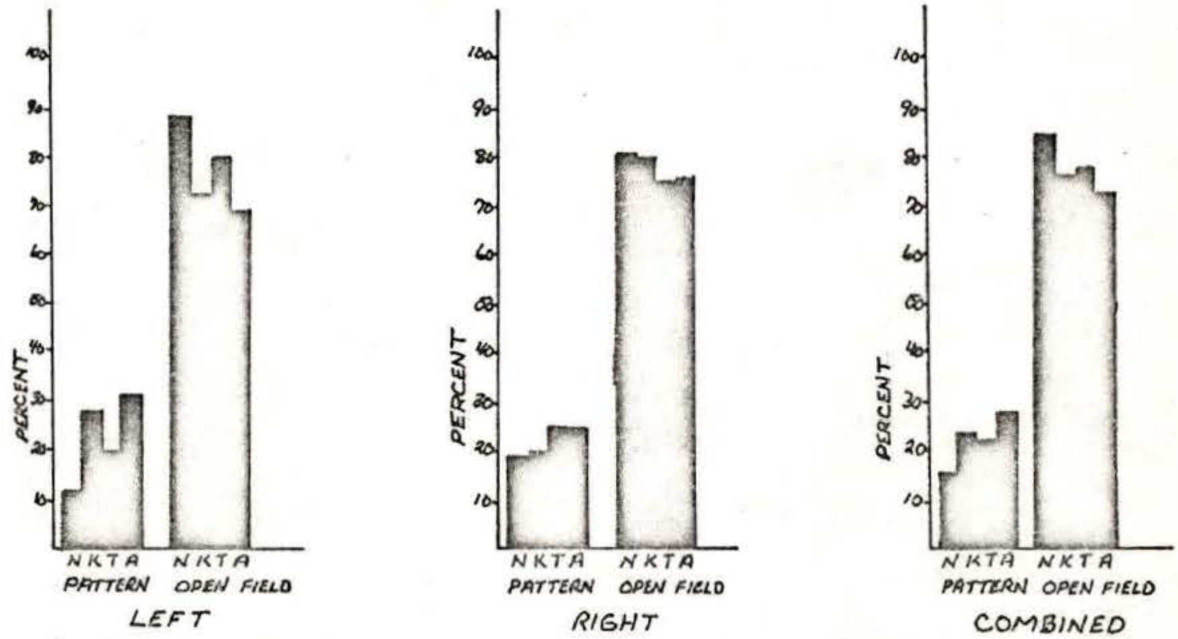


Figure 56. Distribution of patterns and open fields for males by group and feet (separately as well as combined) in the hypothenar area of the sole.

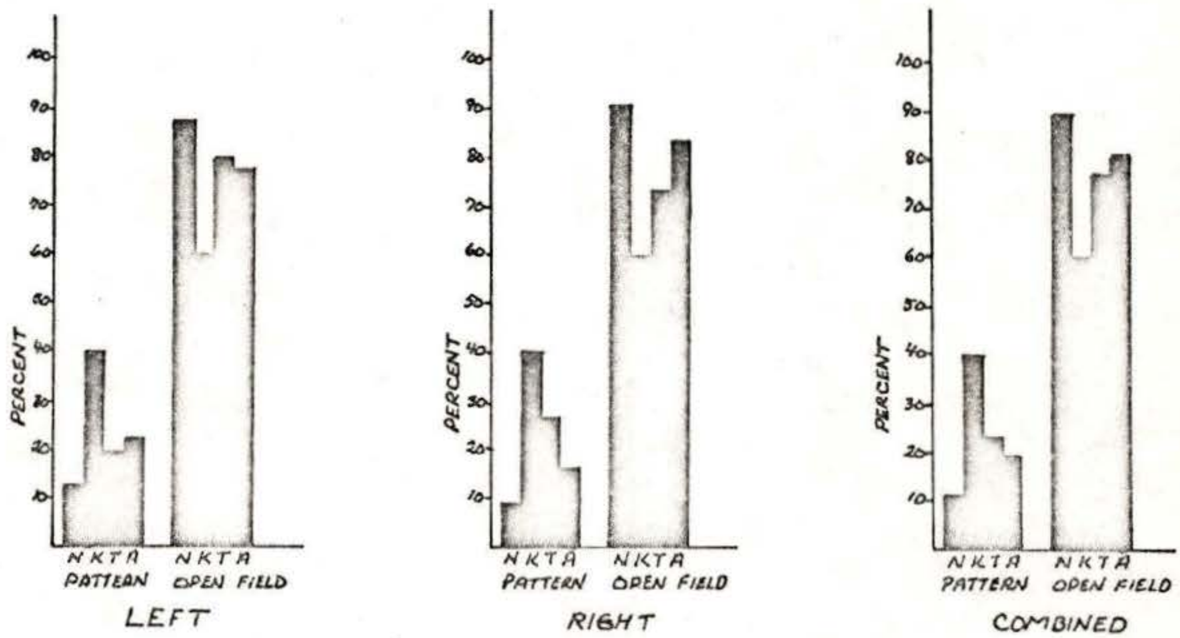


Figure 57. Distribution of patterns and open fields for females by group and feet (separately as well as combined) in the hypothenar area of the sole.

The thenar area, like interdigital area II of the palm, has been excluded from this analysis for obvious reasons (see Table LXIII). In the hallucal area the analysis of frequency distributions by the chi-square statistic involves specific pattern types while for the remaining plantar areas the distributional analysis involves simply the two category system of patterns and open fields. In all cases, the sexes are treated separately while the distributions of left and right feet are combined.

For the hallucal area, neither of the distributions are statistically significant although the female samples have a probability less than 0.10. In interdigital area II, only the male distributions are statistically significant; interdigital area III, again only the male distributions; interdigital area IV, neither distributions are significant; and for the hypothenar area, the female distributions are significant. The highly significant chi-square value for the male distributions in interdigital area II is largely a result of the Tsimshian sample (see Table LXVI) possessing a zero frequency of patterns and the Nootka possessing a much higher frequency of patterns than expected. The significant male distributions in interdigital area III are a result of the Nootka sample possessing a higher frequency of open fields and the Athapaskan a much lower frequency of open fields than expected. The significant female distributions in the hypothenar area are primarily a result of the Kwakiutl sample possessing a much higher frequency of patterns than expected. In the three interdigital areas, males record larger chi-square values than their female counterparts whereas in the two remaining areas the situation is reversed. In the hallucal and hypothenar areas the female differences in

TABLE LXIV: Frequency Distributions of Patterns in the Hallucal Area of the Sole and Values of χ^2 for Males Left and Right Feet Combined

Sample	Frequency	Whorls	Loops	Arches and Others	Total
Nootka	o	13	60	11	84
	e	13.5	62.2	8.3	
	χ^2	0.019	0.078	0.878	0.975
Kwakiutl	o	14	60	6	80
	e	12.9	59.2	7.9	
	χ^2	0.094	0.001	0.248a	0.343
Tsimshian	o	10	27	3	40
	e	6.4	29.6	3.9	
	χ^2	1.501a	0.228	0.041a	1.770
Athapaskan	o	22	124	16	162
	e	26.1	119.9	15.9	
	χ^2	0.644	0.14	0.001	0.785
Total	o	59	271	36	366
	χ^2	2.258	0.447	1.168	3.873

[a] Yates' correction for continuity used

χ^2 = 3.873
d.f. = 6
P < 0.70

TABLE LXV: Frequency Distributions of Patterns in the Hallucal Area of the Sole and Values of χ^2 for Females Left and Right Feet Combined

Sample	Frequency	Whorls	Loops	Arches and Others	Total
Nootka	o	6	50	8	64
	e	11.7	48	4.3	
	χ^2	2.311a	0.083	2.381a	4.775
Kwakiutl	o	8	40	2	50
	e	9.1	37.5	3.4	
	χ^2	0.039a	0.167	0.238a	0.444
Tsimshian	o	11	19	0	30
	e	5.5	22.5	2.0	
	χ^2	5.5	0.544	1.125a	7.169
Athapaskan	o	26	101	9	136
	e	24.8	102.0	9.2	
	χ^2	0.058	0.01	0.009a	0.077
Total	o	51	210	19	280
	χ^2	7.908	0.804	3.753	12.465

[a] Yates' correction for continuity used

$\chi^2 = 12.465$
d.f. = 6
$P < 0.10$

TABLE LXVI: Frequency Distributions of Patterns and Open Fields in Interdigital Area II of the Sole and Values of χ^2 for Males Left and Right Feet Combined

Sample	Frequency	Patterns	Open Fields	Total
Nootka	o	25	59	84
	e	16.8	67.2	
	χ^2	4.002	1.001	5.003
Kwakiutl	o	11	69	80
	e	16.0	64	
	χ^2	1.563	0.391	1.954
Tsimshian	o	0	40	40
	e	8.0	32	
	χ^2	7.031a	2.00	9.031
Athapaskan	o	37	125	162
	e	32.3	129.7	
	χ^2	0.684	0.17	0.854
Total	o	73	293	366
	χ^2	13.280	3.562	16.842

[a] Yates' correction for continuity used

χ^2 = 16.842
d.f. = 3
P < 0.001

TABLE LXVII: Frequency Distributions of Patterns and Open Fields in Interdigital Area II of the Sole and Values of χ^2 for Females Left and Right Feet Combined

Sample	Frequency	Patterns	Open Fields	Total
Nootka	o	5	59	64
	e	9.1	54.9	
	χ^2	1.424a	0.306	1.730
Kwakiutl	o	11	39	50
	e	7.1	42.9	
	χ^2	2.142	0.355	2.497
Tsimshian	o	3	27	30
	e	4.3	25.7	
	χ^2	0.148a	0.066	0.214
Athapaskan	o	21	115	136
	e	19.4	116.6	
	χ^2	0.132	0.022	0.154
Total	o	40	240	280
	χ^2	3.846	0.749	4.595

[a] Yates' correction for continuity used

χ^2 = 4.595
d.f. = 3
P < 0.30

TABLE LXVIII: Frequency Distributions of Patterns and Open Fields in Interdigital Area III of the sole and Values of χ^2 for Males Left and Right Feet Combined

Sample	Frequency	Patterns	Open Fields	Total
Nootka	o	54	30	84
	e	62.4	21.6	
	χ^2	1.131	3.267	4.398
Kwakiutl	o	53	27	80
	e	59.5	20.5	
	χ^2	0.71	2.061	2.771
Tsimshian	o	29	11	40
	e	29.7	10.3	
	χ^2	0.016	0.048	0.064
Athapaskan	o	136	26	162
	e	120.4	41.6	
	χ^2	2.021	5.85	7.871
Total	o	272	94	366
	χ^2	3.878	11.226	15.104

$\chi^2 = 15.104$
d.f. $= 3$
$P < 0.01$

TABLE LXIX: Frequency Distributions of Patterns and Open Fields in Interdigital Area III of the Sole and Values of χ^2 for Females Left and Right Feet Combined

Sample	Frequency	Patterns	Open Fields	Total
Nootka	o	45	19	64
	e	40.2	23.8	
	χ^2	0.573	0.968	1.541
Kwakiutl	o	26	24	50
	e	31.4	18.6	
	χ^2	0.929	1.568	2.497
Tsimshian	o	16	14	30
	e	18.9	11.1	
	χ^2	0.445	0.758	1.203
Athapaskan	o	89	47	136
	e	85.5	50.5	
	χ^2	0.143	0.243	0.386
Total	o	176	104	280
	χ^2	2.09	3.537	5.627

$\chi^2 = 5.627$
d.f. $= 3$
P < 0.20

TABLE LXX: Frequency Distributions of Patterns and Open Fields in Interdigital Area IV of the Sole and Values of χ^2 for Males Left and Right Feet Combined

Sample	Frequency	Patterns	Open Fields	Total
Nootka	o	22	62	84
	e	17	67	
	χ^2	1.471	0.373	1.844
Kwakiutl	o	18	62	80
	e	16.2	63.8	
	χ^2	0.2	0.051	0.251
Tsimshian	o	7	33	40
	e	8.1	31.9	
	χ^2	0.044a	0.38	0.082
Athapaskan	o	27	135	162
	e	32.8	129.2	
	χ^2	1.026	0.26	1.286
Total	o	74	292	366
	χ^2	2.741	0.722	3.463

[a] Yates' correction for continuity used

$\chi^2 = 3.463$
d.f. = 3
$P < 0.50$

TABLE LXXI: Frequency Distributions of Patterns and Open Fields in Interdigital Area IV of the Sole and Values of χ^2 for Females Left and Right Feet Combined

Sample	Frequency	Patterns	Open Fields	Total
Nootka	o	9	55	64
	e	7.1	56.9	
	χ^2	0.276a	0.063	0.339
Kwakiutl	o	7	43	50
	e	5.5	44.5	
	χ^2	0.181a	0.051	0.232
Tsimshian	o	1	29	30
	e	3.3	26.7	
	χ^2	0.981a	0.198	1.179
Athapaskan	o	14	122	136
	e	15.1	120.9	
	χ^2	0.08	0.01	0.09
Total	o	31	249	280
	χ^2	1.518	0.322	1.840

[a] Yates' correction for continuity used

$\chi^2 = 1.840$
d.f. = 3
$P < 0.70$

TABLE LXXII: Frequency Distributions of Patterns and Open Fields in the Hypothenar Area of the Sole and Values of χ^2 for Males Left and Right Feet Combined

Sample	Frequency	Patterns	Open Fields	Total
Nootka	o	13	71	84
	e	19.7	64.3	
	χ^2	2.279	0.698	2.977
Kwakiutl	o	19	61	80
	e	18.8	61.2	
	χ^2	0.002	0.001	0.003
Tsimshian	o	9	31	40
	e	9.4	30.6	
	χ^2	0.001a	0.001	0.002
Athapaskan	o	48	117	162
	e	38.1	123.9	
	χ^2	1.25	0.384	1.634
Total	o	86	280	366
	χ^2	3.532	1.084	4.616

[a] Yates' correction for continuity used

$\chi^2 = 4.616$
d.f. $= 3$
$P < 0.30$

TABLE LXXIII: Frequency Distributions of Patterns and Open Fields in the Hypothenar Area of the Sole and Values of χ^2 for Females Left and Right Feet Combined

Sample	Frequency	Patterns	Open Fields	Total
Nootka	o	7	57	64
	e	13.7	50.3	
	χ^2	2.805a	0.892	3.697
Kwakiutl	o	20	30	50
	e	10.7	39.3	
	χ^2	8.083	2.201	10.284
Tsimshian	o	7	23	30
	e	6.4	23.6	
	χ^2	0.001a	0.015	0.016
Athapaskan	o	26	110	136
	e	29.1	106.9	
	χ^2	0.33	0.09	0.42
Total	o	60	220	280
	χ^2	11.219	3.198	14.417

[a] Yates' correction for continuity used

$\chi^2 = 14.417$
d.f. = 3
$P < 0.01$

the distribution of specific configurational types are greater than those exhibited by their male counterparts, and vice versa in interdigital areas II, III and IV.

In the six plantar configurational areas, there is very little, if any, consistency in either the ranking of groups on a low to high scale or the clustering of two or more groups in relation to percentage frequencies exhibited. The results obtained are even more ambiguous than those for the five palmar areas.

CHAPTER IV

SUMMARY AND DISCUSSION

This chapter is divided into four sections: (1) Quantitative Measures, (2) Qualitative Measures, (3) Quantitative and Qualitative Measures, and (4) Discussion. Its purpose is to summarize and evaluate the results obtained in the foregoing sections with a view to contributing to the interpretation of the dermatoglyphic relationships that exist between each of the four samples of this study. To do this, the patterns of relationship between each of the four samples for each measure used in the analysis must be sorted and presented in summary form. In other words, each of the samples should be ordered in such a way that, for any particular measure, any one sample can be defined in relation to any or all of the other three samples. One way and perhaps the only way that this can be done, considering the nature of the data, is to rank the samples in a linear fashion on the basis of percentage frequencies exhibited for specific pattern types for the qualitative measures and on the basis of calculated mean values for the quantitative measures. The scale used in this ranking process is a numerical one that ranges from lowest to highest frequency or mean value, as the case may be, for each of the four samples. It is then possible to sort out relationships between samples. For the quantitative measures this poses no problem as the significance of the differences in mean values between each pair of samples has been statistically calculated by the student's statistic.

Unfortunately, there is no comparable test for the differences in frequencies exhibited by each of the samples for the various qualitative measures. However, the chi-square statistic has been employed for each of these measures to ascertain whether or not the overall differences between distributions for each sample are statistically significant. Further, in an attempt to establish patterns of relationship between each of the four samples, a totally arbitrary value has been used as a simple numerical measure of relationship between two or more groups on the scale. For example, I have chosen four percent as a maximum limit, i.e., if the differences in percentage frequencies between two or more samples for a specific pattern type is equal to or less than four percent it is taken as an indication of relationship and the groups are bracketed, ( ) or [ ]. This method simply indicates that any two or more ranked groups on the linear scale exhibit percentage frequencies that are either equal to or less than four percent. It adds a further dimension to the straightforward ranking of groups. By doing this it is also possible to achieve some measure of the overall relationship of any one group to the three remaining groups over a large number of variables. For quantitative measures, this method of bracketing has also been used but here it is used in conjunction with the results obtained using the student's t statistic, i.e., two or more groups are bracketed if the differences in their mean values are not statistically significant at the 0.05 level.

Quantitative Measures

The three quantitative measures used in this study are ridge counts, atd angles and heights (in percent) of the t triradius. Using the biomedical program BMD06D, correlation coefficients among these measures were calculated both for the total number of males and females and for each sample separately (in both cases the sexes were treated separately). Of particular interest are the correlations between left and right hand categories for different measures, and between combined hand categories. For males, left and right hand categories for a specific measure tend to be highly correlated, particularly for ridge counts ($r = 0.90$). Further, all ridge count categories are minimally correlated with all categories of both the atd angle and height of t (r's are between 0.00 and 0.17). However, all atd angle categories are moderately correlated with height of t categories (r's are between 0.47 and 0.62). As previously noted, the atd angle is not simply another method of estimating the height of the t triradius, but neither is it completely independent of it. To speak of both measures as being roughly equivalent is to underestimate the degree of variability that can be introduced by the relative positioning of the two interdigital triradii (a and d) involved in the calculation of the atd angle.

The same general pattern of relationships between variables noted for males is also apparent for females. For example, left and right hand categories for specific measures remain fairly highly correlated and all ridge count categories again remain virtually uncorrelated with atd angle and height of t categories. However, there is a noticeable increase in comparison to males in the degree of correlation between atd angle and height of t categories (r's are between 0.57 and 0.81). For both males and females, the combined hands category exhibit the highest degree of correlation. For both males and females, I think it is clear that ridge counts can be treated independently of the other two measures. Because atd angle and height of t measures are moderately correlated, they cannot be treated completely independently.

A summary of the dermatoglyphic relationships of the four samples for the three quantitative variables is presented in Table LXXIV. The hands combined category has been used in this summary for two reasons: (1) all three measures show a fairly high correlation between left and right hand categories, and (2) no significant differences were found between left and right hand means for any of the three measures (see Tables IX, XXXVII and XLVI). The sexes are treated separately not only as a result of the conflicting results shown in Tables VIII, XXXVI and XLV, but also because it has become standard practice to do so. Although the results of the analysis of variance for male and female groupings of the four samples (see Tables X, XXXVII and XLVII) provide less detailed information than the t tests, they do, nevertheless, establish that there does occur significant variation among certain groupings for specific measures. For example, male inter-group variation for mean atd angles is significant at the 0.025 level and female inter-group variation for the height of t triradius measure is significant at the 0.05 level. Variation displayed by other male or female groupings is not statistically significant although relatively high values of F for these groupings indicate that there is, nevertheless, some inter-group variation present. This is substantiated to some extent by the results obtained from the student's analysis. Referring to Table LXXIV, the brackets [ ] or ( ) indicate that the difference in means for groups included within each set of brackets is not statistic-

TABLE LXXIV: A Summary of the Dermatoglyphic Relationships of the Four Samples by Variable and Sex for the Hands Combined Category

Quantitative Variable	Sex	Rank and Relationship Low ⟶ High
Total Mean Ridge Counts	M	(N - A - T - K)
	F	(N - T - A) - K
Mean atd Angles	M	A - (N - K - T)
	F	(N - [K - A) - T]
Mean Height of the t Triradius	M	(N - [A - K) - T]
	F	(N - [K) - A] - T

Brackets [ ] or ( ) indicate that the difference in means for groups included within each set of brackets is not statistically significant at the 0.05 level.

ally significant at the 0.05 level. For example, the differences in means for all four male groups in the category total mean ridge counts are not significant at the 0.05 level. Therefore, none of the four male differences in means for this variable are significantly different. For females in the same category, the Kwakiutl sample is significantly different from the other three at the 0.05 level.

Although the results for the three quantitative variables are not very clear, some points can be made. The Nootka, in almost all cases, exhibit the lowest means of all four groups and the Tsimshian (atd angles and height of t) and Kwakiutl (ridge counts) the highest. The Athapaskan appear to be intermediate in all three cases along with the Tsimshian (ridge counts only) and Kwakiutl (atd angle and height of t). The table appears to reflect some of the observations made previously in the discussion of the correlation analysis, i.e., the independency of the ridge count variable in relation to the other two variables and also the moderately high correlation found between the atd angle and height of t variables. In general, there is some consistency in terms of relative positions on the linear scale, but beyond that nothing is very clear.

Qualitative Measures

Much of Chapter III is involved with the analysis and discussion of the major qualitative measure in dermatoglyphics: pattern type. The frequency distributions of pattern types were analyzed for fingers and for palmar and plantar configurational area. Chi-square tests of pattern types by hand (separately and combined) and sex showed all distributions were significant at the 0.05 level except that for females, right hand (see Tables XXVII to XXXII and Figures 10 to 15). Further a detailed comparative analysis was done for each of the areas examined, but little attempt was made to relate the results of one particular pattern area to another. Therefore, with a view to establishing some of the patterns of relationship that exist for each of the samples in this study, the results obtained have been brought together and summarized in the following way to facilitate comparative analysis: (a) digital data, (b) data for palmar and plantar pattern areas. The method that will be used to present the data has been previously discussed in the opening remarks of this section and need not be repeated here. However, it should be pointed out that this summation, like that for the quantitative measures, will not be concerned with the treatment of hands separately. Instead, all data presented represent the combined hands category for each variable discussed. Sexes will again be treated separately.

Digital Data

Presented in Table LXXV is a summary of the dermatoglyphic relationships of the four samples for specific pattern types by single digits and combined hands. The combined hands category is, in itself, a summary of the data for single digits. Table LXXV is constructed on the basis of the percentage frequencies shown in Tables XXII and XXIII (single digits) and Table XXIV (combined hands). Referring to Table LXXV, the ranking of male groups for the whorl category is of the following order: Nootka - Athapaskan - Tsimshian - Kwakiutl; and for female groups: Nootka - Athapaskan - Kwakiutl - Tsimshian. It will be noted that the differences in the percentages of whorls exhibited by the Tsimshian and Kwakiutl samples (both male and female) does not exceed four percent for either males or females. Basically, the same relationship between groups is found for males and females in the ulnar loop category. For females, the Kwakiutl and Athapaskan are intermediate between the Nootka and Tsimshian extremes. The radial loop category offers little evidence regarding either ranking of the groups or the relationships between them. As indicated by the brackets, none of the percentage frequencies exhibited exceed four percent. As a result, the expressed ranking of groups is less powerful than it might otherwise be. This is true for any two or more groups that exhibit differences in percentages less than or equal to four and are thus bracketed. For females in the arch category, the Kwakiutl and Athapaskan, Nootka and Tsimshian, and Nootka and Athapaskan groups all show a relationship in percentages exhibited. The Athapaskan and Nootka appear to be intermediate between the Kwakiutl and Tsimshian extremes. For males in the same category there appears to be little difference between groups other than the Nootka.

TABLE LXXV: A Summary of the Dermatoglyphic Relationships of the Four Samples for Specific Pattern Types by Single Digits and Combined Hands

		Rank and Relationships of Samples: Low ⟶ High Scale			
		Pattern Types			
Variable	Sex	Whorls	Ulnar Loops	Radial Loops	Arches
Single Digits I	M	(N - A) - K - T	T - (K - [N) - A]	(0 - 0 - 0 - N)	(0 - 0 - 0 - N)
II		(N - [T) - A] - K	(K - [N) - T] - A	(A - [N) - K] - T	(T - K - A) - N
III		N - (T - [A) - K]	K - (A - T) - N	(0 - 0 - 0 - 0)	(A - K - [T) - N]
IV		N - (A - K - T)	[K = T - (A] - N)	(0 - 0 - 0 - K)	(0 - 0 - 0 - N)
V		N - A - T - K	K - T - A - N	(0 - 0 - 0 - K)	(0 - 0 - 0 - N)
I	F	A - N - (T - K)	(K - T) - N - A	(0 - 0 - 0 - 0)	(0 - 0 - 0 - 0)
II		(N - [A) - T] - K	T - (N - [K) - A]	(K - A) - (N - T)	K - (A - N - T)
III		N - K - (A - T)	T - A - K - N	(0 - 0 - 0 - 0)	(0 - A) - (T - N)
IV		N - A - (K - T)	T - K - A - N	(0 - 0 - 0 - N)	0 - 0 - (N - T)
V		N - (K - A) - T	T - (A- K) - N	(0 - 0 - 0 - 0)	(0 - 0 - A) - T
Combined Hands	M	N - A _ (T - K)	(K - T) - (A - N)	(A - N - K - T)	(K = A - T) - N
	F	N - A - (K - T)	T - (K - [A) - N]	(K - A - T - N)	(K - [A) - (N] - T)

[ ] or ( ) - the difference in percentage frequencies between two or more groups residing within brackets is equal to or less than four

= - indicates that the percentage frequencies for the two groups joined by it are equal

0 - indicates zero frequency

Again referring to Table LXXV, it is evident that for males the Nootka and Kwakiutl generally occupy positions on the percentage frequency scale that are furthest apart. The Athapaskan and Tsimshian samples occupy intermediate positions between the Nootka and Kwakiutl extremes. The Tsimshian sample tends to show a closer relationship with the Kwakiutl, while the Athapaskan sample appears to be intermediate between the Nootka and the Tsimshian/Kwakiutl arrangement, sometimes exhibiting percentages most closely associated with those expressed by the Nootka and, at other times, with those expressed by the Tsimshian/Kwakiutl combination. The calculation of chi-squares for the combined hands category (males and females) indicate that both frequency distributions are statistically significant at the 0.001 level (see Tables XXIX and XXXII). The Nootka and Kwakiutl samples contribute most to the total chi-square for males while for females it is the Tsimshian and Nootka samples.

Table LXXVI presents a summary of the results obtained from the calculation of the index of pattern intensity, Furuhata's and Dankmeijer's indices. The values obtained for these indices, although certainly not qualitative, are best presented and discussed in this section as all three measures are concerned with the interrelationship of specific pattern types. As the calculation of the index of pattern intensity and Furuhata's index involve the same patter types (loops and whorls), the similar results obtained are not unexpected. Further, that these indices reflect the above findings (in Table LXXV) is also not unexpected as the same phenomena (pattern types) are of concern in each case. For Dankmeijer's arch/whorl index, the ranking of samples is slightly different from that found for the other two indices.

TABLE LXXVI: A Summary of the Dermatoglyphic Relationships of the four Samples Based on the Index of Pattern Intensity and Furuhata's and Dankmeijer's Indices

Variable	Sex	Rank and Relationship of Samples Low ⟶ High Values
Index of Pattern Intensity	M	N - A - T - K
	F	N - A - T - K
Furuhata's Index	M	N - A - T - K
	F	N - A - K - T
Dankmeijer's Index	M	(K - A - T) - N
	F	(K - A) - (T - N)

Although the Athapaskan and Tsimshian remain intermediate between the Nootka and Kwakiutl extremes, the position of these latter samples on the scale has been reversed.

The use made of brackets in the previous summary to indicate relationship between two or more groups has not been used for these three measures as here the concern is with index values and not percentage frequencies. However, for Dankmeijer's index values, a limited use of brackets is possible as these values tend to cluster, i.e., certain groups (those within brackets) exhibit essentially the same values and can readily be distinguished from other groups. This noticeable clustering of groups doesn't occur with values calculated for the other two indices and thus brackets are not used. For Dankmeijer's index, the Kwakiutl, Athapaskan, and Tsimshian male samples have almost identical values (see Table XXVI) while that for Nootka is markedly different. For females, the relationships change. The Tsimshian, primarily as a result of a major increase in the frequency of arches, have an index value similar to the Nootka, whereas index values for both the Kwakiutl and Athapaskan samples have remained relatively unchanged. Therefore, these two sets of groups can be readily distinguished from one another as can the Nootka males from the three remaining male groups.

The relationships between the values exhibited by the four samples for the index of pattern intensity and Furuhata's index are not as readily discernible. As values for the pattern intensity index must occur over a limited range, zero (ten arches) to twenty (ten whorls), the divergence of values expressed by the four samples cannot be expected to be great. Conversely, the differences between values expressed for Furuhata's index are so great that relationships between samples are also difficult to discern. Further, the differences in values expressed by the sexes of each sample for this index indicates that intra-group differences for the whorl/loop relationship are also great.

Data for Palmar and Plantar Pattern Areas

A summary of the dermatoglyphic relationships of the four samples for palmar and plantar pattern areas is presented in Table LXXVII. The results indicate that there is no apparent consistency in the ranking of groups on the basis of percentage frequencies expressed, but there does appear to be some consistency concerning the relationship between groups.

Frequency distributions of pattern types (hallucal area only) and patterns and open fields were analyzed by the chi-square statistic for four of the five pattern areas of the palm and five of the six pattern areas of the sole; interdigital area II of the palm and the thenar area of the sole were not analyzed as both areas exhibited extremely low pattern frequencies. For the remaining nine pattern areas, the eighteen chi-square tests (sexes kept separate) indicate that only a few of the distributions are actually significant at the 0.05 level, i.e., for the palm: males, thenar/interdigital area I (see Table LV and Figure 35) and interdigital area III (see Table LVII and Figure 39); and for the sole: males, interdigital area II (see Table LXVI and Figure 48), interdigital area III (see Table LXVIII and Figure 50) and females, hypothenar area (see Table LXXIII and Figure 57). It was also found that different samples in the different pattern areas contributed most to the total chi-square. For example, the Nootka males (followed by the Tsimshian) contribute most in the thenar/interdigital I area of the palm (see Table LV while the Athapaskan do so in interdigital area III (see Table LVII). For the sole, the Tsimshian males (followed by the Nootka) contribute most to the total chi-square in interdigital area II but in this pattern area the Tsimshian have a pattern frequency of zero (see Table LXVI);

TABLE LXXVII: A Summary of the Dermatoglyphic Relationships of the Four Samples for Patterns in the Palmar and Plantar Configurational Areas by Sex and Combined Hands and Feet

Pattern Area	Sex	Rank and Relationships of Samples: Low ——→ High Scale Patterns
Palm		
Hypothenar	M	(A - N) - K - T
	F	N - (A - [T) - K]
Thenar/Inter digital I	M	T - (K - A) - N
	F	K - T - (N - A)
Interdigital Area II	M	(O - A - N - K)
	F	(O - O - O - T)
Interdigital Area III	M	T - (N - K) - A
	F	K - (A - N) - T
Interdigital Area IV	M	A - (K - T) - N
	F	T - (N - A) - K
Sole		
Hypothenar	M	N - (T - [K) - A]
	F	N - A - T - K
Thenar	M	(O - O - K - A)
	F	(O - O - A - K)
Interdigital Area II	M	O - K - A - N
	F	(N - T) - A - K

TABLE LXXVII (continued)

		Whorls	Loops	Arches	Others
Interdigital Area III	M		(N - K) - T - A		
	F		(K - T) - A - N		
Interdigital Area IV	M		(A - T) - (K - N)		
	F		T - (A - K - N)		
Hallucal	M	(A - N - K) - T	(T - [N) - (K] - A)	(N - K = T - A)	(O - O - A) - N
	F	N - (K - A) - T	T - (A - [N) - K]	(O - K - A) - N	(O - [K - A) - N]

[ ] or ( ) - the differences in percentage frequencies between two or more groups residing within brackets is equal to less than four

= - indicates that the percentage frequencies for the two groups joined by it are equal

O - indicates zero frequency

the Athapaskan males (followed by the Nootka) contribute most in interdigital area III (see Table LXVIII); and the Kwakiutl females (followed by the Nootka) do so in the hypothenar area (see Table LXXIII). Of the four samples, the Nootka, both males and females, generally contribute substantially to the total chi-square in most areas. The other three samples are generally inconsistent in this respect.

Quantitative and Qualitative Measures

Both quantitative and qualitative measures were used to analyze a body of dermatoglyphic data that was first grouped on the basis of band affiliation for each individual represented and then later recombined to form larger units on the basis of major linguistic affiliation. It is these larger units that constitute the four samples used in this study. The results of both the quantitative (analysis of variance and student's t) and qualitative (percentage frequency and chi-square) analysis indicate that there does occur significant intra-and inter-group variation among the four samples for specific measures. In general there is very little consistency in either the intra- or inter-group variation displayed by the samples and the results, at least in terms of the initial hypothesis concerning the interrelationships of the four samples, must certainly be viewed as negative. However, the implications of these results in terms of future research in this area are far more explicit and will accordingly be discussed in the concluding section. But prior to that discussion, a review of results obtained is in order.

For the three quantitative variables analyzed, the results of the analysis of variance indicated that male and female inter-group variation is present but statistically significant in only two of the nine categories (male combined atd angle and female height of t triradius). Further analysis by means of the student's statistic showed that significant intra-group (sex only, not bimanual) and inter-group variation for both males and females is also present. In terms of the original hypothesis, a definite problem is encountered when the results obtained for each variable are combined with a view to specific interpretation of possible relationships between samples.

The results obtained by the analysis of qualitative variables are equally difficult to interpret. Analysis by the chi-square statistic shows that while some of the differences in the percentage frequency distributions of samples for certain variables are statistically significant, others are not. For example, all digital pattern type distributions are significantly different except for the female right hand category while only a few of the pattern distributions are significant in the palmar and plantar configurational areas. Again there is a problem of interpretation when the results for each variable are taken together. This problem will be discussed in the following section.

In view of the evidence that has been summoned and evaluated in this chapter, can anything be said concerning the interrelationships of the four samples? Relying solely upon those measures, both quantitative and qualitative, that either exhibit statistically significant distributions for the four samples or those that are commonly used for discriminative purposes, it is possible to tentatively suggest a general ordering of the dermatoglyphic relationships that exist for the samples in this study. The following list specifies those variables, for the combined hand (or foot) category only, used for this purpose (variable applies to both sexes unless otherwise specified):

Ridge count

atd angle

Height of t triradius

Digital pattern types

Index of pattern intensity

Thenar/interdigital area I of the palm (males only)

Interdigital area III of the palm (males only)

Hypothenar area of the sole (females only)

Interdigital area II of the sole (males only)

Interdigital area III of the sole (males only)

In general, for both males and females ranked on a low to high percentage frequency or mean value scale, the Nootka and the Kwakiutl and Tsimshian samples are most divergent while the Athapaskan sample is almost consistently intermediate between these two extremes. Further, it is difficult to suggest which of the two samples, Kwakiutl or Tsimshian, is most divergent from the Nootka as this situation differs for both sexes from variable to variable. Similarly, the Athapaskan can only be described as intermediate between these two extremes as its relationship to both extreme positions changes also from variable to variable.

Discussion

It is tentatively suggested that the results of the analysis of specified variables indicate that of the four samples the Nootka and the Kwakiutl and Tsimshian (on different variables) are most divergent while the Athapaskan essentially occupies an intermediate position. This very general conclusion concerning the dermatoglyphic relationships that are seen to exist between the four samples of this study must be viewed as tentative for the following reasons: (1) the four samples used here do not represent known biological populations, (2) the small size of the Tsimshian sample, and (3) the lack of comparative dermatoglyphic material for these and other Indian populations in British Columbia. Each one of these factors requires further elaboration.

To consider the first and primary reason why these results should not be accepted without reservation, it is essential that the twofold purpose of this study be reiterated: (1) to contribute to the understanding of the biological relationships that exist (on the basis of dermatoglyphic data) between each of the four Indian populations represented by the four samples, and (2) to inquire into the nature of the relationship that possibly exists between the biological and linguistic realms or, in other words, to examine the validity of using linguistic samples as operational units for research in physical anthropology in this area.

Clearly the results of this study indicate that linguistic samples are only of limited use as operational units. The significant differences found for the distributions of particular variables do suggest that some degree of biological differentiation is present at this level but nothing so strong as to suggest that the linguistic samples represent biological populations. Instead, what is perhaps a more accurate assessment is to suggest that the results reflect a substantial degree of biological overlap, both with other Indian populations and with the white population in general. Control data for both Indian and white populations are needed before this situation can be accurately assessed and understood. Certainly what is now needed is to accurately define, if possible, a series of biological populations in areas such as this and then to examine, with known biological populations, the biological relationships of the populations sampled. The use of linguistic samples as operational units is probably still feasible for those few populations that are isolated but is severely limited for populations that exist in a more complex social setting.

Further, concerning the question of interrelationship between the linguistic and biological realms, the results of this study do not support the linguistic relationships that exist for the four samples. The two linguistically related groups in this study (Kwakiutl and Nootka) are not the two groups most closely related in terms of the dermatoglyphic evidence. If at some time in the distant past there existed a degree of correlation between such factors for groups in this area, I think it is unreasonable to expect that the present situation would reflect this relationship, i.e., that such factors have either remained unchanged or that they have changed at similar rates. A positive correlation between these two factors would not have been as easily explained. It is my view that the long established classification system used for neatly dividing the Indian population of this area into convenient categories should be discarded by researchers, particularly those in the biomedical fields, as it no longer reflects the reality of the contemporary situation.

In assessing the results of this study it is imperative that the small size of the Tsimshian sample (5.7 percent of the families in the bands that were sampled) be taken into account as the validity of the conclusions in any inter-population comparison is directly influenced by sample size. However, the other three samples are of adequate size.

Dermatoglyphics as a method has received wide use for the purpose of making gross racial comparisons but only of late has this method been used as an analytic tool at the local population level. As such the method currently suffers from a lack of refinement and thus is hampering its use at this level. Until the scope of its method includes techniques applicable at this level, i.e., an increase in the number of quantitative variables as well as new methods of analysis, the interpretation of results will unfortunately remain a persistent problem.

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List of Abbreviations

AA American Anthropologist

AJPA American Journal of Physical Anthropology

CA Current Anthropology

HB Human Biology

SJA Southwestern Journal of Anthropology

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APPENDIX I

LIST OF DERMATOGLYPHIC DEFINITIONS

The definitions ascribed to each of the following terms (left undefined in the text) indicate the way in which these terms have been used in this thesis. For a complete list of definitions, see Penrose (1968) and Cummins and Midlo (1961).

Open field - a straight or nearly straight field of parallel lines. Indicates that no patterns are present (patternless configurations).

Arch - a configuration that shows a marked curvature in the field of lines. There is no triradius present.

Tented arch - an arch with a triradius located in or near the mid-axis of the pattern area.

Vestige - an arrangement of ridges that approach true patterns but do not contain a definite triradius.

Triradius - the meeting point of three opposing ridge systems.

Core - the central feature of a pattern.

Loop - a pattern with only one triradius and where the ridges curve around only one extremity of the pattern, leaving the other side of the pattern open. An ulnar loop opens to the ulnar margin and a radial loop opens to the radial margin.

Whorl - a generalized pattern possessing two triradii and distinguished by a concentric design around a single core.

Whorl deviate - a composite whorl distinguished from [true] whorls by possessing more than one central core.

APPENDIX II

COLUMN ENTRY CODE FOR COMPUTER APPLICATION

IDENTIFICATION

Column 1-3 : Individual identification number

4 : Major Linguistic groupings

- 01 Tsimshian - Tsimshian
- 02 Kwakiutl - Kwakiutl
- 03 Nootka } Wakashan
- 04 Athapaskan } Wakashan

5 : Linguistic subgroupings

- 01 Tsimshian
- 02 Northern Kwakiutl
- 03 Southern Kwakiutl
- 04 Northern Nootka
- 05 Central Nootka
- 06 Southern Nootka
- 07 Chilcotin Athapaskan
- 08 Carrier Athapaskan
- 09 Sekani Athapaskan

6-7 : Band identification number

- 01 Hazelton } Tsimshian
- 02 Kispaiox } Tsimshian
- 03 Kitwanga } Tsimshian
- 04 Kitwancool } Tsimshian

Column 6-7 :

05	Glen Vowell		Tsimshian
06	Kitkatla		Tsimshian
07	Port Simpson		Tsimshian
08	Kincolith		Tsimshian
09	Bella Bella	N. K.	Kwaiutl
10	Owekana	N. K.	Kwaiutl
11	Gilford Island	S. K.	Kwaiutl
12	Tsawataineuk	S. K.	Kwaiutl
13	Mamalillikulla	S. K.	Kwaiutl
14	Turnour Island	S. K.	Kwaiutl
15	Nimpkisk	S. K.	Kwaiutl
16	Kwawkewlth	S. K.	Kwaiutl
17	Quatsino	S. K.	Kwaiutl
18	Campbell River	S. K.	Kwaiutl
19	Kyuquot	N. N.	Nootka
20	Ehatesaht	N. N.	Nootka
21	Nuchatlaht	N. N.	Nootka
22	Nootka	N. N.	Nootka
23	Hesquiaht	C. N.	Nootka
24	Ahousaht	C. N.	Nootka
25	Clayoquot	C. N.	Nootka
26	Ucluelet	C. N.	Nootka
27	Uchucklesaht	C. N.	Nootka
28	Opetchesaht	C. N.	Nootka
29	Ohiet	C. N.	Nootka
30	Nitinaht	S. N.	Nootka
31	Anaham		

Column				
6-7 :	32	Alexis Creek	Chilcotin	Athapaskan
	33	Nemiah Valley	Chilcotin	Athapaskan
	34	Ulkalcho	Carrier	Athapaskan
	35	Stony Creek	Carrier	Athapaskan
	36	Cheslatta	Carrier	Athapaskan
	37	Omineca	Carrier	Athapaskan
	38	Necoslie	Carrier	Athapaskan
	39	Stuart - Trembleur Lake	Carrier	Athapaskan
	40	Fraser Lake	Carrier	Athapaskan
	41	Stellaquo	Carrier	Athapaskan
	42	Takla Lake	Carrier	Athapaskan
	43	Lake Babine	Carrier	Athapaskan
	44	Finlay River	Sekani	Athapaskan
	45	McLeod Lake	Sekani	Athapaskan

8 : Sex

01 Male

02 Female

9 : Blank

DIGITAL AREA

Column 10-12 : Total left ridge count

13-15 : Total right ridge count

16-18 : Total ridge count

19-20 : Total ridge count coded

01	0 - 4
02	5 - 9
03	10 - 14
04	15 - 19
05	20 - 24
06	25 - 29
07	30 - 34
08	35 - 39
09	40 - 44
10	45 - 49
11	50 - 54
12	55 - 59
13	60 - 64
14	65 - 69
15	70 - 74
16	75 - 79
17	80 - 84
18	85 - 89
19	90 - 94
20	95 - 99
21	100 - 104
22	105 - 109

Column 19-20 :	23	110 - 114
	24	115 - 119
	25	120 - 124
	26	125 - 129
	27	130 - 134
	28	135 - 139
	29	140 - 144
	30	145 - 149
	31	150 - 154
	32	155 - 159
	33	160 - 164
	34	165 - 169
	35	170 - 174
	36	175 - 179
	37	180 - 184
	38	185 - 189
	39	190 - 194
	40	195 - 199
	41	200 - 204
	42	205 - 209
	43	210 - 214
	44	215 - 219
	45	220 - 224
	46	225 - 229
	47	230 - 234
	48	235 - 239
	49	240 - 244

Column 19-20 :	50	245 - 249
	51	250 - 254
	52	255 - 259
	53	260 - 264
	54	265 - 269
	55	270 - 274
	56	275 - 279
	57	280 - 284
	58	285 - 289
	59	290 - 294
	60	295 - 299
	61	300 - 304
	62	305 - 309
	63	310 - 314
	64	315 - 319
	65	320 - 324
	66	325 - 329
	67	330 - 334
	68	335 - 339
	69	340 - 344
	70	345 - 349
	71	350 - 354
	72	355 - 359
	73	360 - 364
	74	365 - 369
	75	370 - 374
	76	375 - 379

Column 19-20 : 77 380 - 384

78 385 - 389

79 390 - 394

80 395 - 399

81 400 - 404

82 405 - 409

83 410 - 414

84 415 - 419

85 420 - 424

86 425 - 429

87 430 - 434

88 435 - 439

89 440 - 444

90 445 - 449

91 450 - 454

92 455 - 459

93 460 - 464

94 465 - 469

95 470 - 474

96 475 - 479

97 480 - 484

98 485 - 489

21 : Pattern Type - 15

01 - Arch

02 - Tented Arch

03 - Ulnar Loop

04 - Radial Loop

Column 21 : 05 - Whorl

06 - Whorl Deviate

22 : Pattern Type - L4

23 : Pattern Type - L3

24 : Pattern Type - L2

25 : Pattern Type - L1

26 : Pattern Type - R1

27 : Pattern Type - R2

28 : Pattern Type - R3

29 : Pattern Type - R4

30 : Pattern Type - R5

PALMAR AREA

31-32 : ATD Angle Left Hand

33-34 : ATD Angle Right Hand

35-36 : ATD Mean

37-38 : Height of the t Triradius, Left Hand

39-40 : Height of the t Triradius, Right Hand

41-42 : Height of the t Triradius, Mean

43 : I. D. Area II Left Hand

01 - Open Field

02 - Distal Loop)
03 - Accessory Distal Loop)
04 - Vestige) Pattern
05 - Whorl)
06 - Other)

Column 44 : I. D. Area II Right Hand

45 : I. D. Area III Left Hand

46 : I. D. Area III Right Hand

47 : I. D. Area IV Left Hand

48 : I. D. Area IV Right Hand

49 : Hypothenar Area Left Hand

01 - Open Field

02 - Loop Pattern)
) Pattern
03 - Other)

50 : Hypothenar Area Right Hand

51 : Then./I_1 Area Left Hand

01 - Open Field

02 - Pattern)
) Pattern
03 - Other)

52 : Then./I_1 Area Right Hand

PLANTAR AREA

53 : Hallucal Area Left Foot

01 - Distal Loop)
) Loop
02 - Other Loops)

03 - Whorl

04 - Arch

05 - Other

54 : Hallucal Area Right Foot

Column 55 : I. D. Area II Left Foot

01 - Distal Loop)
02 - Proximal Loop)
03 - Whorl) Pattern
04 - Vestige)
05 - Other)

06 - Open Field

56 : I. D. Area II Right Foot

57 : I. D. Area III Left Foot

58 : I. D. Area III Right Foot

59 : I. D. Area IV Left Foot

60 : I. D. Area IV Right Foot

61 : Thenar Area Left Foot

01 - Pattern

02 - Open Field

62 : Thenar Area Right Foot

63 : Hypothenar Area Left Foot

01 - Pattern

02 - Open Field

64 : Hypothenar Area Right Foot

VITA

Surname: HAGGARTY Given Names: JAMES COLTON

Place of Birth HALIFAX, N. S. Date of Birth: SEPTEMBER 13, 1943

Educational Institutions Attended, with Dates of Entering and Leaving:

VICTORIA COLLEGE, VICTORIA 1962 to 1963

UNIVERSITY OF VICTORIA, VICTORIA 1963 to 1966

UNIVERSITY OF VICTORIA, VICTORIA 1967 to 1971

.... to ....

.... to ....

Degrees, Diplomas, etc., Awarded, with Dates and Names of Institutions:

B.Sc. .... University of Victoria, Victoria

Honors and Awards:

University of Victoria Graduate Scholarship, 1968/69

University of Victoria Teaching Assistantship, 1968/69

University of Victoria Academic Assistantship, Summer 1969

University of Victoria Graduate Scholarship, 1969/70

University of Victoria Academic Assistantship, 1969/70

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