A demographic study of some populations in shahrestan nowshahr, mazandaran, Iran, with reference to the genetic structure

Haideh Mehrai

A DEMOGRAPHIC STUDY OF SOME POPULATIONS IN SHAHRESTAN NOWSHAHR, MAZANDARAN, IRAN, WITH REFERENCE TO THE GENETIC STRUCTURE

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HAIDEH MEHRAI MSc

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University of Durham
Department of Anthropology

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ABSTRACT

The main objective of this thesis is to define the population structure of Shahrestan Nowshahr, Iran, by determining whether the population comprises one large, panmictic unit or small, localized breeding clusters, and the extent to which the pattern of mobility affects this structure.

This study has been carried out by quantifying the nature and extent of migration within and from outside the study area. The components of analysis have included the past and present demographic structure, the distribution and localization of dialects and languages, the spatial (matrimonial) and temporal (parent and offspring) continuity of gene flow, the orientation of movement, the extent of commonality of surnames and the pattern of relatedness and kinship within and among the subdivisions.

The results have been used to assess the extent to which genetic mobility has been determined by geographic, demographic, linguistic and cultural constraints placed on the breeding size of the population. The consequences upon the genetic structure of the population in terms of departure from random mating and panmixia and the potential for genetic differentiation through local, selective pressures and random genetic drift have also been projected.

Inferences from these analyses indicate that the interaction of these factors have influenced and determined the migration pattern and the extent of the reproductive isolation of the Shahrestan. Shahrestan Nowshahr is not a homogeneous unit, but is composed of a series of local, partially isolated units with little genetic flow between them, thus limiting the size of the population, contributing to deviation from panmixia and conducive to random differentiation of local gene frequencies. The temporal increase in the range of movement indicates the breaking down of isolation, due to an overall change in the demographic, cultural and socio-economic structure of the population, providing greater possibilities for admixture and genetic homogeneity.

MATERIAL AND METHODS

During the winter of 1980, a demographic and migration survey was conducted through the distribution of questionnaire forms to nine schools in Shahrestan Nowshahr. The schools were chosen from all three Bakhshes (administrative sub-division) to obtain a random sample of the total population. In total 1047 questionnaire forms were collected, yielding information on 13098 individuals, representing just under ten percent of the total population. Of these 29% were from Bakhsh Markazi, 48% from Bakhsh Chalous and 24% from Bakhsh Kelardasht, which represented samples from all the nineteen subdivisions, which comprised seventeen Dehestans (conglomerates of villages) and two cities. Some of the dehestan were represented by very few samples.

The questionnaire forms were formulated to cover demographic and migrational information on the members of each household. The data consisted of the following.

1) Respondent's parents
sex, age, occupation, dialect/language, number of marriages, birthplace, residence before marriage, date of residence before marriage, marriage place, date of marriage, places moved to, date of entrance and departure, place of work, whether living or dead, surname, sibship size.

2) Respondent's grandparents
Father's father's birthplace, Father's mother's birthplace. Mother's father's birthplace, Mother's mother's birthplace.

3) Respondents and their sibs
sex, age, birthplace, workplace, date of birth, date of death, birth order.

In association with this survey, which investigated the demographic structure of the present population, the national census returns of 1956, 1966 and 1976 were also used to study the past demography of the Shahrestan.

The main method of analysis has been based on the aggregate results from both sources. Data collected were transformed in coded forms to the computer (NUMAC, Computer Department, University of Durham), and statistical analyses were made using the SPSS and SPSSX, Statistical Packages for Social Scientists (Nie et al, 1975, 1984). The administrative delineation of the population was based on the census boundaries.

The first chapter summarizes the historical structure of the Caspian Provinces and more specifically those of Ostan of Mazandaran and Shahrestan Nowshahr, through an examination of past migrations, linguistic and ethnic affiliations, geographic and administrative boundaries, traditional customs and communication network.

In the second chapter an attempt has been made to explain the interrelationship between the demographic and the genetic structure of populations, and the importance of the dynamics and evolution of demographic parameters and processes in terms of micro-evolutionary processes. To that end, a review of the various mathematical models was also made.

The third chapter is an analysis of the demographic features and evolution of Shahrestan Nowshahr during the last thirty years in terms of population size and density, sex and age structure, marital condition and family structure, fertility and mortality, the geographic origin of the population and the extent of migration.

The fourth chapter examines the prevalence and distribution of languages and dialects, and assesses the relative ethnic isolation of the sub-populations, and its effect on the mating patterns of the individuals.

The fifth chapter is an analysis of the migrational bahaviour of the population. The components of marital mobility such as endogamy and spatial exogamy, matrimonial distance, the orientation of movement, in conjunction with the extent of birth-place concordance of parents and offspring and sib-pairs, post-marital mobility and the overall movement of the population have been analyzed, to examine both the spatial and temporal structure of gene flow, and its effect on the breeding size of the population

Chapter six examines the pattern of relatedness between the sub-divisions using the matrix model of Hiorns et al (1969), to obtain information on kinship patterns within and between them. A surname analysis also provides information on the extent of surname localization. Genetic relatedness is also assessed through an isonymic anlysis, by the method of Lasker (1977). Data on the extent of consanguinity and preferential marriages pertaining to Iran as a whole is also presented.

Chapter seven presents some genetic and serological data on the peoples of the Caspian Provinces. The results are further discussed in terms of their association with environmental parameters such as geographic and socio-cultural factors, past migrations, prevalence of diseases and diet.

The final chapter discusses some theoretical aspects of the population structure of Shahrestan Nowshahr and assesses the degree of biological isolation and interrelationship of the subdivisions.

In the absence of other available sources, the longitude and latitude coordinates of localities have been used to calculate distances between them.

Throughout the analysis, where samples were sufficient, data have been presented at three territorial levels: Shahrestan, Bakhsh and Dehestan. It was impossible to examine the data at village level due to the paucity of some samples. Temporally, the data have been studied at two periods: the parental and grandparental generations. Finally, abbreviations have been used to simplify and avoid repetition of several variables (see list of abbreviations on page xiii).

The choice of Shahrestan Nowshahr as the area of study was primarily because of its geographic location, situated between the Caspian Sea and the Alborz mountain ranges, thereby separated from the rest of Iran. The area itself is geographically and ecologically dimorphic, presenting a mosaic of relatively isolated settlements distributed at various altitudes, and interspersed with various topographical barriers, thus restricting free movement and admixture. The variety of ethnic groups who reside in the different regions is another important feature of the area. The highland terrain is mostly inhabited by the Khajevand and Lak Kurds and some of the indigenous population, while a more heterogeneous population inhabits the coastal and urban regions. The final factor to consider is the kinship structure of the population, particularly among the more rural and isolated regions of the area, where the sedentary, and agriculture lifestyle of the people, in addition to religion, tradition and ethnicity have had a significant influence on the population structure.

These factors appear to present an interesting structure for studying the extent to which they have contributed to the demographic and genetic structure of the Shahrestan and the pattern of relationships between its subdivisions.

INDEX TO GEOGRAPHIC ABBREVIATIONS

O.	=	Ostan
Sh.	=	Shahrestan
B.	=	Bakhsh
De.	=	Dehestan
Kac	=	Kachrostagh
Kal	=	Kalej
Ala	=	Alavikola
Kpy	=	Kalrudpey
Bal	=	Baladeh Kojour
Tav	=	Tavabe Kojour
Kuh	=	Kuhparat
Cha	=	Chalandar
Khe	=	Kheyroud Kenar
Zan	=	Zanoussrostagh
Pan	=	Panjakrostagh
N-C	=	Nowshahr City
Hum	=	Humeh
Kel	=	Kelarostagh
C-C	=	Chalous City
Kld	=	Kelardasht
K-E	=	Kuhestan East (e-Shargh)
K-W	=	Kuhestan West (e-Gharb)
Bir	=	Birunbashm
O.W	=	Outside World

CHAPTER ONE

IRAN

1.1 THE COUNTRY AND PEOPLES OF IRAN

The land of Iran, which comprises 628,000 sq. km., lies geologically in the Great Alpine Fold Belt. It is divided into three sections, the major section being the Great Plateau, bordered in the north by the Alborz Mountain Ranges, and in the south and west by the Zagros Mountains, and in the east by Pakistan and Afghanistan. The other two sections are the Caspian Littoral, which lies between the Alborz Mountains and the southern shores of the Caspian Sea, and the Coastal Plain adjoining the Persian Gulf.

Knowledge of the earliest inhabitants of Iran, based on archaeological evidence, suggests that Middle Paleolithic remains associated with Neanderthal man and the Mousterian culture were found on the western slopes of the Zagros mountains of Iran and Iraq, and in the northern parts of the Alborz and Hindu Kush Mountains, Soviet Central Asia and Afghanistan. During the period 25,000 to 15,000 years ago, the Aurignacian man (Upper Paleolithic) migrated across the Mediterranean coastal areas, the Fertile Crescent and the shores of the Caspian. According to Carbon-14 testing, remains found in both Hotu and Belt Caves, north Iran, date to around 10,000 years old, thus indicating human habitation in the area during the closing stages of the last glacial period (Sunderland, 1968).

The Indo-Iranian invasions occurred around 2000 BC. The invading peoples were the early Aryans, who came from Transoxiana and Turkestan. They settled the southern shores of the Caspian Sea in what was once called Hyrcania, now known as Mazandaran (Olmstead, 1948). They have been tentatively described as Caucasian or Caspian, in the absence of sufficient and reliable evidence as to their ethnic origins (Arberry, 1953). The Aryans further established themselves in the north west of Iran, and subsequently spread over the Iranian Plateau. From these early settlements, some great civilizations arose, including those of Elam, Media and the Persian Empire itself. Iran once comprised parts of Transcaucasia, Central Asia, north west India, Mesopotamia as well as the Afghano-Persian Plateau. During this time, Iran underwent various racial and cultural invasions, the most important of which were the Greek Conquest of Alexander the Great in 331 BC, and the Islamic Conquest in the seventh century. The main avenue of persistent invasion followed the trade and caravan route to China, namely the famous "Silk Route", otherwise known as the "Great Khorassan Road". Later incursions came mainly from Central Asia; Turks and Mongols invading in the thirteenth century, Ottomans and Afghans in the sixteenth and seventeenth.

The peoples of Iran retain a mosaic of racial and liguistic characteristics; a heterogeneous population as a result of the inflow of various migrants from many parts of the world and the consequent flight of the indigenous inhabitants to refuge areas in the Alborz and Zagros mountains. Thus, one may conclude that while the plains became the territory where admixture was greatest, the mountains have provided isolated areas where different religious beliefs, old traditions, customs, languages and dialects have evolved and been maintained. Therefore the diversity and heterogeneity of the people of Iran is more characteristic than their homogeneity.

Numerically the Persians constitute three quarters of the population.The remainder are Turks who are concentrated in the north-west provinces, descendants of Turkish invaders, and Kurds and Lurs who dwell in the Zagros Mountains and the western parts of the Caspian provinces. In addition Ghashghai, Shahsavans, Bakhtiaris, Torkomans, Laks, Afshars and Arabs are relatively homogeneous groups who are disseminated over the country. The main language is Persian, a branch of the Aryan languages, in addition to the sub-branches of dialects in the Zagros and Alborz mountains and the Caspian Lowlands. Turkish, Kurdish and Luri are the most frequently spoken after Persian.

Basically three distinct groups belonging to the Aryan branch of the family of Indo-European peoples can be distinguished: the Mediterranean, the Caucasus and the Alpine, in addition to many other groups ranging from the Altaic Torkomans in the north-east to the Baluchis in the south-east.

1.2 ALBORZ AND THE CASPIAN PROVINCES

The Alborz mountain chain in the north of Iran, runs southward from the Caucasus, follows the curve of the Caspian Sea and crosses Khorassan in north-east Iran to join the Hindu-Kush and the Himalayas, dividing the high plateau of Iran from the lowlands of the Caspian (see Figure 1.1).

Alborz is a Persian word derived from two Zend words signifying " high mountains " (Le Strange, 1905). The highest peak is Mount Damavand (5671 meters), situated in the Larijan Valley. These mountain ranges are interspersed with numerous valleys and rivers. The majority of the streams flow northwards down the ravines to the Caspian where they have formed fertile deltas, of which the plains of Mazandaran and Gilan are the largest (Field, 1939). The Caspian lowlands are low-lying plains about 400 miles in length, but variable in width ranging from 1 - 20 miles, and they open into the broad Torkoman Plains in the east.

The southern coast of the Caspian is not part of the Middle East geographically, but rather a continuation of the North- Eurasiatic area. It is not like the Iranian Plateau, which has been assumed to be the home of Upper Paleolithic man, but similar to the south of France, Italy and Spain which were the sites of Neanderthal man (Noushin, 1975). The mild and temperate climate of the area in addition to the existence of numerous caves (Mahjouri, 1966), and the importance of forests and wood (Noel, 1921) provided a suitable environment for Neanderthal man. Coon (1957), suggests that in the favoured climate of the southern shores of the Caspian, Mesolithic man profited from the abundance of game and waterfowl available to him in early post-glacial times, and practised agriculture and later animal domestication, at a time which seems to have been earlier than has been recorded elswhere.

Archeological studies by De Morgan (1896) in Lankeran in the Russian Talish area, has drawn attention to the geographical, archeological and anthropological similarity between the above-mentioned area and the Caspian Coast. The above evidence comes mainly from the existence of 'Dolmens' or tombs which might indicate associations between Europe and Asia in terms of racial affinity and migrations.

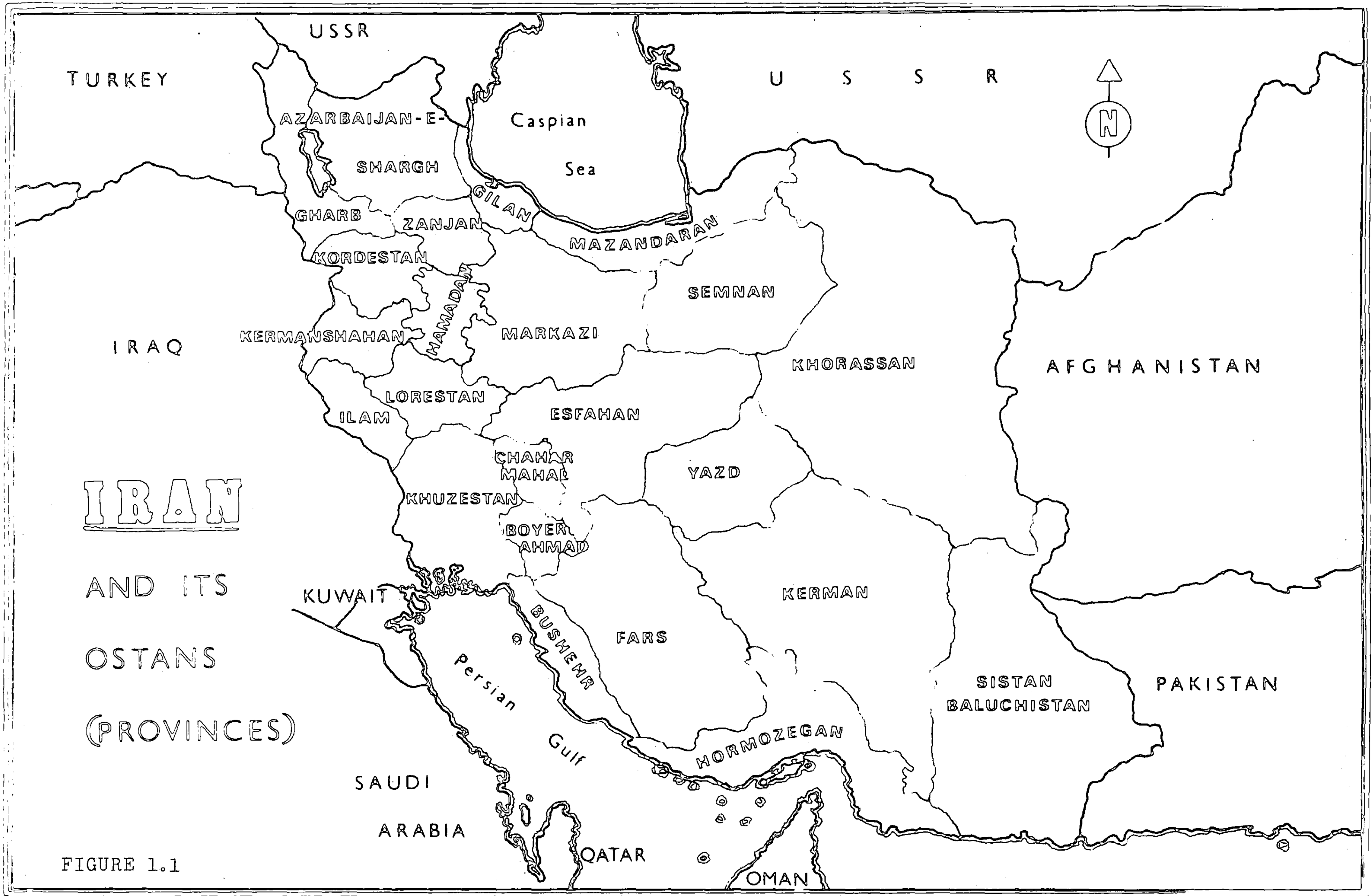
After the Ice Age, the southern coast of the Caspian from the north-east to the north-west was an available and possible passageway to the flanks and coast of the Black Sea (Yousefinia, 1977; and Mahjouri,1966). Excavations of two caves of Hotu and Belt in Behshahr are indicative of Neolithic origins and widespread migrations from the Caspian coast to the Mediterranean shores (Sunderland,1968; Noushin,1975). Mojtahedzadeh (1973), states that the Aral, Black and Caspian Seas are remants of a much larger sea called Tethys, which later separated and underwent changes in various geographical aspects.

The Caspian Littoral is divided into two belts: the maritime edge comprising low marshy, semi-penetrable jungle clad plains, which stretches to the mountain base, varying in distance; The elevated and forest clad regions. Among the recesses of the three ranges are the 'yelaghs' or summer quarters situated in the open place of the forest zone and on the slopes of the mountains, whereas the lowland people depend upon herds and flocks.

The climate is temperate and humid in the lowlands caused by the mountains that act as barriers to the clouds that drift to the south by the northerly winds, and thereby descend as mist and rain on the lowlands. The humidity and dampness has also been associated with various diseases and hemolytic disorders. In the elevated mountainous valleys the climate is cold and is a major cause of the winter and summer migrations between the coast and the highlands.

The Caspian provinces, namely Mazandaran and Gilan (see Figure 1.1), differ substantially from all the other provinces of Iran. They are mountainous, abounding in forests and adapted to a variety of cultivation and, owing to the barrier of the mountains and difficulty of movement, have remained relatively isolated.

The Caspian area has been the territory of invaders and Asiatic militants from both the east and the west; in addition to this the policy of forced sedentarization and mass resettlement of tribes by various monarchs, either to disperse localized power or to employ the migrants for protection of the regions or as resistance to tribal upheavals, have introduced non-native populations to these areas at different periods. So, in addition to the aborigines, there are various other tribes disseminated throughout the area. The Abdol-Malekis, who speak Kurdish, were transplanted numerous times to Nour, and were further moved to Sari. The Khajevand Kurds , who speak Kurdish and Turkish, were brought over from Kurdistan and Luristan, and settled in western Mazandaran; they are mainly from the Allialahi sect of Islam. The Laks are a large tribe subdivided into many families and are widely dispersed, but their main principal seats are in Fars and Luristan; they are original Persians and speak Lurish and Kurdish, and also belong to the Allialahi sect. Other tribes are the Giryalis, Usanlus, Jahanbeglus and the Imranlus, who are of the Kurd-o-Turk tribes.



USSR
TURKEY
AZARBAIJAN-E-GHARB
SHARGH
Caspian
Sea
U S S R
N
GILAN
ZANJAN
KORDESTAN
MAZANDARAN
SEMNAN
HAMADAN
MARKAZI
IRAQ
KERMANSHAHAN
KHORASSAN
AFGHANISTAN
LORESTAN
ESFAHAN
ILAM
CHAHAR MAHAL
YAZD
IRAN
KHUZESTAN
BOYER AHMAD
AND ITS
OSTANS
(PROVINCES)
KUWAIT
KERMAN
BUSHEHR
FARS
Persian
Gulf
SISTAN BALUCHISTAN
PAKISTAN
HORMOZEGAN
SAUDI
ARABIA
QATAR
OMAN

FIGURE 1.1

According to Sir Justin Scheill (1856), the former constituted the most important tribe in Mazandaran. The remaining incomers have been a few Baluchis, Afghans, Armenians, Georgians, Mongols and Taleghanis. The majority of these tribesmen were transplanted by Agha Mohammad Khan Qajar in the eighteenth century. Prior to him some colossal resettlement was effected by Shah-Abbas and Nadir Shah in the seventeenth century (Perry, 1975). The Qajars, who originated from Turkestan and numbered about two thousand families, designated Asterabad in east Mazandaran as their principal place (Morrier,1815; Rabino,1928). Many of the non-indigenous tribes have to some degree mixed with the local people, with the exception of the Kurds and the Lurs who have retained their language and culture to some extent.

1.3 MAZANDARAN AND ITS BOUNDARIES

Mazandaran lies geographically between 36° and 39° North and 51° to 56° East. It was formerly known as Tabaristan, a district forming part of the old province Farshwadgar, which comprised Azarbaijan, Ahar, Gilan, Deylam, Tabaristan, Ray, Ghom, Damghan and Gorgan (Rabino, 1928). Tabaristan, which in the local dialect signified "mountainous land", comprised its own subdivisions; Royan, Amol, Sari, Tamiseh, Mamatir, Natel and Kalar. Royan was an ancient mountainous area located in the western part of Tabaristan. Its name is mentioned as "Raoidhita" and "Royishmand" in the Avesta, sacred writings of the Zoroastrians. Two important areas within Royan were the cities of Kaje (or Kojour) and Mazan (Amoli, 1969).

Royan was the border district of Mazandaran and Deylam and was further subdivided into regions: Natelkenar(Nour), Kojour, Kelarestagh, Taleghan, Tonekabon and Lora. The plains capital of Tabaristan was Amol in the lowland, and the mountain capital was the old city of Royan, which was also called Shahrestan (Noushin,1975). Royan, which later changed its name to Rostamdar, became equivalent to the western borders of Mazandaran, comprising Taleghan, Tonekabon, Kelarestagh, Kojour and Nour. The area called Mazan was at its center but it is not certain whether it is the same area as the present Marzanabad. In the thirteenth century the name Tabaristan became obsolete and was replaced by Mazandaran. Originally it was called 'Muz-andarun', Muz being the name of a mountain on the confines of Gilan in the east, and andarun, meaning within the area (Rabino,1928). It is also possible that Tabaristan was the name of the highlands, and Mazandaran that of the lowlands. Before the final divisions, Tonekabon, Kelarestagh and Kojour became intergrated into one unit called 'The Triple Canton' or 'Mahal-i-Selas' (Rabino,1913;Fortescue, 1920). It is not certain whether Nour, which had regions overlapping with Kojour, was also considered as part of this canton.

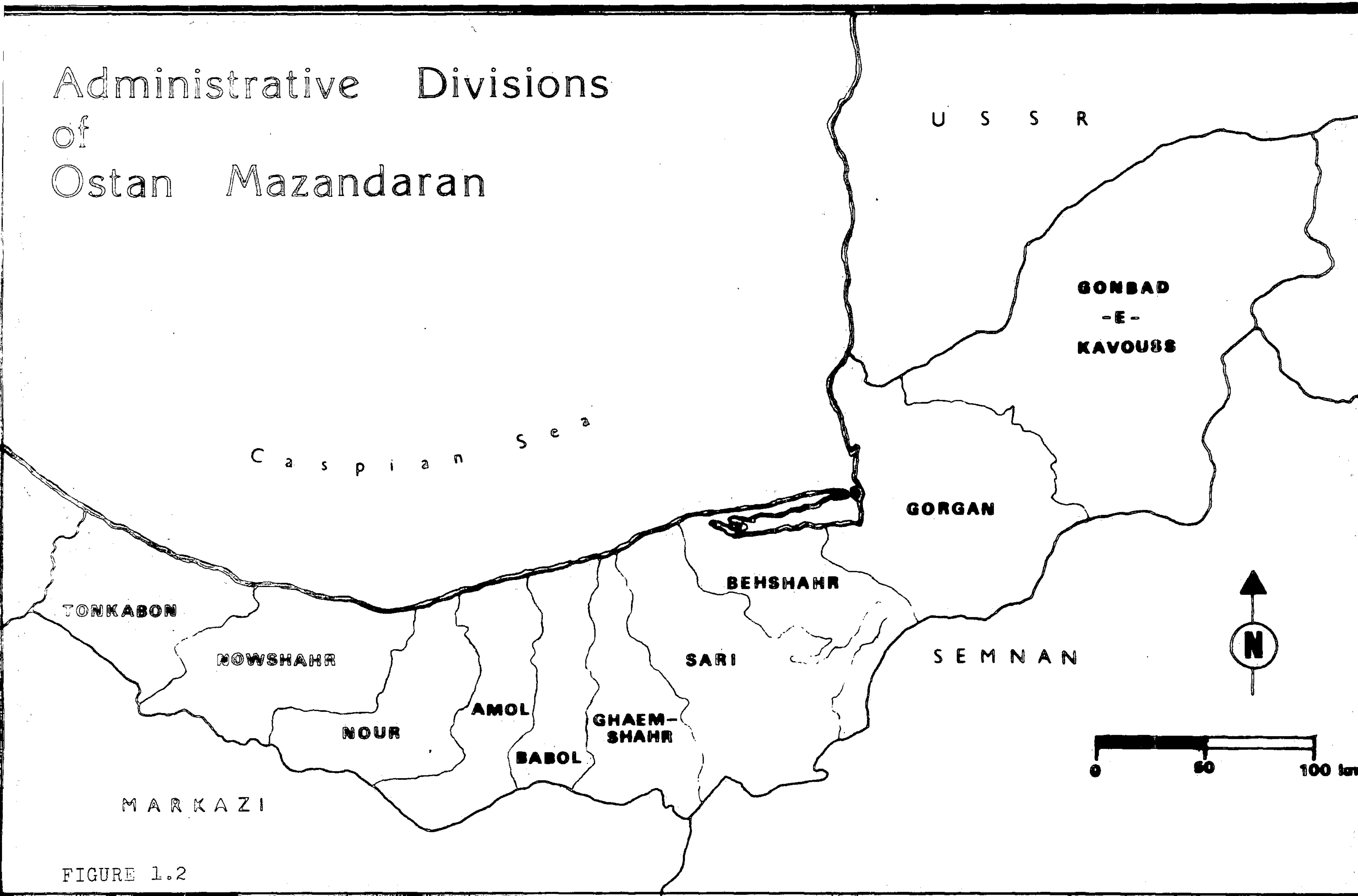
The final changes in these divisions were made in 1938, and the present boundaries were established at that time. Now the Caspian Littoral has two administrative provinces which are Gilan and Mazandaran in the west and east respectively, and they are territorial divisions reflecting geographical divisions.

1.4 SHAHRESTAN NOWSHAHR

Presently the province of Mazandaran is divided into ten shahrestans(administrative divisions), as follows from west to east: Tonekabon, Nowshahr, Nour, Amol, Babol, Ghaem-shahr, Sari, Behshahr, Gorgan and Gonbad-kavouss (Fig. 1.2). Shahrestan Nowshahr is situated in the western part of Mazan-daran, and is bordered to the north by the Caspian Sea, in the west by Shahrestan Tonekabon, and in the south and east by Shahrestan Nour. It is divided into three Bakhshes or administrative units: Bakhsh Markazi (Central), Bakhsh Chalous, and Bakhsh Kelardasht. Each Bakhsh contains 'Dehestans' which are conglomerates of 'Dehs' or villages (Fig. 1.3).

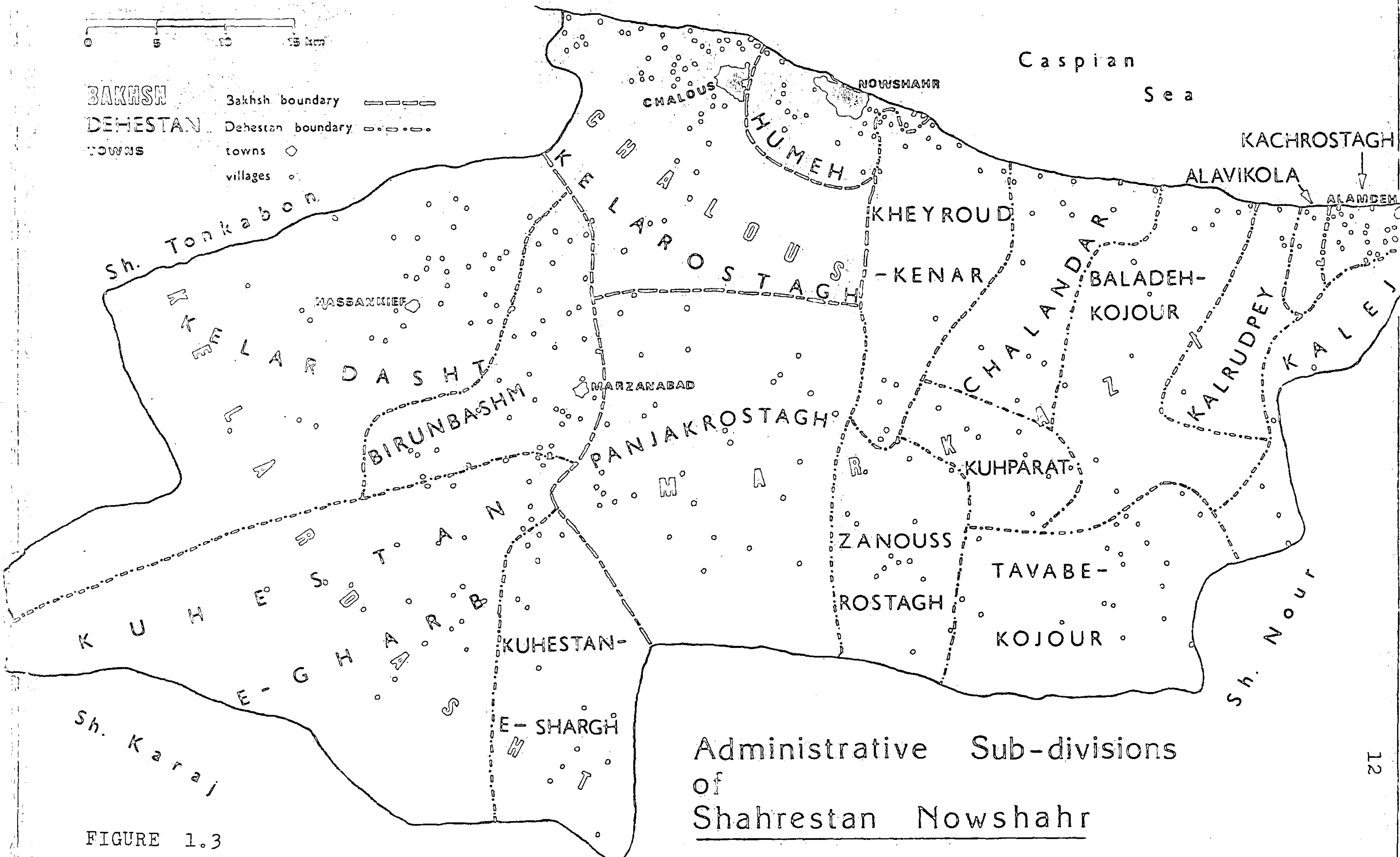
Bakhsh Chalous had a wider limit than it has presently; it contained two regions: The Yelaghs, which were the moun-tainous regions, and the Gheshlaghs (winter quarters) which comprised the coastal plains. Now it is limited mainly to the plains , and some of the adjacent villages are located at higher altitudes. This Bakhsh extends along the coast from the Namakabroud River in the west to the Chalous River in the east, which separates it from Bakhsh Markazi; in the south it extends as far as the most northernly mountains of the Alborz. It contains two areas, namely Chalous City situated in the plains of Kelarestagh, and Dehestan Kelarestagh itself. The Chalous river crosses right through the city, but settlement is mainly orientated towards the western side of the river. Many of the adjacent villages which were scattered in the area have now fused together and are a part of the city.

Chalous city is a new city built during the 1920's, and



Administrative Divisions of Ostan Mazandaran

FIGURE 1.2



Administrative Sub-divisions of Shahrestan Nowshahr

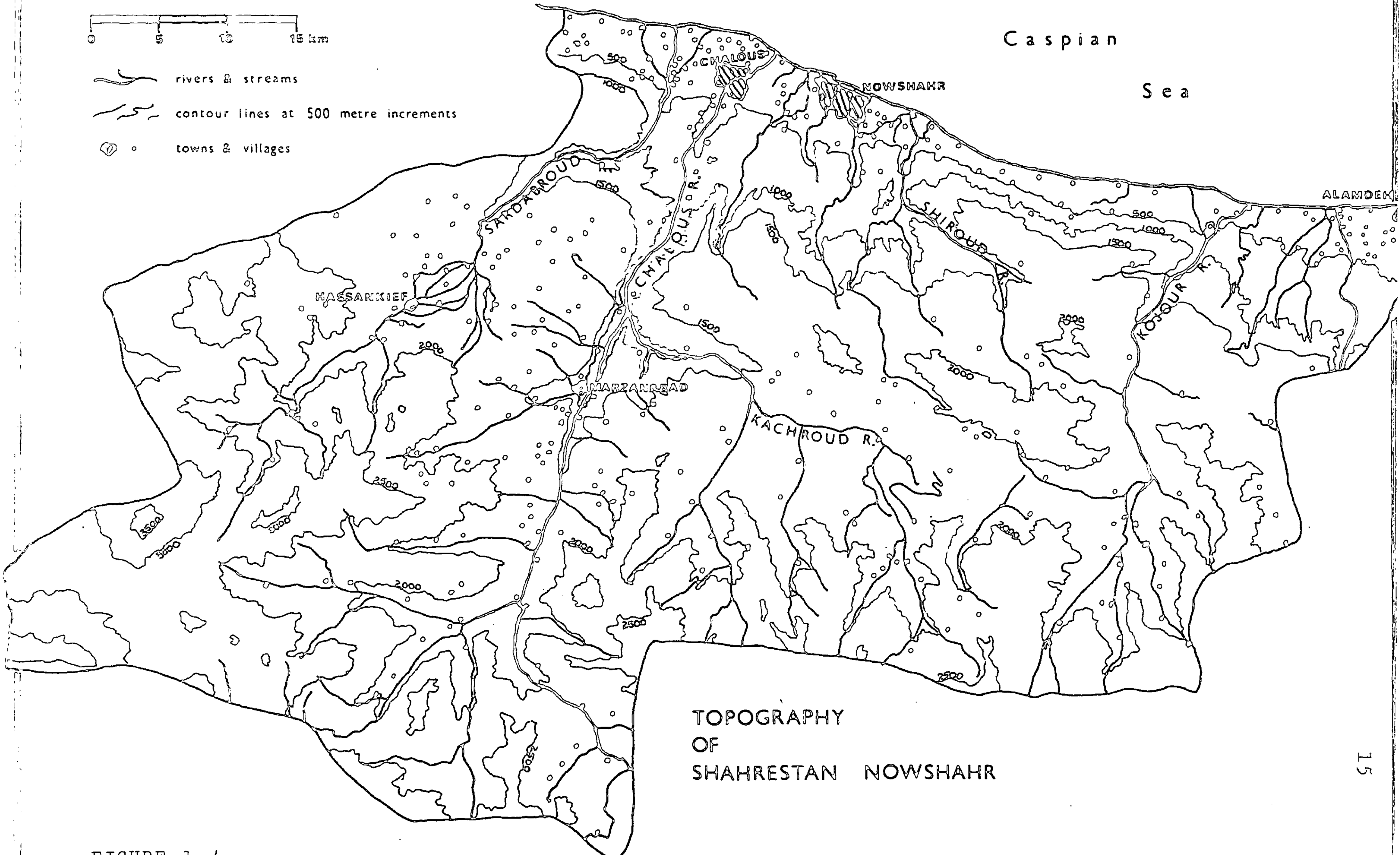
FIGURE 1.3

it became highly populated when the Textile Industry was built in the 1930's. Most of the labour force came from Gilan, but also from various other places in the country. Later the town developed and became one of the centers of attraction for the rural people because of the social facilities it provided. It also became an attractive resort area for tourists mainly because it was the nearest sea-side place from Teheran.

To the east of Chalous river, Bakhsh Markazi begins, with the plains and valley of ancient Kojour at its center. It is bordered in the east and south by Shahrestan Nour (an ancient principality), and in the north by the Caspian Sea. Topographically it is divided into two regions: coastal and mountainous. It is subdivided into twelve Dehestans: Humeh, Kheyroud-kenar, Chalandar, Alavikola, Kalrudpey, Kachrestagh, Baladeh-kojour, Tavabe-kojour, Kouhparat, Kalej, Zanouss-Rostagh, and Panjak-Rostagh. The first six dehestans are coastal, and the rest are located in the foothills and the valleys of the mountains. Nowshahr city is located in Dehestan of Humeh. Before 1930 it was only a small village called Dehno, but it later became a vital port, and it is presently the administrstive center of the Shahrestan. The climate varies according to the type of terrain, from temperate and humid in the coast to extreme cold in the mountains.

The third Bakhsh is Kelardasht, which used to be a part of Kelarestagh. It is situated in the elevated regions of the Shahrestan, and in the foothills of the mountains. It contains four dehostans: Kelardasht, Biroun-Bashm, Kouhestan-Shargh and Kouhestan-Gharb. Most of these regions are situated in the western side of the Chalous River, while a part of Kouhestan-Shargh extends to the east side of the river. These regions which are located in the heights of the mountain ranges, have always constituted the most impassable areas of the Alborz mountains. Apparently in the past important settlements existed, the evidence being mainly from various cemeteries and forts. The inhabitants of these areas are mainly Kurds and Laks, who migrate to the Chalous valley in the winter months.

The new boundaries are based upon the importance of ecology and geography, but they also reflect, to some degree, the older boundaries. Both Bakhsh Markazi and Bakhsh Chalous are almost equivalent to the more ancient division of Kojour and Kelarestagh respectively, with Bakhsh Kelardasht being incorporated into the latter. One of the main reasons for such a division must have been the existence of the Chalous River separating these two divisions. Rivers large and small have had an important influence upon the type of settlements withing the Shahrestan, in addition to their effects on the lifestyles of people in terms of movement and their subsistence pattern. The Chalous River, which has its source in the heights of Dalir and Kandevan in the south, passes through the city of Chalous and flows into the Caspian. It is an important source of irrigation for the low-lying plains. The next important river is the Sardabroud River, originating from the mountains of Takht-e-Soleiman in Bakhsh Kelardasht, and runs through the plains of Kelardasht. Finally, the Zanouss River, in the Dehestan of Zanouss-Rostagh, originating from the mountains of Nour in Kojour, waters the plains of Kojour (Fig. 1.4). Numerous rivers and streams run through the Shahrestan, further impeding movement and communication.



TOPOGRAPHY
OF
SHAHRESTAN NOWSHAHR

FIGURE 1.4

1.5 TRIBES AND INHABITANTS OF MAZANDARAN AND NOWSHAHR

Of the ancient tribes of Mazandaran and the Caspian provinces, there is very scanty and ambigous information. According to the Avesta and mythical references, the early and indigenous tribes of Mazandaran were the 'Div', who were Pre-Aryan, and were given this name by the early Aryans (Mahjouri,1966;Noushin,1975). Strabo (1912)* and Field (1939) refer to the 'Dahae' or 'Daans' as the nomads of the Caspian. The 'Mazan-Div' seem to be the earliest inhabitants, and the word itself finds its root in the Pahlavi language, which is itself from the Avesta. Mojtahedzadeh (1973), states that early inhabitants were not subdued very easily by the Aryans, and the dimorphism of the races in terms of religion and social attributes, might have resulted in the flight of these pre-Aryans to the more remote areas in the mountain.

The early Aryans who arrived in these areas, themselves comprised many sub-branches. The 'Amards' or 'Amardi' or 'Mardan' have been suggested to be the first Aryans who settled in the various localities, and were of Mazandarani origin (Yousefinia,1977). The name Mazandaran can derive from the 'Mardanderoun' tribe or alternatively from the 'Amard' territory (Mahjouri, 1966). The next important tribe were the 'Teypour' also referred to as Mazandarani. It is not certain whether they were contemporary with the Amards or replaced them later. Noushin (1975) states that the name 'Teypourestan', comes from the name of the tribe. Strabo (1912), mentions the 'Teypourans' living amidst the Hircanians and the Aryans, around the coast. Another suggestion is that the Amards were conquered by

* trans. HS Hamilton & W Falconer

Alexander, around 330 BC, and later resettled by the Parthians in 176 BC, and subsequently replaced by the Teypour tribe (Rabino,1928).

The chronology is not very clear, but it is possible that the Div were the indigenous group and pre-Aryan, and were later joined by the Amards and the Teypours, with possible admixture and racial association between them. Noushin (1975), states that the Div were settled in the present regions of Amol, Nowshahr and Tonekabon, while the Teypours resided in Behshahr, Sari and Ghaemshahr, further to the east in Mazandaran. Strabo (1912), also refers to the various additional tribes that inhabited the Caspian coast, and who gave their name to the territories they occupied: these tribes are the Hiracanians, Caspii, Mardian, Dropici, Kadousi, Galae, Vitti, Parhasi, Sacae and Anariacae. The Khazar tribe is also mentioned as a Central Asian Turkish group, who came down the Volga to the western flanks of Mazandaran (Mojtahedzadeh,1973). Marashi (1966), regards the Sukhra group as the forefathers of the original Mazandarani people, who settled in Natel, Rostamdar, Kojour and Kelarestagh. Although the sources of information are unclear, it can be deduced that the earliest indigenous folk of the area might have been a composition of pure Caspian and Aryan racial stock, or the Mazan-Aryan race. Most of the natives might have migrated to the mountains to escape invasions, became isolated, and according to various Iranian researchers it is in the mountains that the pure Mazandarani are to be sought. According to Yousefinia(1977), obvious differences exist in the physical characteristics of the inhabitants of the two regions (the plains and the mountains), and the causes could be historical events, migrations, and environmental associations with diseases.

Various independent kingdoms were established in the Caspian areas of which Mojtahedzadeh(1973) and Noushin(1975) quoting Ebn-Esfandiar, name the Bavandian, Gavbaregan, Ostandar, and Marzban. The Ispahabads of Tabaristan were the native rulers in the Alborz mountains who ruled independently for a century after the arrival of the Arabs. Rabino (1913) states that the inhabitants of Tonekabon, Kelarestagh, Kojour and Nour, who were formerly part of Rostamdar, did not consider themselves as Mazandarani, and the Mazandarani themselves regarded them as Gileks (from Gilan).

Due to the resettlement of tribes in Mazandaran, the area comprises a heterogeneous population. In Shahrestan Nowshahr, apart from the native Mazandarani, the main predominant tribes are the Khajevands and the Laks who were brought over from Azarbaijan, Kurdistan and Luristan in the eighteenth century. In the three districts of Nowshahr these two tribes have occupied the yelaghs in the foothills of the mountains (Rabino,1913; Fortescue,1920; Noel,1921). These mountainous valleys are situated in the districts of Kojour and Kelardasht. These same tribes have also been resettled in the adjacent Shahrestan of Tonekabon, in the west. In Kojour the Khajevands reside mainly in Poul (Dehestan of Zanouss-Restagh). Noel(1921) refers to Poul as a strong Khajevand stronghold. They also inhabit the villages of the Dehestan of Kelardasht. Fortescue (1920), states that the tribes of Mazandaran were powerful during the reign of Nassir-oldinshah, but internal cohesion between the different sections was loose, and though the

Kelardasht and Poul chiefs were interrelated, it was weak and there were ill feelings towards the Kojouris.

Other tribes in Kojour are the Turks, who were transplanted by Fatali-Shah from Turbat-i-Sheikhjami, and presently reside in the village of Varazan (Wells, 1898). In Chalous the tribes are more varied, but they have assimilated with the original inhabitants, and comprise the Gileks, Tonekaboni, Taleghani, in addition to migrants from other parts of Iran. According to the Institute for Malaria Eradication (1981), the inhabitants of Shahrestan Nowshahr constitute Khajevands and Lakks (8-10%); Gilaks (20%), who are mainly from Rasht and its vicinity, and came around sixty years ago, and reside mainly in the cities of Nowshahr and Chalous; Turks (2-3%), who arrived twenty to twenty five years ago; Taleghanis (2-3%) who came around fifty years ago, and reside in Chalous; Ghomi (5-10%), who came from Ghom, Kashan and Yazd, and reside in Dehestans of Kojour and Kheyroudkenar.

1.6 OCCUPATION

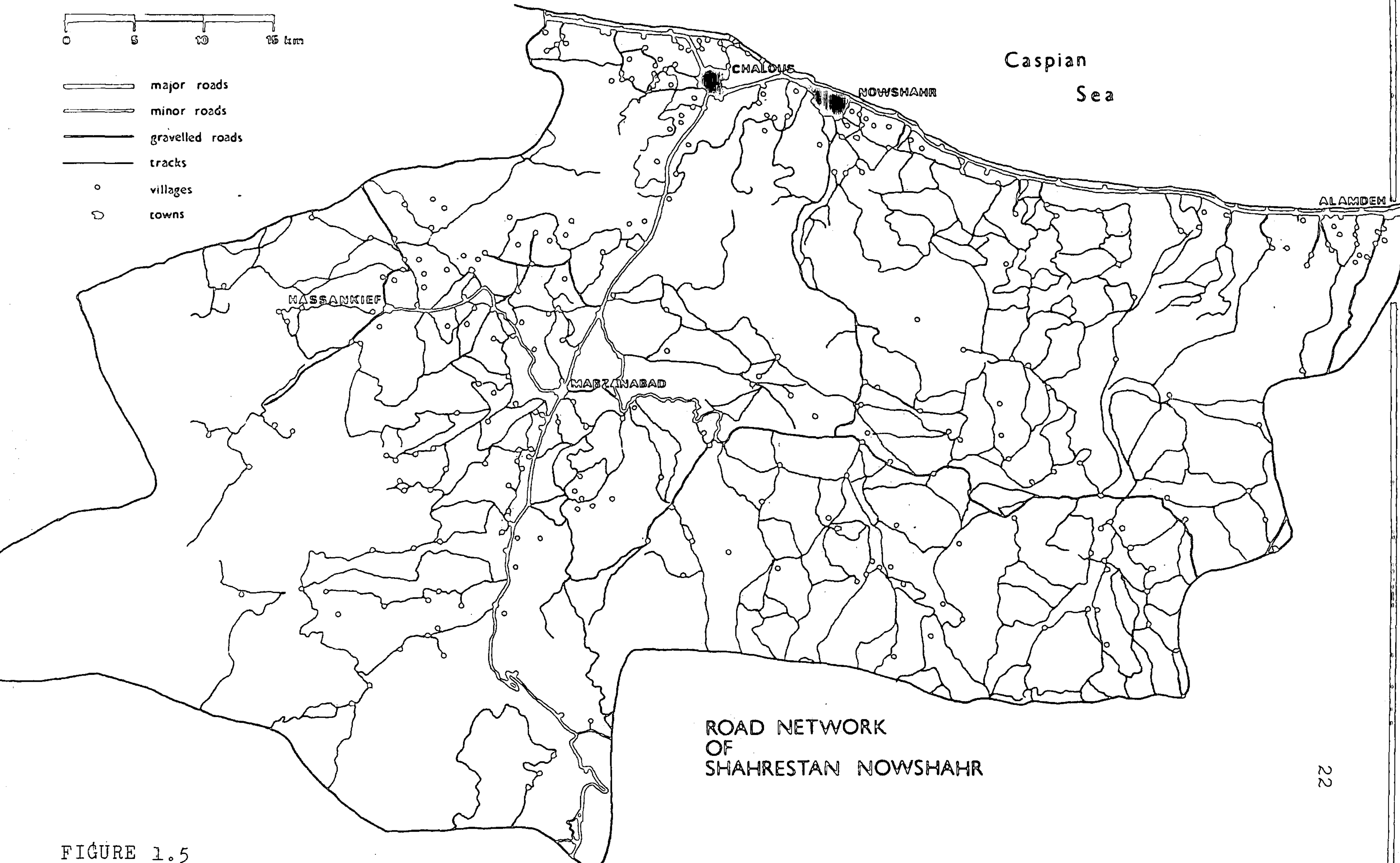
The main occupation in Shahrestan Nowshahr is agriculture, and the chief product is rice. The plains inhabitants also depend on fishing which produces an important part of their diet. In the mountains, it is mainly pastoralism in addition to the cultivation of wheat and millet, and cattle and sheep constitute the principal source of wealth. The herders are transhumant between the yelaghs and the gheshlaghs. In the mountainous plains of Kelardasht, the Khajevands and Laks supplement their subsistence with home-made industries, such as gilims (coarse carpets) and jajims, made from wool. Dairy products from the hills of Kojour are brought down to the lowlands to be sold. As in earlier times there is an association between the coastal and mountainous areas, through the tradition of seasonal migrations when goods are bartered. In Nowshahr and Chalous cities it is mainly small retailers and government servicemen. In the tourist seasons many migrate from the rural areas to the cities as labourers in hotels, restaurants and various other jobs.

1.7 ROUTES OF COMMUNICATION

The geography and ecology of the Caspian regions have always constituted a major obstacle to a wider range of movement and contact. The existence of numerous rivers, the hazardous passes and the ruggedness of the terrain, have been cotributing factors to the isolation of the villages, in addition to being hindrances to development. Before 1940 the roads were muddy ditches, and pack-mule and horse formed the only means of transport. Rabino (1910), claims that there were no bridges on the main rivers and most of movement was by foot or with track animals. These difficult roads also formed the trading route between the capital and the Alborz, where most of the trading took place. Other older routes were a consequence of the various invasions of the Caspian provinces. One summer route from Teheran to the north was available, but could not be used in the winter due to snow and avalanches. There were also routes that connected western Mazandaran to Gilan in the east and Asterabad in the west; but it was through thick forests and passage was dependent on the state of the rivers. Within Chalous and Kojour, few minor roads existed to connect the few hamlets and villages.

During the Saffavid and Qajar dynasties some roads were constructed, which enabled more contact between the lowland and highland, where charcoal and rice were exchanged for dairy products and woollen material. Between 1930 and 1940 many roads and bridges were constructed, due mainly to the rapid growth of Tehran, which created a two-way movement in trade and compounded the effect of a steady movement of people into Mazandaran from the west.

At present an almost permanent road, built in 1933, connects Tehran to Chalous City via the Kandevan passes. In Marzanabad, situated twenty-five kilometres south of Chalous, a minor route branches off the Chalous road and goes westward for twenty-four kilometres to villages in the mountains of Kelardasht. This route continues into the adjacent Shahrestan of Tonekabon. In Doab, just north of Marzanabad, another minor road goes eastwards for fifty-seven kilometres to the plains of Kojour. It also routes to the villages of Lashak and Veysar, finally reaching the Shahresan of Nour in the east. From Chalous City there are asphalted roads that run along the coast into the Ostan of Gilan in the west, and to the eastern borders of the country. In Alamdeh, the last village in the east, a minor route passes through the mountains and forests for twenty-six kilometres to reach the coal mines of Galanderoud and further on the Kojour Valley. This route once held a special economic significance, being the route for



ROAD NETWORK
OF
SHAHRESTAN NOWSHAHR

FIGURE 1.5

Chalous, since it provided passage for the fuel needed for the Textile Industry. The textile industry was itself a major cause for the construction of roads and bridges between Nowshahr and Gilan, mainly for the transportation of silk. The Chalous Bridge was built around 1953, and it connects Chalous and Nowshahr cities which are nine kilometers apart (Fig. 1.5).

The construction of new roads and bridges, in addition to minor roads within the interior of the region, has inevitably allowed more contact and exchange between the isolated hamlets and villages. As a result of this, some areas have become important centers as market or administrative centers. In general, there exists an intricate network of routes within the Shahrestan, and it the consequence of agricultural productivity and its beauty as a resort area attracting migrant and visitors, and finally the emergence of market towns, all contributing to the economic development of Nowshahr.

1.8 SOCIAL CUSTOMS AND TRADITIONS

The kinship system of the Persian village is cognatic with strong preference for cousin marriages (Spooner,1966). Marriage follows the old tradition of the extensive family and patrilocality. The four priciples governing marriages are as follows: a) Generality of marriage and its universality which finds its origin in the religious teachings; b) Precocity, or early marriage, due to economic necessity and social considerations, which is evident in the rural areas where a higher proportion of both sexes marry at an earlier age; the limit of age at marriage is 15 and 18 for females and males respectively, but the context of the law is rarely observed, (Moezi, 1967;Behnam,1968). The reasons for early marriage are mainly the importance of bondage and interdependence, as a socio-economic necessity, in addition to encouragement given to marriage and production of children, who constitute an important section of the labour force; c) Polygamy, which is more prevalent in the urban areas, because of the more subsistence hardships in the rural; d) Endogamy and consanguinity, which are widely practised in the rural villages. One main reason for the high rate of marriages of relatives is the geographical features which dictate the zone of marriage and limits movement and contact between the villages. Other reasons are social factors which encourage a closed economy and the strengthening of family relationships. These religious, socio-economic, and geographical factors have exerted considerable influence on the pattern of relatedness between the inhabitants.

Sociological changes, industrialization and urbanization, during the last forty years have transformed the structure of family tradition and the principles governing conjugal life. Some social factors are the mass exodus from the rural to the urban centres, better education, military service, and more independence of women changing marriage principles and fertility, and a transition from the extended family to the nuclear family. The prevailing social customs and tradition have also been the result of the settlement patterns.

1.9 SETTLEMENT PATTERNS AND MOVEMENT

The disposition of relief and water supply has been the main determinant of the geographical distribution of the population and their pattern of settlement. Most settlements have been orientated towards the exterior or interior of the mountains, on the foothills and in the valleys and plains, where water and temperature has allowed optimal conditions for cultivation. The Caspian coastal provinces are the most populated regions of Iran apart from the Zagros regions. The delta plains formed at the mouths of the Caspian rivers have been very densely populated since water has been used for irrigation. In Shahrestan Nowshahr, two thirds of the population reside in the rural areas. Population density is also very high in the littoral near the foothills and in the broad valleys of Kojour, Poul and Kelardasht.

The 'Deh' is equivalent to a small village, and is the centre of habitation as well as the economic unit of agriculture and consumption; a great majority of the rural population resides in these units. It also constitutes a social unit and most frequently consists of related persons. The villages of the north are mainly of the scattered type, where settlements were at first small due to difficulties of soil clearance, but most of the hamlets and dehs have fused together to comprise dehestans or conglomerates of dehs. On the coast the settlements are more continuous, while in the mountains the villages tend to be more closely knit and distributed discontinuously.

As the result of agrarian reform and various social and economic changes during the last thirty to forty years, there has been a change in the state of villages, which are now being transformed and which will inevitably influence the subsistence pattern, the mode of living and demographic composition of the rural population in terms of sex, age and the cognate system of relationships. Most importantly, the emergence of new towns, which are simply industrial settlements, have attracted migrants from the rural and isolated villages. Manufacturing, resort or administrative centres such as Chalous and Nowshahr have grown very rapidly, producing an urban population whose members consist mainly of formerly rural people. In addition, more voluntary settlements in the towns, mainly in search of jobs and better social and economic standards, have drawn migrants from the mountains, resulting in regional depopulation.

1.10 CENSUS RETURNS

The first general census of Iran was conducted in 1939-40 by the Iranian Ministry of the Interior, which provided an estimate of the population of Iran without any details on birth and death rates and other vital statistics (Firoozi, 1977). The first national census was undertaken by the General Department of Public Statistics, affiliated to the Ministry of the Interior, in 1956. It comprises detailed data on age, sex, marital status, migration and socio-economic characteristics of the population. According to the Parliamentary Act that established the Statistical Centre of Iran, a population and housing census was to be conducted every ten years. The 1966 and 1976 censuses provided a more detailed profile of the total country, each Ostan and Shahrestan. Attempts were also made to produce new concepts and methods of improving the data (Statistical Centre of Iran, 1976).

Prior to these periods a variety of sources were used which were mainly estimates of travellers, geographers and diplomats based on the local rulers' information on the number of houses, tents, etc. Statistics were also collected in the Achaemenid Period, but was limited to army and taxation.

With regard to vital statistics, in 1926 a decree was approved regarding vital registration, implemented in 1928 as a Civil Registration Office, which covered only Teheran; in 1940 a new code was used, which necessitated the registration of births and deaths, sponsored by the Ministry of Health.

The most important earlier demographic checks on the population were famine, plague and cholera which periodically greatly reduced the population.

1.11 CONCLUSION

In summary, it can be said that the history and cultural roots of Iran are as varied as its peoples. The geographic composition of the country has created relatively isolated population enclaves with distinct ethnic and linguistic affiliations. This is particularly evident in the Alborz and Zagros mountains. Only in the last forty years have detailed statistics allowed people to study changes in the structure and compostion of populations within Iran.

APPENDIX A

SUBDIVISIONS AMONG THE KHAJEVAND AND LAK TRIBES

KHAJEVAND SUB-BRANCHES

In:	Kojour	Poul	Kelarestagh
	Siahserani	Garussi	Sangzorali
	Sharafrud	Kurdistani	Malamiri
	Shahsavand	Kakavand	Kermanshahi
			Tork

LAK SUB-BRANCHES

In: Kelardasht

Karak
Delphany
Turk
Nanakali

CHAPTER TWO

THE DEMOGRAPHIC AND GENETIC STRUCTURE OF POPULATIONS

2.1 DEFINING MENDELIAN POPULATIONS

Population genetic studies aim at understanding the causes underlying the spatial and temporal genetic differences observed within and between populations in physical and bio-chemical characteristics, such as anthropometric measurements, blood-group polymorphism and susceptibility to various diseases and physiological disorders. These biological diversities have been interpreted as adaptive responses by the population to the environment, and it is upon these variations that evolution operates through the mechanism of natural selection to ensure the survival of the most adaptive. The biological significance of these studies has encouraged more research into the factors that produce regional differences in the genetic composition of populations. Since genes as units of inheritance can only be understood in an ecological context, it is necessary to study the geography, history, and the demographic structure of populations.

On observing genetic variation on a geographical scale a systematic gradual change is evident in gene frequency distributions; this clinal component as opposed to sharp divisions is indicative of gradual gene flow, and is very much influenced by the geographic distance that separates the regions, the extent of selection intensities and historical migrations to these areas. The geographical distribution of humans is not regular and random, and topographic barriers like mountains, rivers and uninhabited spaces, or social and cultural factors such as ethnicity, religious, linguistic and dialect differences are influential in producing regional genetic differentiation. These factors constitute important barriers to movement, impeding gene transmission and further contribute to the sub-division of populations into clusters, within which some degree of biological and cultural similarity exists.

These population clusters or demes (small endogamous group), are usually the smallest unit in the hierarchy of Mendelian populations. It is not very simple to define and recognize these Mendelian units. They may be considered as a hierarchy of groups at different levels whose rank depends upon changing degrees of relationship (Boyce et al,1971; Kucheman and Harrison, 1972). Dobzhansky (1955), defines Mendelian and breeding units as " a reproducing community of individuals who share a common gene pool". These breeding units have important evolutionary implications for population geneticists, since micro-evolution operates at this level, and it is the accumulation of generational changes and reorganization in the genetic composition that leads to the broad phylogenetic changes and macro-evolution (Johnston,1973). Lasker describes evolution as a change in the frequency of genes in a breeding population by the interaction of mutation, natural selection, random genetic drift, admixture (gene flow) and inbreeding (Lasker, 1954).

Hardy-Weinberg's mathematical model examines and predicts how frequencies of genes and their combinations remain at genetic equilibrium from one generation to another in Mendelian populations. Their theorem is based on a number of assumptions that rarely conform to real populations. The major criteria are large size, random mating, no differential fertility (equal potential for contributing to the next gene pool) and mortality (random survival of all offspring), non-overlapping generations, no differential selection(identical fitness) and no mutation. Since these criteria are not met and systematic forces operate to disturb the genetic equilibrium expected, most genetic studies aim at understanding the causes for the disequilibrium.

Factors that tend to deviate from the expected genetic contuinity are varied and interrelated. They are different selective regimes, genetic drift, socio-cultural factors that dictate the mating system, historical events, geographical factors and the size of the population. Genetic drift operates very strongly in small populations, or if the population is sub-divided into genetically isolated subgroups. It is a sampling process by which the subsequent generations may differ by chance in their proportions of hereditary traits from the previous generation. This happens either through intergenerational gametic sampling, or through the 'founder effect'. The latter effect is caused either by the 'Bottleneck-effect' i.e a socially systematic process of fission and fusion (Kempton, 1971;Fix,1975 1978) or the 'Headman-effect', again a social system that causes differential contribution to the gene pool where large contributions by heads of villages to the gene pool, through the practise of polygamy, can cause random effects (Underwood, 1979). These random fluctuations of gene frequencies in the process of gene transmission can result in the transfixation of certain alleles and the consequent loss of others, and renders the population prone to selective pressures. In addition to the small size of the population, the mating system could prohibit marriages outside a biological and cultural range, consequently leading to inbreeding. Non-random mating violates the required condition of panmixia, with the predictable genetic consequence of changing the genotype distribution. Genotypic assortative mating and inbreeding (preferential matings between related individuals) produce different conditions for natural selection to operate, since more autosomal homozygous combinations appear in the population (Schull, 1972).

Another mechanism that acts to counter-balance the effect of drift is gene flow, resulting in the transmission of genes from one population to another and reducing the genetic variability between formerly distinct breeding units, as well as producing new genotypic combinations. So while drift and and inbreeding accelerate genetic differentiation and create genetic enclaves, gene flow and migration slows the process and reduces the effect of selective pressures.

Other than these evolutionary mechanisms, the demographic structure and evolution of populations are important as a basis for analyzing the genetic structure and for determining the effects of evolutionary forces upon the population (Spuhler,1959; Sutter, 1963; Ward and Weiss, 1976). Demographic parameters such as population size and density, sex ratio, age composition, number of births and deaths, pattern and distribution of settlements and religious and cultural factors in terms of behavioural patterns that determine the nature of movement and mate selection, determine to a large extent how genes are distributed and combined in populations, and their overall pattern and direction of movement. It is possible to quantify the extent of the effects of random processes, the intensity of natural selection and the amount of gene flow to maintain genetic homogeneity from the demographic dynamics of the population. The biological implications of demography also becomes evident, since in some respect it defines Mendelian units, upon which the evolutionary forces operate.

2.2 THEORIES OF POPULATION STRUCTURE

Population size is a fundamental concern in considering stochastic genetic processes. It is very much determined by the comparative fertility, mortality and migration dynamics (Küchemann and Harrison, 1972). The genetic size of a population is different from the demographic size, since the former deals with the number of potential breeders within a specific age range that contain all the genetic material in the reproducing generation that can be transmitted to the next generation. Many factors tend to affect the breeding size of a population: inconstancy in size, unequal sex ratio, differential fertility and fecundity, variance in the number of offspring produced, age at marriage, and other socio-cultural factors like non-random mating and differential migration. These factors can result in reduction in the actual size of the population. Various formulae are used to account for these variances.

Inequality in the sex ratio can be calculated by:

$$Ne=4NfNm/Nf+Nm$$

where Nf and Nm are the numbers of females and males respectively. The variance in the number of gametes produced by all couples can be estimated by the formula:

$$Ne=4N-2/2+Sk^2$$

where N is the number of potential breeders, and Sk^2 is the variance in the number of gametes. These parameters define the effective size of the population and determine the amount and type of genetic material to be contributed to the succeeding generation.

If selection is not differential within a geographical area, then the demographic factors can determine to a large extent the local genetic structure through the analysis of the pattern of movement and gene flow and its trend of spatial and temporal change. Movement in this term will imply short-range movement, and its genetic implication considers movement of an individual which directly or indirectly leads to a choice of a mate and the subsequent movement of pairs which determine where the offspring is born (Harrison and Boyce, 1972). If gene flow is mainly due to marriages as in sedentary and agriculture societies, then the pattern of relatedness between the populations can be analyzed through the marital movement, in terms of the amount of gene flow between them, the size of the geographical area over which it flows and its overall directional tendencies. The analysis of matrimonial and parent-offspring migration is also a useful method of investigating panmixia or isolation, and the extent that the movement pattern is facilitating or impeding genetic differentiation (Lalouel and Langaney, 1976).

Matrimonial and parent-offspring distances are important measures of population structure, but their distribution is also of genetic concern. The fact that people tend to choose their mates within some limited part of the distribution is reflected in migration studies of many different species. It has been shown that mating outside a central home-base decreases in frequency with increasing distance, and thus gene dispersion tends to be highly leptokurtic (Sutter and Tran-Ngoc-Toan, 1957; Cavalli-Sforza, 1958).

Cavalli-Sforza (1958,1962), studied the diffusional and gravitational components of migration. He noted that the distribution of matrimonial migration does not follow normal diffusion. In his gravitational model it is assumed that the probability of migration to another subdivision is directly proportional to its size and inverse to the distance travelled. He applied his model to migration data from the Parma Valley in Italy, and showed that marital distribution shows marked kurtosis.

Boyce et al (1967), considered local marriage movement within Oxfordshire villages, through their model of 'Neighborhood Knowledge'. Their model shows how the spatial arrangements of populations and their size determine marital movement, in terms of the frequency with which mates are chosen from different populations and the distribution of marriage distance, so that distance becomes inversely proportional to the contribution of individual units.

The behavioural tendency to choose a partner living nearby, rather than one chosen geographically at random, has also been confirmed by other researchers (Swedlund, 1972;Coleman, 1977; Majumdar, 1977). Both spatial exogamy, the distribution of marriage distances and the orientation of gene flow are affected by various demographical and ecological factors: the geographical distribution and structure of settlements the size and density of settlements, the number of villages at particular distances, individual contributions in terms of marriage partners, socio-cultural factors, communication network and the existence of natural barriers.

Coleman (1973,1977), emphasized the importance of matrimonial mobility in association with population size and density, and considered various factors that affected the propensity to migrate. His 'Central Place Theory' explained the basis for the gravitational effect of movement and the variation in marital mobility within and between settlements.

Malhotra and Majumdar (1974), considered the distances between the population units of the spouses in the study of spatial gene distribution. They devised a method whereby the correlation between marriage distance and geographical distance is used as a means of estimating the genetic distance between them, accounting for different parental stocks, mating patterns, selection and mutation.

Most studies of the structure of small human populations, focus on the effect of micro-evolutionary processes such as genetic drift, gene flow and migration (Moran, 1959;Lasker, 1960; Smith, 1969;Roberts, 1967;Harpending, 1974;Morton et al, 1976). Since most populations are distributed irregularly in any given geographical area, population sizes are often small enough for random genetic drift to be accounted for, while quite low levels of migration between relatively isolated populations may have a significant effect in counteracting divergence (Küchemann and Harrison, 1972). Different mathematical theorems and models have been formulated to express the relationship between these evolutionary factors and the dynamics of genes within and between the Mendelian units, and to present the framework in which the causes of the observed genetic variation can be sought. Various components of movement and some of the genetic parameters of human behaviour, such as inbreeding and consanguinity, have been incorporated into these models to study the effects of drift and migration and the pattern of relatedness between sub-divided populations.

The notion of isolate was first used by Wahlund (1928), who demonstrated that human populations consist of smaller units and are restricted in movement by various factors. Later Dahlberg (1929), proposed to evaluate, within the bounds of panmixia, the size of the isolate by estimating the number of marriages between first cousins to the total number of inhabitants (cited by Sutter and Tran-Ngoc-Toan, 1957).

Wright (1931,1943), considered the evolutionary significance of isolates and subdivided populations and introduced two important demogenetic concepts: Ne, the effective population size, which he defined as the proportion of the population that effectively contributes to the gene pool at any given time; and Me, the effective migration rate, defined as the effective proportion of gametes in a population which is replaced each generation by immigrants, estimated from the formula:

$$Me=Q-Qo/q-Q$$

where q and Qo, are the frequency of certain alleles in the recipient and immigrant populatioms respectively, and Q, those in the hybrid population (Wright, 1967; cited by Jorde (1980)).

Wright (1931, 1943), devised two models for measuring, the effects of subdivision (genetic drift) and migration. In his 'Island Model' he considers a spatially subdivided population, between which there is random genetic exchange. Through this model he predicts an equilibrium in genetic variance between all the clusters, whereby migration would balance the chance of random drift. His model was based on the assumptions of similar effective size and homogeneity of exchange in terms of distance. He further improved the model by considering the phenomenon of 'Isolation by Distance', which he further incorporated into his 'Diffuse Model' to account for local genetic variation in terms of distance. He noticed that the range of migration of an individual or a population is usually smaller than the total range of the species and this limited the distance of movement, genetic exchange and consequently the formation of a single panmictic unit. In his second model he assumed a diffusedly distributed population, with the extent of mobility defined by the concept of 'neighborhood size', which restricted the distance from which genes can be drawn.

Later models were formulated mainly to investigate the cause of genetical covariance between populations, with emphasis in the analysis of the actual form of movement and the way it affected the development and levels of inter-population similarity. Malecot's 'Isolation by Distance' model (1969), studied the process and the cause of local genetic differentiation, in addition to evaluating kinship coefficients between populations for various genetic, anthropometric, migration and isonymic data. The coefficient of kinship $\emptyset$ was based on the probability that at any locus two randomly chosen individuals will have a gene in common, identical by descent. In his model he presented a structure in which the populations are distributed continuously and the probability of migration, and hence genetic similarity defined in terms of relatedness and kinship coefficients, is dependent on the distance that separates the units, so that the probability of common ancestry decreases with distance. Some criticisms of his model include those of the assumption of uniform systematic pressure, uniform and constant population size, constant migration rate, and ignoring assortative mating and social stratification (Jorde, 1980).

Yasuda and Morton (1966), validated Malecot's theorem, by showing in their model the inverse relationship between kinship coefficient and distance. In the 'Stepping Stone Model', Kimura and Weiss (1964), studied the phenomenon of random local differentiation in covariance with the amount of distance. They considered the structure in which populations are distributed discontinuously in clusters, subjected to inter-exchange only between neighbouring populations. They predicted that correlation between the colonies decreases as distance between them increases and that the rate of decrease increases with higher dimensional models. The criticisms attributed to this model are that the number of sub-divisions are infinite, that migration is symmetrical and has a constant rate, and that it is based on an equilibrium situation.

An alternative approach to the analysis of movement pattern is the 'Matrix Model', in which some of the deficiencies of the above models are resolved (Bodmer and Cavalli-Sforza, 1968, 1974; Smith, 1969; Hiorns et al, 1969). In these models the observed exchange values between the sub-divisions are measured and further compounded in the form of migration matrices and their effects accumulated by iterating the matrix. Long-range migration (systematic pressure) and differences in population size within the system can be separately identified and their effects determined. These models work on the probability of movement between each unit and they are based, preferably, upon the birthplaces of parents and offspring, while matrimonial migration can only be used on the assumption of no differential fertility. Bodmer and Cavalli-Sforza's model uses a backward stochastic migration matrix to study populations that diverge from original identity, and from that it predicts the amount of spatial gene frequency in terms of covariance within and between populations. Smith's matrix model is based on the knowledge of effective size, selective values and migration coefficients, whereby equilibrium between sub-divisions is established when selection, mutation and migration reduce the effect of drift. Hiorns et al's model considers a hypothetical population whose individual sub-divisions are unrelated. Their model mainly studies the development of relatedness between population units, and interest is focussed on the pattern of development of relatedness rather than gene frequency variation.

All categories of models described above, the continuous and discontinuous, are based on various assumptions that are not totally applicable to real population structures. Most of their assumptions do not take into account ecological, historical and socio-cultural heterogeneity of populations. According to Jorde (1980), in real populations the structure that would most fit a model is one that lies somewhere between the 'Island' and the 'Continuous' models, since the existence of large, uninhabited spaces and variation in population density renders the latter category questionable, while the former model exaggerates the high rate of mobility observed in populations.

There are other methods for examining and estimating the genetic relationship within and between populations. The method of 'isonymy', defined as the commonality of surnames, estimates the mean kinship coefficient within and between populations from the frequency of identical surnames (Lasker, 1977). A more accurate assessment of populations can be made with a full pedigree analysis and family reconstitution extending back to the founder population. Wright (1922), developed the 'Coefficient of Inbreeding', to quantify and measure the the deviation of genotype frequency in an inbred population from that expected under panmixia. Inbreeding coefficients have been calculated from various data, such as genetics, pedigrees, isonymy and migration data.

Many studies on population structure have been made using a variety of data such as vital statistics, pedigrees and genealogies, migration, consanguinity, language, anthropometric, serological and socio-economic (Salzano, 1961; Roberts et al, 1965, 1981b; Eriksson et al, 1973a, 1973b; Kucheman et al, 1974; Harrison et al, 1974a; Clegg, 1975, 1977; Fix and Lie-Injo, 1975; Workman et al, 1975; Skolnick et al, 1976; Coleman, 1980, 1981, 1984; Crawford, 1980; Ferak et al, 1980; Leslie, 1980; Weiss, 1980; Workman and Jorde, 1980; Brennan, 1981; Relethford et al, 1981; Fix, 1982; Roberts, 1982; Swedlund, 1982,1984; Brennan and Relethford, 1983; Jovanovic et al, 1984; Sunderland, 1982).

Studies of the genetic, demographic and migration structure of small populations have made immense contribution to formal genetics, regional history and pre-history, epidemiology and several other fields. More recent studies are focusing on problems and questions dealing with the relationship between genetics and physiological attributes, and its influence on the distribution of diseases, taking into account the importance of demography and migration (Ward et al, 1980).

Quoting Mielke et al (1976), " the total description of population structure requires the intergration of biological, social and demographic data set in an ecological framework ... and how this complex structure changes and evolves through time".

CHAPTER THREE

DEMOGRAPHIC STRUCTURE

3.1 INTRODUCTION

The focus of demography is on changes in the size, distribution and composition of populations, and these are controlled by the processes of fertility, mortality and migration. These processes are themselves affected by the composition of the population in terms of sex ratio, age structure, marital status, family size, age at marriage, age-specific fertility rates, and infant mortality, in addition to the socio-economic status in terms of ethnicity, language, subsistence patterns, kinship structures, mating patterns and migratory attributes. The interaction of these parameters and processes condition and determine the evolution of the demographic struture of the population with regards to the geographic distribution and growth of the population.

Information about Iran's past demography is fragmentary, but some estimates on its population size can be obtained from studies of historians (both Persian and Arab), and European travellers. Post-Islamic Iran experienced a population rise, but between the thirteenth and twentieth century, it underwent a rapid decline. The causes for the depopulation were many: the Mongol Invasion under Ghengiz Khan (1154-1227), the massacre by Tamberlaine (1336-1405), wars between feudal lords, territorial separation of parts of Iran and famine and epidemics between 1851 and 1856 (Le Population de l'Iran, 1974).

Demographic statistics for Iran extend only over the last three decades and indicate a steady increase in population (2.8%). The birth rate is still high (45 per 1000), but the death rate is lower (20 per 1000), whilst a high rate of internal migration is evident (Behnam, 1977).

Most of the demographic data have been extracted from the 1956, 1966 and 1976 census returns, and tables 3.2 - 3.8a, and 3.9 - 3.23 are based upon them.

3.2 PAST DEMOGRAPHY OF SHAHRESTAN NOWSHAHR

3.2.1 Population size

Shahrestan Nowshahr covers an area of 3695 sq km, and is an administrative division of the province of Mazandaran. The total population as enumerated in the 1976 census was 146,799 persons, with a total of 27,014 households. The population have all been reported as settled with a fixed residence. This area is subdivided into three Bakhshes: Markazi, Chalous and Kelardasht, and further subdivided into two cities, Nowshahr and Chalous and seventeen Dehestans (Fig. 1.3). Table 3.1 presents the figures for each subdivision in terms of population and household sizes and number of Abadies (settled areas), for the 1956-1976 periods.

The demographic evolution in terms of population size is presented in table 3.2. The total Shahrestan increased by 36.7% and 33% in the two intercensal periods respectively. The figures for Nowshahr city are 231.8% and 80.4%, and for Chalous city they are 52% and 73.8%. No figures are available on the temporal trends for the individual dehestans in the 1956 - 1966 period, as the villages had not then been amalgamated into their

Table 3.1

DISTRIBUTION OF POPULATION IN SHAHRESTAN NOWSHAHR BY SIZE AND HOUSEHOLD

Area	1956	1966	1976	Number of Abadies*	Number of Households
SHAHRESTAN NOWSHAHR	80701	110352	146799	331	27014
URBAN	12475	23853	42045		8419
Nowshahr	2717	9016	16263	-	-
Chalous	9758	14837	25782	-	-
RURAL (DEHESTANS)	68226	86499	104754		18595
Alavikala	-	1541	2326	6	428
Baladeh-Kojour	-	3973	5685	12	1048
Birunbashm	-	7889	10056	38	1628
Chalandar	-	3466	4937	14	862
Humeh	-	4818	5005	11	868
Kachrostagh	-	3899	5823	14	1042
Kalej	-	2206	2409	11	430
Kalrudpey	-	2507	3290	6	665
Kelardasht	-	12540	13750	37	2365
Kelarostagh	-	13053	16889	49	2916
Kheyyrud-Kenar	-	5977	9045	16	1627
Kuhestan-e-Gharb	-	1281	1210	12	215
Kuhestan-e-Shargh	-	2758	2650	27	431
Kuhparat	-	3805	3311	9	627
Panjakrostagh	-	6560	7283	39	1376
Tavabe-Kojour	-	5018	5746	15	1136
Zanusrostagh	-	5207	5329	15	997
Marzanabad	1241	1360	2835	(incl. in Birunbashm)	
Alamdeh	1074	-	2526	(incl. in Kachrostagh)	

* settled areas

Source: Census returns for 1956, 1966, 1976.

corresponding dehestans but the figures for the total rural area shows an increase of 21.1% and 26.8% between the three census years. The figures for the rural area have been subdivided for the 1966-1976 period, and it is evident that individual dehestans show a very heterogeneous trend in population size and growth, ranging from -3.9% to 51.3%. The figures also show that increase in size has been substantially higher in the urban areas during both decades. Individual villages range in size from 6 to 1669 people, and two villages of Alamdeh and Marzanabad have increased substantially and are emerging as new market centres. The sizes of the dehestans range from 1210 persons in D. Kouhestan-east to 16889 in D. Kelarestagh. Population growth in the dehestans does not appear to be correlated linearly with the size of the population, but rather with the spatial location of the areas; the coastal areas show the highest growth rate, between 30 and 50%, while the more remote, isolated and mountainous areas show a slower growth rate or, alternatively, decreasing trends; this decrease can be attributed mainly to emigration since there is no evidence of especially high mortality there.

The distribution of the population in terms of urban and rural areas shows changes in the balance. The urban area shows a linear increase, while in the rural area a decreasing trend is observable. The trend for increasing urbanization and growth will be discussed later, in association with the other demographic parameters such as fertility, mortality, migration and changes in the socio-economic conditions of the area (Table 3.3).

Population density has increased from 21.8 to 29.9 to 39.7 during the intercensal periods, but there are no figures for the urban-rural differences.

Table 3.2

PERCENTAGE CHANGE IN POPULATION SIZE

Area	1956-1966	1966-1976
SHAHRESTAN NOWSHAHR	36.70	33.03
URBAN	91.20	76.30
Nowshahr	231.80	80.40
Chalous	52.05	73.77
RURAL (DEHESTANS)	26.78	21.10
Alavikola	-	50.94
Baladeh-Kojour	-	43.09
Birunbashm	-	27.47
Chalandar	-	42.40
Humeh	-	3.88
Kachrostagh	-	49.35
Kalej	-	9.20
Kalrudpey	-	31.23
Kelardasht	-	9.65
Kelarostagh	-	29.39
Kheyyrud-Kenar	-	51.30
Kuhestan-e-Gharb	-	-5.50
Kuhestan-e-Shargh	-	-3.90
Kuhparat	-	-12.98
Panjakrostagh	-	11.02
Tavabe-Kojour	-	14.51
Zanusrostagh	-	2.34
Marzanabad	-	-
Alamdeh	-	-

3.2.2 Population Growth

Changes in population size are the outcome of changes in the three main demographic parameters: fertility, mortality and migration. These in turn affect the number and distribution of the population. Population size increase is a reflection of either a high birth rate (natural increase), or an increase in immigration, while decrease is the result of death or emigration.

According to the theory of 'Demographic Transition', Iran in general is in the transitional period, characterized by lower mortality rates and relatively high birth rates. Changes, therefore, can be attributed mainly to fertility and migration. Fertility is more instrumental than migration in populations undergoing demographic transition, but there is also evidence of a high rate of internal migration within Iran during the last forty years due to industrialization, rapid economic growth and urbanization (Hemassi, 1974; Behnam, 1977; Firoozi, 1977). In order to elucidate the factors that underlie the evolution in the size of Shahrestan Nowshahr, taking into account the variation observed in trend of the rural and urban areas, both fertility and migration have been examined.

3.2.3 Fertility

The inefficiency of adequate birth and death registration in Iran have prevented the calculation of direct measures of fertility. Indices of fertility have been obtained indirectly from the age and sex distribution. The 'child-woman' ratio (or the 'General Fertility Rate') has been computed by taking the number of children under five years of age per one-thousand woman in the age group of (15-49), ie the reproductive period.

This age group roughly delimits the total reproductive women, and it is also a measure of effective fertility after the bulk of infant and child mortality has occurred, and it is therefore based on survivors only (Momeni, 1970). In general this is a relative measure, and underestimates the actual birth rate.

Tables 3.4 and 3.5 present figures for the fertility rates of Shahrestan Nowshahr and Ostan Mazandaran. In Shahrestan Nowshahr, during the three periods, fertility shows a decreasing trend between the two decades; this is observed in both the urban and rural areas. The values for the 1956 period are only available for the (15-54 years) age groups, while those for 1966 and 1976 are based on a more standard age group (15-49). The rural area shows a higher fertility rate than the urban areas in both 1966 and 1976, while the 1956 results show the highest rate in Chalous city; this is most probably due to the fact that it was considered as part of the rural area.

Higher fertility is characteristic of the rural areas of Iran in general and it has been reported that the reproductivity of rural women is twice that of urban woman (Nehaptian and Khazaneh, 1977), therefore substantial differences exist between the two areas (Fig 3.1). Although Iran is experiencing relatively lower mortality rates, differential rates are expected in the two areas. Birth rate and mortality rate are both higher in the rural areas due to a lower standard of health, and higher infant and child mortality. In general, the rural areas are more in an early transitional period compared with the urban areas which have undergone rapid changes in their socio-economic standards.

Table 3.3

RURAL AND URBAN DISTRIBUTION OF POPULATION

Area	1956	1966	1976
Rural	84.5%	78.4%	71.4%
Urban	15.5	21.6	28.6
	100.0%	100.0%	100.0%

Table 3.4

FERTILITY RATE DURING 1956 - 1976

Area	1956	1966	1976
SHAHRESTAN NOWSHAHR	968	890	776
Nowshahr City	869	846	732
Chalous City	1049	804	627
Rural	972	908	822

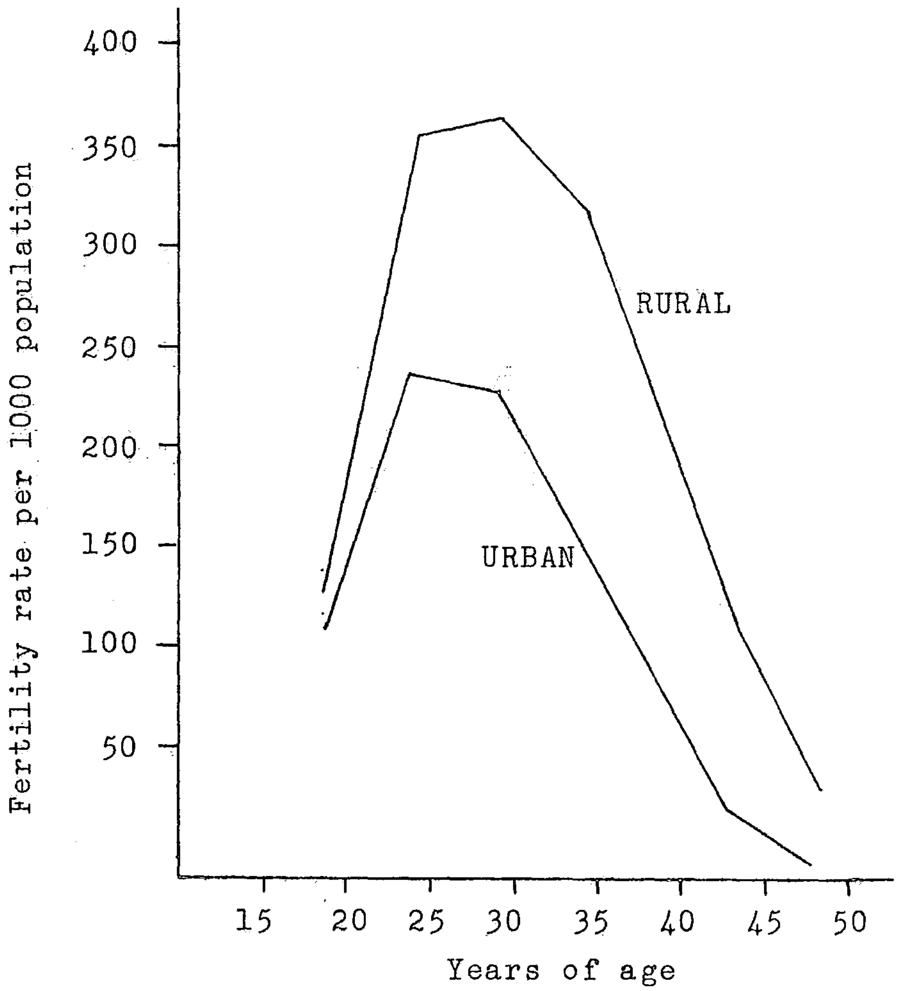
Table 3.5

FERTILITY RATE IN OSTAN MAZANDARAN IN 1976

Total	Urban	Rural
758	628	824

Figure 3.1

AGE-SPECIFIC FERTILITY RATES IN URBAN AND RURAL AREAS



Source: Nehaptian and Khazaneh (1976)

Fertility is very much affected by other demographic parameters, and these will be analyzed individually to clarify the differential rates of the urban and rural areas, and secondly to explain the decreasing trend in the total Shahrestan.

3.2.4 Conjugal condition

Marital status is important in the study of demographic change in the reproductive potential of the population. This depends mainly on the proportion of married, single, divorced and widowed individuals, the age and sex distribution and the residential distribution of the population. These have a direct effect on the fertility and growth of the population.

Table 3.6a presents data on the conjugal condition of the inhabitants of Shahrestan Nowshahr during the 1956-1976 period. The proportion married has decreased throughout the period, but more rapidly in the 1956-1966 period; this trend is also valid for both urban and rural areas, and for both males and females. It is also apparent that there is a consistent pattern in all periods and both areas with a higher proportion of females married than males. The rural areas show a higher percentage of married individuals for both sexes. The highest proportion of married individuals are in areas with under 5000 people and, according to the 1956 census, 71.8% of males and 75.9% of females were married.

The proportion of individuals who are single, ie either never married, widowed or divorced, are presented in tables 3.6 b, c and d. The proportion of never married individuals shows increase from 1956 to 1976, but the change is very significant in the first intercensal period; the same trend is observed

Table 3.6a

PROPORTION OF MARRIED INDIVIDUALS IN SHAHRESTAN NOWSHAHR AGED TEN YEARS AND OVER.

	1956*	1966	1976
MALES	71.5%	57.2%	55.5%
Urban+	69.8	47.7	52.5
Rural	71.5	60.1	57.2
FEMALES	75.5	61.2	57.5
Urban	74.4	57.8	56.2
Rural	75.4	62.2	58.2
MALE & FEMALE	73.4	59.2	56.5
Urban	72.0	51.9	54.2
Rural	73.4	61.2	57.7

* The 1956 Census did not investigate marriages in the age group 10 - 14 years, but began instead at 15 years.

\+ Urban = aggregate results of both Nowshahr and Chalous Cities.

Table 3.6b PROPORTION OF NEVER MARRIED INDIVIDUALS.

		1956	1966	1976
Sh. Nowshahr				
	males	25.8%	40.0%	42.9%
	females	7.9	27.7	34.6
Nowshahr city				
	males	27.4	50.4	43.4
	females	8.1	31.8	34.5
Chalous city				
	males	26.9	45.2	48.9
	females	11.1	33.2	38.3
Rural				
	males	25.6	37.5	41.2
	females	7.4	26.3	33.6

Table 3.6c PROPORTION OF WIDOWED INDIVIDUALS.

		1956	1966	1976
Sh. Nowshahr				
	males	2.1%	1.4%	1.3%
	females	15.8	10.0	7.5
Nowshahr city				
	males	1.5	0.5	1.1
	females	14.8	7.9	6.4
Chalous city				
	males	2.1	1.1	1.0
	females	14.8	8.5	7.2
Rural				
	males	2.1	1.6	1.4
	females	16.0	10.5	7.7

Table 3.6d PROPORTION OF DIVORCED INDIVIDUALS.

		1956	1966	1976
Sh. Nowshahr				
	males	0.6%	0.4%	0.2%
	females	0.9	0.6	0.5
Nowshahr city				
	males	1.4	0.4	0.3
	females	0.3	0.5	0.6
Chalous city				
	males	0.9	0.8	0.3
	females	2.0	1.3	0.5
Rural				
	males	0.5	0.4	0.2
	females	0.7	0.5	0.4

for both sexes and in both the rural and urban areas. In general, the percentages are significantly smaller for females and in the rural area. Widowhood shows decrease in both areas and for both sexes, but female widowhood is substantially higher and this could be attributed to the earlier death of males who are usually older than their spouses. In their general demographic survey of Iran, Nehaptian and Khazaneh (1976) estimated an average of six years age differences between spouses and they stated this factor as one of the causes of female widowhood, in addition to the fact that males can marry more often than the females. Indices on divorce show a decrease in each area but the females show higher incidences; there is very little difference between the two areas.

In order to elucidate the factors underlying the changes in the proportion of married and single individuals, the proportion of married individuals in different age groups has been examined. Table 3.7 reveals that the proportion in the younger age group is declining for both males and females. From 1956 to 1976, the age group with the highest proportion of married men has increased from (40-44) to (45-49) years; for females it it has increased from (25-29) to (30-34) years. It is also evident that in the younger age groups, especially (15-19) years, females show a much higher frequency of marriages in comparison with males. An urban-rural comparison does not reveal very different results, except that males in the rural areas tend to marry at a later age in the 1966 and 1976 periods (Table 3.8a).

3.2.5 Age at marriage

Early marriage has been practised in Iran for a long time and low age at marriage is well-documented. According to the Iranian Civil Law, the minimum age at marriage is 18 and 15 years for males and females respectively, but the law is rarely observed. This is more valid in the rural areas, where the percentage of early marriages is high. According to Moezi (1967), in his report on the fertility survey of rural villages in Iran, 19.7% of females and 4.7% of males had married before the legal age. Young girls in the rural areas are engaged at birth and married at puberty. In general the proportion of married individuals in the age group (15-19) years is highly different in the urban and rural regions (Table 3.8b). Table 3.8c presents mean age at marriage for the population of Iran, signifying the differences between the two areas and the sexes.

Average age at marriage in Mazandaran is reported to have been 19.6 years in the urban areas, and 18.9 in the rural, in 1966 (Momeni, 1970). No estimate of age at first marriage in Shahrestan Nowshahr is recorded in the census returns, but from table 3.7, it is evident that low age at marriage is characteristic of the total population, with differences between the two areas. It can also be deduced that this trend is decreasing in frequency for both sexes and in both areas; this is mainly due to sociological transformation such as literacy and migration.

Variations observed between the urban and rural areas in conjugal condition are largely the results of factors such as the subsistence pattern of agriculture, land dependency, labour demand, economic pressures, religious and traditional

Table 3.7

MARITAL STATUS OF INHABITANTS AS A PERCENT OF THE TOTAL POPULATION, BY AGE AND SEX

Age Groups	1956 Males	1956 Females	1966 Males	1966 Females	1976 Males	1976 Females
10 - 14 yrs	-	-	-	0.7	-	-
15 - 19	4.5	44.0	5.5	40.7	6.9	26.8
20 - 24	32.1	93.2	37.5	90.2	50.0	77.6
25 - 29	8.3	96.3	81.5	97.2	86.3	94.0
30 - 34			94.2	96.7	96.0	96.5
35 - 39	95.1	90.5	95.0	95.2	98.0	96.1
40 - 44			96.7	90.8	97.9	93.0
45 - 49	94.6	68.6	96.4	84.8	98.1	86.8
50 - 54			94.7	69.2	96.7	79.2

Table 3.8a AGE GROUPS WITH THE HIGHEST PROPORTION OF MARRIAGES: URBAN AND RURAL COMPARISON

Area		1956	1966	1976
URBAN				
Nowshahr city				
	males	45-54	40-44	35-39
	females	25-34	25-29	30-34
Chalous city				
	males	35-44	40-44	35-39
	females	25-34	30-34	30-34
RURAL				
	males	35-44	45-49	40-44
	females	25-34	25-29	30-34

Table 3.8b PROPORTION OF MARRIED INDIVIDUALS IN (15-19) YEARS AGE GROUPS.

	City	Rural	Total
Males	2.1%	6.3%	4.4%
Females	40.1	50.1	46.1

Source: La Population de l'Iran, 1974.

Table 3.8c MEAN AGE AT FIRST MARRIAGE

	City	Rural	Total
Males	26.8	24.9	25.7
Females	19.0	18.2	18.7

Source: La Population de l'Iran, 1974.

Table 3.8d AGE DIFFERENCES BETWEEN SPOUSES

	AREA		
	City	Rural	Total
YEARS	8.5	8.2	8.3

Source: La Population de l'Iran, 1974.

Table 3.9 TOTAL POPULATION OF SHAHRESTAN NOWSHAHR BY AGE GROUPS

Age groups	1956	1966	1976	Ostan Mazandaran (1976)
0 - 14 years	44.3%	48.5%	46.7%	46.5%
15 - 49	40.5*	48.5	50.0	50.3
50 +	15.2+	3.0	3.3	3.2
	100.0%	100.0%	100.0%	100.0%

* 15 - 44 year age group

\+ 45+ year age group

beliefs in the universality of marriage and the kinship structure in the rural areas.

The overall decrease-trend observed in the total population, in the proportion of males and females married, and the increase in the age of marriage bear directly upon the reproductive potential of the population. It is evident that there is an association between these parameters and the changes in the size and growth of the population. No document exists on the extent of illegitamacy in the census records, and thus no projection can be made on its effect on family structure.

3.2.6 Age structure

Age is another important feature of the population structure and is very closely related to birth and death rates, marital status and incidence of migration. Table 3.9 presents data on the age structure of the total Shahrestan. The figures indicate a potentially young and growing population in all three periods; ie a population that is reproducing itself with under 50% of the total population in the reproductive age. This age structure is characteristic of the transition period of high birth and death rates, where there are high proportions of young and adult, and lower proportion for those 49 years and older; this situation is conducive to high fertility.

Structural age differences between the sexes as revealed in table 3.10 indicate a higher proportion of males in the prereproductive period (0-14 years), with a higher proportion of females in the reproductive (15-49) years.

Table 3.11 presents figures for the age composition of the urban and rural areas. They indicate a younger population ie (0-14 years) in the rural areas in all three periods; this is

Table 3.10

AGE STRUCTURE BY SEX

Age Groups	1956 Male	1956 Female	1966 Male	1966 Female	1976 Male	1976 Female
0 - 14 yrs	44.6%	44.2%	49.3%	47.5%	47.7%	45.6%
15 - 49	40.7*	40.5*	40.6	42.3	40.9	44.1
50 +	14.7+	15.3+	10.0	10.2	11.4	10.3
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* 15-44 yr age group + 45 + yr age group

Table 3.11

AGE COMPOSITION: URBAN AND RURAL COMPARISON

Age Groups	1956	1966	1976
	(as a percent of population)		
0 - 14			
Nowshahr City	45.3	42.8	44.3
Chalous City	46.0	48.3	43.3
Rural	44.4	49.0	47.9
Places 5000+	51.5	-	-
15 - 49			
Nowshahr City	41.1	49.3	47.2
Chalous City	42.9	43.9	47.1
Rural	40.5	40.2	40.6
Places 5000+	40.1	-	-
50 +			
Nowshahr City	13.6*	7.9	8.5
Chalous City	11.1*	7.8	9.6
Rural	15.1*	10.8	11.5
Places 5000+	8.4*	-	-

* 45 + yr age group

mainly because of higher fertility and more desire for births, and partly due to improved health standards and fewer deaths among infants and children. Another important cause for the young age composition is the rural exodus of those aged mainly in the age group of (15-64), thus increasing the proportion of under 15 years. The urban areas show a higher proportion in the reproductive age group in all three periods; this is again a reflection of the migration pattern within the Shahrestan, ie a higher proportion of emigrants from the rural area is in the age group (15-49 years), resulting in the variation observed between the urban and rural areas. According to Smith and Zpoff (1970), the age pyramid in the rural areas shows an indentation at ages near the middle of the scale where large numbers move to the urban centres, while in the urban areas there will be a bulge in that age group.

The median ages in the total population in 1956, 1966 and 1976 were 19.2, 15.7 and 16.4 years respectively. This is yet another indication of a young population that is becoming older. No figures are available for the urban and rural areas separately, but it is expected that the median age will be lower in the rural areas, for the reasons explained above.

The urban and rural differences in age structure reveal different socio-economic status, level of development and urbanization and social and traditional customs in terms of marital status, age at marriage and fertility.

3.2.7. Sex ratio

The sex ratio has a direct influence upon the various demographic processes in the population, and variability in this parameter bears upon the mating structure. At birth, boys are more numerous than girls, and this initial excess is later balanced by higher mortality among males than females, thus leading to an expected ratio of 100. Deviation from this balance is caused by differential mortality and migration by sex.

Iran generally has a high sex ratio, due mainly to high immigration of skilled workers, and possibly a high maternal death rate in the rural areas. Table 3.12 presents figures on the sex ratio of Shahrestan Nowshahr. The ratio reveals more males than females in all three periods, with a widening of the gap in the 1966-1976 intercensal period. Both Chalous and Nowshahr cities show a higher ratio than the rural areas. Further analysis by age-groups indicates a higher ratio in the (0-14) age groups, except for the 1976 period (Table 3.13). The variance observed in the sex ratio in terms of age groups are a by-product of both migration and birth and death rates. If migration is minor, then the imbalance is influenced by birth and death rates, ie where both birth and death rates are high, higher ratios and percentages of young individuals may then be expected. If both birth and death rates are low, then a lower ratio and an older population will be found. Other than these two factors, migration will be the major force determining the proportion of the sexes in the population: immigration will increase the sex ratio, while emigration will lower the ratio.

The higher sex ratio in the urban areas is caused mainly by the increased immigration of young men from the rural areas, with a consequent decrease in the sex balance of the latter area. Some other causes for the imbalance may be due to high maternal death rates or undernumeration of females in the rural areas (Firoozi, 1977).

Table 3.12

SEX RATIO IN SHAHRESTAN NOWSHAHR: URBAN/RURAL COMPARISON

per 100 females

Area	1956	1966	1976
Nowshahr City	108.2	113.6	107.5
Chalous City	107.3	105.9	107.5
Rural	104.3	101.5	99.9
Towns with 5000+ hab.	103.8	-	-
Total Area	104.4	104.2	102.0

Table 3.13

POPULATION OF SHAHRESTAN NOWSHAHR BY AGE GROUP AND SEX RATIO

per 100 females

Age Groups	1956	1966	1976
0 - 14 yrs	105.2	107.4	106.6
15 - 49	104.7	96.6	105.5
50 +	99.7	102.6	113.5

3.2.8 Family size and type

Differential family size is a consequence of differential fertility as observed in the urban and rural areas, in addition to the other demographic variables associated with it. Family size is a measure of the number of children per married couple, and this could further be subdivided into the number of children ever born and the number surviving. Family size is affected by the average age at marriage, trends in marriage rates, alteration in the sex balance, trends in divorce and widowhood, age composition, mortality features and proportion of offspring reaching adulthood; other factors are socio-economic, such as class differentials, medical advances and subsistence patterns.

In the census there are no figures for 'family size', and instead 'household size' has been taken to represent it. Although there is a distinction between the two, and the latter does not necessarily involve kinship, and also does not take into account completed family size and those members who have left the family, it could be taken as an approximate representation. This is further supplemented by the concept of nuclear and extended family type.

Table 3.14 presents figures for the trends in household size in Shahrestan Nowshahr. There is no variation in this parameter temporally in the total Shahrestan, but there are differences between the urban and rural areas. Both cities in the urban areas show a decrease, while in the rural area an increase is observed; this increase is in accordance with the better health standards, resulting in lower infant and maternal death rates. In general, both fertility and family size is in total decline in Iran, but they are usually lower in the urban areas (Population Growth Survey of Iran, 1976; Paydarfar, 1977).

Table 3.15 presents data on the distribution of family type in Shahrestan Nowshahr. The 'nuclear family' is defined as a unit composed of a husband, wife and children, while the 'extended family' defines a household in which some relatives live with the nuclear family under one roof. The nuclear family type appears to be increasing in the total area, but there is variation in between the two areas. The rural area shows a higher proportion of extended families, but this is also in decline.

The higher proportion of extended families in the rural area is again determined by the agricultural subsistence pattern, and the social and tradional customs; these in turn have consequences on the mating pattern of the population in terms of kin marriages and consanguinity. The overall decline of extended families is mainly the outcome of socio-economic changes, agrarian reforms and development, and it is characteristic of the transitional phase, with the consequent changes in the family structure.

3.2.9 Migration

Another component of population change in size and composition is the amount of inflow and outflow of migrants. Migration could also be selective in terms of sex, age, marital status and other social and cultural factors. Iranian migration data are available only in the form of lifetime migration. In the first census, the location of origin and destination of migrants is defined and population interchange between contiguous and non-contiguous areas can be tabulated; in the second census,

Table 3.14

AVERAGE HOUSEHOLD SIZE

Area	1956	1966	1976
Nowshahr City	5.2	5.4	5.0
Chalous City	-	5.2	5.0
Rural	5.4	5.4	5.6
Total Area	5.4	5.4	5.4

Table 3.15

DISTRIBUTION OF FAMILY TYPE

Area	Year	Nuclear	Extended	Total
Nowshahr City	1966	91.4%	8.6%	100.0%
	1976	90.4	9.6	100.0
Chalous City	1966	90.6	9.4	100.0
	1976	91.4	8.6	100.0
Rural	1966	86.1	13.9	100.0
	1976	87.5	12.5	100.0
Total Area	1966	87.1	12.9	100.0
	1976	88.5	11.5	100.0

the birthplace of the migrants is not given, while age and sex of the migrants are stated to examine migration differentials; in the third census these deficiencies are covered. It is evident that comparative analysis between the three periods is not possible. In general, internal migration within Iran has been very high due to rapid increases in urbanization, industrialization and the transfer of labour from the rural to the urban areas (Hemassi, 1974).

Table 3.16 presents figures and percentages for the number of migrants to Shahrestan Nowshahr, in addition to accounting for migrational differences in terms of sex and residence. It is evident that immigration has been more intense in the urban areas, except for the 1956 period, where the urban-rural division was not so distinguishable. Male migrants are also more numerous than their female counterparts in both the 1966 and 1976 periods.

One way of looking at the extent of migration within an area is to examine the population in terms of birthplace composition (Table 3.17). The proportion of migrants in the total area seems to have decreased , but the trend is not linear. In both Chalous and Nowshahr cities the same decreasing trend of immigration is observed, which could be a reflection of more internal migration; the rural areas show a decrease in the 1956-1966 period, which is quite substantial, but in the next intercensal period a slight increase is observed. The proportion of migrants has been highest in the urban areas, with a ratio close to one, while the rural areas present a population composed mainly of indigenous inhabitants, with a ratio of 90 to 10.

Table 3.16

TOTAL MIGRATION INTO SHAHRESTAN NOWSHAHR

Type		1956	1966	1976
MALE	Immigrants	-	8983	12114
	Urban proportion	-	64.5%	60.4%
	Rural proportion	-	35.5%	39.6%
FEMALE	Immigrants	-	7636	10604
	Urban proportion	-	64.8%	64.5%
	Rural proportion	-	35.2%	35.5%
TOTAL	Immigrants	12942	16619	22718
	Urban proportion	11.2%	64.7%	62.3%
	Rural proportion	88.8%	35.3%	37.7%

Table 3.17

DISTRIBUTION OF MIGRANT AND NON-MIGRANT POPULATION BY AREA

Area		1956	1966	1976
URBAN				
Nowshahr City:	Migrant	53.5%	47.4%	34.3%
	Non-Migrant	46.5	52.6	65.7
		100.0	100.0	100.0
Chalous City:	Migrant	-	41.4	33.2
	Non-Migrant	-	58.6	66.8
		-	100.0	100.0
RURAL	Migrant	14.7	7.2	8.2
	Non-Migrant	85.3	92.8	91.8
		100.0	100.0	100.0
TOTAL AREA	Migrant	16.0	15.1	15.5
	Non-Migrant	84.0	84.9	84.5
		100.0	100.0	100.0

Migrational differences between the urban and rural areas are a reflection of population growth and the expansion of the towns. Before the 1930's, both Nowshahr and Chalous cities were small villages, having little communication with other parts of the country. It was the major developments in the agriculture and industrial section of Mazandaran that transformed these villages into economically active centres. Nowshahr city, formerly known as Habibabad, became a harbour town between 1933-1940, where items such as rice, tobacco, fish, caviar, cotton, silk, sugar, tea, timber and citric fruits were exported; it also became an attractive resort area. Chalous city also underwent transformation, specifically when the Textile Industry functioned; it also became important in terms of trade in timber. Presently it is one of the centres of commerce and agriculture.

These economic and industrial developments were mainly the consequences of the construction of roads, bridges and tunnels across the Alborz as well as along the coast, land clearance, intense cultivation and agricultural production. These resulted in the expansion of the villages into market centres and provided most of the social facilities, including schools, hospitals and employment. These changes had a major impact on the growth of the population. A similar trend may also be visible in the villages of Marzanabad, Alamdeh and Hassankief, where the population is expanding and becoming a focal place for the immigration of the more isolated and rural population.

According to Bharrier (1977), before 1956 the number of villages increased faster than the number of towns (due partly to the settlement of nomads) while the growth of some towns was for the most part due to migrants from other towns; in the decades following, the number of towns increased faster than the number of villages mainly because rural migration to the urban areas increased.

In general, internal migration within Iran has been mainly one-directional, that is from the rural to the urban places. The main 'push factor' in migratory terms is found in the rural, agricultural areas, where there is a decline in agricultural productivity, an increase in mechanization and land reform and distribution. In the urban centres, the 'pull factors' are found, where opportunities for better health, jobs, wages and education are provided. The effects of such migrations has also affected the population distribution; the urban/rural ratio has changed, and consequently resulting in the differences in population growth of the urban and rural areas, ie growth would be substantially lower in the rural areas in spite of high fertility and higher in the urban areas due to intense immigration.

3.2.10 Origin of migrants

Table 3.18 presents figures on the place of birth of immigrants in Shahrestan Nowshahr. It is evident that the origin of migrants are mainly from provinces other than Mazandaran, where the study area is located; only a small fraction of the migrants are from the other shahrestans of same province, therefore inter-provincial migration has been higher than inter-shahrestan migration. A further analysis examines rural-urban differences in terms of migrants (Table 3.19), and the same trend is observable although the differences in the proportion between the same and other provinces is significantly different. See also Figures 3.2 and 3.3.

Table 3.18

BIRTHPLACE DISTRIBUTION OF IMMIGRANTS

Birthplace	1956	1966	1976
Same Province	5.2%	2.8%	3.8%
Other Provinces	10.5	11.1	11.5
Foreign	0.3	1.2	0.2
Total	16.0%	15.1%	15.5%

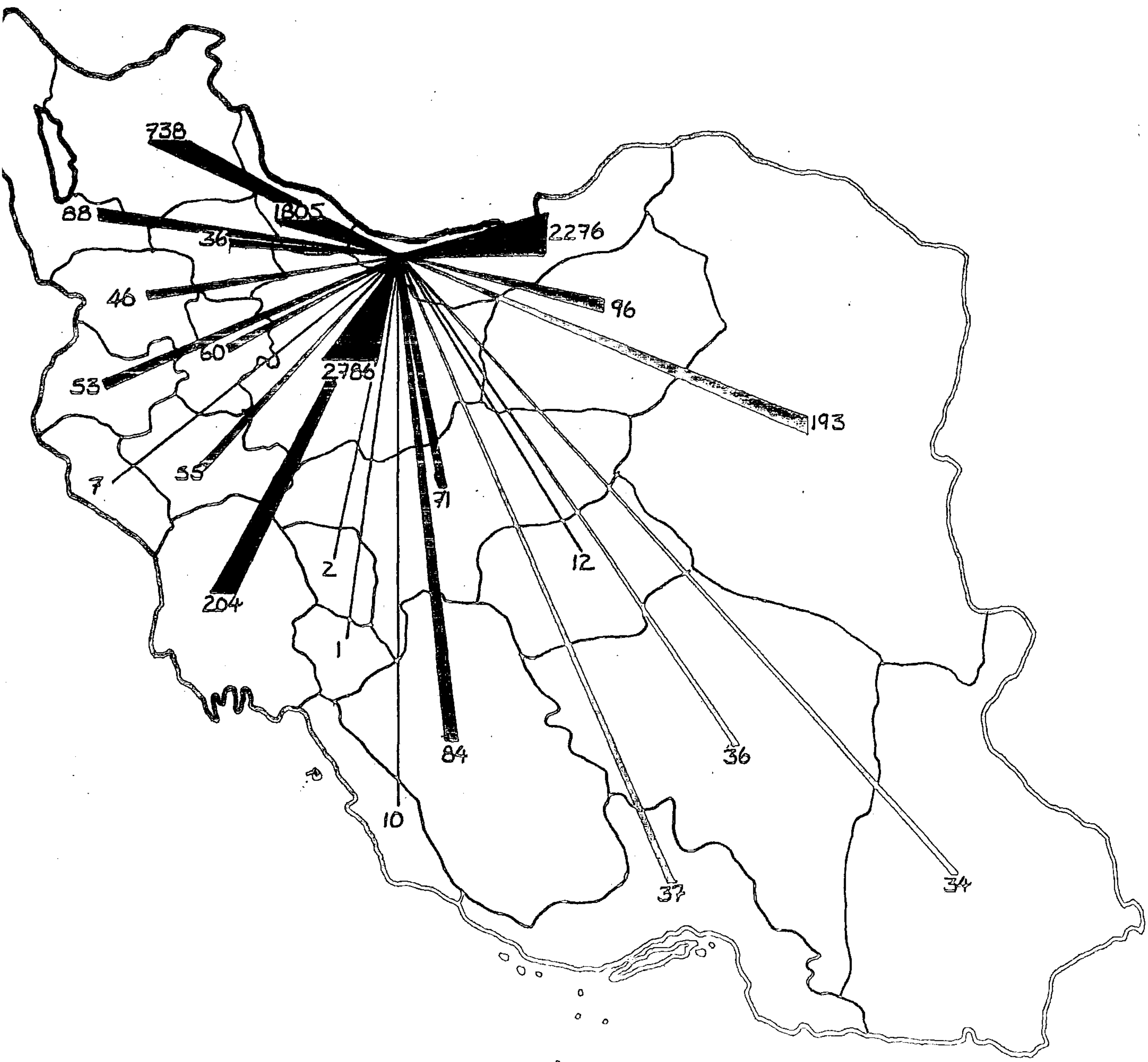
Table 3.19

BIRTHPLACE DISTRIBUTION OF IMMIGRANTS:
AN URBAN/RURAL COMPARISON

Area	Birthplace	1956	1966	1976
NOWSHAHR CITY	Same Province	12.3%	9.5%	7.2%
	Other Provinces	40.0	37.1	26.9
	Foreign	1.2	0.8	0.2
	Total Migrants	53.5%	47.4%	34.3%
CHALOUS CITY	Same Province	-	6.5%	6.3%
	Other Provinces	-	34.8	26.8
	Foreign	-	0.1	0.1
	Total Migrants	-	41.4%	33.2%
RURAL	Same Province	4.1%	2.8%	2.6%
	Other Provinces	10.5	4.4	5.4
	Foreign	0.1	0.0	0.2
	Total Migrants	14.7%	7.2%	8.2%

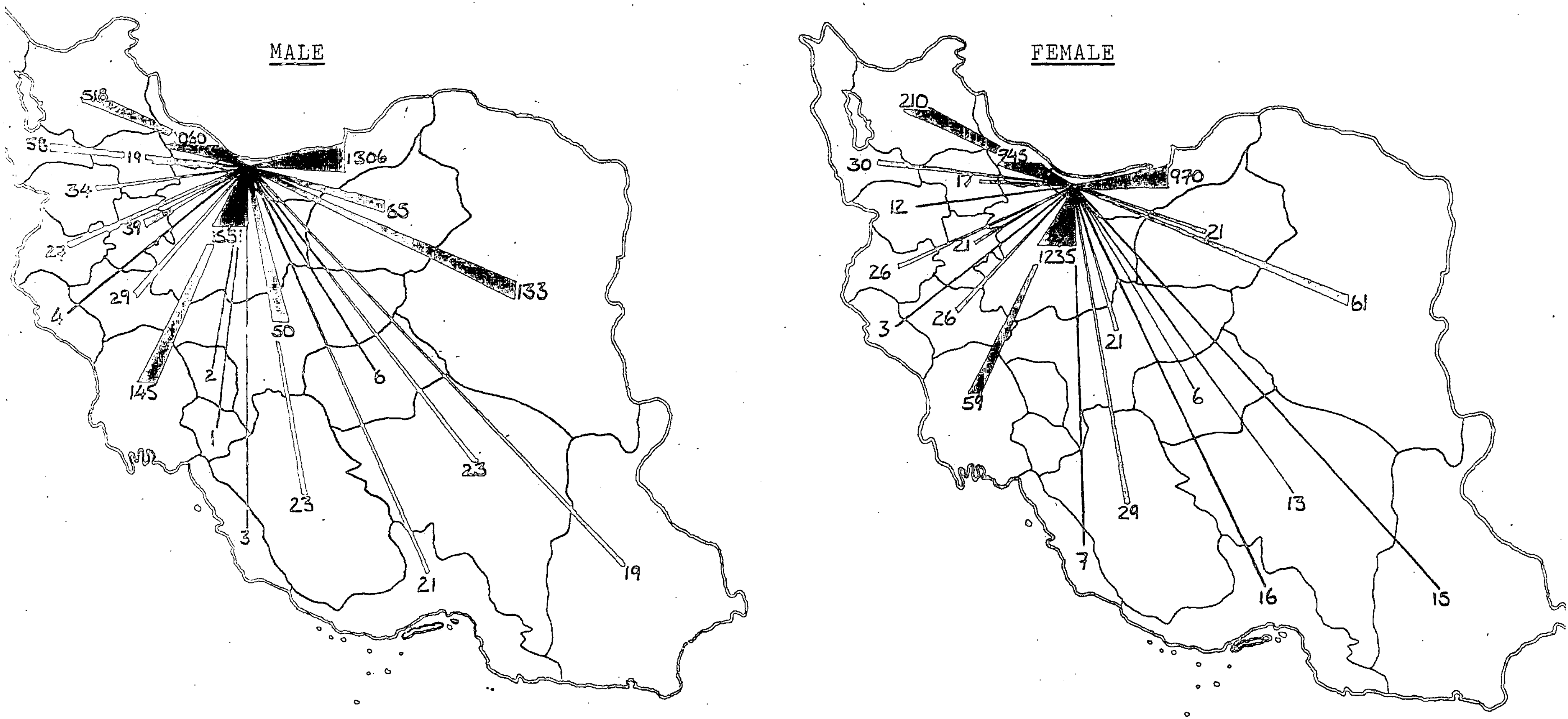
Figure 3.2

ORIGIN OF MIGRANTS TO SHAHRESTAN NOWSHAHR IN 1971, BOTH SEXES



Source: Based on the 1976 Census.

Figure 3.3 ORIGIN OF MIGRANTS TO SHAHRESTAN NOWSHAHR IN 1971, BY SEX



Source: Based on the 1976 Census.

Both Chalous and Nowshahr cities show a decrease in the number of migrants between 1956 and 1976.

A further analysis examines the locations in 'other provinces' (Table 3.20). The highest proportion of immigrants are from the province of Gilan in 1956 and 1976, followed by Mazanadaran, Markazi and East-Azarbaijan. There is variation in the proportion between the two periods: according to the 1976 census, the migrants from Gilan have increased, with a subsequent decrease from Mazandaran and Markazi. The proportion from all other provinces has also increased. The overall pattern presents migration mainly from the contiguous provinces of Gilan and Markazi (See Fig. 1.1), in addition to a high proportion from the same province. A male/female comparison reveals a fractionally higher proportion of female immigrants, but the difference is not significant (Table 3.21).

During the five years prior to the last census, ie in 1971, 9074 persons, which is 6.1% of the total population, living in the Shahrestan were immigrants (Table 3.22). Of these, 59.2% were males and 40.8% were females. The highest number of migrants originated from the province of Markazi, followed by Mazandaran, Gilan and East-Azarbaijan. This pattern was similar for both sexes. The females constituted more migrants from the contiguous provinces, while a higher proportion of males came from more distant places. There are no figures for urban-rural differences and therefore no analysis is possible.

An age analysis of the migrants revealed a higher proportion of migrants in the (10-29 years) age group for both sexes. In the older age groups, which showed a decreasing percentage

Table 3.20

ORIGIN, BY PROVINCE, OF MIGRANTS INTO SHAHRESTAN NOWSHAHR

Province	1956	1966	1976
Total immigration	12873	16619	22718
Mazandaran	32.3%	-	24.3%
Gilan	37.4	-	40.2
Markazi	20.3	-	17.3
Azarbaijan-e-Shargh	6.4	-	6.7
Others	3.6	-	11.4
Total	100.0%	100.0%	100.0%

Table 3.21

PROVINCIAL ORIGIN OF MIGRANTS INTO SHAHRESTAN NOWSHAHR BY SEX

Province	Both	Male	Female
Mazandaran	3.8%	3.7%	3.8%
Gilan	6.2	6.2	6.2
Markazi	2.7	2.9	2.5
Azarbaijan-e-Shargh	1.0	1.4	0.7
Others	1.8	2.1	1.4
Total	15.5%	16.3%	14.6%

Table 3.22

PROVINCIAL ORIGIN OF MIGRANTS INTO SHAHRESTAN NOWSHAHR IN 1971 BY SEX

PROVINCE	Male	Female	Both
Total immigration	5372	3702	9074
Mazandaran	24.3%	26.2%	25.1%
Gilan	19.7	26.2	19.9
Markazi	28.9	33.4	30.7
Azarbaijan-e-shargh	9.6	5.7	8.0
Others	17.5	14.6	16.3
Total	100.0%	100.0%	100.0%

Table 3.23

AGE COMPOSITION OF MIGRANTS INTO SHAHRESTAN NOWSHAHR

Age groups	Male	Female	Both
5 - 9 years	12.1%	17.4%	14.3%
10 - 19	25.5	24.2	25.0
20 - 29	34.8	36.4	35.4
30 - 39	15.5	11.7	14.0
40 - 49	7.5	4.5	6.3
50 - 59	2.8	2.9	2.8
60 +	1.8	2.9	2.2
Total	100.0%	100.0%	100.0%

Table 3.24

CRUDE DEATH RATES IN IRAN BY SEX (per thousand)

	Urban	Rural
Male	6.50	10.20
Female	5.60	9.90
Both	6.06	10.04

Source: Nehaptian and Khazaneh, 1976.

with age, the males constituted more of the migrants (Table 3.23). Other parameters such as marital status, occupation and ethnicity could further delimit the demographic range of the migrants, but data were not available in the census. Differences in the demographic parameters in terms of migration could not be tabulated separately for the urban and rural areas.

Some generalizations about the characteristics of the migrants are possible: the intermediate age groups constitute the bulk of the migrants to the Shahrestan; the proportion of male migrants is higher than that of the female; the propensity to migrate over long distances is more evident for males; and that distance is an influential element, whereby migration more frequently takes place between contiguous provinces.

Hemmasi's (1974) thorough analysis of migration in Iran confirms some of the results obtained from the analysis of Shahrestan Nowshahr. His study reveals some important characteristics of migration in Iran, particularly that the motives for migration are very much influenced by the structural characteristics of the places of origin and destination (the pull and push factors), resulting in consequent rural depopulation and urban overpopulation. His study also reveals migration differentials in terms of socio-economic status and family structure, ie migration has a family orientated structure.

3.2.11 Mortality

Systematic indices of mortality in the smaller population units in Iran are not available. In general, mortality is decreasing throughout the country, but with large differences between the urban and rural areas (Demography and Vital Statistics in Iran, 1976). Mortality differences are much higher than fertility differences, this being a reflection of the socio-economic conditions prevailing in the urban and rural areas. According to Nehaptian and Khazaneh (1976), raw death rates in the urban area is only 60% that of the rural area, but they also emphasize differences in the age structure and migration pattern of the two areas (Table 3.24). The total mortality index in the province of Mazandaran in 1976 was 9.6 (7.5 in the urban, and 10.1 in the rural), (Population Growth Survey of Iran, 1976). Mortality is in general higher among the very young and in both areas the highest death rates are found in infants in (1-4) years age group, but the difference decreases with the older age groups. Infant mortality is more frequent in the rural areas, specifically those under one year: in the urban area for every 1000 births, only 62 die, while in the rural this figure is doubled to 120 (Nehaptian and Khazaneh, 1976). Infant mortality in Mazandaran is reported to be 75.6 in the urban section and 130.0 in the rural (Population Growth Survey of Iran). Differential mortality in terms of sex indicates that female mortality is higher than male mortality in the rural area and this is mainly due to higher maternal deaths. The main causes of deaths are primarily infective and parasitic diseases, of which the most important is hookworm in Shahrestan Nowshahr; circulatory, respiratory and digestive disorders are other causes of deaths.

3.2.12 Summary

A comparative analysis of the 1956, 1966 and 1976 censuses of Shahrestan Nowshahr indicates a changing pattern in the structure and composition of the population, and the trend conforms to the demographic generalization of the 'Transition Period'. The total population has increased very rapidly in size but the urban-rural analysis reveals a heterogeneous trend in the growth, whereby the urban areas show the highest rate, while the rural areas show varying changes in conjunction with their localities and the extent of their isolation from main roads and vicinity to large centres of social and economic activities. The effective growth rate for Mazandaran has been estimated at 3%: 4.5% for the urban and 2% for the rural (Plan and Budget Organization, 1976).

Both family structure and migration patterns have been analyzed to explain the observed trends and the differences between and within the areas. Fertility rate shows a declining trend throughout the three periods in the total population in conjunction with lower proportions of married individuals and a decline in early marriages in both sexes, but differences are observed in these parameters between the urban and rural areas. Family size shows an increase in the rural areas, which is a reflection of lower mortality and of an increase in survival rates of infants and children. There is also evidence of an increase in nuclear families, but extended families remain more frequent in the rural areas. The sex ratio is different between the two areas mainly because of rural emigration. The age structure indicates a young population with the highest proportion in the pre-reproductive period; the trend is one of increase in the productive age group and a higher median age, reflecting the trend in the conjugal and family structure. Both the urban and rural areas show differences in the age composition and this is the result of the migration pattern.

Migrational analysis reveals that immigration and admixture has been substantially higher in the urban areas, but the overall trend of migration to Shahrestan Nowshahr is decreasing. The origin of migrants are mainly from the same or adjacent provinces of Gilan and Markazi. This pattern is similar for for both urban and rural areas. Migrational differences in terms of sex and age reveal more male migrants over longer distances, and the highest proportion of migrants are found in the (20-29) years age group.

Since there are no periodic indices on birth and death rates in the study area, direct estimates of the contributory components of fertility (natural growth) and migration to the overall increase in population size has not been possible; it is only through the above-discussed demographic parameters that one can speculate about the main causes for the changes. In general it appears that Iran is in the period of transition from high birth and death rates to lower rates, in addition to intense within-country migration. In accounting for fertility and mortality differences between the urban and rural areas it can be assumed that in the rural areas higher fertility could have been conducive to increased natural growth, but high mortality and emigration must also be accounted for, hence the slower rate of growth for the rural areas.

Population growth has been mainly attributed to migration as a consequence of regional agricultural and socio-economic developments, increase in communication networks, expansion of towns and villages and increased urbanization. These in turn have altered the population composition in terms of age, sex, family structure and ethnic composition.

3.3 PRESENT DEMOGRAPHIC FEATURES

3.3.1 Samples

The present demographic analysis is based upon the data collected during the field-work, and mainly covers aspects of the composition of the population in terms of the reproductive potential of the women, family size and birthplace origins of the inhabitants within Shahrestan Nowshahr. The data on the demographic parameters of each individual are not complete, and factors such as sex and age structure cannot be assessed very accurately since they do not cover all the co-existing generations. The data were collected from 1047 households; of these 495, 303 and 249 are from Bakhsh Markazi, Chalous and Kelardasht respectively.

3.3.2 Sex and age structure

A total of 11996 samples were examined in terms of sex composition, ie 6043 males and 5953 females, yielding a ratio of 101.5 for the total population. The age structure presented in table 3.25, indicate that 29.8, 61.3 and 8.8% of the population are in the age groups of (0-14), (15-49) and (50+) years respectively. These figures do not correspond to the census results and are not characteristic of a young population that is reproducing itself. The highest percentage of individuals are in the age groups of (15-19) and (10-14) respectively for both males and females. The mean and mode for the total area is 24 and 16 years respectively. The causes for the observed discrepancy, ie a low proportion in the pre-reproductive age groups, is mainly due to the fact that the data do not cover information on the age structure of the children of the

Table 3.25

AGE STRUCTURE BY SEX

Age Groups	Males	Females	Sex unknown	Total
0 - 4 yrs	200	159	1	360
5 - 9	322	327	6	655
10 - 14	671	629	15	1315
15 - 19	810	882	18	1710
20 - 24	483	464	11	958
25 - 29	266	265	10	541
30 - 34	144	214	3	361
35 - 39	120	258	1	378
40 - 44	172	212	1	385
45 - 49	258	201	0	459
50 - 54	175	127	0	302
55 - 59	129	60	0	189
60 - 64	115	26	0	141
65 - 69	25	3	0	28
70 - 85	29	1	0	30
Total	3919	3828	66	7813
Mean	25.0	23.2	-	24.0
Mode	18.0	15.0	-	16.0

DISTRIBUTION

Age Groups	Males	Females	Both	Sex Ratio
0 - 14 yrs	30.4%	29.1%	29.8%	107.0
15 - 49	57.5	65.2	61.3	90.3
50 +	12.1	5.7	8.8	218.0
Total	100.0%	100.0%	100.0%	102.4

respondents' siblings; this inevitably has resulted in the under-enumeration of the younger population. The grandparental generation has not been included either, thus both factors have resulted in the over-representation of the reproductive age-groups. Further analysis in the three subdivisions has not been done due to the misrepresentation of the sampling.

3.3.3 Family structure

Table 3.26 presents data on the distribution of married individuals (both males and females) within specific age groups. The figures indicate that the highest proportion of married females are in the age group of (15-19), while for the males it is in the age group of (20-24). In general, 94.5% of females have been married before the age of 25, while 87.7% of the males have married before the age of 30. This same trend is observable when the analysis considers the place of birth of the inhabitants, ie within the individual Bakhshes.

The average age at marriage for females is 17.8 years, and for the males it is 24.4 years. Differences of one year are observed in a further analysis of the subdivisions (Table 3.27). These indices are very similar to the average age at marriage of the country as a whole (See Table 3.8c). Differences between the three Bakhshes are not expected to be very high because they mainly comprise the rural area, and more samples are needed to detect for any variation between the urban and rural areas.

Age disparity has also been calculated between the spouses (Table 3.28). An average of 7.4 years is observed between the husbands and wives. Bakhsh Chalous indicates a smaller number

Table 3.26

PROPORTION OF MARRIED FEMALES WITHIN SPECIFIC AGE GROUPS

Age Groups	Samples born in Shahrestan Nowshahr	Bakhsh Markazi	Bakhsh Chalous	Bakhsh Kelardasht	Total Samples (all birth-places)
Total in Sample	385	168	51	166	627
10 - 14 yrs	16.2%	20.2%	9.8%	13.8%	16.2%
15 - 19	57.2	53.5	74.3	56.0	55.4
20 - 24	23.5	24.5	11.9	26.0	22.9
25 - 29	2.3	1.2	4.0	3.0	4.3
30 - 34	0.8	0.6	0.0	1.2	1.0
35 - 39	0.2	0.0	0.0	0.0	0.2
Minimum age	12	12	13	12	12
Maximum age	30	30	26	30	35

PROPORTION OF MARRIED MALES WITHIN SPECIFIC AGE GROUPS

Age Groups	Samples born in Shahrestan Nowshahr	Bakhsh Markazi	Bakhsh Chalous	Bakhsh Kelardasht	Total Samples (all birth-places)
Total in Sample	398	180	42	176	650
15 - 19 yrs	16.6%	16.1%	23.9%	15.4%	14.7%
20 - 24	41.2	44.3	33.1	41.0	40.7
25 - 29	29.9	27.3	33.4	31.6	32.3
30 - 34	5.9	5.6	7.2	6.2	6.7
35 - 39	3.9	4.5	2.4	2.9	3.3
40 - 44	1.9	1.7	0.0	2.3	1.6
45 - 49	0.3	0.0	0.0	0.6	0.5
50 +	0.3	0.6	0.0	0.0	0.2
Minimum age	15	15	15	15	15
Maximum age	52	52	39	45	52

Table 3.27

MEAN AGE OF SPOUSES AT MARRIAGE (YEARS)

	Samples born in Shahrestan Nowshahr	Bakhsh Markazi	Bakhsh Chalous	Bakhsh Kelardasht	Total samples (all birth-places)
HUSBANDS	398	180	42	176	651
Mean	24.2	24.2	23.5	24.4	24.4
Standard Deviation	5.5	5.6	5.5	5.5	5.4
WIVES	385	168	51	166	627
Mean	17.5	17.2	17.4	17.9	17.8
Standard Deviation	3.2	3.2	2.8	3.4	3.7

Table 3.28

AGE DISPARITY (IN YEARS) BETWEEN SPOUSES

	Samples born in Shahrestan Nowshahr	Bakhsh Markazi	Bakhsh Chalous	Bakhsh Kelardasht	Total samples (all birth-places)
TOTAL	487	206	28	219	870
Mean	7.2	7.4	5.1	7.4	7.4
Standard Deviation	6.2	5.7	4.7	6.6	6.2

of years between the spouses, and this could be due to small number of samples or a tendency to choose mates with smaller age disparity. Nehaptian and Khazaneh (1976), observed a difference of 6 years between the spouses in both rural and urban areas in Iran; in another Iranian survey, age difference between the males and females were found to be an average of 8.3 years (8.5 in the urban areas, and 8.2 in the rural areas) (Population of Iran, 1976).

The reproductive potential of the females, family size and infant and child mortality has been examined in Shahrestan Nowshahr. This analysis that like for conjugal status has been attempted for one generation only, ie the respondents' mothers. The mean number of births per female in the Shahrestan, and in the three Bakhshes are presented in Table 3.29. The results show an average of 7.5 births per female in the total area. In the subdivisions different averages are observed, in addition to different variances. Bakhsh Chalous shows the smallest number of births, while Bakhsh Markazi and Kelardasht show larger averages. Since females' reproductive potential varies with age, the average number of births has also been tabulated in five year intervals, giving information on the females's completed family size. Differences are observed between the Bakhshes in the number of children at each interval.

In order to distinguish between the number of children born and the number that survive, the data have been examined only on the number of children alive (Table 3.30). The figures indicate an average of 6.2 children per female, which also indicates the extent of child mortality. For females who are

Table 3.29

MEAN AVERAGE NUMBER OF BIRTHS PER FEMALE

Age Groups	Samples born in Shahrestan Nowshahr	Bakhsh Markazi	Bakhsh Chalous	Bakhsh Kelardasht	Total samples (all birth-places)
FEMALES	618	273	72	273	971
CHILDREN	4844	2098	529	2203	7298
25 - 29 yrs					
Mean	3.3	3.5	3.0	0.0	3.4
Variance	0.3	0.5	0.0	0.0	0.3
30 - 34 yrs					
Mean	6.0	5.9	4.7	6.2	5.8
Variance	3.6	3.9	2.3	3.4	3.4
35 - 39 yrs					
Mean	6.8	6.7	6.5	7.2	6.6
Variance	3.6	3.8	4.1	2.9	4.4
40 - 44 yrs					
Mean	7.8	8.0	7.0	7.9	7.4
Variance	3.8	2.7	4.7	4.4	4.9
45 yrs +					
Mean	8.9	8.9	8.4	8.9	8.6
Variance	5.0	5.9	5.4	4.1	5.4
ALL AGES					
Mean	7.8	7.7	7.3	8.1	7.5
Variance	5.4	5.9	5.8	4.7	5.9

born in Shahrestan Nowshahr, ie excluding the migrants, the figure is 6.4. Bakhsh Kelardasht shows the highest figure of 6.6, in conjunction with high number of children. From Table 3.30 it is observed that on average a female will have 6.8 children by the time she has reached 45 years; the figure for those born in the Shahrestan is 6.9, and for the three bakhshes of Markazi, Chalous and Kelardasht they are 6.7, 6.9 and 7.2 respectively. Differences in these figures are indicative of differential behaviour in reproduction but they are not substantially different. Significant differences are found between the rural and urban areas in reproductive potential and these are mainly the result of differential age at marriage and number of years of married life. Nehaptian and Khazaneh, (1976), observed that in the rural areas of Iran married woman have an average of 9.5 children, while the figure for the urban regions is only 7.6.

The mean number of children dying is presented in Table 3.31. The figures indicate an average of 1.3 for the total population, 1.5 for those born in the Shahrestan and 1.4, 1.2 and 1.6 for Bakhsh Markazi, Chalous and Kelardasht respectively. Infant and child mortality analysis reveals that of both sexes close to 50% of those dying are under five years of age. A male/female comparison reveals more male mortality in the under five year age group, yielding a ratio of 108.8. These results cannot be assessed with total certainty because of the possibility of misreporting and emigration (Table 3.32).

The extent of polygamy has also been examined, and it is observed that males have a higher proportion of multiple marriages, ie 17%, than have females which is only 4% (Table 3.33).

Table 3.30

MEAN AVERAGE NUMBER OF SURVIVING CHILDREN PER FEMALE

Age Groups	Samples born in Shahrestan Nowshahr	Bakhsh Markazi	Bakhsh Chalous	Bakhsh Kelardasht	Total samples (all birth-places)
FEMALES	657	297	75	285	1041
CHILDREN	4190	1829	469	1892	6451
25 - 29 yrs †					
Mean	4.0	4.3	3.0	0.0	3.7
Variance	2.0	2.3	0.0	0.0	1.5
30 - 34 yrs					
Mean	5.1	5.2	4.2	5.1	4.9
Variance	1.6	1.7	0.9	1.6	2.2
35 - 39 yrs					
Mean	5.9	5.7	6.0	6.4	5.7
Variance	3.3	3.5	3.4	2.7	3.8
40 - 44 yrs					
Mean	6.3	6.5	6.3	6.2	6.1
Variance	3.5	4.5	6.4	2.4	4.0
45 yrs + *					
Mean	6.9	6.7	6.9	7.2	6.8
Variance	4.0	4.3	3.8	3.7	4.2
ALL AGES					
Mean	6.4	6.2	6.2	6.6	6.2
Variance	3.9	4.2	4.2	3.4	4.3

* completed family size

† higher values obtained due to smaller sample size than in Table 3.29.

Table 3.31

MEAN AVERAGE NUMBER OF CHILD MORTALITY PER FEMALE

	Samples born in Shahrestan Nowshahr	Bakhsh Markazi	Bakhsh Chalous	Bakhsh Kelardasht	Total samples (all birth-places)
FEMALES	628	276	74	278	985
CHILDREN	879	363	88	428	1246
Mean	1.5	1.4	1.2	1.6	1.3
Variance	2.6	2.3	3.8	2.5	2.3

Table 3.32

INFANT AND CHILD MORTALITY

Age Group	Male	Female	Total
Less than 1 yr	46 (18.4%)	33 (13.6%)	97 (18.4%)
Less than 5 yrs	77 (30.8%)	80 (33.1%)	162 (30.7%)
5 yrs and over	127 (50.8%)	129 (53.3%)	269 (50.9%)
Total	250 (100.0%)	242 (100.0%)	528 (100.0%)

Table 3.33

NUMBER OF MULTIPLE MARRIAGES

Spouse	Number in Sample	Number of multiple marriages 0	1	2	3
HUSBANDS	954	83.5%	7.4%	7.5%	1.5%
WIVES	839	96.0%	2.0%	1.0%	1.0%

Table 3.34

AGE DISPARITY BETWEEN SIBLINGS

Number of Siblings in Sample	4651
Mean Average	2.7 years
Modal Average	2.1 years

A final analysis examines the age disparity between the sibs. Table 3.34, reveals that an average of 2.7 years exists between the ages of the siblings. One would expect that the smaller the average interval between births the larger the final family size tends to be, but this factor is also dependent on other variables such as age at marriage and duration of marriage.

Since the data were distributed to schoolchildren, consequently only married females (respondents' mothers) were accounted for, therefore no account has been made for unmarried females and childless families.

The results obtained from the present analysis do not sufficiently represent the total reproductive perfomance of the population, since they only account for one generation, and it is also not possible to detect any differences between the urban and rural areas, but they do provide relative indices on the essential evolutionary parameters, such as age-specific fertility rates, total fertility, completed family size, mortality rates of children, age disparity between spouses and sibs, and the extent of multiple marriages. These variables are either missing in the census records or alternatively they are difficult to extract.

3.3.4 Birthplace composition

The birth localities of individual members of the family, namely the father, mother, father's father, father's mother, mother's father, mother's mother and all children, in addition to the total family, are presented in Table 3.35. Of those born in Shahrestan Nowshahr, Bakhsh Chalous presents the lowest proportion, mainly because it is the smallest of the three Bakhshes and also because historically it was united with Bakhsh of Kelardasht. Of those born outside the Shahrestan, Ostan of Gilan shows the maximum contribution of 8.8%, followed by the other Shahrestans of Ostan of Mazandaran, 5.7%. Ostan Markazi (Central), comprises almost one half of the non-indigenous inhabitants from all the other parts of Iran. This pattern is similar for all the family members, except for the children, who show much lower values. Individual family members show heterogeneous proportions in their birthplace origins (Table 3.35). The mothers' parents (MF and MM), show higher percentages of those born in the Shahrestan, ie 70.2 and 69.3% respectively, while the fathers' parents (FF and FM) show the least proportions, ie 55.8%. This could be indicative of the fact that males have migrated to this area more frequently than females within the last two generations.

Of the total population, 76.7% were born within the area, and only 23.3% elsewhere. It is mainly the children's birthplaces that contributes to this high proportion, followed by the mothers' parents. There is not much difference between the father's and mother's percentages of locally born (Table 3.36). The proportion of locally born people to those born elsewhere appears to be lower than the 1976 census results, which indicates 85.5%; this might be due to the lack of reporting on the respondents' children birthlocalities, or else the samples do not cover the more isolated regions where the extent of migration might well be much less. A final assumption is that more people have migrated to the Shahrestan within the last six years.

Table 3.35

DISTRIBUTION OF BIRTHPLACE ORIGINS OF INDIVIDUAL MEMBERS WITHIN THE SURVEYED FAMILIES OF SHAHRESTAN NOWSHAHR

Area	F	M	FF	FM	MF	MM	CH	TOTAL
Number in Sample	1044	1037	980	974	613	607	7340	12595
Bakhsh Markazi	28.5%	28.9%	24.9%	25.8%	32.5%	32.9%	36.6%	33.2%
Bakhsh Chalous	6.1	7.2	3.1	2.8	2.0	1.8	22.9	15.1
Bakhsh Kelardasht	28.2	27.6	27.8	27.2	35.7	34.6	27.6	28.4
Ostan Mazandaran	6.7	7.7	8.7	8.9	8.0	8.8	4.1	5.7
Ostan Gilan	18.1	18.0	19.7	20.8	11.4	10.7	2.8	8.8
Ostan Markazi	4.2	4.4	5.4	4.9	3.3	3.8	3.7	4.0
Other Ostans	8.2	6.1	10.4	9.6	6.8	7.1	2.2	4.7
Foreign	0.0	0.0	0.0	0.0	0.3	0.3	0.1	0.1
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 3.36

RATIO OF THOSE BORN IN SHAHRESTAN NOWSHAHR TO ELSEWHERE

Area	F	M	FF	FM	MF	MM	CH	TOTAL
Shahrestan Nowshahr	62.8%	63.7%	55.8%	55.8%	70.2%	69.3%	87.1%	76.7%
Elsewhere	37.2	36.3	44.2	44.2	29.8	30.7	12.9	23.3
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

F = Father
M = Mother
FF = Father's Father
FM = Father's Mother
MF = Mother's Father
MM = Mother's Mother
CH = Children

3.3.5 Migrants

The localities providing the majority of migrants are similar to those observed in each of the three censuses, ie migrants entering the Shahrestan are mainly from the provinces of Mazandaran, Gilan and Markazi. This pattern and orientation of movement reveals the importance of geographic elements and roadway network in controlling the origin of migrants. these proportions also parallel those of the census results, which indicate more inter-provincial than inter-shahrestan mobility, ie within Ostan Mazandaran. These similarities indicate the extent to which the samples represent the total population.

In order to examine more precisely the exact locations of the migrants since provinces are large territories encompassing many shahrestans, the data have been analysed to locate the specific ostans and shahrestans (Table 3.37a, b). The first point to recognize is that all the provinces of Iran have contributed to the total migrants, although the porportions are very low compared with the three major localities.

An analysis at the Ostan level indicates that Ostan Azarbaijan (in N.W Iran) comprises the highest proportion of the non-contiguous provinces (1.8%) from a total of 4.7%, This is followed by Ostan Khorassan (in N.E Iran) with 1.2%, all the remainder being less than 1.0%. The individual family members show more varied proportions of migrants from Azarbaijan than from Khorassan. In the former, male parents show a higher proportion than female parents. In general, the pattern of mobility between Sh. Nowshahr and other Ostans (even at a second level) reveals a unidirectional, linear pattern of movement across the northern borders of Iran along the northeast and northwest axis.

Although the Ostans of Mazandaran, Gilan and Markazi are the largest contributors to the population of the Shahrestan, it is necessary to consider from which shahrestans within each ostan the migrants originate. The shahrestans of Ostan Markazi have not been analysed since the majority originated from the capital, Tehran, followed by Shahrestan Karaj, which borders on Nowshahr. The total contribution from Markazi is an average of 4.0%, but the actual percentages vary between the family members. Analysis of the two other main ostans, Mazandaran and Gilan, reveal a varied proportion of contributions from individual shahrestans within the ostans. From Gilan, the shahrestans near to Shahrestan Nowshahr, namely Roudsar, Rasht, Fuman, Lahijan and Langarud comprise the highest proportions; the shahrestans further away constitute less. The variation is apparently due to either the size of the population or to the actual distance from the Shahrestan. Another important factor is that the shahrestans further to the west speak Gilaki, rather than Mazandarani, and this could be an influential barrier to migration.

Within Ostan of Mazandaran (which also includes Sh. Nowshahr), the largest contributions are from the two adjacent Shahrestans of Tonekabon and Nour, situated on the western and eastern borders of the Shahrestan respectively. Shahrestan of Tonekabon contributes 2.5% and Shahrestan Nour contributes 1.5% from the total of 5.7%. The historical importance and links between these two areas have already been discussed. Together, the remaining seven shahrestans of Mazandaran contribute less than 1.0%.

Table 3.37a

DISTRIBUTION OF BIRTHPLACE ORIGIN OF MIGRANTS BY OSTAN AND SHAHRESTAN LEVELS

Ostan	Shahrestan	F	M	FF	FM	MF	MM	CH	TOTAL
Mazandaran	Nowshahr	62.8%	63.7%	55.8%	55.8%	70.2%	69.3%	87.1%	76.7%
	Amol	0.3	0.5	0.3	0.2	0.3	0.5	0.2	0.2
	Babol	0.7	0.7	0.8	0.6	0.3	0.5	0.1	0.3
	Gonbad-e-Kavouss	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.05
	Gorgan	0.7	0.7	0.7	0.8	0.5	0.8	0.5	0.6
	Behshahr	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.03
	Nour	1.7	1.5	3.7	3.5	3.8	3.1	0.6	1.5
	Sari	0.3	0.5	0.3	0.3	0.0	0.0	0.1	0.2
	Shahi	0.1	0.3	0.2	0.2	0.5	0.3	0.3	0.3
	Tonkabon	2.9	3.5	2.7	2.9	2.6	3.5	2.2	2.2
		69.5	71.4	64.5	64.3	78.2	78.0	91.3	82.08
Gilan	Astara	0.3	0.5	0.2	0.2	0.2	0.2	0.03	0.1
	Bandar-e-Anzali	1.2	0.9	0.9	1.1	0.5	0.5	0.1	0.5
	Fuman	2.6	2.0	5.0	4.5	3.3	2.0	0.1	1.5
	Lahijan	1.8	3.1	1.7	2.1	1.8	1.0	0.3	1.0
	Langarud	1.9	1.9	1.9	2.7	0.8	1.2	0.2	0.9
	Rasht	4.0	4.9	3.7	3.9	2.1	2.6	0.5	1.8
	Roudbar	0.6	0.4	0.7	0.6	0.2	0.0	0.3	0.3
	Roudsar	4.7	3.2	4.6	4.5	2.1	2.5	1.0	2.2
	Sumehsara	0.5	1.0	0.3	0.5	0.3	0.5	0.1	0.3
	Tavalesh	0.3	0.0	0.1	0.1	0.0	0.0	0.2	0.2
		17.9	17.0	19.1	20.2	11.3	10.5	2.83	8.8

Table 3.37b

DISTRIBUTION OF BIRTHPLACE ORIGIN OF MIGRANTS BY OSTAN

Ostan	F	M	FF	FM	MF	MM	CH	TOTAL
Mazandaran	69.5%	71.4%	64.5%	64.3%	78.2%	78.0%	91.3%	82.08%
Gilan	17.9	17.0	19.1	20.2	11.3	10.5	2.83	8.8
Azarbaijan	3.4	1.9	5.0	4.3	3.1	2.6	0.6	1.8
Boyer Ahmad	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bushehr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chahar Mahal	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.01
Esfehan	0.4	0.1	0.5	0.5	0.5	0.0	0.03	0.2
Fars	0.5	0.1	0.3	0.4	0.2	0.0	0.04	0.1
Hamadan	0.3	0.4	0.3	0.3	0.2	0.2	0.01	0.1
Hormozegan	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.01
Ilam	0.1	0.1	0.0	0.0	0.0	0.0	0.01	0.02
Kerman	0.2	0.1	0.4	0.2	0.2	0.2	0.0	0.1
Kermanshahan	0.2	0.3	0.4	0.3	0.3	0.2	0.04	0.2
Khorassan	1.1	1.1	1.2	1.1	0.8	1.0	1.2	1.2
Khuzestan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kordestan	0.0	0.1	0.0	0.0	0.0	0.2	0.1	0.02
Lorestan	0.5	0.5	0.5	0.5	0.7	0.8	0.1	0.3
Markazi	4.2	4.4	5.4	4.9	3.3	3.8	3.7	4.0
Semnan	0.4	0.2	0.3	0.4	0.2	0.2	0.1	0.2
Sistan Baluchistan	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.01
Yazd	0.3	0.3	0.3	0.3	0.3	0.3	0.0	0.2
Zanjan	0.8	1.0	1.1	1.0	0.5	1.0	0.1	0.4
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

The analysis of the origin of migrants has revealed the extent to which the birthplace composition of the present inhabitants of Shahrestan Nowshahr reflects the pattern of migrations that took place in the past, the past political and administrative boundaries in relation to the ethnic distribution, and finally the importance of the geographic and topographic factors.

Table 3.38 presents figures for migrational differences by sex. This analysis has excluded the children, since they constitute a very small proportion of the migrants. The results indicate that the male/female proportions of migrants do not differ substantially, although slight variation is observed when considering the proportions from non-contiguous provinces (Other Ostans). It is also evident that the category 'Foreign born' does not constitute an important contribution to the study area, although they originate from neighboring countries in the northwest and northeast.

A final analysis examines the proportion of individual family members from the subdivisions of Shahrestan Nowshahr (Table 3.39a,b). The highest proportions of the samples come from the less rural, and isolated, and more populated regions of the Shahrestan. Within Bakhsh Markazi, the Dehestans of Humeh (which contains Nowshahr City), Kachrostagh and Kalej comprise more than 24.5% of the samples; from Bakhsh Chalous, both the city and the Dehestan of Kelarestagh comprise 20.0%; and in Bakhsh Kelardasht, both Birounbashm and Kelardasht contribute to 33.0% of the samples; the remaining dehestans individually contribute from 3.0 to 0.6% of the total percentage.

Table 3.38

MIGRATION DIFFERENTIALS, BY SEX

Area	Male	Female
Bakhsh Markazi	28.6%	29.2%
Bakhsh Chalous	3.7	3.9
Bakhsh Kelardasht	30.6	29.8
Ostan Mazandaran*	7.8	8.5
Ostan Gilan	16.4	16.5
Ostan Markazi	4.3	4.4
Other Ostans	8.5	7.6
Foreign	0.1	0.1
Total	100.0%	100.0%

* Other than Shahrestan Nowshahr

Table 3.39a

RESPONDENTS, BY GENERATION AND RELATIONSHIPS

Person	Number in Sample
Fathers	656
Mothers	661
Fathers' Fathers	546
Fathers' Mothers	543
Mothers' Fathers	430
Mothers' Mothers	421
Children	6392
Total	9649

Table 3.39b

DISTRIBUTION OF BIRTHPLACES BY BAKHSH, DEHESTANS AND CITIES

Bakhsh	Dehestans	F	M	FF	FM	MF	MM	CH	TOTAL
Markazi	Alavikola	0.9%	0.3%	1.3%	1.3%	0.7%	0.5%	0.8%	0.8%
	Baladeh-Kojour	3.0	3.3	3.5	3.9	4.0	3.8	1.9	2.4
	Chalandar	0.8	0.9	0.9	0.7	1.2	1.2	0.4	0.6
	Humeh	3.4	5.9	0.7	1.5	1.9	1.7	15.5	11.2
	Kachrostagh	6.4	7.4	6.0	5.3	7.7	8.8	7.5	7.3
	Kalej	7.2	7.3	7.7	7.6	10.5	10.2	4.9	6.0
	Kalrudpey	2.7	1.8	2.2	2.4	2.3	2.1	1.5	1.7
	Keyrrud-Kenar	1.8	2.1	1.3	1.8	0.9	0.7	1.9	1.8
	Kuhparat	5.0	4.1	5.7	6.8	4.7	4.5	2.2	3.2
	Panjakrostagh	1.7	1.5	2.0	2.2	1.6	2.1	1.2	1.4
	Tavabe-Kojour	3.7	3.0	3.8	3.9	4.7	5.2	1.8	2.5
	Zanoussrostagh	7.0	6.2	7.9	7.4	5.6	6.2	1.4	3.2
	Nowshahr City	1.8	1.5	1.6	1.5	0.7	0.5	1.1	1.2
		45.4	45.4	44.7	46.2	46.3	47.5	42.1	43.3
Chalous	Kelarostagh	6.7	7.3	4.2	4.2	2.6	2.1	9.6	8.0
	Chalous City	3.0	4.1	1.3	0.7	0.2	0.5	16.7	11.7
		9.8	11.3	5.5	5.0	2.8	2.6	26.3	19.7
Kelardasht	Birunbashm	11.1	12.1	11.9	12.3	12.6	12.8	8.9	10.0
	Kelardasht	27.4	26.2	31.7	30.8	33.0	32.8	19.6	23.1
	Kuhestan-e-Gharb	5.0	4.2	4.9	4.4	4.4	2.9	2.4	3.1
	Kuhestan-e-Shargh	1.2	0.8	1.3	1.3	0.9	1.4	0.7	0.9
		44.8	43.3	49.8	48.8	50.9	49.9	31.7	37.0
		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

In summary, the analysis of birthplace origins among the inhabitants of Shahrestan Nowshahr reveals that over 76% of the population is indigenous. The grandparental generation show a higher proportion of locally born individuals in comparison to the parental generation, indicating more migration within the recent generation. Immigration into the Shahrestan has been mainly from the Caspian Littoral, ie the Shahrestans of Gilan and Mazandaran, in addition to those of Ostan Markazi.

3.4 EVOLUTIONARY IMPLICATIONS OF DEMOGRAPHY

The interplay of environmental, socio-economic, demographic and biological factors are the bases upon which evolutionary mechanisms such as selection, genetic drift and gene flow operate. Demography is essential for evaluating and determining the pattern and potential for micro-evolutionary processes within a population. An analysis of the processes and dynamics of demography elucidates the extent of the association between the Mendelian/genetic and demographic population. It is through an analysis of the demographic parameters that the actual genetic and effective population that will contribute to the next generation may be defined. The breeding pattern of populations is very much determined by the actual size and composition of populations, in terms of distribution, density, age/sex and family structure, fertility and mortality rates, extent and orientation of movement and growth patterns. These factors will indicate the extent to which the population composition is conducive to selection pressures and genetic drift. If variance exist within these parameters then selection will act differentially, the opportunity for drift will be enhanced and consequently genetic variation will be observed.

As was indicated in the comparative analysis of Shahrestan Nowshahr, the various demographic variables examined revealed differences between the urban and the rural areas. in addition to temporal differences. Since these differentials bear directly upon the genetic size of the population, some degree of selection differentials and drift in gene frequency would be expected. Data on demographic parameters of genetic concern in the individual dehestans or villages are not available but variation is expected due to factors such as geographic location, extent of isolation, means of communication, vicinity to larger economic centres and ethnic and kinship structure. The only informative data on these dehestans are their patterns of growth, which indicate heterogeneous rates and which possibly is a reflection of the actual processes operating within each of the units. The best example would be the hierarchical level of urbanization, as is becoming evident in the three villages of Marzanabad, Alamdeh and Hassankief.

Only a thorough demographic analysis of the individual dehestans and villages will provide information on the causes of the heterogeneity observed in the rates of growth; an assessment of the evolutionary trend could then be made. Differential demographic structures have also been associated with various other parameters, such as altitude (Gupta, 1980a), occupational and social stratification (Ajami, 1969, 1976; Mukhopadyap, 1981) and dietary deficiency, malnutrition and parasitic load (Basu et al, 1980, 1981).

CHAPTER FOUR

LANGUAGES AND DIALECTS

4.1 DISTRIBUTION AND LOCALIZATION

One component of demography deals with the languages and dialects spoken by the inhabitants of an area. Through an analysis of the distribution, regionalization and localization of languages and dialects, it is possible to demonstrate movement patterns in the past and in the present, and to examine the extent of admixture and panmixia.

The two predominant dialects spoken in the Caspian Provinces are Mazandarani and Gilaki. They are both branches of the Persian language, which is Aryan and derived from Old and Middle Persian. Mazandarani is mainly spoken in the east of the Caspian Littoral, while Gilaki is more orientated to the west. Both dialects are further subdivided into a number of sub-dialects and patois, confined to well-defined territories. The root of the Mazandarani dialect has its origin in the Pahlavi Sassanid Language, which has now mixed with Dori Persian and local dialects, so although they are very distinct now, they are akin to Persian. The sub-dialects of Mazandarani such as Kelarsaghi, Kojouri, Kelardashti, Tonekaboni and Mahali (local), are specific to smaller territorial regions, ranging from dehestans to some nucleated villages.

In Shahrestan Nowshahr, a total of four languages and twenty eight dialects or sub-branches of the languages are spoken (Table 4.1). It is evident that the two predominant

Table 4.1

DISTRIBUTION OF LANGUAGES AND DIALECTS IN SHAHRESTAN NOWSHAHR

Languages/Dialects	Male	Female	Both
Total Sample	1038	1038	2076
Gilaki	36.50	38.00	37.20
Mazandarani	23.50	24.70	24.10
Kordi	10.30	9.70	10.00
Farsi	9.60	9.60	9.60
Torki	4.90	4.10	4.50
Mazandarani/Gilaki	2.90	2.70	2.80
Rashti	2.50	3.00	2.70
Taleghani	2.30	1.90	2.10
Kelarsaghi	1.30	1.30	1.30
Mahali (local)	1.10	1.10	1.10
Kelardashti	0.90	1.00	0.95
Kord-Khajevandi	1.10	0.80	0.90
Khajevandi	0.50	0.40	0.45
Yazdi	0.30	0.30	0.30
Lori	0.30	0.20	0.25
Tonekaboni	0.10	0.30	0.20
Araki	0.20	0.20	0.20
Ashkouri	0.30	0.10	0.20
Semnani	0.20	0.10	0.15
Dezfuli	0.20	0.10	0.15
Massouleh	0.20	0.00	0.10
Doonayi	0.10	0.10	0.10
Nessai	0.10	0.10	0.10
Arabic	0.10	0.10	0.10
Kord-Khorassan	0.10	0.10	0.10
Taleghani-Khajevandi	0.00	0.10	0.05
Kord-Kermanshahi	0.10	0.00	0.05
Rudsari	0.00	0.10	0.05
Takestani	0.10	0.00	0.05
Hamadani	0.10	0.00	0.05
Taleshi	0.10	0.00	0.05
Mashadi	0.10	0.00	0.05
Total	100.00	100.00	100.00

dialects are Gilaki (37.2%) and Mazandarani (24.1%), followed by Kordi (10.0%), Farsi (9.6%) and Torki (4.5%). The remainder are sub-dialects of Mazandarani and Gilaki, or sub-branches of the Kurdish and Persian languages.

The data on the languages, dialects and sub-dialects have been amalgamated into seven major categories to examine their general distribution. These are Mazandarani, Gilaki, combined Mzandarani and Gilaki, Kordi, Torki, Farsi and all others. Table 4.2 presents the total proportions of each category in the Shahrestan, in addition to the percentages for each parent individually. It is apparent that Gilaki (42.5), Mazandarani (27.6) and the combined Mazandarani/Gilaki (2.8) dialects, comprise the bulk of the Persian dialects (72.9%) spoken there. These are followed by Kordi (11.6), Farsi (9.6) and Torki (4.5) respectively. The 'Others' category comprises only 1.3% of the total.

As Shahrestan Nowshahr is situated in the Province of Mazandaran, it is expected that Mazandarani would be the prevailing dialect, but this expectation is not fulfilled. One cause for the observed predominance of Gilaki is because the study area is situated in the most westernly region of the province, close to Gilan Province. Another reason is related to the past migration patterns, ie migration to Mazandaran from Gilan in the past has been intense, mainly because the former underwent economic and agricultural development at an earlier stage; in addition to this, when the Textile Industry began to function in Chalous City, it extracted the bulk of

Table 4.2

DISTRIBUTION OF LANGUAGES AND DIALECTS IN SHAHRESTAN NOWSHAHR

Languages/Dialects	Male	Female	Both
Total Sample	1038	1038	2076
Gilaki	41.9	43.1	42.5
Mazandarani	27.0	28.3	27.6
Kordi	12.0	11.1	11.6
Farsi	9.6	9.6	9.6
Torki	4.9	4.1	4.5
Mazandarani/Gilaki	2.9	2.7	2.8
Others	1.7	1.1	1.4
Total	100.0	100.0	100.0

its labour from the shahrestans of Gilan. These factors reflect the clinal component of language and dialect distribution in areas where major topographic barriers have not impeded movement of people. This clinal factor is more evident along the Caspian coast where movement has been facilitated by efficient roadway and transport systems.

Kurdish (Kordi) is the next frequently spoken language in Shahrestan Nowshahr. It is a branch of the Iranian branch of Aryan and Indo-European family of languages, and it is grammatically distinct from Persian (De Morgan, 1904). Kurdish is an Iranian language descended from the Medes who inhabited the north-west of Iran, as opposed to Persian which finds its source in the southwest; it is not a homogenous language, but an amalgamation of various ethnic and tribal elements, ie it comprises many related tribes (Limbert, 1968). Around 200 years ago various Kurdish tribes were transplanted from Kurdistan, Luristan and Azarbaijan, and resettled in Gilån, Mazandaran and Khorassan. Presently in Shahrestan Nowshahr two Kurdish tribes, the Khajevands and Laks reside in the highland valleys of Kojour and Kelardasht.

Turkish is less pronounced in Shahrestan Nowshahr. It differs in grammar and construction from the Aryan languages. Turkish is not so well-defined in terms of territory as Kurdish, thus there has not been a major influx of Turkish elements in the area.

Farsi is the main Persian dialect, and it is mainly spoken in the capital (Teheran) and in the more urban areas open to the inflow of migrants. Other dialects such as those of the

Zagros areas and cities of Iran are also spoken, but very infrequently.

In order to elucidate further the distribution of the languages and dialects on a more local scale within the study area, the distribution has been subdivided into the corresponding nineteen subdivisions (Table 4.3 and Figures 4.1 - 4.3). A more detailed pattern becomes available on the distribution and localization of languages and dialects. Primarily it is observed that the total area shows a very heterogeneous distribution. Some of the subdivisions are represented by very few samples and the percentages must be assessed with caution, but in general the total picture reveals the past history, migration and settlement patterns within the Shahrestan.

The dehestans situated in the east, reveal that Mazandarani is the prevailing dialect, while moving towards the west a clinal component becomes apparent, whereby a combination of Mazandarani and Gilaki dialects become observable. Dehestans of Baladeh-Kojour and Zannouss-Restagh, which have been settled by the Kurds, have the highest proportion of Kurdish speakers in the Shahrestan, followed by the dehestans of Kelardasht, Birounbashm Kouhestan-Shargh and Kouhestan-Gharb. Torki shows a high percentage in Dehestan of Chalandar, but the samples are too small to assess this with confidence; it is also spoken in Nowshahr and Chalous cities, and in Dehestan Kelardasht. It is interesting to observe the diversity of dialects and languages spoken in the two cities. In Chalous city, Farsi shows a high percentage, followed by Gilaki, Mazandarani, Kordi and Torki. In Nowshahr city, both Gilaki and Mazandarani are predominant,

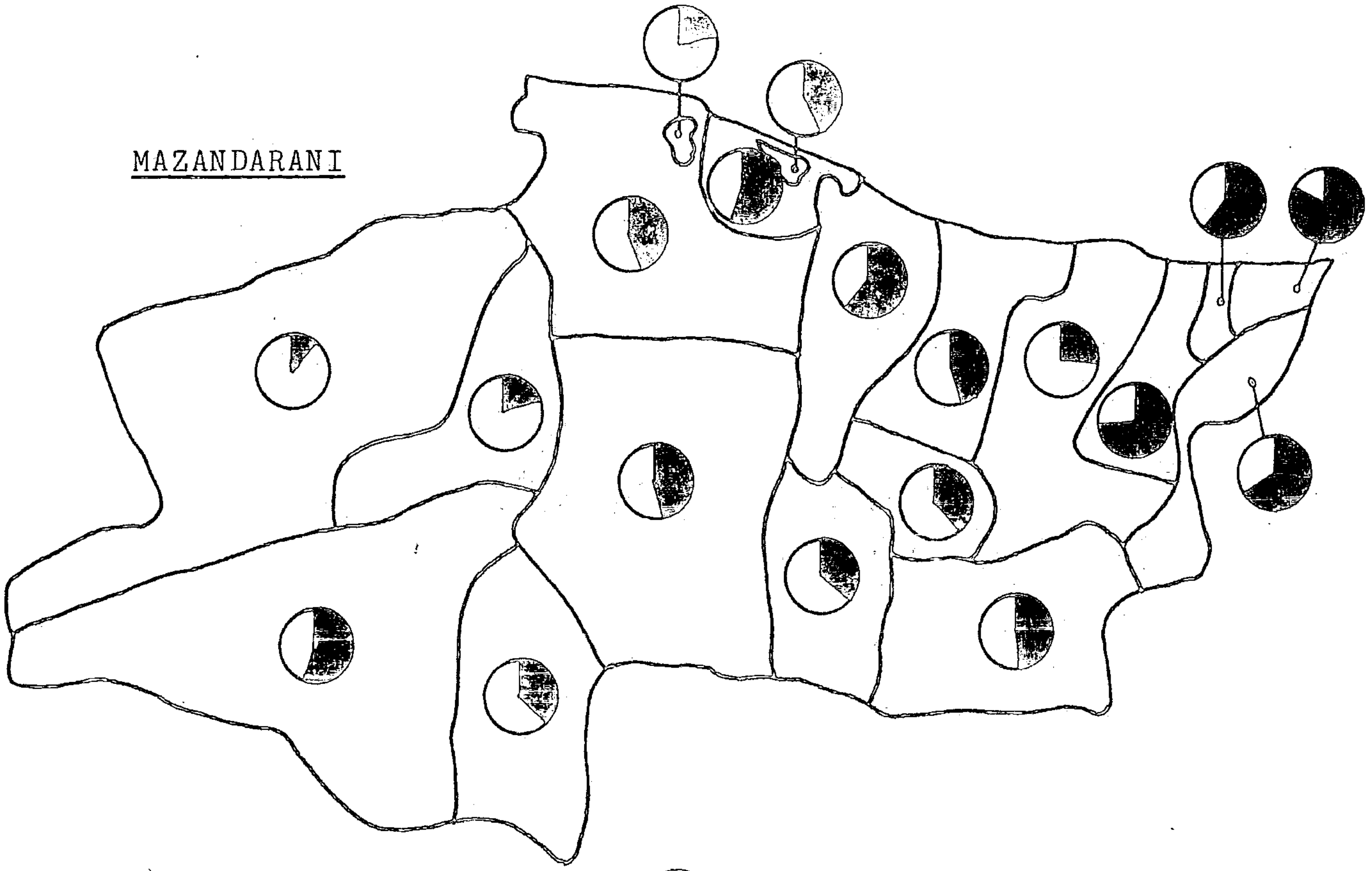
Table 4.3

DISTRIBUTION OF LANGUAGES/DIALECTS IN THE SUBDIVISIONS

		MAZANDARANI		GILAKI		MAZANDARANI & GILAKI		KORDI		TORKI		FARSI		TOTAL	
		No	%	No	%	No	%	No	%	No	%	No	%	No	%
KACHROSTAGH	Male	37	88.1	4	9.5	1	2.4	.	.	.	.	.	.	42	100.0
	Female	38	77.6	8	16.3	1	2.0	.	.	.	.	2	4.1	49	100.0
	Total	75	82.4	12	13.2	2	2.2	.	.	.	.	2	2.2	91	100.0
KALEJ	Male	31	66.0	14	29.8	1	2.1	1	2.1	.	.	.	.	47	100.0
	Female	33	68.8	13	27.1	1	2.1	1	2.1	.	.	.	.	48	100.0
	Total	64	67.4	27	28.4	2	2.1	2	2.1	.	.	.	.	95	100.0
ALAVIKOLA	Male	4	66.7	1	16.7	1	16.7	.	.	.	.	.	.	6	100.0
	Female	1	50.0	1	50.0	.	.	.	.	.	.	.	.	2	100.0
	Total	5	62.5	2	25.0	1	12.5	.	.	.	.	.	.	8	100.0
KALRUDPEY	Male	13	72.7	4	22.2	1	5.6	.	.	.	.	.	.	18	100.0
	Female	9	75.0	3	25.0	.	.	.	.	.	.	.	.	12	100.0
	Total	22	73.3	7	23.3	1	3.4	.	.	.	.	.	.	30	100.0
BALADEH-KOJOUR	Male	6	30.0	3	15.0	.	.	11	55.0	.	.	.	.	20	100.0
	Female	5	22.7	3	13.6	.	.	14	63.6	.	.	.	.	22	100.0
	Total	11	26.2	6	14.3	.	.	25	59.5	.	.	.	.	42	100.0
TAVABE-KOJOUR	Male	12	50.0	9	37.5	2	8.3	1	4.2	.	.	.	.	24	100.0
	Female	9	45.0	9	45.0	1	5.0	1	9.0	.	.	.	.	20	100.0
	Total	21	47.8	18	40.9	3	6.8	2	4.5	.	.	.	.	44	100.0
KUHPARAT	Male	15	45.5	16	48.5	.	.	.	.	.	.	2	6.1	33	100.0
	Female	8	29.6	17	63.0	.	.	1	3.7	.	.	1	3.7	27	100.0
	Total	23	38.3	33	55.0	.	.	1	1.7	.	.	3	5.0	60	100.0
CHALANDAR	Male	1	20.0	3	60.0	.	.	.	.	1	20.0	.	.	5	100.0
	Female	4	66.7	2	33.3	.	.	.	.	.	.	.	.	6	100.0
	Total	5	45.5	5	45.5	.	.	.	.	1	9.0	.	.	11	100.0
KHEYROUD-KENAR	Male	7	58.3	5	41.7	.	.	.	.	.	.	.	.	12	100.0
	Female	9	64.3	5	35.7	.	.	.	.	.	.	.	.	14	100.0
	Total	16	61.5	10	38.5	.	.	.	.	.	.	.	.	26	100.0
ZANOUSS-ROSTAGH	Male	15	32.6	11	23.9	1	2.2	19	41.3	.	.	.	.	46	100.0
	Female	14	34.1	10	24.4	1	2.4	16	39.0	.	.	.	.	41	100.0
	Total	29	33.3	21	24.1	2	2.3	35	40.3	.	.	.	.	87	100.0
PANJAKROSTAGH	Male	5	45.5	2	18.2	3	27.3	.	.	.	.	1	9.1	11	100.0
	Female	5	50.0	2	20.0	3	30.0	.	.	.	.	.	.	10	100.0
	Total	10	47.6	4	19.0	6	28.6	.	.	.	.	1	4.8	21	100.0
NOWSHAHR CITY	Male	6	27.3	9	40.9	.	.	2	9.1	1	4.5	4	18.2	22	100.0
	Female	20	51.3	8	20.5	.	.	1	2.6	3	7.7	7	17.9	39	100.0
	Total	26	42.6	17	27.9	.	.	3	4.9	4	6.6	11	18.0	61	100.0
HUMEH	Male	5	41.7	5	41.7	.	.	.	.	.	.	2	16.7	12	100.0
	Female	7	70.0	3	30.0	.	.	.	.	.	.	.	.	10	100.0
	Total	12	54.5	8	36.4	.	.	.	.	.	.	2	9.1	22	100.0
KELAROSTAGH	Male	23	53.5	13	30.2	2	4.7	5	11.6	.	.	.	.	43	100.0
	Female	17	34.0	23	46.8	2	4.3	5	8.5	.	.	.	.	47	100.0
	Total	40	44.5	36	40.0	4	4.4	10	11.1	.	.	.	.	90	100.0
CHALOUS CITY	Male	3	15.8	6	31.6	.	.	1	5.3	1	5.3	8	42.1	19	100.0
	Female	7	25.9	9	33.3	.	.	.	.	1	3.7	10	37.0	27	100.0
	Total	10	21.7	15	32.6	.	.	1	2.2	2	4.3	18	39.2	46	100.0
KELARDASHT	Male	18	10.1	111	62.0	.	.	42	23.5	1	0.6	7	3.9	179	100.0
	Female	23	13.3	111	64.2	.	.	34	19.7	3	1.7	2	1.2	173	100.0
	Total	41	11.6	222	63.1	.	.	76	21.6	4	1.1	9	2.6	352	100.0
KUHESTAN EAST	Male	2	25.0	3	37.5	1	12.6	2	25.0	.	.	.	.	8	100.0
	Female	3	60.0	2	40.0	.	.	.	.	.	.	.	.	5	100.0
	Total	5	38.5	5	38.5	1	7.6	2	15.4	.	.	.	.	13	100.0
KUHESTAN WEST	Male	18	54.5	5	15.2	4	12.1	6	18.2	.	.	.	.	33	100.0
	Female	15	53.6	3	10.7	2	17.1	7	25.0	.	.	1	3.6	28	100.0
	Total	33	54.2	8	13.1	6	9.8	13	21.3	.	.	1	1.6	61	100.0
BIRUNBASHM	Male	14	19.2	22	28.8	11	15.1	26	35.6	.	.	.	.	73	100.0
	Female	15	18.8	22	27.5	17	21.3	24	30.0	.	.	2	2.5	80	100.0
	Total	29	19.0	44	28.8	28	18.3	50	32.6	.	.	2	1.3	153	100.0
TOTAL		477	36.3	500	38.1	56	4.3	220	16.8	11	0.8	49	3.7	1313	100.0

Figure 4.1

DISTRIBUTION OF LANGUAGES/DIALECTS IN SHAHRESTAN NOWSHAHR



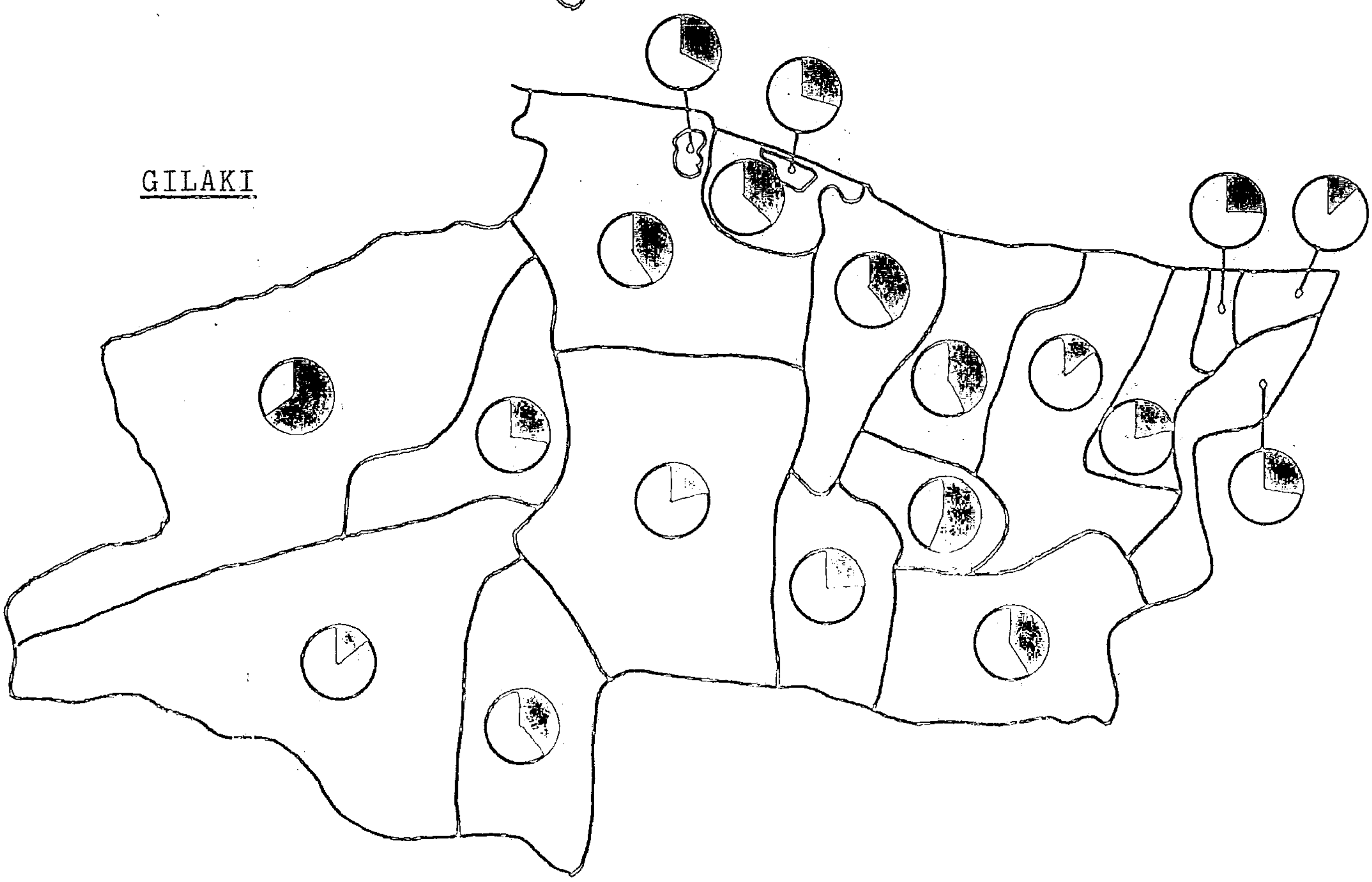


Figure 4.2

DISTRIBUTION OF LANGUAGES/DIALECTS IN SHAHRESTAN NOWSHAHR

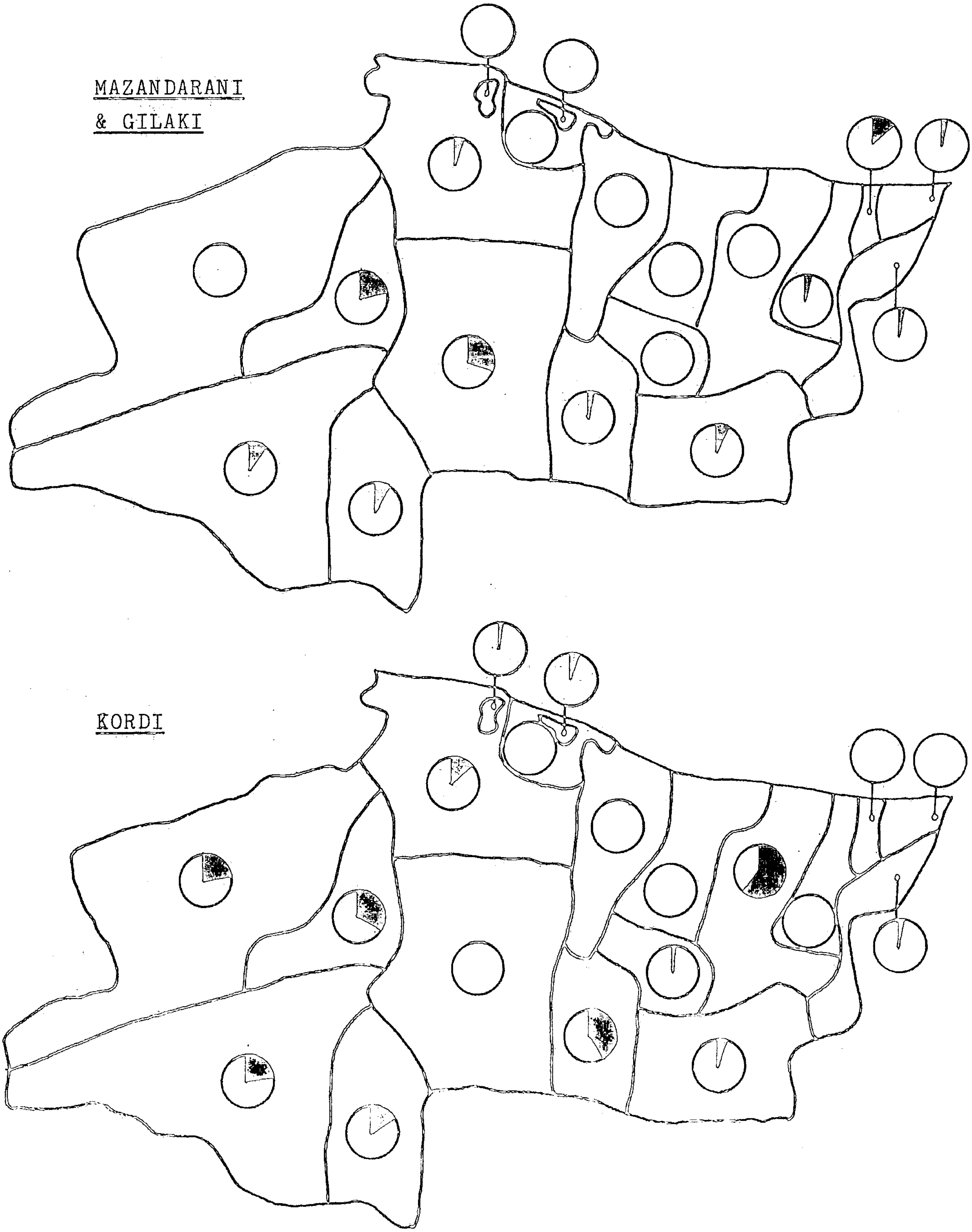
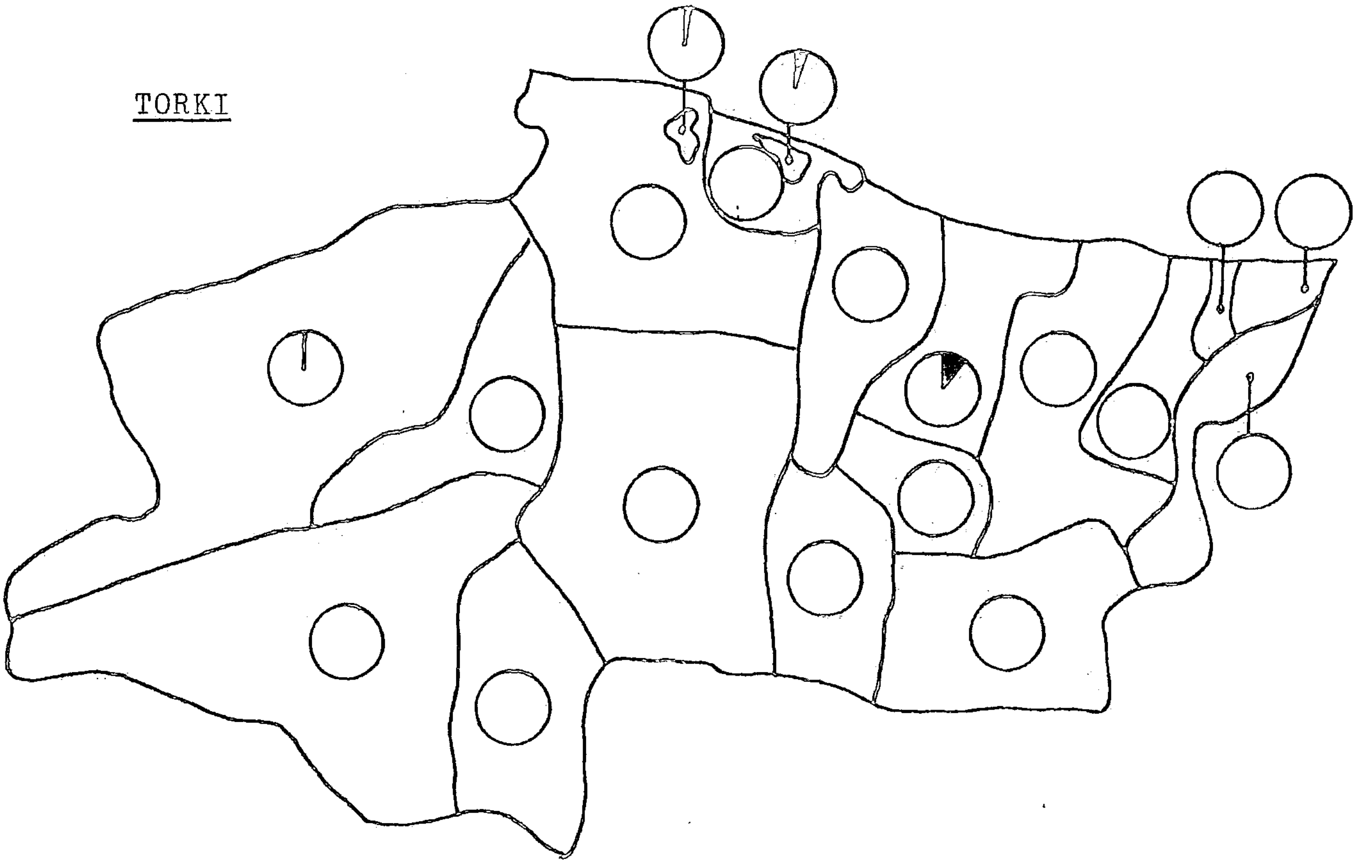


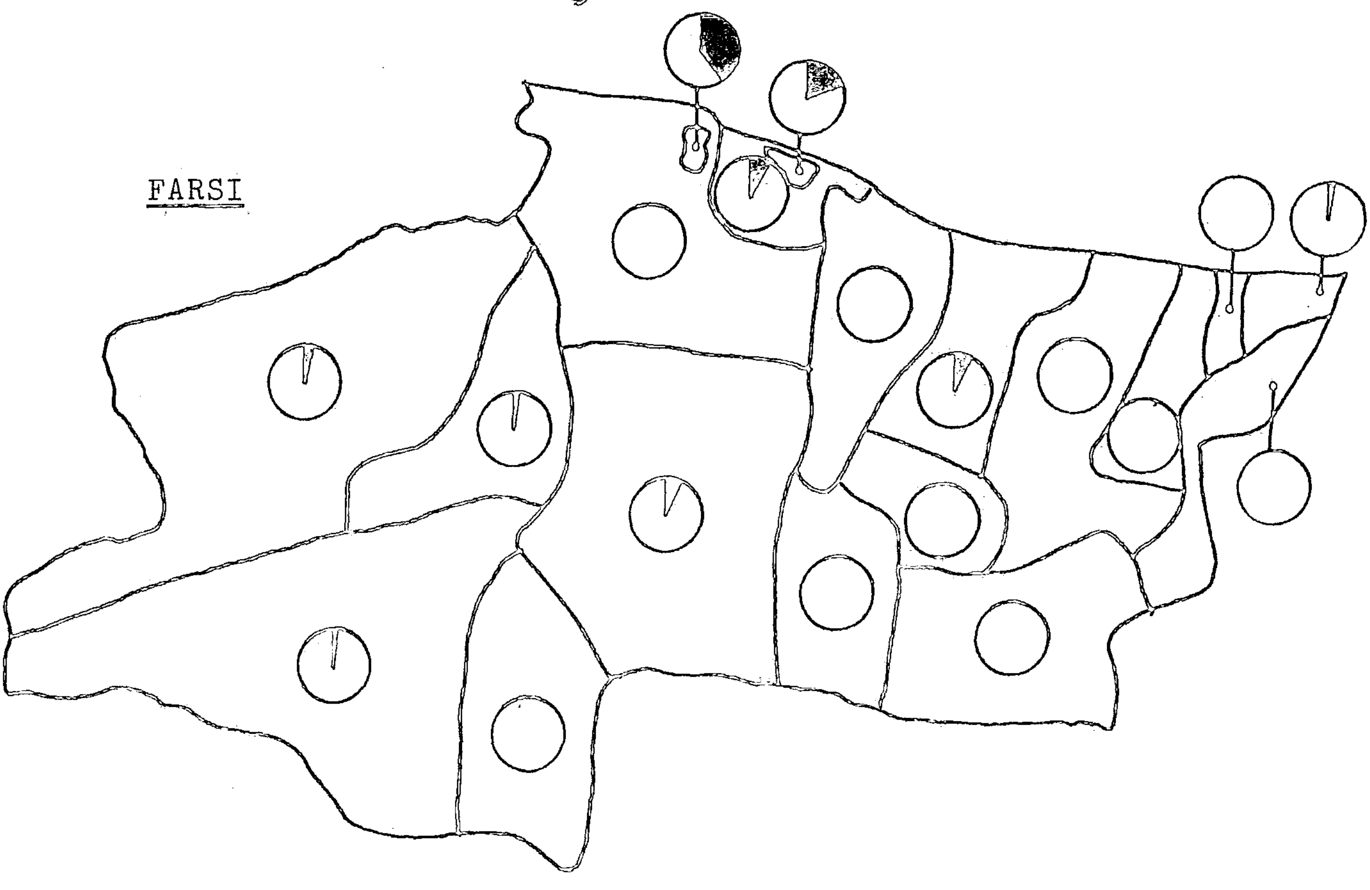
Figure 4.3

DISTRIBUTION OF LANGUAGES/DIALECTS IN SHAHRESTAN NOWSHAHR

TORKI



FARSI



followed by Farsi, Kordi and Torki. This heterogeneous ditribution within the urban areas, as opposed to a more homogenous one in some of the dehestans, is a reflection of the intensity of migrations to these areas. Although the two northern dialects are predominant, a high proportion of Farsi speaking people, who most probably have migrated from Teheran and its surrounding areas, constitute a major section of the total inhabitants. It is interesting to see that the distribution of languages and dialects also parallel those of the birthplaces of the inhabitants of the individual subdivisions.

Since Shahrestan Nowshahr is subdivided into three main administrative Bakhshes, the data have been analyzed to observe for the distribution within each Bakhsh.(Table 4.4 and Fig. 4.4). As expected, Bakhsh Markazi reveals a high percentage of Mazandarani, followed by Gilaki and Kordi. In Bakhsh Chalous, Gilaki and Mazandarani both prevail at high proportions, followed by Farsi, Kordi and Torki. Bakhsh Kelardasht, situated on the western borders, shows that Gilaki prevails, followed by Kordi, Mazandarani and Farsi. It is interesting to observe that, when considering only those who have been born in the Shahrestan, there is no evidence of languages or dialects other than has been mentioned above, thus all other local dialects pertaining to other parts of Iran are only spoken by the migrants and comprise a small proportion of the total distribution. This factor indicates the extent to which migration to the area has mainly originated from the surrounding areas, and emphasizes the importance of geographic elements

Table 4.4 DISTRIBUTION OF LANGUAGES AND DIALECTS WITHIN THE THREE BAKHSHES OF SHAHRESTAN NOWSHAHR

		MAZANDARANI		GILAKI		MAZANDARANI & GILAKI		KORDI		TORKI		FARSI		TOTAL	
		No	%	No	%	No	%	No	%	No	%	No	%	No	%
BAKHSH MARKAZI	Male	157	52.7	86	28.9	10	3.4	34	11.4	2	0.7	9	3.0	298	100.0
	Female	162	54.0	84	28.0	7	2.3	34	11.3	3	1.0	10	3.3	300	100.0
	Total	319	53.4	170	28.4	17	2.8	68	11.4	5	0.8	19	3.2	598	100.0
BAKHSH CHALOUS	Male	26	41.9	19	30.6	2	3.2	6	9.7	1	1.6	8	12.9	62	100.0
	Female	23	31.1	31	41.9	2	2.7	4	5.4	1	1.4	13	17.6	74	100.0
	Total	49	36.0	50	36.8	4	2.9	10	7.4	2	1.5	21	15.4	136	100.0
BAKHSH KELARDASHT	Male	52	17.7	140	47.8	16	5.3	76	25.9	1	0.3	8	2.7	293	100.0
	Female	56	19.6	138	48.3	19	6.6	65	22.7	3	1.0	5	1.7	286	100.0
	Total	108	18.7	278	47.9	34	5.9	131	22.6	4	0.7	13	2.2	579	100.0
SHAHRESTAN NOWSHAHR	Male	235	36.0	245	37.5	28	4.3	116	17.8	4	0.6	25	3.8	653	100.0
	Female	241	36.5	253	38.3	28	4.2	103	15.6	7	1.1	28	4.2	660	100.0
	Total	476	36.3	498	37.9	56	4.3	219	16.7	11	0.8	53	4.0	1313	100.0

Fig. 4.4 DISTRIBUTION OF LANGUAGES AND DIALECTS IN SHAHRESTAN NOWSHAHR, BY BAKHSH

in determining the pattern and orientation of movement. The correlation of the birthplaces and languages/dialects of the inhabitants in general reveal that the distribution varies according to the geographic region and past settlements.

Small differences are observed between the males and females in the distribution of languages and dialects. Both Mazandarani and Gilaki show higher proportions in the females, while the males show higher percentages in the non-indigenous languages of Kordi, Torki and other Persian dialects. This indicates that a higher proportion of males have migrated to the Shahrestan, while a larger proportion of females are local and indigenous.

4.2 MATING PATTERNS AND LINGUISTIC AFFINITIES

In order to investigate the extent to which mating pattern is dictated by linguistic affiliations, the degree of correspondence between the languages/dialects of the spouses has been examined (Table 4.5). When considering all the inhabitants of Shahrestan Nowshahr, there is a high degree of correspondence between the parents in terms of language and dialect. Eighty two percent of males who speak Mazandarani have married females speaking the same dialect, while 87% of females are married to males with the corresponding dialect. High corresponding values are also observed for Gilaki, Kordi and Farsi, and to a lesser extent for Torki. This same pattern also appears when considering only those spouses born within the Shahrestan and the individual Bakhshes, although the smallness of the

Table 4.5 DIALECT AND LINGUISTIC CORRESPONDENCE BETWEEN SPOUSES IN THE BAKHSHES OF SHAHRESTAN NOWSHAHR

SAMPLES/BIRTHPLACE	MAZANDARANI		GILAKI		MAZANDARANI / GILAKI		KORDI		TORKI		FARSI		OTHER	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%
BAKHSH MARKAZI														
Husbands	158		82		7		28		3		10		.	
+ Wives	133	84.2	72	87.8	7	100.0	21	75.0	1	33.3	7	70.0	.	.
Wives	155		85		10		34		.		9		.	
+ Husbands	142	91.6	71	83.5	7	70.0	26	76.5	.	.	7	77.8	.	.
BAKHSH CHALOUS														
Husbands	18		27		2		4		.		13		.	
+ Wives	15	83.3	21	77.8	1	50.0	3	75.0	.	.	9	69.2	.	.
Wives	25		19		2		6		.		8		.	
+ Husbands	17	68.0	17	89.5	1	50.0	5	83.8	.	.	6	75.0	.	.
BAKHSH KELARDASHT														
Husbands	32		135		19		59		3		5		.	
+ Wives	24	75.0	120	88.9	15	78.9	50	84.7	1	33.3	4	80.0	.	.
Wives	52		140		16		76		1		7		.	
+ Husbands	49	94.2	126	90.0	14	87.5	55	72.4	1	100.0	4	57.1	.	.
SHAHRESTAN NOWSHAHR														
Husbands	208		244		28		91		7		28		.	.
+ Wives	172	82.7	213	87.3	23	82.1	74	81.3	2	28.6	20	71.4	.	.
Wives	232		244		28		116		4		24		.	
+ Husbands	208	89.7	214	87.7	22	78.6	86	74.1	1	25.0	17	70.8	.	.
ALL SAMPLES														
Husbands	256		394		28		101		43		100		.	
+ Wives	210	82.0	332	84.3	23	82.1	82	81.2	28	65.1	72	72.0	.	.
Wives	277		432		30		125		51		98		17	
+ Husbands	241	87.0	374	86.6	23	76.7	92	73.6	28	54.9	72	73.5	11	64.7

samples must also be accounted for. From this analysis, it can be concluded that there is preference in choosing and marrying a spouse who speaks the same language or dialect. This pattern of non-random mating demonstrates the low level of admixture and panmixia based on linguistic affinities. Necessarily, the fact that the northern provinces are separated from the rest of the country by the Alborz Ranges must have had a strong influence on the mating pattern, thus enforcing marriages based on similar linguistic affinities. But isolation has not been total and movement between the shahrestans of Mazandaran, Gilan and Markazi must have allowed for a wider choice and a more random pattern. This has been already demonstrated by the comparative distribution between the rural dehestans and the two urban cities, therefore the high correspondence should mainly be attributed to the more isolated regions of the Shahrestan, where movement has been limited by various factors such as topography, kinship structure and lack of communication facilities.

These analyses have elucidated some interesting facts on the distribution of languages and dialects in Shahrestan Nowshahr and its consequences on the mating pattern and the genetic structure of the population. Some of the important points are that heterogeneous distribution of the languages and dialects indicates some degree of localization; that migration has been intense between Mazandaran and Gilan; that the Kurds constitute an essential component of the population; and that the extent and direction of migration has been greatly influenced and dictated by the geographic features of the environment, thus limiting the range of gene flow mainly to and within the Caspian coast. The interaction of these factors have been determined to a large extent by the pattern of mating within the Shahrestan, and it is highly dependent on geographic proximity and linguistic affiliations.

CHAPTER FIVE

MIGRATION AND GENE FLOW

5.1 INTRODUCTION

Population geneticists study the extent of local genetic movement and examine the effects of such small-scale migrations between population units to define and delineate evolutionary and Mendelian units. The genetic composition and structure of these Mendelian units can be examined through the migratory behaviour of the individuals who introduce and reciprocate new genes into other population units and assimilate different genetic units.

Two important microevolutionary processes operating within a population and affecting its genetic structure are gene flow and random genetic drift. Since populations are not distributed randomly over geographical areas and settlements are often discontinuous, large population units are often structurally composed of smaller partially isolated breeding populations. The genetic structure of such hierarchical systems of sub-populations are very much determined by the pattern of human migration and the extent of gene flow between them.

The extent of genetic movement of humans determine the level of differentiation between the sub-populations. Where migration rate is high, population units homogenize more quickly and genetic variability between them is decreased. Migration also has the effect of providing more evolutionary plasticity for selection to act upon, and more potential for adequate responses to a variety of environmental pressures. The scale of migration per generation is very much dependent on the size of the population. If the effective size of the population is small and migration is low, then population units may eventually drift away from the founder population, and consequently lead to genetic diversification between the units and genetic uniformity within each unit. Population units that have differentiated genetically through various factors, such as geographic and socio-cultural and small effective size, would display high levels of endogamy and a high degree of inbreeding and consequently depart from the Hardy-Weinberg state of panmixia.

From census records, general migration patterns of populations can be established covering all the movements from birth to final residence place. But migration does not necessarily imply genetic movement, since it can involve the introduction of new genes into a population from outside without actually being integrated into the population.

One means of actually establishing indices of gene flow (admixture) or isolation is through the study of marital exogamy, that is the proportion of marriages that involve a spouse from outside the defined population unit (which may be defined on a geographic, demographic and linguistic basis). Spatial exogamy is studied by examining the birthplace distribution of marriage partners, thus indicating the possibility of marriages linking genetically different or spatially separated populations. It also assesses the extent to which there is correspondence between the demographic and genetic unit. When spatial exogamy is high it is indicative of frequent mobility, a wider geographical marriage horizon and a more open gene pool, in addition to the lesser likelihood of chance fluctuations in gene frequencies. Alternatively, a high rate of endogamy (marriages contracted within a population unit) could result in the localization of genes, increased genetic variance between population units, and a higher possibility for drift to operate, and if the unit is a kin-structured society it could become more inbred as a result of consanguinity. Exogamy indices can also be further analyzed to distinguish between gene flow with neighbouring populations which are genetically less different in composition to those of far distant places which share less of the gene pool.

Another method of assessing the magnitude of marital movement and the level of relatedness between populations, in terms of the geographical area over which the gene flow occurs, is by measuring the distance between marriage partners' birth localities. If the marriage distance is short and movement is limited, the new genes coming from the outside may flow across the range slowly and result in differences in the occurrence of the genotype, while increased marriage distance and greater mobility decreases local differentiation.

The importance and relevance of the study of mating patterns in relation to genetic movement and population structure, and as an essential component of parent and offspring mobility, has been examined and demonstrated in many studies (Cavalli-Sforza, 1958, 1962; Küchemann et al, 1967; Boyce et al, 1967, 1968, 1971, 1973; Yasuda, 1968, 1975; Imaizumi and Furusho, 1972; Kücheman and Harrison, 1972; Malhotra and Majumdar, 1974; Reddy and

Mukherjee, 1975; Jeffries et al, 1976; Bourgoin and Khang, 1978; Coleman, 1978; Mukherjee et al, 1978; Malhotra, 1978c, 1980; Majumdar and Malhotra, 1979; Floris and Vona, 1980; Relethford and Brennan, 1982).

A more useful and informative index of genetic mobility would be based on the birth localities of parents and offsprings. This index is an actual measure of genetic flow since it accounts for variances in various esential factors such as fecundity, fertility, family size and mortality which determine the overall genetic composition of the population. In addition to this, the distribution of the distances between the birthplaces, indicates the extent of localization or the spread of genes across a geographical or a socio-demographic area.

Conclusively, the pattern of human movement or more explicitly the mating patterns of humans where applicable, are one determinant of how genes are combined in genotypes, and how their structure and distribution can affect the processes of microevolution. The behavioural pattern of finding a spouse is in itself a complex interplay of biological, demographic and socio-cultural factors, and it is through the study of these factors that Mendelian populations can be defined.

5.2 GENERAL MIGRATION PATTERNS

Primarily the general movement pattern of the population of Shahrestan Nowshahr has been analyzed by examining all the movements taken by the individual parent (respondents' parents) from his/her birthplace to any other localities for various reasons such as accompanying parents, marriage, work or moving with spouse. This general analysis is carried out in three steps: movement from birthplace to resident place before marriage; from birthplace to marriage place; and total movements from birthplace to present place of residence.

Table 5.1 presents percentages on the correspondence between each parent's birthplace and residence place before marriage. The figures demonstrate that 62.2% of the female population and 60.7% of the males before marriage resided in the same locality as their birthplace. The data have been further broken down to examine such correspondence at the smaller territorial levels. Of those born in B.Markazi, the correspondence is 93.8% for the males and 95.7% for the females; in B.Chalous, the corresponding figures are 90.5% and 94.7%; and in B.Kelardasht they are 91.3% and 94.4%; for all those born in the Shahrestan, ie excluding the migrants, the figures are 96.6% and 97.4% respectively. These figures primarily indicate higher indices of correspondence for the female population at all territorial levels, demonstrating that females are moving from their birthplace less frequently than their male counterparts. A second important factor is that movement is very much orientated to within the unit, either at the Shahrestan or Bakhsh level. Thirdly, the direction of movement for reasons other than marriage can be observed: out of Sh. Nowshahr, movement is orientated more towards O.Mazandaran and 'Other' ostans, and far less towards O.Gilan. Within the individual Bakhshes, there does not appear to be very substantial differences in term of inter-bakhsh movement, except in B.Kelardasht, where orientation is more towards B.Chalous.

Table 5.1 CORRESPONDENCE BETWEEN BIRTHPLACE AND RESIDENCE BEFORE MARRIAGE

		Residence before marriage						
Birthplace	No.	Bakhsh Markazi	Bakhsh Chalous	Bakhsh Kelardasht	Ostan Mazandaran	Ostan Gilan	Other Ostans	Total
B. Markazi								
Male	291	93.8%	1.0%	1.0%	1.0%	0.3%	2.7%	100.0%
Female	299	95.7	0.7	1.0	1.7	0.3	0.7	100.0
B. Chalous								
Male	63	3.2	90.5	3.2	1.6	0.0	1.6	100.0
Female	75	1.3	94.7	1.3	1.3	0.0	1.3	100.0
B. Kelardasht								
Male	288	1.0	4.9	91.3	1.4	0.3	1.0	100.0
Female	286	0.3	2.8	94.4	1.7	0.3	0.3	100.0
			------Shahrestan Nowshahr------					
Sh. Nowshahr								
Male	642		96.6		1.2	0.3	1.9	100.0
Female	660		97.4		1.7	0.3	0.6	100.0

Total Inhabitants	No.	Both born and resident in Sh. Nowshahr
Male	1022	60.7%
Female	1033	62.2

Table 5.2

BIRTHPLACE AND RESIDENCE BEFORE MARRIAGE DISTANCE DISTRIBUTION

Birthplaces	No.	Same Unit	Mean (in km)
Total Area			
Male	1016	70.3%	44.9
Female	1029	83.6%	21.7
Sh. Nowshahr			
Male	641	84.2%	6.4
Female	660	90.6%	6.5
B. Markazi			
Male	290	81.4%	7.9
Female	299	90.0%	7.4
B. Chalous			
Male	63	87.3%	3.9
Female	75	89.3%	4.2
B. Kelardasht			
Male	288	86.5%	5.4
Female	286	91.6%	6.3

A final factor is that the proportion of females residing in O.Mazandaran is higher than the males, while the proportion of males residing in all other ostans is higher than the females; this shows that males are travelling to more distant places more frequently than females.

In order to elucidate the distance factor involved in the movement of the sexes, the distance between the birthplaces and places of residence before marriage has been calculated and presented in Table 5.2. The females present higher proportions than the males in the '0' distance category. This category implies either same village or city, and is more informative since it deals with movement from within the smallest unit of habitation. The mean values also give indices on the distances moved, indicating the short range of movement of the inhabitants.

Similar analyses have been done on the correspondence between birthplaces and marriage places of the individual parents (Table 5.3). Of the total inhabitants of Sh. Nowshahr, 61.2% of the males and 62.3% of the females are born and married in the Shahrestan, while only 1.7 and 1.5% of the males and females respectively are born there but married elsewhere. Considering only those inhabitants who have been born in the Shahrestan, it is observed that 97.3% of males and 97.6% of the females are also married there. When the data are divided into the Bakhshes there appears to be a larger difference between the figures for the respective sexes, although they are both high. Firstly, the high values indicate movement very much orientated within the territorial level; secondly, the figures from the Bakhsh level are lower than those from the Shahrestan level, indicating more

Figure 5.3 CORRESPONDENCE BETWEEN BIRTHPLACE AND MARRIAGE PLACE

		Marriage place						
Birthplace	No.	Bakhsh Markazi	Bakhsh Chalous	Bakhsh Kelardasht	Ostan Mazandaran	Ostan Gilan	Other Ostans	Total
B. Markazi								
Male	298	94.3%	2.7%	0.6%	0.7%	0.7%	1.0%	100.0%
Female	300	93.0	2.7	1.4	1.3	0.3	1.3	100.0
B. Chalous								
Male	64	3.1	93.7	1.6	1.6	0.0	0.0	100.0
Female	75	6.7	80.0	8.0	2.7	0.0	2.6	100.0
B. Kelardasht								
Male	294	1.7	5.4	89.5	3.1	0.0	0.3	100.0
Female	286	1.4	9.4	88.1	1.1	0.0	0.0	100.0
		-------Shahrestan Nowshahr-------						
Sh. Nowshahr								
Male	656		97.3		1.8	0.3	0.6	100.0
Female	661		97.6		1.4	0.1	0.9	100.0

Total Inhabitants	No.	Both born and married in Sh. Nowshahr
Male	1042	61.2%
Female	1035	62.3%

$p < .001$

mobility between the bakhshes than with outside the total area; thirdly, B.Markazi shows the highest correspondence for both sexes, while in B.Chalous 20% of the females are marrying outside the unit (14.7% to other two bakhshes, and 5.3% to other ostans), and in B.Kelardasht also 12% of the females marry outside the unit (10.8% to other bakhshes and 1.1% to other ostans). Is is also observed that movement of the local inhabitants is mainly orientated towards O.Mazandaran and all 'Other' ostans, rather than to Gilan.

Table 5.4 presents percentages on the correspondence between the birthplaces and marriage places, based on distances. In the total area, 63% of males and 57.2% of females marry in the same unit (village or city) as their birthplace. Considering only those born in the Shahrestan, the respective indices are higher, 80.7% and 70%. At all territorial levels the figures are higher for males than females, reflecting the Iranian tradition and custom of moving to the husband's place on marriage. The mean values also indicate shorter distances travelled by males, except for B.Kelardasht, but these values have probably been affected by a few incidences of long distances, thus distorting the actual average distances moved.

Movement to Shahrestan Nowshahr from other ostans have also been analyzed (Table 5.5). It is observed that movement in terms of marriage to the individual bakhshes is heterogenous. From O.Mazandaran higher proportions have moved to B.Markazi, followed by Chalous, and much less to Kelardasht. From O.Gilan movement is directed more towards B.Chalous, which is the nearest region, and less than half of that proportion to Markazi and a negligible proportion to Kelardasht. Finally, movement from

Table 5.4

BIRTHPLACE AND MARRIAGE PLACE DISTANCE DISTRIBUTION

Birthplaces	No.	Same Unit	Mean (in km)
All Inhabitants			
Male	1035	63.0%	52.1
Female	1030	57.2%	45.2
Sh. Nowshahr			
Male	654	80.7%	7.0
Female	660	70.0%	8.2
B. Markazi			
Male	298	77.5%	7.9
Female	300	71.3%	10.9
B. Chalous			
Male	63	87.3%	3.8
Female	74	67.6%	10.6
B. Kelardasht			
Male	293	82.6%	6.8
Female	286	69.2%	4.8

Table 5.5

BIRTHPLACE AND MARRIAGE PLACE DISTRIBUTION OF NON-INDIGENOUS INHABITANTS

		Marriage Place			
Birthplace	No.	Bakhsh Markazi	Bakhsh Chalous	Bakhsh Kelardasht	Shahrestan Nowshahr
O. Mazandaran					
Male	69	20.3%	18.8%	7.2%	46.4%
Female	79	25.3	13.9	11.4	50.6
O. Gilan					
Male	189	15.3	37.6	1.6	54.5
Female	187	15.0	36.4	1.1	52.4
Other Ostans					
Male	128	16.4	18.0	1.6	35.9
Female	108	11.1	13.9	3.7	28.7

all 'Other' ostans shows that both Markazi and Chalous are the main recipients. Slight differences are observed between the sexes in the proportions of immigrants, and in general males outnumber females when considering ostans other than the one in which Shahrestan Nowshahr is situated. In general, immigration from Ostans of Mazandaran and Gilan is much higher than all other ostans, reflecting the geographic influence on the axis of movement, ie along the Caspian Littoral.

A final analysis examines the total movements of parents, ie from their birthplace to all other places visited and to final residence at the time of sampling. This analysis will only indicate orientation of movement and the possible direction of gene flow if the areas moved to are equivalent to the birthplaces of the offspring. Table 5.6 presents figures on the concordance of the places moved to, to the birthplaces of the individual parent. Taking birthplace as the criterion, it is revealed that from all those fathers born in the Shahrestan, only 47.1% have moved, and from this proportion, 76% have moved within the unit itself. The respective figures for the mothers are 54.6% and 80.1%. For both sexes, movement out of the Shahrestan is mainly orientated towards Mazandaran and 'Other' ostans, and only a small proportion move to Gilan. Even within the individual bakhshes a higher percentage of females have moved and this might be due to their movement for marriage, but instead the proportion of emigration is higher for the males.

B.Markazi shows high within-bakhsh movement for both sexes, 67.2% for males and 71.8% for females. In B.Chalous, movement is less localized and more distributed between the other bakhshes

Table 5.6 CONCORDANCE OF ALL MOVEMENTS TO BIRTHPLACES

Places moved to:	All	Shahrestan Nowshahr	Birthplaces Bakhsh Markazi	Bakhsh Chalous	Bakhsh Kelardasht	Ostan Mazandaran	Ostan Gilan	Other Ostans
FATHERS								
No.	694	309	161	27	121	67	188	128
as %	66.3	47.1	54.0	41.2	41.2	-	-	-
B. Markazi	32.5	-	67.2	14.8	9.5	31.7	21.9	35.3
B. Chalous	23.9	-	9.9	31.1	29.0	18.0	36.9	20.3
B. Kelardasht	10.9	-	3.1	16.4	35.9	7.2	5.1	1.7
Sh. Nowshahr	67.2	76.0	-	-	-	-	-	-
O. Mazandaran	11.4	10.7	7.2	19.7	12.6	24.6	9.9	5.4
O. Gilan	5.4	2.4	2.4	4.9	1.9	3.0	13.5	3.3
Other Ostans	16.0	10.9	10.2	13.1	11.1	15.0	12.6	34.0
MOTHERS								
No.	738	361	178	44	139	65	177	100
as %	70.5	54.6	59.3	58.7	48.6	-	-	-
B. Markazi	33.8	-	71.8	14.1	6.5	29.9	21.4	36.1
B. Chalous	24.6	-	8.4	34.8	27.0	18.8	35.8	19.1
B. Kelardasht	13.5	-	2.4	18.5	48.4	6.5	3.6	2.7
Sh. Nowshahr	71.8	80.1	-	-	-	-	-	-
O. Mazandaran	10.9	10.4	8.7	16.3	10.1	27.9	9.0	6.0
O. Gilan	4.3	1.6	1.0	4.3	1.2	2.6	14.8	2.2
Other Ostans	13.0	8.0	7.7	12.0	6.9	14.3	15.4	33.9

and ostans. In B.Kelardasht, local movement comprises only one-third of the total movement and there appears to be a strong preference for moving to the contiguous Bakhsh of Chalous. Movement from outside of the Shahrestan are mainly orientated towards Markazi and Chalous and far less to Kelardasht, so that the latter area is receiving fewer migrants, and this is probably due to Chalous and Nowshahr cities which are the main large urban centres within the Shahrestan.

An alternative way of looking at general movement patterns of the male population is to calculate the concordance between the fathers' birthplace and workplace, assuming that the female counterparts accompany the husbands. Table 5.7 demonstrates that from the total population, 62.7% of the fathers are born and work in the Shahrestan, and only 2.9% work elsewhere. When considering only those born in the Shahrestan, the figure is 95.5%. High corresponding values are also observed in the three bakhshes. In general the place of work of the males is primarily orientated towards the place of birth, and then to within the Shahrestan and finally to Mazandaran and other areas. Of those born outside the study area, movement in terms of work, is directed at an increasingly higher proportion to Markazi and Chalous, and far less to Kelardasht.

Although these indices of general movement patterns do not necessarily imply gene flow, and movement of genetic concern (matrimonial and parental) will be discussed later, they provide some useful information on the migratory characteristics of the population, in terms of the extent of mobility, orientation of movement to and from Shahrestan Nowshahr , the heterogeneous

Table 5.7 CONCORDANCE OF FATHER'S BIRTHPLACE AND WORKPLACE

Birthplace	No.	Workplace: Bakhsh Markazi	Bakhsh Chalous	Bakhsh Kelardasht	Ostan Mazandaran	Ostan Gilan	Other Ostans	Total
B. Markazi	258	87.2%	6.6%	1.2%	3.1%	0.4%	1.6%	100.0%
B. Chalous	52	13.5	82.7	0.0	3.8	0.0	0.0	100.0
B. Kelardasht	247	6.9	11.3	77.7	2.8	0.0	1.2	100.0
O. Mazandaran	51	52.9	27.5	13.7	5.9	0.0	0.0	100.0
O. Gilan	145	34.5	51.0	6.2	3.4	3.4	1.4	100.0
Other Ostans	95	50.5	33.7	4.2	1.1	1.1	9.5	100.0
		------Shahrestan Nowshahr------						
Sh. Nowshahr	557		95.5		3.1	0.2	1.3	100.0

Birthplace	No.	Works in Sh. Nowshahr	Works outside Sh. Nowshahr
Sh. Nowshahr	848	62.7%	2.9%

distribution of the migrants, and finally sexual migrational differences. In general, the important points elucidated from these results indicate that movement is orientated towards to the place of birth, that females are moving mainly for marriage, that males are moving longer distances, and finally that the inflow of migrants to the Shahrestan is not uniform and Chalous and Nowshahr cities are the main recipients of the new genes. It should also be emphasized that the origin of the new genes are mainly from the adjacent areas of the Caspian Littoral.

It is difficult to assess these results with total confidence since they are based on large population units, which are composed of smaller units and are characteristically different in population size and density, geographic features and linguistic affinities. Therefore it might be expected that the inflow and outflow of genes might themselves be varied within each village or urban centres. A second problem is that the results are based on one segment of the population only, ie the respondents' parents, and does not take into account movement of the grandparents and those of the latest generation, ie the respondents' sibs. Allowing for these two factors, the results are informative and instructive for further extrapolation on the consequences of the observed movement patterns.

5.3 MATRIMONIAL MOBILITY

5.3.1 Spatial gene distribution

The data on the level of endogamy and spatial exogamy based on the birthlocalities of spouses in Shahrestan Nowshahr have been analyzed from a total of 2586 marriages. The results are presented at two temporal levels to examine for any variation with time: the grandparental generation (fathers' parents and mothers' parents), and the parental generation (respondents' parents). No data are available on the marriage practices of the offspring generation, ie the respondents and their sibs.

Table 5.8 presents the incidence percentages of endogamy and spatial exogamy within Shahrestan Nowshahr. The composite value of endogamy (ie where both partners are born in the Shahrestan) for the grandparental generation is 57.5%, from a total of 1553 marriages. The proportion of exogamous marriages, where one partner marries a spouse from outside the unit, is only 7.8%; the exogamy rate for the males and females are 3.7% and 4.1% respectively. Of the total marriages, 34.7% are contracted outside the Shahrestan, that is where both partners are exogamous. In the parental generation the proportion of marriages that take place in loco is 55.3% of the total population, a value slightly lower than the former generation. The proportion of exogamous unions, ie where only one partner is local, is 16.2%, which is almost twice that of the last generation. The exogamy rate for the male spouses is 7.7% and for the female spouses it is 8.5%. Only 28.5% of the marriages are contracted by couples who have migrated to the Shahrestan, and this figure is lower than the earlier generation.

From observation of the results it is evident that the main difference in the marriage practices of the two generations is reflected in the degree of exogamous matings of the local population with the outside world. The temporal increase in

Table 5.8

INCIDENCE OF ENDOGAMY AND EXOGAMY IN SHAHRESTAN NOWSHAHR

	Grandparents		Parents		All	
	No.	%	No.	%	No.	%
Both partners Endogamous	892	57.5%	571	55.3%	1463	56.6%
Males Exogamous	58	3.7	80	7.7	138	5.3
Females Exogamous	64	4.1	88	8.5	152	5.9
Both partners Exogamous	539	34.7	294	28.5	853	32.2
Total number of marriages	1553	100.0%	1033	100.0%	2586	100.0%

Table 5.9

SEX DISTRIBUTION OF THE LOCAL AND EXOGAMOUS PARTNERS

		Grandparents		Parents		All	
		Male	Female	Male	Female	Male	Female
Local	No.	892	892	571	571	1463	1463
Partner	%	93.9	93.3	87.7	86.6	91.4	90.6
Exogamous	No.	58	64	80	88	138	152
Partner	%	6.1	6.7	12.3	13.4	8.6	9.4
Total	No.	950	956	651	659	1601	1615

exogamy between the two generations was examined statistically and significant differences were observed (x^2=34.69 p=.0001).

Table 5.9 presents data on the sex distribution of the local and exogamous partners. In both generations the males constitute the more local partner, while the females are more often the exogamous partner. Statistical tests reveal that the differences between the sexes are not significant, and mobility differentials in terms of sex do not exist.

Migration of couples, where both partners are exogamous, shows a decrease from 34.7% to 28.5% between the two generations. This can be mainly attributed to increased migration within the Shahrestan, as was revealed from the demographic analysis, ie there has been intense migration from the rural areas of the Shahrestan to the more urbanized villages and market centres.

One factor that needs to be accounted for in terms of temporal trend in mating patterns is that the breakdown into generational time might not be completely realistic, since generations do overlap, and this factor might introduce some bias in the overall results. One example would be the fact that females marry at younger ages than their male counterparts, and therefore the generation time-scale of their corresponding parents might overlap. To delete any such bias, the data have been amalgamated to look at the overall marriage patterns during the last sixty years. An average of 56.6% of the total marriages are endogamous; the degree of spatial exogamy is 11.2%, of which the males constitute 5.3% and the females 5.9%. The proportion of migrants couples who have moved into the Shahrestan is 32.2% of the total population. The combined results of both generations reveal that over 50% of the population who are born in the Shahrestan are marrying locally, while the level of outbreeding of the indigenous inhabitants is slightly above 10%. These two factors indicate little migration in terms of marriage and that gene flow is orientated towards the region of birth.

Traditionally in Iran, the family system is based on cognative marriages, with a marked preference for relatives as spouses. Other factors such as religion, social customs and economic necessities also dictate marital processes. One important factor that needs to be emphasized is the geographic and topographic elements of the environment that determine the pattern of settlements and the density of the population. In the Alborz mountain ranges, ie in the upland valleys, settlements are nucleated and discontinuous, and topographic barriers like mountains, rivers and uninhabited space have been very conducive to localized marriages. As a by-product of the geographic features, demographic factors have also contributed to the high proportion of in loco breeding. Factors such as precocity of both sexes leave very little time to move around before marriage. Cavalli-Sforza (1958), regards this factor as the diffusional component of marital mobility, based on the assumption that the distance between the birthplaces of spouses increases with increasing age. Other factors include the sedentary lifestyle due to the agricultural economy, kinship ties, ie marriages within the extended family network, the patrilineal and patrilocal system of family life and the inefficient means of communication and transport.

Although endogamy is common in Iran, there is variation between the urban and rural areas. In the more developed areas of Shahrestan Nowshahr, where the demographic structure and composition of the population has changed, the whole life-style of the inhabitants, including the mating patterns have also changed, resulting in increased opportunities for marrying persons outside the extended family network or beyond the confined range of the village of habitation. In the earlier chapter the demographic analysis revealed that the urban areas like Chalous and Nowshahr cities and the less rural villages such as Marzanabad, Hassankief and Alamdeh have increased largely in size, mainly due to immigration from the isolated rural regions. In the two cities, there was also evidence of heterogeneity in terms of birthplace origin and linguistic affiliation, indicating increased potential for marriage unions to link different regions.

In the more rural areas mobility has been low with little admixture, and the constraints are mainly due to underdevelopment, traditional values and geographic isolation. In general, the temporal changes are a reflection of the overall change in the social behaviour of the population, and consequently these changes are affecting the genetic composition and structure of the population.

Table 5.10 demonstrates the extent of admixture in Shahrestan. The admixture rate is based upon the number of exogamous partners and the number of migrant couples who are both exogamous (Dobson and Roberts, 1971; Dobson, 1973; Sheets, 1980). In the grandparental generation, the admixture rate is 21.3%,

Table 5.10

ADMIXTURE RATES IN SHAHRESTAN NOWSHAHR

	Number of Exogamous Partners	Number of Exogamous Couples	Total Population	Marital Admixture
Grandparental Generation	122	539	3106	.213
Parental Generation	176	294	2066	.224
Both Generations	290	853	5172	.221

Table 5.11

ENDOGAMY LEVELS IN IRAN

District	Born in same place	Born in different place
Kazeroun	76.6%	23.4%
Torbat Heydarieh	76.8%	23.2%
Tonkabon	58.5%	41.5%

Source: Khazaneh (1968)

while in the parental generation it is 22.4%. The extent of admixture for both generations is 22.1%, that is assuming no differential fertility or mortality on the part of the migrants. It is apparent that migration to Shahrestan Nowshahr has not been very intense and the frequencies of intra-Shahrestan marriages are quite high, indicating localization of marriages. The rate of marital admixture has not increased substantially between the two successive generations and one can extrapolate that the gene pool of the offspring generation will be derived mainly from the native inhabitants of the area.

Unfortunately, the analyses have treated the data on aggregate form and the results are based on an overall general pattern in which variation between the urban and rural villages and towns cannot be distinguished. The extent of endogamy, spatial exogamy, sex differentials in terms of marital mobility and admixture rate is expected to differ in the different localities, and vary with time. The low levels of exogamy demonstrated in the Shahrestan indicate intense breeding within the area, but it is also necessary to examine the components of marital mobility in the smaller territorial units, ie the villages, to reach an estimate of the effective size of the population, and to examine for any tendency for genetic diversification to occur. The paucity and nature of the data have put many constraints on the analysis: it is not possible to discover which territorial divisions are contributing to the increase in spatial gene distribution and which are the main recipients to the migrant genes; whether endogamy levels have remained the same in the more isolated sections but have increased in the more mobile regions such as the cities and towns; how the change and the imbalance in the sex ratio, conjugal life, age at marriage and in general rural depopulation have affected the different localities of Shahrestan Nowshahr differentially. These factors could only be speculated upon indirectly through the census and demographic records, which have indicated a dimorphic demographic structure. It should further be added that even within the rural section of the Shahrestan, which constitutes more than two-third of the area, there are variations in factors, such as geography and topography (coastal, hinterland and highland valleys), settlement patterns (continuous in the coast and nucleated in the mountains and the hinterland), population growth of the individual dehestans and the demographic composition, accessibility to larger centres, uniformity in languages and dialects, the kinship structure and finally the extent of admixture and migration.

These factors suggest that Shahrestan Nowshahr is a heterogeneous territory in terms of geography and demography, and it is therefore necessary to extend the study of matrimonial mobility to smaller territorial units. This has been done as far as possible when analyzing the data for matrimonial distances which will be discussed in the next section.

The only available and comparative data on endogamy levels in Iran are in a study by Khazaneh (1968), based on three localities in Iran (Table 5.11). According to his analyses, endogamy levels range from 58.5% to 76.8%. He observes that in Tonekabon (it is not certain whether he is referring to the Shahrestan, the District or the City), which is adjacent to the western

Table 5.12

POPULATION SIZE, DENSITY AND GEOGRPAHIC AREA OF SHAHRESTAN NOWSHAHR AND ITS ADMINISTRATIVE SUB-DIVISIONS

Locality	Population Size	Population Density*	Area in sq. km*
SHAHRESTAN NOWSHAHR	146799	39.7	3695.0
DEHESTANS			
Kachrostagh	5823	294.0	19.8
Kalej	2409	28.9	83.2
Alavikola	2326	140.0	16.6
Kalrudpey	3290	36.5	40.0
Baladeh Kojour	5685	23.2	245.0
Tavabe Kojour	5746	23.4	245.0
Kuhparat	3311	36.8	90.0
Chalandar	4937	29.9	165.0
Kheyroud Kenar	9045	46.9	193.0
Zanoussrostagh	5329	33.7	158.0
Panjakrostagh	7283	12.9	565.0
Humeh	5005	88.6	56.5
Kelarostagh	16889	57.2	295.0
Kelardasht	13750	24.1	570.0
Kuhestan East	1210	5.8	210.0
Kuhestan West	2650	5.7	465.0
Birunbashm	10056	47.9	210.0
CITIES			
Chalous	25782	2578.0	10.0
Nowshahr	16263	2033.0	8.0

* approximate figures

region of Shahrestan Nowshahr, 58.5% of the population comprise partners where both are born within the area. The endogamy rate is very similar to the value obtained in this study, ie 56.6%. He also found a linear relationship between endogamy levels and population density. No data are available on the population density of the dehestans and the villages, but using the population size of the dehestans, it was possible to arrive at an approximate estimation of their densities and geographic areas.(Table 5.12). In general, one can speculate that the relationship between endogamy and population density would also prove to be valid within the smaller divisions of the Shahrestan, ie in certain regions population density will be low enough to be conducive to high levels of endogamy and increased propensity to marry within the enclosed nucleated unit of settlement.

Migrational differences by sex were also observed by Khazaneh (1968), in which he observed a high percentage of the females living with their husbands in different localities from those of their parents, and he attributed this to the traditional custom of wives moving to the husbands' residence at marriage. Patrilocality , based on this analysis, is not evident, and the results from the analysis of birthplace and marriage place concordance revealed only small differences with no statistical significance. It might be possible that further analysis on smaller units of habitation would reveal differences in migration by sex, since traditionally it is the female spouse who moves on marriage, but on the other hand, due to economic changes within the Shahrestan, males constitute more often the mobile sex who are in search of jobs and better prospects of living.

5.3.2 Matrimonial distance

An important component of marital movement is the distance between the birthlocalities or resident places of marriage partners. Distance determines mating patterns in humans and has the effect of either facilitating matings and admixture between individuals or populations, or alternatively restricting genetic movement. The genetic implications of distance in terms of marriage behaviour are that they delineate the distribution and the range over which movement occurs and limit the flow of genes. The geographic distance between the birthplaces of spouses, ie matrimonial distance, can be a useful index in defining Mendelian populations and the size of the gene pool, whereby local genetic structure can be determined (Harrison and Boyce, 1972).

Since the data concern samples of which a large proportion are mainly involved in a sedentary economy and very infrequently move from their birthplaces except through marriages, marriage distance has been defined as genetic distance and a means of estimating the magnitude of the gene pool.

Distances between the localities in the data have been calculated from the longitude and latitude coordinates for each locality. No other data were available on actual distances, and an alternative method of measurement was not possible.

Tables 5.13 - 5.20 and Figures 5.1 - 5.7 present results on the frequency distribution of marriage distances in Shahrestan Nowshahr and the three Bakhshes. The analysis also examines both spatial and temporal variation in the distribution. The results are presented at two levels: marriage distances and distribution of spouses where both partners are endogamous to the specific unit of study, ie mainly looking at short range movements; and secondly, marriages where one partner is exogamous, ie long range movements. This latter factor indicates the extent of systematic pressure from outside the population unit (De Vore, 1980).

Distances within the smallest unit of habitation ranging from village to town and city have been arbitrarily considered as zero, therefore the '0' distance class is the pooled results of shorter distances which range to under 1000 meters, and comprise one unit of population.

Within Shahrestan Nowshahr, where both partners are endogamous, the mean marriage distance for the grandparental generation are 4.1 and 3.8 kilometers for the fathers' and mothers' parents respectively, showing an average of 3.9 kms. The figure for the parental generation is 5.8 kms, demonstrating a temporal increase between the two generations. Since the few marriages contracted over longer distances can distort and artificially inflate the actual marriage distances (Harrison and Boyce, 1972), the median distances have also been presented to provide a more accurate description of the distances over which the genes are moving. The median distances for both generations are in the '0' distance class, and they range from 630 to 740 metres. Road distances measured between the various settlements in Shahrestan Nowshahr showed a range from a maximum of 9 kms. to a minimum of 200 meters, and an average of 2000 metres. Assuming that the settlements are between one half to one square kilometre in area, the median values imply very intense localized movement, either confined to the smallest territorial division, ie the village, or with the nearest settlement unit. The difference between the two generations shows an increase of only 100 metres, and this might be the result of a temporal increase in the population size of the villages.

The difference between the two successive generations is more acutely observed in the frequency distribution of marriage distances. In the first generation almost 80% of all marriages are contracted within the '0' distance class, and only 10% of the marriages are contracted over 15 kms., while in the present generation, this figure has decreased to 67.6%, and more spouses (15.8%) are marrying beyond the 15 kms. range. These results indicate a temporal increase in the range of movement of genes, but a high proportion of interbreeding is confined to within the unit of birth.

On examination of marriage distances including long-range movement, ie including spouses from outside the Shahrestan, the temporal increase is more substantial. The grandparents show a mean marriage distance of 15.2 and 16.7 kms. for the fathers' and mothers' parents respectively, while for the parents the figure is 40.3 kms. Again the median distances reveal distances confined to the '0' distance class, indicating an increase from 700 to 950 metres.

The large difference in the mean distances as opposed to the median distances is also reflected in the range of movement for both generations. The maximum range for the previous generation is around 400 kms., while for the next generation it is increased to 800 kms. It is evident that in the more recent generation more genes are moving from longer distances into

Table 5.13

FREQUENCY DISTRIBUTION OF MARRIAGE DISTANCES IN SHAHRESTAN NOWSHAHR (SHORT RANGE MOVEMENT)

Distance	FF+FM			MF+MM			F+M		
(in km)	No	%	cf*	No	%	cf*	No	%	cf*
0 - 1	389	78.0	78.0	313	79.6	79.6	385	67.4	67.4
1 - 5		6.2	84.2		6.2	85.8		9.6	77.2
5 - 10		3.6	87.8		2.5	88.3		5.1	82.1
10 - 15		2.0	89.8		2.0	90.3		2.1	84.1
15 +		10.2	100.0		9.7	100.0		15.8	100.0
Total		499			393			571	
Mean		4.1			3.8			5.8	
Median		0.64			0.63			0.74	
Variance		121			112.4			141.6	
Range		74			67			51	
Skewness		3.2			3.5			2.1	
Kurtosis		10.8			13.1			3.3	

* cf = cumulative frequency

Figure 5.1

DISTRIBUTION OF ENDOGAMOUS MARRIAGE DISTANCES IN SHAHRESTAN NOWSHAHR (SHORT RANGE MOVEMENT)

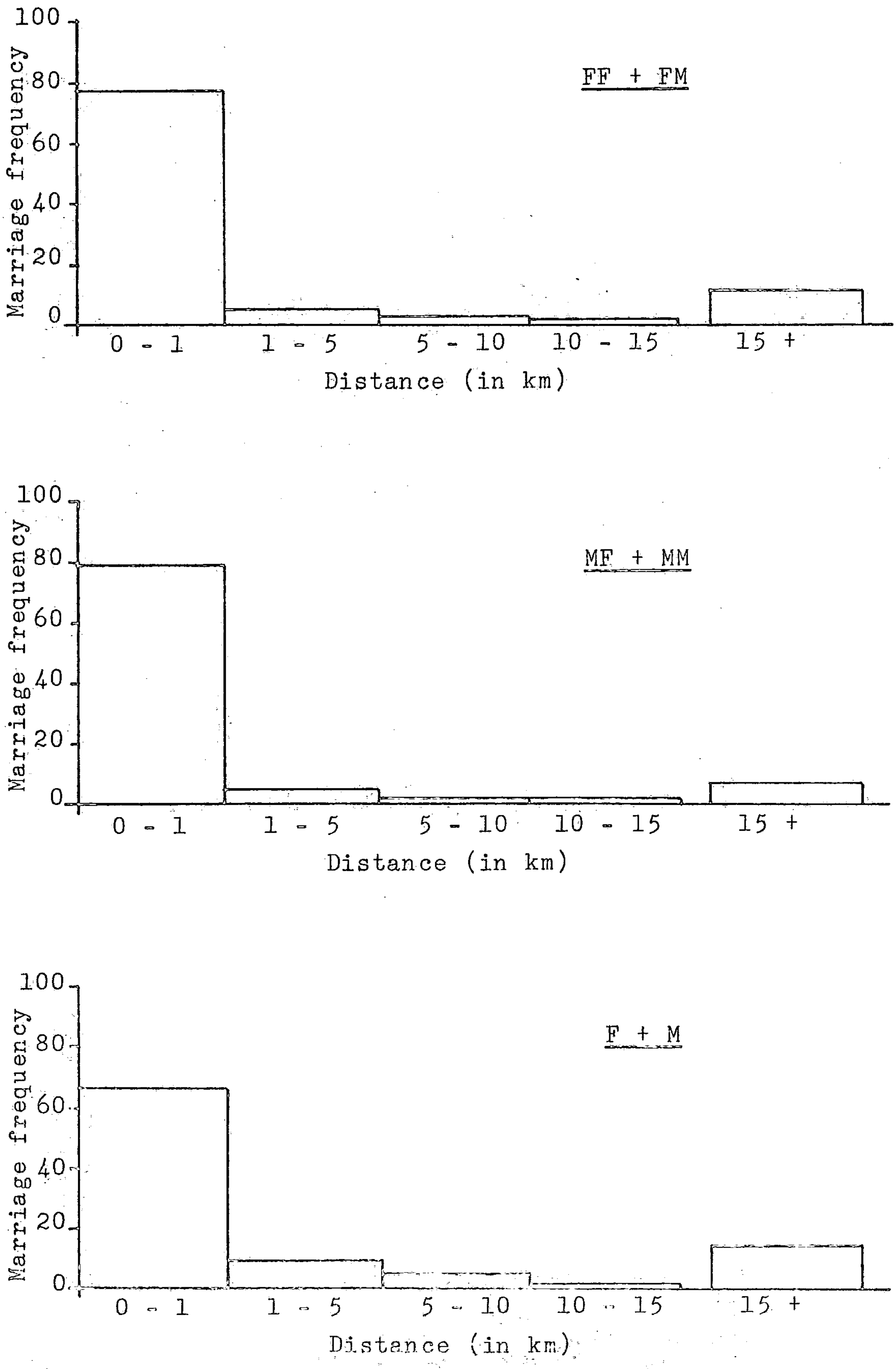


Table 5.14

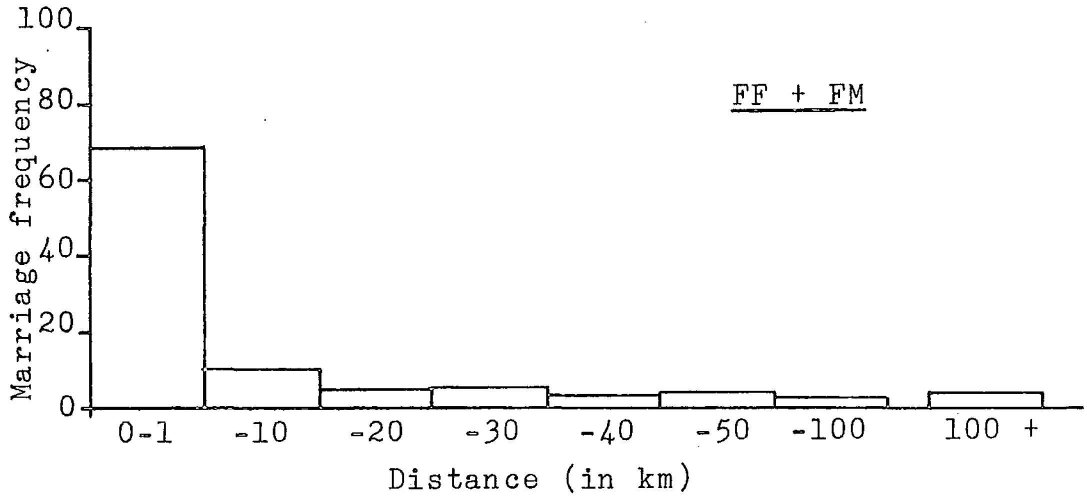
FREQUENCY DISTRIBUTION OF MARRIAGE DISTANCES IN SHAHRESTAN NOWSHAHR (LONG RANGE MOVEMENT)

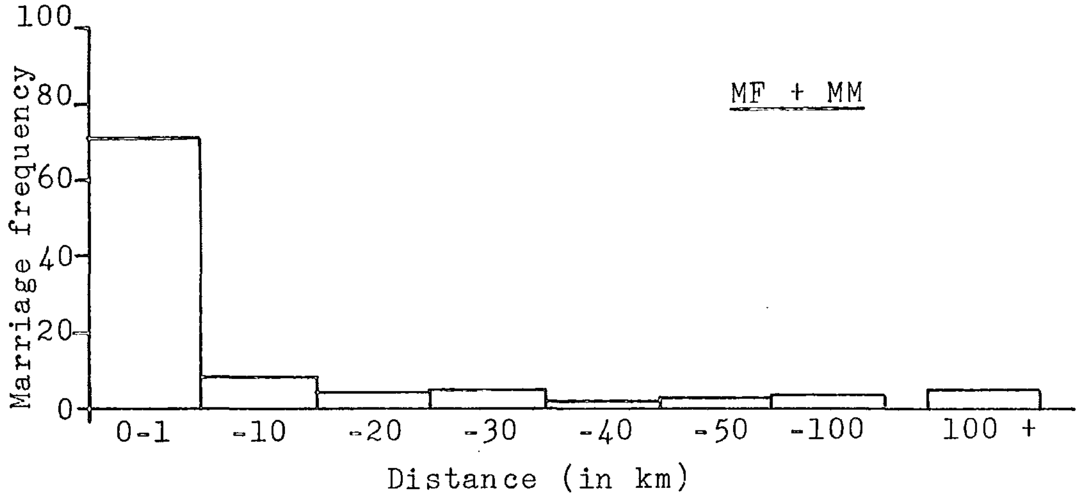
Distance	FF+FM			MF+MM			F+M		
(in km)	No	%	cf*	No	%	cf*	No	%	cf*
0 - 1	389	68.5	68.5	313	70.5	70.5	386	52.4	52.4
1 - 10		9.3	77.8		8.1	78.6		11.4	63.8
10 - 20		4.1	81.9		4.1	82.7		3.8	67.6
20 - 30		4.5	86.4		4.9	87.6		6.5	74.1
30 - 40		3.2	89.6		2.0	89.6		4.9	79.0
40 - 50		3.4	93.0		2.7	92.3		2.7	81.7
50 - 100		2.8	95.8		3.0	95.3		4.1	85.8
100 +		4.2	100.0		4.7	100.0		14.2	100.0
Total		568			444			737	
Mean		15.2			16.7			40.3	
Median		0.73			0.71			0.95	
Variance		2098			3014			9101	
Range		435.2			464.0			830.0	
Skewness		5.3			5.4			4.3	
Kurtosis		34.7			34.0			24.1	

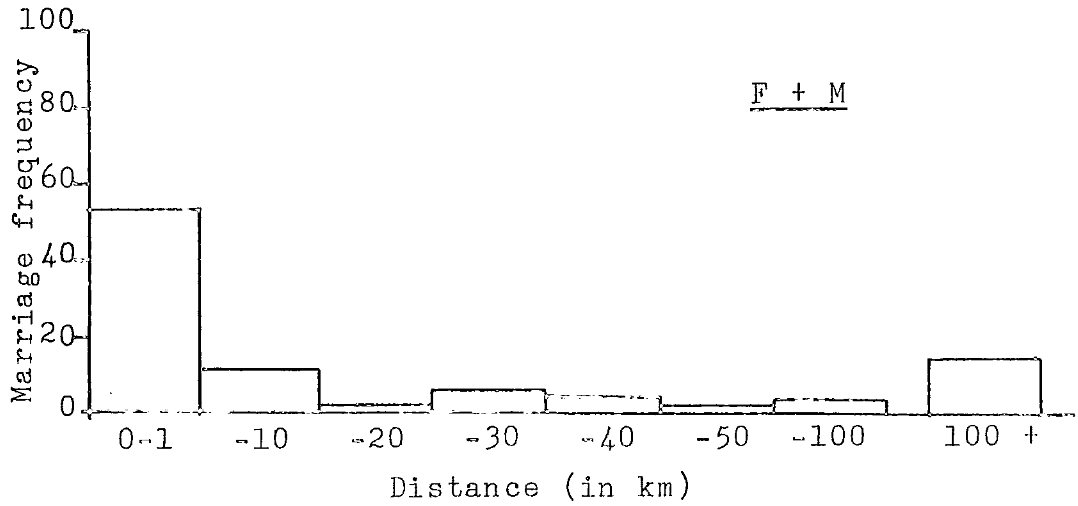
* cf = cumulative frequency

Figure 5.2

DISTRIBUTION OF MARRIAGE DISTANCES (EXOGAMOUS) IN SHAHRESTAN NOWSHAHR (LONG RANGE MOVEMENT)







the Shahrestan.

Almost 70% of the grandparents have married within the unit of birth, while for the parents this value has decreased to 52.4%. Statistical tests reveal significant differences between the two generations, X^2=51.66 p=.0001. The distribution of the distances for both periods also reveal a gradual decrease in the number of marriages with increasing distance. The variance in the size of the gene pool also reveals an increase with time between the two periods. A more detailed analysis of the distribution reveals that an average of only 20% of the exogamous partners are born outside the mean marriage distance, ie 20% for the fathers' parents, 19% for the mothers' parents and 21% for the parents themselves. It is incorrect to assume that these values are equal to systematic pressure, since on further observation it is observed that a large proportion of these percentages are from shorter distances and contiguous areas, and that almost 90% of the grandparents are marrying within the range of 50 kms., and 86% of the parents within less than 100 kms. These observations reduce the extent of systematic pressure and the effect of long-range migrations.

To examine spatial differences in matrimonial distances within the Shahrestan, the same analysis has been carried out for the three Bakhshes. Primarily, within each Bakhsh an increase in the mean marriage distance is observed, concomitant with a decrease in the proportion of marriages contracted in the '0' distance class. These results apply to both short and long range movements.

Within B.Markazi, only 69.2% of the endogamous parents

Table 5.15

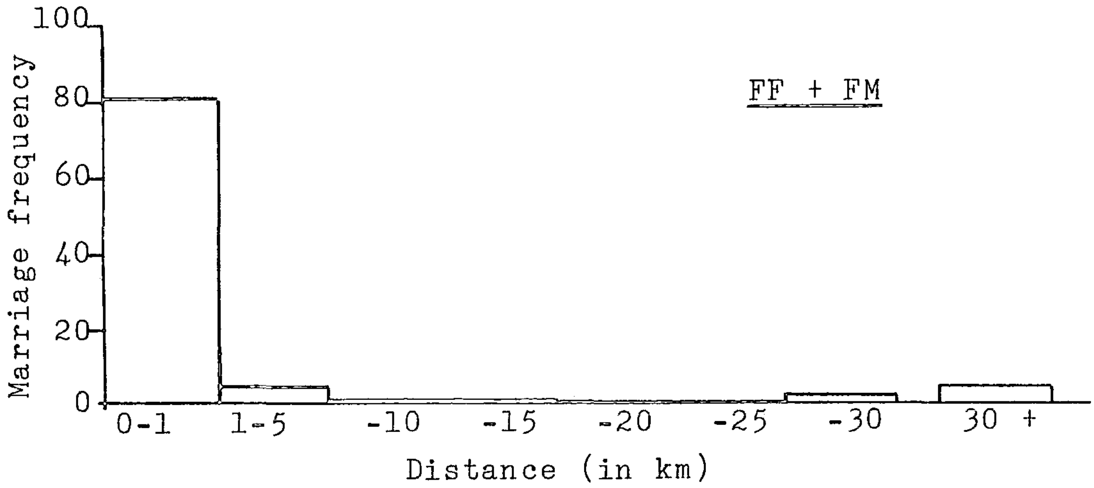
FREQUENCY DISTRIBUTION OF MARRIAGE DISTANCES IN BAKHSH MARKAZI (SHORT RANGE MOVEMENT)

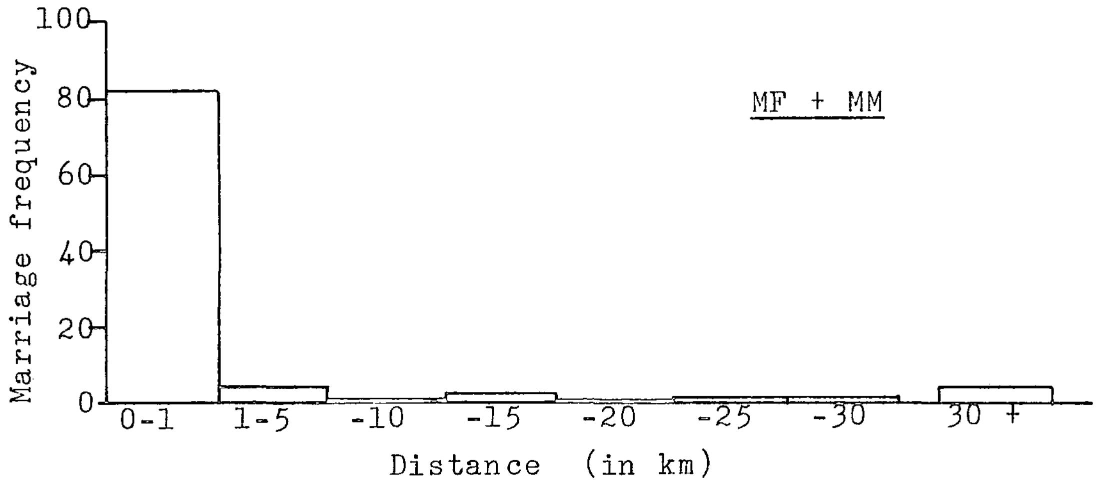
Distance (in km)	F's parents No	%	cf*	M's parents No	%	cf*	Parents No	%	cf*
0 - 1	179	82.5	82.5	144	82.8	82.8	170	69.2	69.2
1 - 5		5.0	87.5		4.0	86.8		9.3	78.5
5 - 10		1.4	88.9		1.7	88.5		4.1	82.6
10 - 15		1.4	90.3		2.9	91.4		0.8	83.4
15 - 20		0.5	90.8		0.5	91.9		0.4	83.8
20 - 25		0.9	91.7		1.2	93.1		1.6	85.4
25 - 30		2.8	94.5		1.1	94.2		4.4	89.9
30 +		5.5	100.0		5.8	100.0		10.2	100.0
Total		217			174			247	
Mean		3.5			3.6			6.3	
Median		0.61			0.61			0.73	
Variance		96.04			106.9			162.6	
Range		44			64			51	
Skewness		2.8			3.3			2.0	
Kurtosis		6.9			11.2			2.4	

* cf = cumulative frequency

Figure 5.3

DISTRIBUTION OF ENDOGAMOUS MARRIAGES IN BAKHSH MARKAZI (SHORT RANGE MOVEMENT)





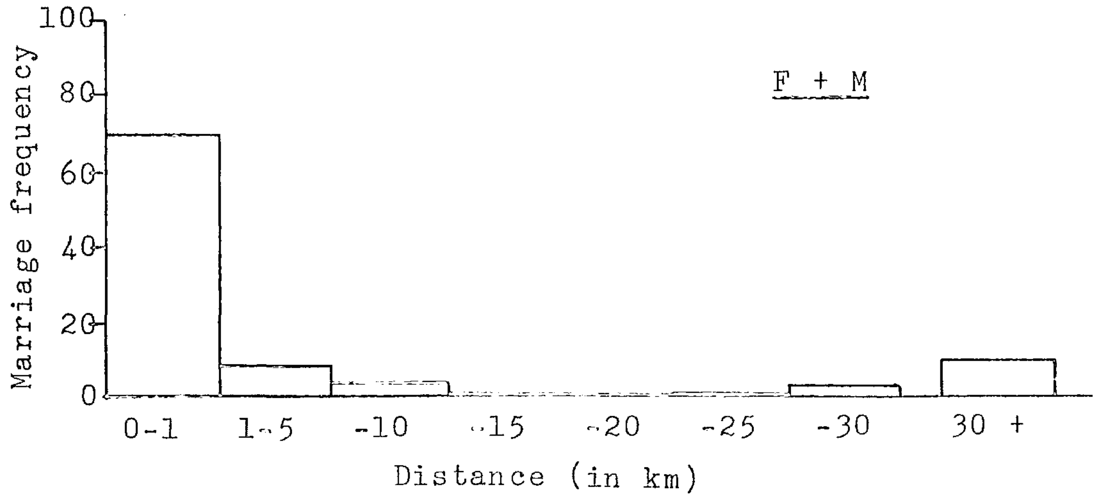


Table 5.16

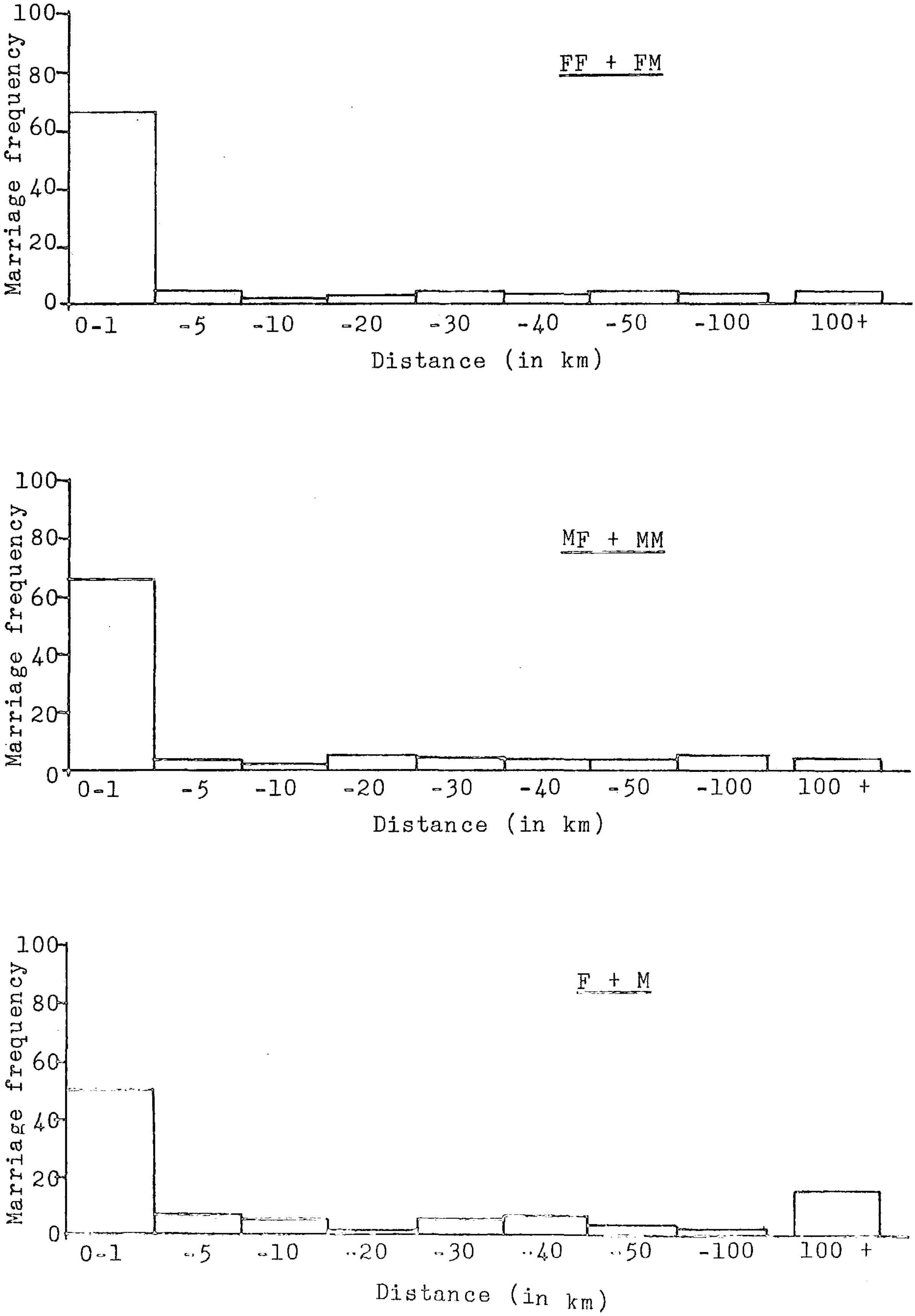
FREQUENCY DISTRIBUTION OF MARRIAGE DISTANCES IN BAKHSH MARKAZI (LONG RANGE MOVEMENT)

Distance (in km)	F's parents No	F's parents %	F's parents cf*	M's parents No	M's parents %	M's parents cf*	Parents No	Parents %	Parents cf*
0 - 1	179	66.8	66.8	144	66.4	66.4	170	49.4	49.4
1 - 5		5.2	72.0		3.6	70.0		7.8	57.2
5 - 10		2.6	74.6		2.3	72.3		5.8	61.0
10 - 20		3.7	78.3		5.6	77.9		1.4	62.4
20 - 30		4.9	83.2		4.6	82.5		5.8	68.5
30 - 40		4.5	87.7		4.1	86.6		7.2	75.5
40 - 50		5.2	92.9		4.2	90.8		5.2	80.9
50 - 100		3.2	96.3		5.0	95.8		3.7	84.6
100 +		3.7	100.0		4.2	100.0		15.4	100.0
Total		268			217			346	
Mean		16.4			18.8			48.8	
Median		0.75			0.75			1.02	
Variance		2256.2			2959.4			12066.6	
Range		429.0			442.8			830.0	
Skewness		5.4			5.4			3.7	
Kurtosis		34.9			34.0			16.6	

* cf = cumulative frequency

Figure 5.4

DISTRIBUTION OF EXOGAMOUS MARRIAGE DISTANCES IN BAKHSH MARKAZI (LONG RANGE MOVEMENT)

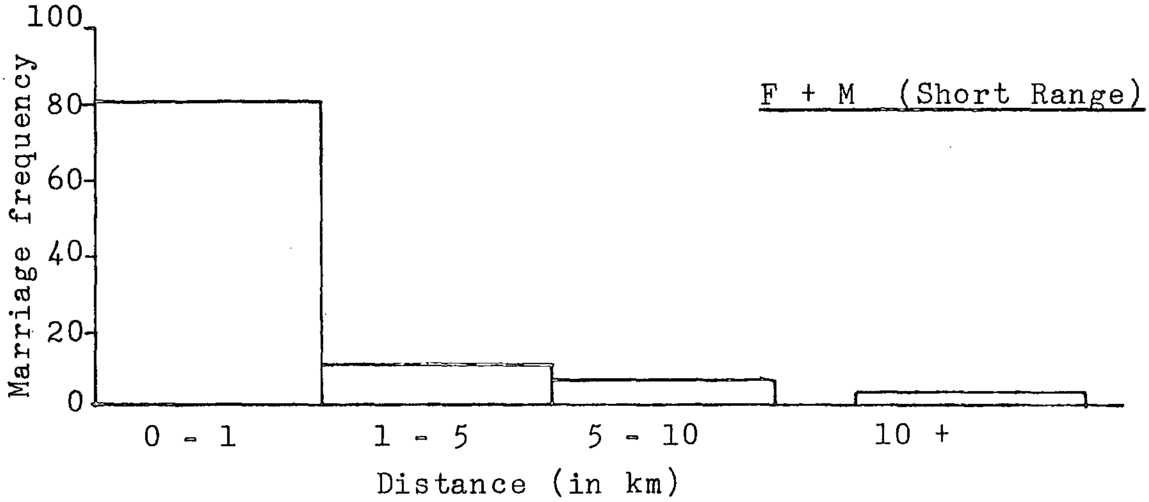


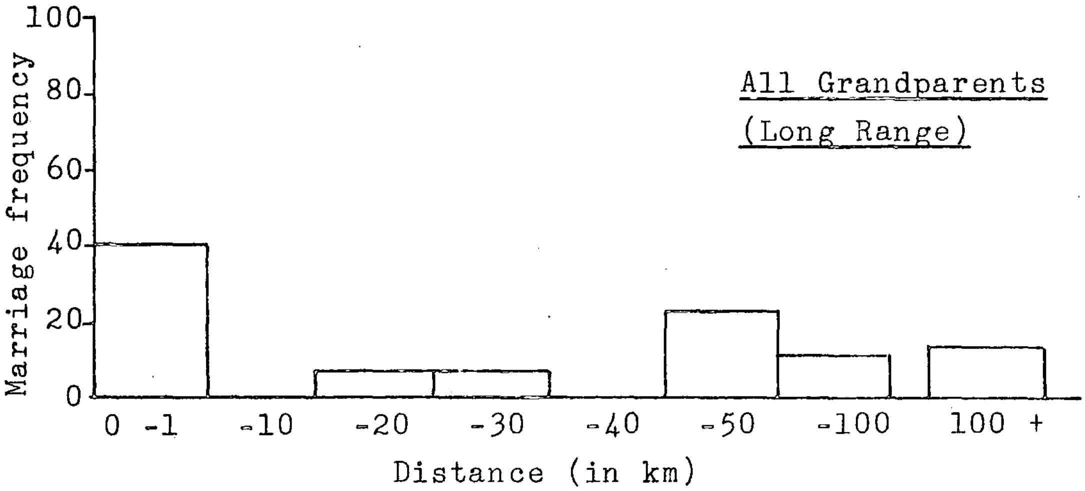
are marrying in the unit of birth, compared with 82% of the grandparents; the difference is statistically significant $X^2=15.60$ $p=.0001$. The mean marriage distance has also increased from 3.5 to 6.5 kms., while the median values show an increase from 600 to 730 meters only. The distribution also demonstrates movement very much limited to short distances. Considering exogamous partners in the analysis, the proportion of '0' class shows a decrease from 66% to 49% between the two generations, $X^2=24.8$ $p=.0001$. The mean distances between the birthplaces of spouses shows an increase from an average of 17 to 49 kms., while the median value has only increased by 250 metres. The range of movement has increased from 400 to 800 kms. It is also observed that 10 to 20% of the exogamous partners are coming in from outside the mean marriage distance for the succeding generations.

In B.Chalous the samples are too small, and the analysis is hampered by this factor. Considering only endogamous marriages, the grandparents reveal 100% birthplace concordance, while for the parents it is reduced to 80.6%. with a mean of 1.4 kms, and a median of 600 metres. Exogamous marriages reveal a more heterogeneous distribution of marriage distances, with lower proportions of '0' class marriages for both generations, ie 40% and 23.4% respectively. The frequency distribution demonstrates a multi-modal distribution, although the main mode lies at '0' . This area witnesses a large proportion of marriages involving partners from the same unit, in addition to numerous long distance marriages. The histograms (Fig 5.5) , show how the shape of the distribution has changed for the two generations.

Figure 5.5

DISTRIBUTION OF MARRIAGE DISTANCES IN BAKHSH CHALOUS





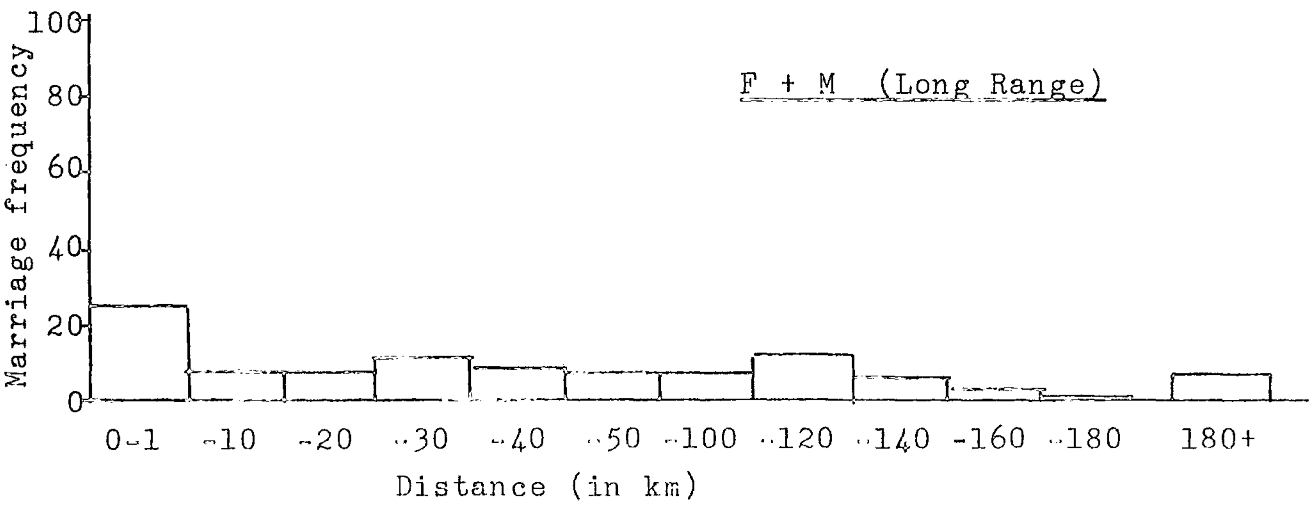


Table 5.18

FREQUENCY DISTRIBUTION OF MARRIAGE DISTANCES IN BAKHSH CHALOUS (LONG RANGE MOVEMENT)

Grandparents				Parents			
Distance (in km)	No	%	cf*	Distance (in km)	No	%	cf*
0 - 1	22	40.0	40.0	0 - 1	25	23.4	23.4
1 - 10		0.0	40.0	1 - 10		6.5	29.9
10 - 20		7.3	47.3	10 - 20		6.5	36.4
20 - 30		7.3	54.6	20 - 30		10.3	46.7
30 - 40		0.0	54.6	30 - 40		8.4	55.1
40 - 50		21.8	76.4	40 - 50		7.4	62.5
50 - 100		10.9	87.3	50 - 100		7.5	70.1
100 +		12.7	100.0	100-120		11.2	81.3
				120-140		6.6	87.9
				140-160		2.8	90.7
				160-180		1.9	92.6
				180 +		7.4	100.0
Total		55				107	
Mean		39.0				64.7	
Median		30.5				35.4	
Variance		1839				8554	
Range		148.5				774.5	
Skewness		1.1				4.5	
Kurtosis		0.7				32.0	

* cf = cumulative frequency

Table 5.17

FREQUENCY DISTRIBUTION OF MARRIAGE DISTANCES IN BAKHSH CHALOUS (SHORT RANGE MOVEMENT)

Distance	Grandparents			Parents		
(in km)	No	%	cf*	No	%	cf*
0 - 1	22	100.0	100.0	25	80.6	80.6
1 - 5		0.0	100.0		9.7	90.3
5 - 10		0.0	100.0		6.4	96.7
10 +		0.0	100.0		4.3	100.0
Total		22			31	
Mean		0.0			1.4	
Median		0.0			0.6	
Variance		0.0			14.4	
Range		0.0			18.3	
Skewness		0.0			3.5	
Kurtosis		0.0			13.5	

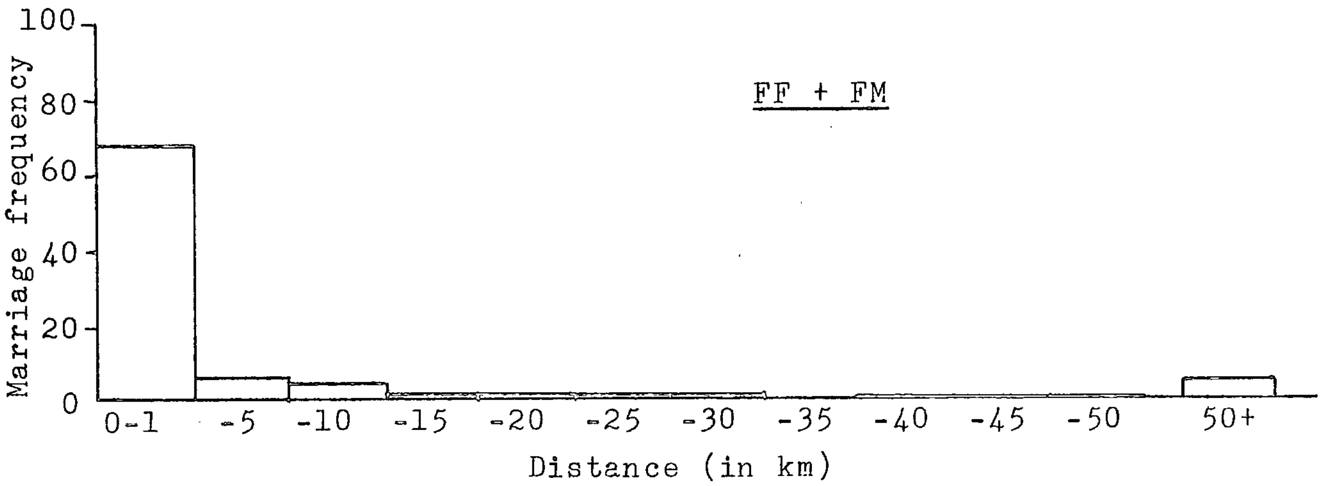
* cf = cumulative frequency

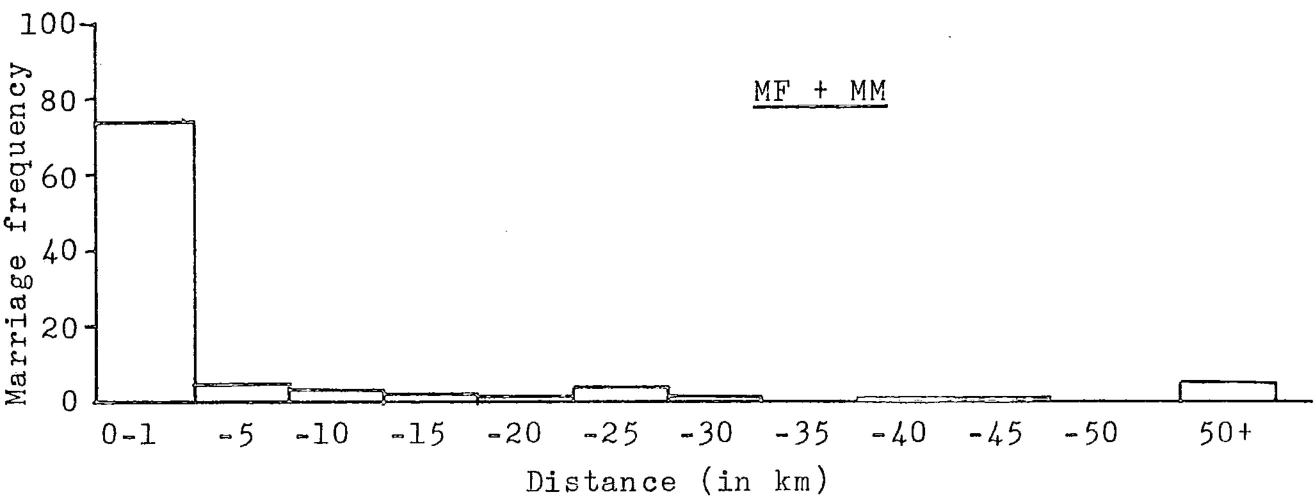
The grandparental distribution shows distance classes in which there are no movements, while in the parental one the distribution has become more continuous, although the multimodality is still apparent. These distributions might be a function of large and small areas surrounding the region, and affecting the pattern of matrimonial distances. In both generations almost 50% of the exogamous partners are from outside the mean marital distance, representing a very heterogeneous population. The mean and median for the grandparents are 39 and 30 kms., while for the parents the difference is much wider, ie 64.7 and 35.4 kms. Both the variance and range has increased between the generations, but no significant differences are observed.

Within B.Kelardasht, mean marriage distance, median distances and the proportion of marriages contracted within the unit of birth, reveal only slight variation between the generations, in the short-range movements. The frequencies of '0' distance class are quite high for both, ranging from 75 to 80%. Such high percentages are a reflection of the geographical nature of this area, which is extremely mountainous and inaccesable, thus restricting movements. Considering long-range movements, the proportion of marriages taking place in the spouses' birthplaces reflects a temporal decrease from an average of 70% to 58.6%. This difference is statistically significant, $X^2=11.95$ $p=.0005$. The mean marriage distance shows an increase from 13.5 to 21 kms., although the median distance has changed from 700 to 850 meters only. The frequency distribution reveals a gradual decline of marriages with increasing distance, as was observed in B.Markazi. The distribution also shows that an

Figure 5.7

DISTRIBUTION OF EXOGAMOUS MARRIAGE DISTANCES IN BAKHSH KELARDASHT (LONG RANGE MOVEMENT)





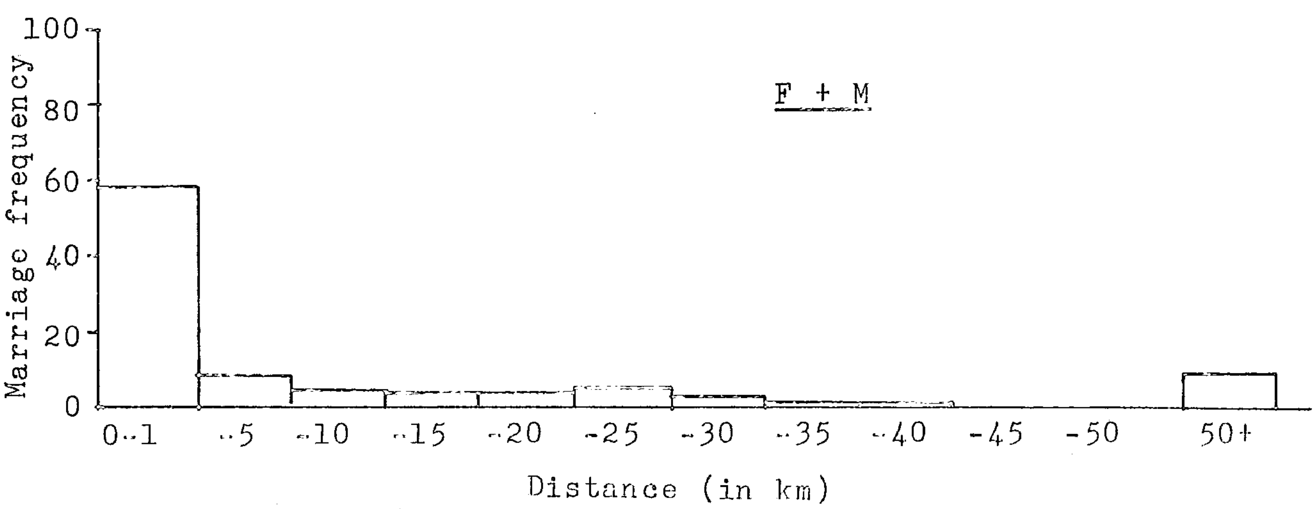


Table 5.18

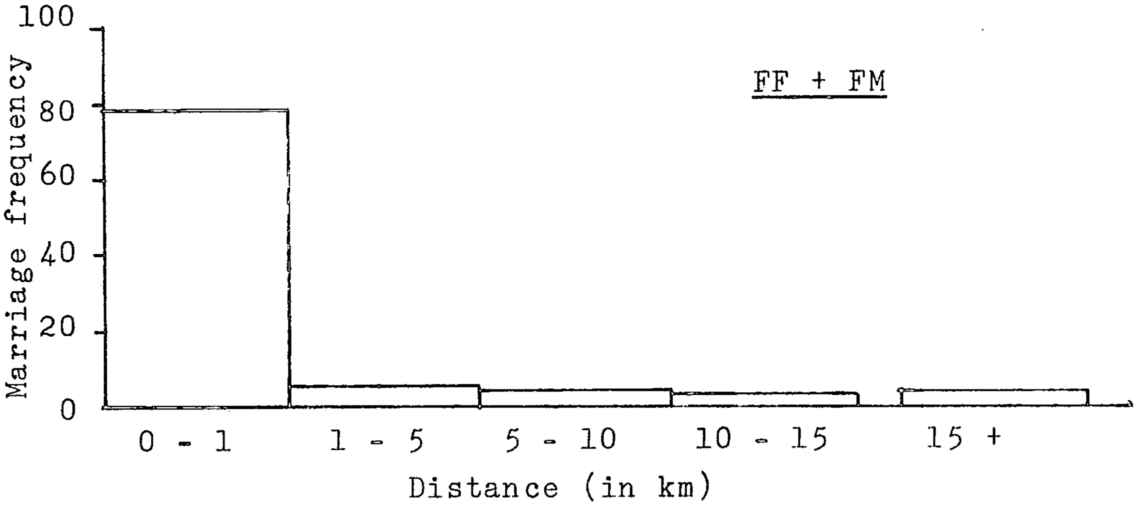
FREQUENCY DISTRIBUTION OF MARRIAGE DISTANCES IN BAKHSH KELARDASHT (LONG RANGE MOVEMENT)

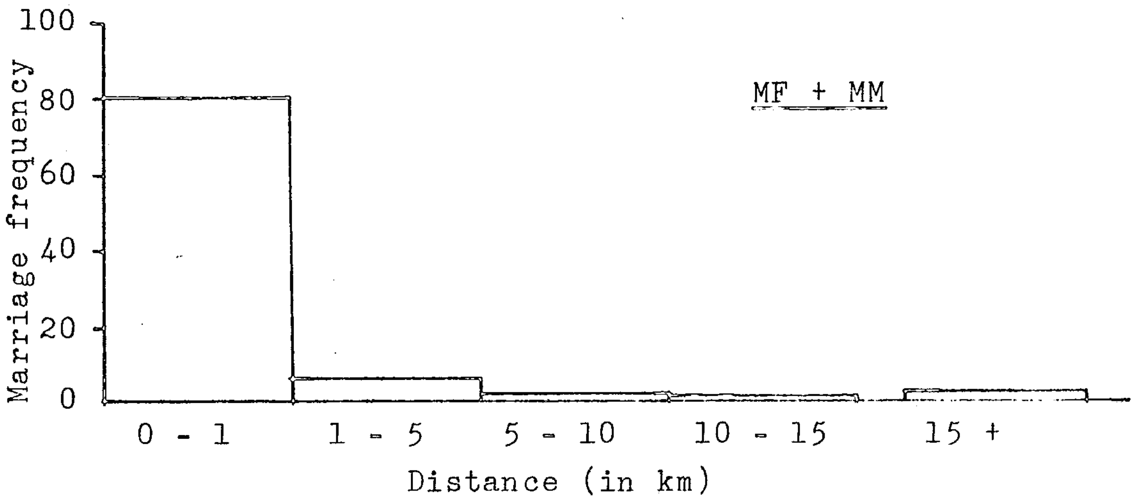
Distance (in km)	FF+FM No	FF+FM %	FF+FM cf*	MF+MM No	MF+MM %	MF+MM cf*	F+M No	F+M %	F+M cf*
0 - 1	193	68.2	68.2	164	73.5	73.5	190	58.6	58.6
1 - 5		6.7	74.9		6.7	80.2		8.7	67.3
5 - 10		5.6	80.5		3.6	83.8		4.6	71.9
10 - 15		2.5	83.0		2.2	86.0		3.4	75.3
15 - 20		2.1	85.1		1.3	87.3		3.1	78.4
20 - 25		2.5	87.6		4.0	91.3		5.5	83.9
25 - 30		2.1	89.7		1.3	92.6		3.1	87.0
30 - 35		0.3	90.0		0.0	92.6		1.6	88.6
35 - 40		1.4	91.4		0.0	92.6		1.8	90.4
40 - 45		1.4	92.8		1.0	93.6		0.3	90.7
45 - 50		1.1	93.9		1.0	94.6		0.3	91.0
50 +		6.0	100.0		5.4	100.0		9.0	100.0
Total		283			223			324	
Mean		13.4			13.7			21.5	
Median		0.73			0.68			0.85	
Variance		1904.4			2949.2			4453.8	
Range		435.2			464.0			763.5	
Skewness		5.6			5.9			6.3	
Kurtosis		39.6			39.2			53.7	

* cf = cumulative frequency

Figure 5.6

DISTRIBUTION OF ENDOGAMOUS MARRIAGE DISTANCES IN BAKHSH KELARDASHT (SHORT RANGE MOVEMENT)





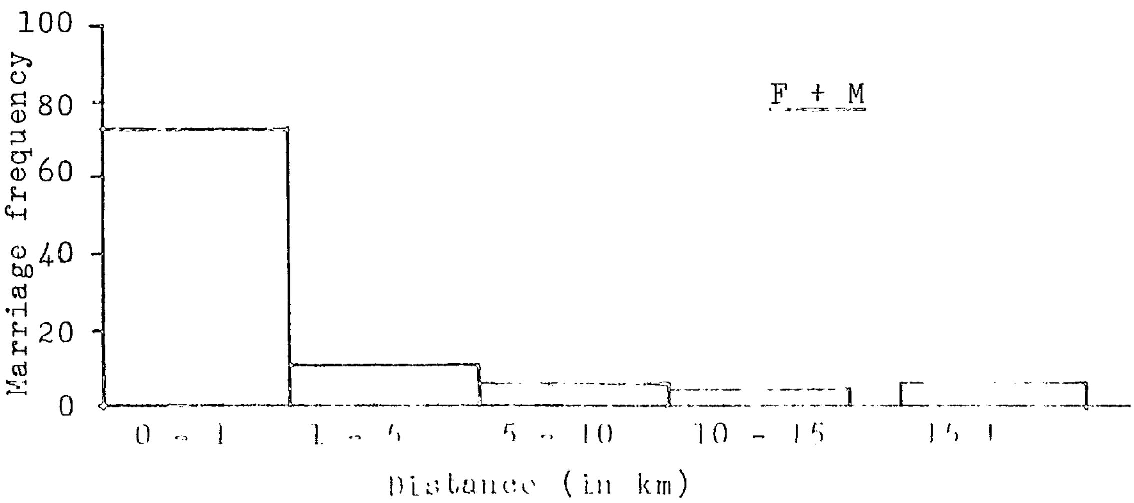


Table 5.19

FREQUENCY DISTRIBUTION OF MARRIAGE DISTANCES IN BAKHSH KELARDASHT (SHORT RANGE MOVEMENT)

Distance	FF+FM			MF+MM			F+M		
(in km)	No	%	cf*	No	%	cf*	No	%	cf*
0 - 1	193	79.1	79.1	164	81.6	81.6	190	75.1	75.1
1 - 5		7.0	86.1		7.9	89.5		9.5	84.6
5 - 10		6.1	92.2		3.5	93.0		5.9	90.5
10 - 15		2.5	94.7		2.0	95.0		3.6	94.1
15 +		5.3	100.0		5.0	100.0		5.9	100.0
Total	244			201			253		
Mean		2.3			1.8			2.4	
Median		0.63			0.61			0.67	
Variance		39.8			26.9			34.9	
Skewness		3.7			3.4			3.0	
Kurtosis		14.6			10.9			8.8	

* cf = cumulative frequency

average of only 16% of all exogamous partners are from outside the mean marital distance, while for the parents the figure is 21%.

The marriage distance analysis has elucidated the pattern and components of marital mobility in Shahrestan Nowshahr. The main feature of the marital movement is that there is a strong tendency for marriages to take place in the same locality as the birthplaces of the spouses, that is choosing a spouse born in the same area. The mean marital distance shows an increase in both short and long range movements between the two generations, both in the Shahrestan and the individual bakhshes. Temporal increase in mean marriage distance has also been observed in other studies (Sutter and Trang-Ngoc-Toan, 1957; Fracaro, 1959; Küchemann et al, 1967; Boyce et al, 1968, 1971; Beckman and Cedergren, 1971; Hiorns et al, 1973; De Vore, 1980).

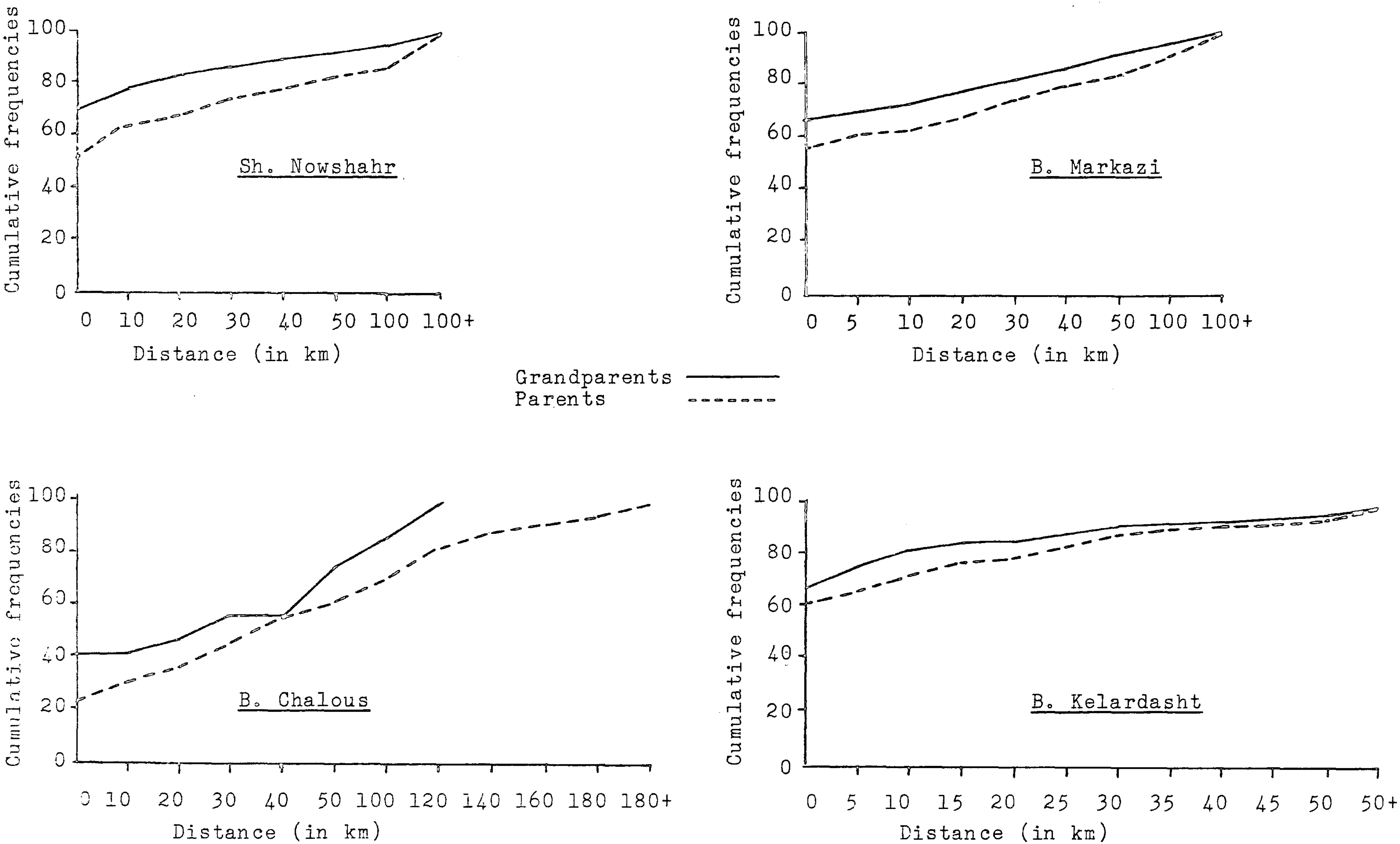
The median values are obviously more applicable to the majority of the cases, since a large proportion of the population is still marrying locally, with few occurrences of long-distance marriages. The kurtosis and skewness values reveal that the distribution of the marriage distances are highly skewed towards the origin, ie the birthplace. Several other researchers have also observed that in sedentary populations the distribution of marital distance is asymmetrical and has leptokurtic tendencies (Sutter and Trang-Ngoc-Toan, 1957; Cavalli-Sforza, 1958; Fracaro, 1959; Boyce et al, 1967, 1973; Malhotra and Kanhere, 1975; Reddy and Mukherjee, 1975; Coleman, 1977b, 1979; Mukherjee et al, 1978; Majumdar and Malhotra, 1979; Malhotra, 1980).

The proportion of local breeding has decreased from the grandparental to the parental generation, and significant differences were observed. The extent of interbreeding within the Shahrestan, ie between the villages appears to be limited to short distances and contiguous settlements. The results indicate that the effect of long-range migration or systematic pressure constitutes only a small proportion of the migration, and accounts for only a small portion of the recipient's gene pool. The proportion of migrants from outside the unit of habitation is around 20 - 30% in the short range movement, and between 30 - 40% in the long-range movement, but as the cumulative frequencies on Fig. 5.8 show these percentages of outbreeding are orientated towards short distances from the center, and are confined to the borders of the study area rather than to distant places. The frequency distribution also conforms with other studies pertaining to decrease in frequency of marriages as a function of distance (Boyce et al, 1967).

Various models of population structure have emphasized the importance of distance as a determinant of movement patterns and admixture between Mendelian units, and have incorporated this factor. The 'Neighborhood Knowledge' model of Boyce et al (1967) explains marriage movement on the basis of the distances between the neighborhoods and their population sizes which determine the knowledge of the surrounding areas. This model is similar to the 'Gravitational Model' of Cavalli-Sforza (1958, 1962), whereby movement is limited around the central residence place. Both these models are based on the behavioural and migratory attributes of the inhabitants in regards to their

Figure 5.8

CUMULATIVE PERCENTAGE DISTRIBUTION OF MARRIAGE DISTANCES (LONG-RANGE MOVEMENT)



environments.

Other models have also emphasized the influence of distance on the level of interbreeding and admixture or, alternatively, on the degree of deviation from panmixia. The 'Isolation by Distance' model of Wright (1943), studies genetic exchange and migration range; that of Malecot (1967) correlates local differentiation with distance; Kimura and Weiss (1964) observe decrease of genetic correlation with distance, and Yasuda and Morton (1966) correlate the coefficient of kinship with distance.

The general pattern of the marriage distances and its highly skewed shape allows extrapolation on the relatedness within the population in terms of genealogical relationship. It is evident that a large proportion of the samples in each generation is selecting mates within a small geographic range. The small range and spread of the distances indicate restricted mobility and localization of genes. Malhotra and Majumdar (1974) inferred that the more the geographical distance between the units of settlements, the smaller the inter-migration rate, resulting in increasing genetic distance between them. The present results also indicate that with increasing distance the migration rate in terms of marriages has decreased. The implications of these factore are primarily that the effective size of the settlements are small with such highly localized gene pool and limited distribution, and that this situation is highly conducive to the process of random genetic drift and local genetic differentiation.

In his study, Khazaneh (1968) also included an analysis on the mean distances between the birthplace of spouses (Table 5.20). His results indicated small range of movement and short

Table 5.20

MEAN DISTANCE BETWEEN PLACES OF BIRTH (IN KM)

District	Husband & Wife	Husband's Parents	Wife's Parents
Kazeroun	2.10	0.17	0.19
Torbat Heydarieh	3.10	0.14	0.12
Tonkabon	3.20	0.26	0.59

Source: Khazaneh (1968)

mean distances. He also found lower marital distances between the parents of the husbands and wives, and attributed this to the phenomenon of economic development and improved communication in association with a decrease in endogamy rate.

In general, the analysis of the marriages distances and their distributions has given an indirect estimate of the homogeneity of the numerous small settlements comprising Shahrestan Nowshahr.

5.3.3 Orientation of marital mobility

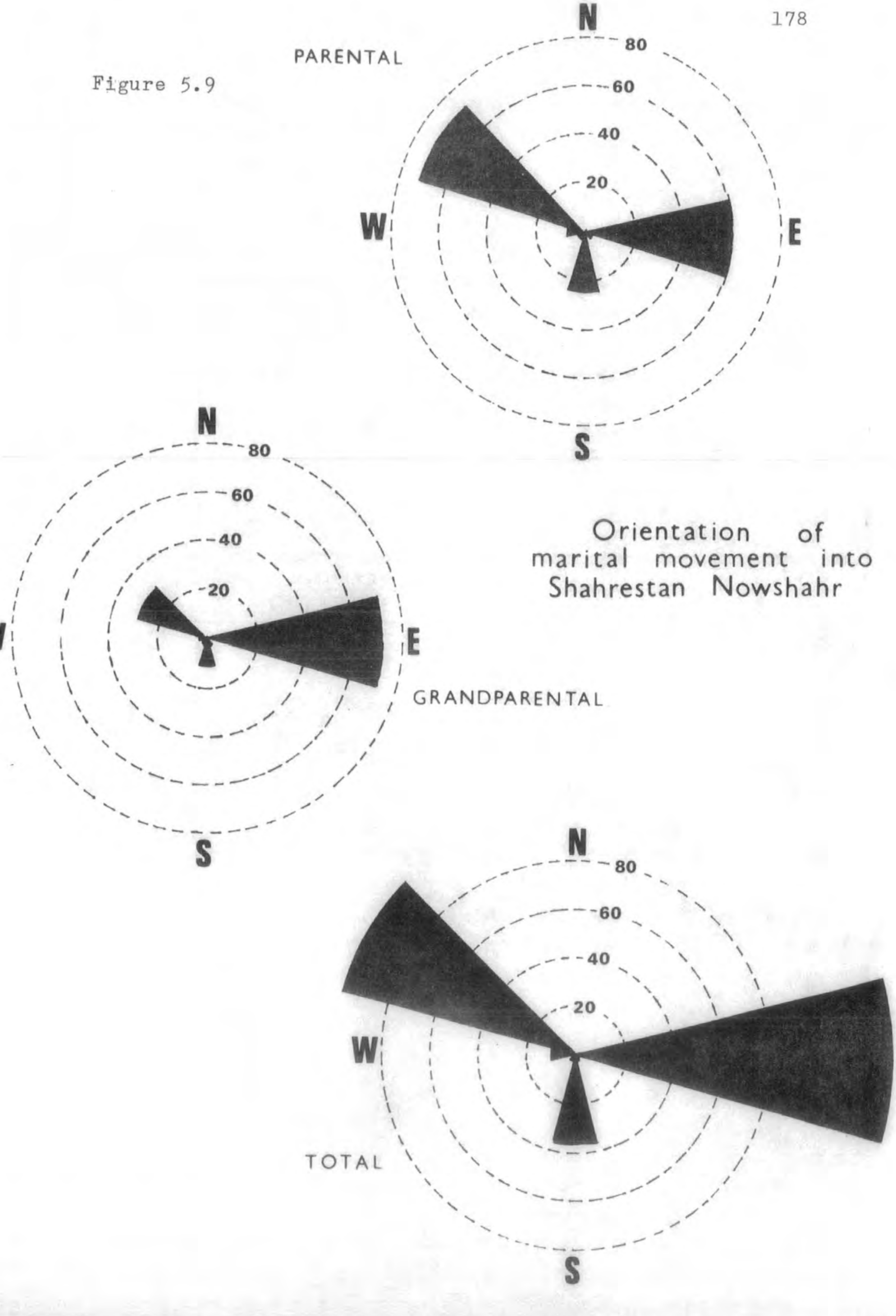
The geographical and spatial pattern of gene flow is one component of marital mobility that indicates the orientation and direction of movement. The general pattern of movement has been shown to be asymmetrical with distinct orientations (Boyce et al, 1968, 1971). The asymmetry and non-randomness is mainly attributed to the effect of local geography (mountains, rivers, forests, swamps and uninhabited land), differences in population sizes (Harrison and Boyce, 1971), and the pattern and network of roadways inhibiting free movement to any direction. Other influential factors could be linguistic and cultural elements which introduce a selective and purposeful tendency to the direction of movement. These factors determine the axes along which movement occurs, and can also be used as indications of the degree and intensity of relatedness between populations.

One method of examining the orientation of movement is through the census records, which indicate the general flow of people from one population to another. The analysis of the orientation of marital mobility is a more informative index, from a genetic point of view, since it encompasses movement of genes that would contribute to the gene pool of the next generation. Factors like differential fertility and mortality and post-marital movement and change of residence of spouses could result in no impact on the genetic structure.

The analysis of orientation of marital mobility in Shahrestan Nowshahr has been examined by looking at the birth-localities of the exogamous partners who have moved into the area. Figures 5.9 and 5.10 demonstrate that there is a distinct and consistent orientation to the marriage movement in both grandparental and parental generations. Three main axes of movement are observed in both generations: i.e. the Ostans of Mazandaran, Gilan and Markazi. In the grandparental generation, from a total of 122 exogamous partners, 72 (59%) are moving in from O.Mazandaran, 25 (20.5%) from Gilan, 13 (10.7%) from Markazi, 4 (3.3%) from Zanjan and 3 (2.5%) from Azarbaijan; the other 5 (4%) are from other localities in Iran. In the parental generation orientation still follows the same axes, although the proportions and the contributions to the recipient population are more evenly distributed between the eastern and western axes. From a total of 168 exogamous partners, 59 (35%) are from Mazandaran, 61 (36.3%) from Gilan, 23 (13.7%) from Markazi, 11 (6.5%) from Azarbaijan, 8 (4.8%) from Zanjan and 6 (3.6%) from the rest of Iran.

The general pattern of movement for both generations is mainly orientated from the two contiguous provinces of Mazandaran and Gilan, and a northwest-northeast axis is observed. This is mainly attributed to the geographic position of the Caspian

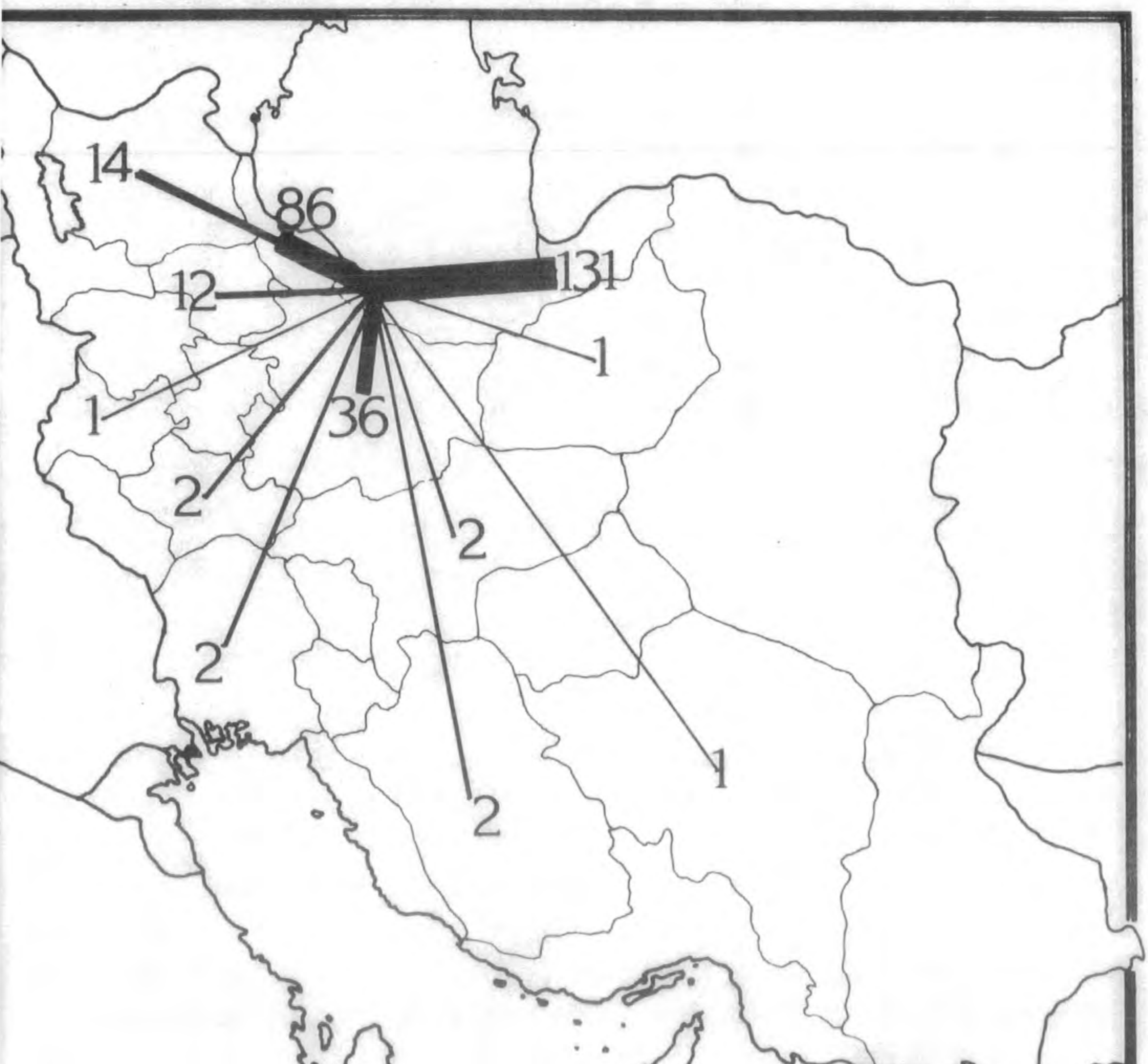
Figure 5.9



Orientation of marital movement into Shahrestan Nowshahr

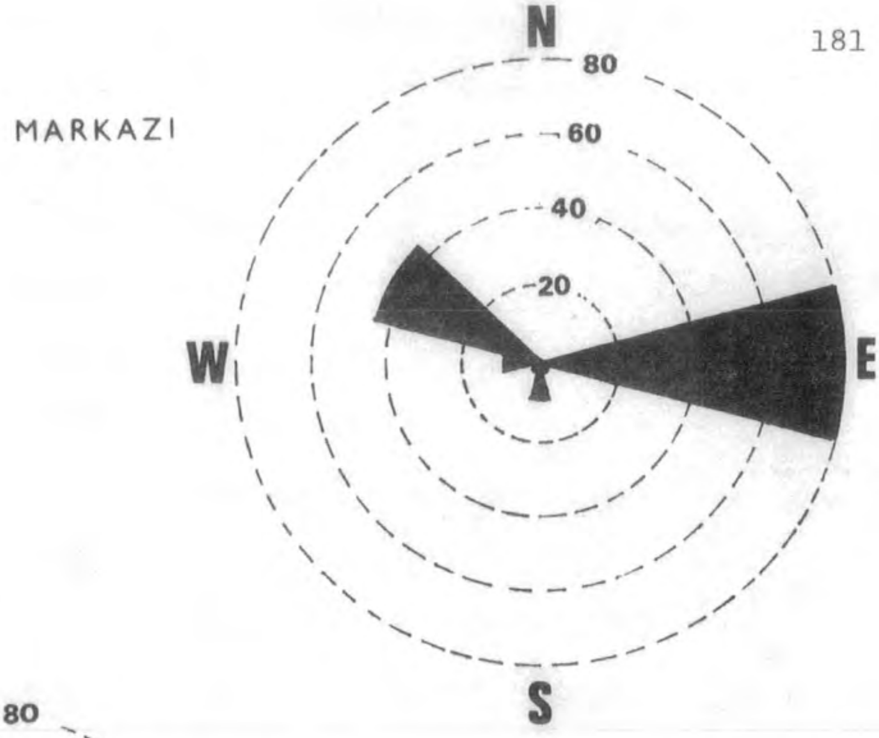
Figure 5.10

Orientation of Marital Movement into Shahrestan Nowshahr



Provinces which are bordered by the Alborz Mountains in the south, thus delineating up to 75% of the movement to the littoral area. The third important axis is a south-north axis, ie from Ostan of Markazi, which comprises 12.4% of the total exogamous partners. All three lines of movement also coincide with the roadways into Shahrestan Nowshahr: a major road from Teheran in O.Markazi, via the Alborz ranges and Kandevan passes, to Shahrestan Nowshahr; this further follows two directions along the coastline, east towards Mazandaran and west towards Gilan. Movement from Markazi has slightly increased, in addition to the movement from other ostans such as Azarbaijan and Zanjan which are situated further in the northwest. These may be the result of development and reconstruction of roads, tunnels and bridges during the last forty years, allowing more movement from more distant places. The most important element observed is that the orientation reflects historical pattern of movement that has been determined by the local geography, and it is still evident that the geographic features are influencing the present pattern of movement and contributing to the delineation of the Caspian area from the rest of Iran.

Orientation of marital movement into the three Bakhshes of Shahrestan Nowshahr reveal the same pattern (Fig. 5.11). In B.Markazi and Kelardasht, around 50% of the genes are coming from the shahrestans of O.Mazandaran and between 20 to 30% from those of Gilan; B.Kelardasht receives more incoming genes from O.Gilan. Contributions from O.Markazi is only 6% to B.Markazi, while it is 16.9% to B.Kelardasht. Contributions from all other ostans is 19.5% in B.Markazi and 7.2% in B.Kelar-



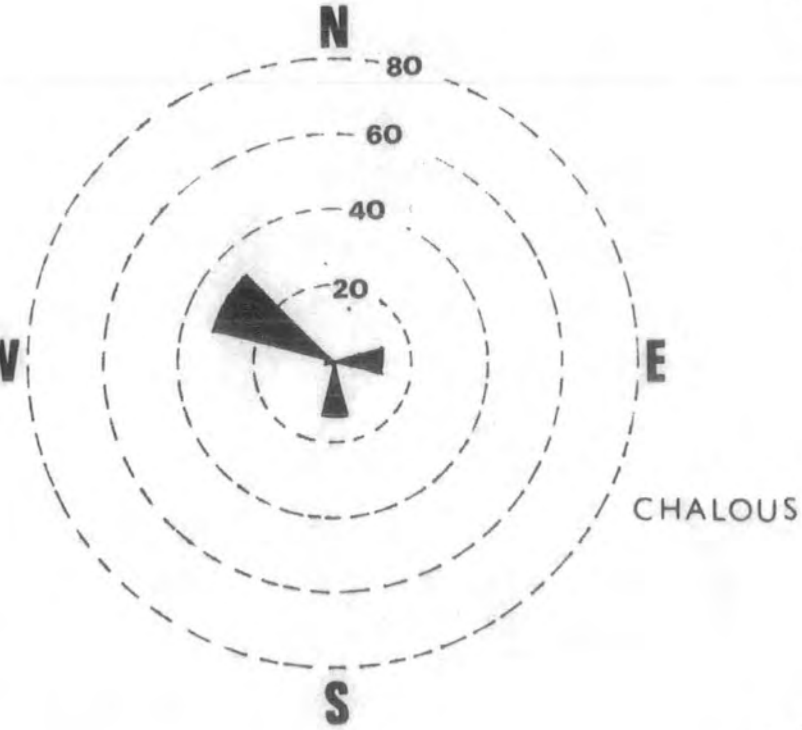
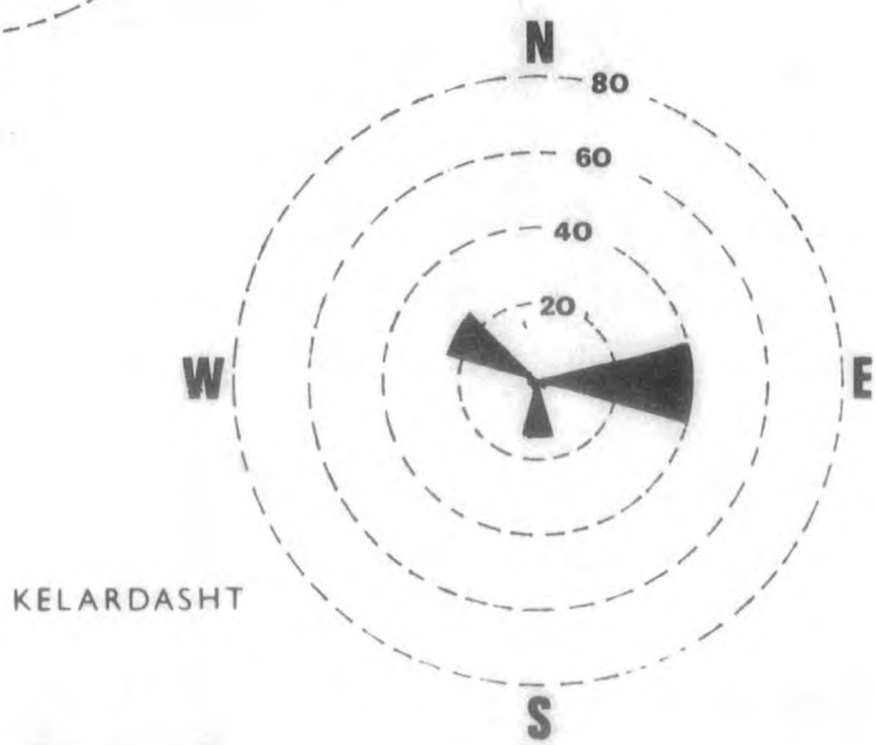


Figure 5.11

Orientation of marital movement into Shahrestan Nowshahr by Bakhsh



dasht. Bakhsh Chalous represents a different pattern of genetic movement: the main contributors are from O.Gilan (55.2%), and 22.4% from O.Markazi, and only 19% from O.Mazandaran.

One interesting factor to be emphasized is that the pattern of gene flow into the Shahrestan very highly parallels the orientation of general movement as examined from the census material and from the present study. They also show that mobility is orientated between the two provinces of Mazandaran and Gilan, therefore intensifying the importance of the geography of the area as the essential contributor to the pattern of movement. This parallelism also indicates that the general migration pattern is to a large extent based on marriage unions.

Another component of marital movement is the direction of movement, which is examined by measuring the reciprocal movement between different population units (Boyce et al, 1968). For such an analysis migrational data are required on each population unit in order to measure the comparative contributions made by each to the other. The giver/receiver ratio, which is the relative degree of interchange between pairs of units, indicates the direction of movement. The direction of movement is affected by various factors such as population sizes, local geography and the extent of urbanization. Reciprocity can be measured by marital migration analysis. No analysis was possible on this component of marital movement since the census records only provides information on where people come from and not where they go to.

5.4 PARENT-OFFSPRING MOVEMENT

5.4.1 Parent-offspring birthplace concordance

The extent of concordance and distance between the birthplaces of parents and those of their offspring is a measure of actual genetic movement. The extent of admixture and panmixia, or conversely the isolation of a population, can be examined through the distribution of the distances between their birthplaces. Such analyses also demonstrate the extent to which the offspring generation reflects the gene pool of the parent population.

The results of the analyses of birthplace concordance and distance distribution between parents and offspring are based on two generations: those of the father and his parents and those of the mother and her parents; and secondly those of the father and his offspring and the mother and her offspring. The latter analysis is based on two approaches; looking at parents with only their first offspring, and parents with all their offspring, to examine any tendency for the degree of concordance of birthplaces to decrease with post-marital movement. For the sake of brevity, the terms father's father, father's mother, mother's father, mother's mother, father, mother, first offspring and all offspring will be abbreviated as follows: FF, FM, MF, MM, F, M, O1, O respectively.

Table 5.21 indicates the concordance of birthplaces of grandparents-parents and parents-offspring in the total population of Sh. Nowshahr. The index 'both born' in Sh. Nowshahr of grandparents-parents show an average of 59.9% in the total

Table 5.21

PROPORTION OF CONCORDANCE OF BIRTHPLACES OF PARENTS AND OFFSPRING IN THE TOTAL POPULATION

Family Pairs	Total	Both born in Sh. Nowshahr No.	%	Parent born in Sh. Nowshahr No	%	Offspring born in Sh. Nowshahr No	%	Neither born in Sh. Nowshahr No	%
FF-F	979	538	55.0	8	0.8	81	8.3	352	35.9
FM-F	970	528	54.4	15	1.5	83	8.6	344	35.5
MF-M	611	422	69.1	8	1.3	39	6.4	142	23.2
MM-M	605	409	67.1	12	2.0	43	7.1	141	23.3
$F-O_1$	1010	612	60.6	29	2.8	211	21.0	158	15.6
$M-O_1$	1004	619	61.7	30	3.0	201	20.0	154	15.3
F-O	7311	4702	64.3	175	2.4	1670	22.8	764	10.4
M-O	7247	4711	65.0	194	2.7	1616	22.3	726	10.0

population. This value is based upon the individual percentages of the four grandparents and their offspring, which ranges from 54.4% to 69.1%. The index for the parents and their first offspring and all their offspring shows an average of 61.1% and 64.7% respectively. The proportion of offspring born in Sh. Nowshahr but whose parents are not born there, shows a substantial increase between the two generations, from an average of 7.8% to 21.5%. Only a small proportion of parents who are born in the Shahrestan have offspring born elsewhere, in both generations. These primary results indicate that almost sixty five percent of the total population's gene pool is composed of the indigenous inhabitants, and further, that temporally an increase in the size of the gene pool is observed in the second generation since a higher proportion of offsprings are being born in Sh. Nowshahr who have parents born elsewhere.

As was indicated above, the proportions of parents who are born in the Shahrestan but have offspring born elsewhere is small in both generations, indicating little genetic mobility by the parents. Table 5.22 presents the percentage concordance of birthplaces between parents who are born in Shahrestan Nowshahr and those of their offspring. It is observed that over 95% concordance is evident. The difference between the two generations is only between 1 and 2%. The three Bakhshes also reveal the same pattern of small genetic contribution to other populations by the parents. Both B.Markazi and B.Kelardasht show a slight increase of 2 to 5% between the generations, and B.Chalous shows the least concordance between the parents' and offspring birthplaces, in addition to a larger difference

Table 5.22

PROPORTION OF CONCORDANCE BETWEEN BIRTHPLACES OF PARENTS AND OFFSPRING IN SHAHRESTAN NOWSHAHR AND ITS THREE BAKHSHES

Family	Sh. Nowshahr			B. Markazi			B. Chalous			B. Kelardasht		
Pairs	No	%	Total	No	%	Total	No	%	Total	No	%	Total
FF-F	538	98.5	546	241	98.8	244	27	90.0	30	256	94.1	272
FM-F	528	97.2	543	235	93.6	251	20	74.1	27	245	92.5	265
MF-M	422	98.1	430	193	97.0	199	11	91.7	12	207	94.5	265
MM-M	409	97.1	421	185	92.5	200	7	63.6	11	198	94.3	210
F-O_1	612	95.5	641	263	90.4	291	55	90.2	61	250	86.5	289
M-O_1	619	95.4	649	263	89.5	294	54	74.0	73	237	84.0	282
F-O	4702	96.4	4877	1942	92.6	2097	452	89.0	508	1898	83.5	2272
M-O	4711	95.9	4911	1915	89.3	2144	418	76.4	547	1803	81.2	2202

between the famale parent and the offspring. Sexual dimorphism in birthplace concordance will be discussed later.

5.4.2 Parent-offspring birthplace distance

A more informative and detailed means of examining the extent of localization and the distribution of genes is to measure the distances between the birthplaces of parents and their offsprings. Such analyses allow examination of the range of genetic movement on the smallest scale of measurement, that is from the actual unit of habitation, namely the village or the town, while the former analyses were based on larger administrative divisions.

Tables 5.23 - 5.28 and Figures 5.12 - 5.17 show the frequency distribution of distances between the places of birth of parents and offspring in both generations, in addition to the necessary statistical parameters such as the mean, variance, median, skewness and range of the distribution. Throughout the analyses only those parents who are born in the unit of study are recognized, and migrant parents have been excluded.

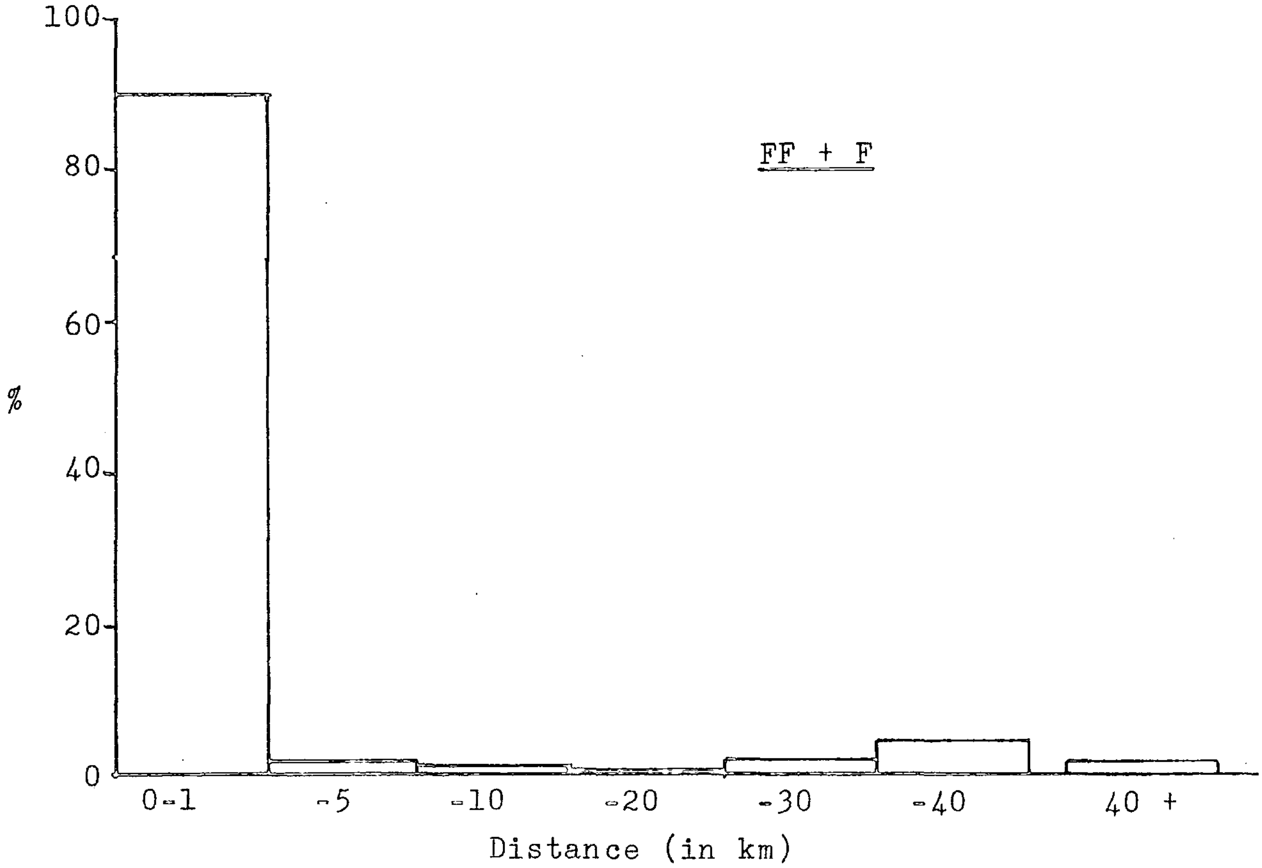
The results in the '0' distance class for the grandparent-parent generation reveal a high proportion of the birthplaces to be similar. The percentages for FF-F, FM-F, MF-M, MM-M, are 88.4%, 72.6%, 85.8% and 76.7% respectively. These high percentages indicate that a large proportion of the indigenous population of Sh. Nowshahr is contributing to the gene pool of the next generation. The distribution of the distances also reveals that these high indices of birthplace concordance are limited to the village or town of birth. Genetic movement from the villge, in terms of offspring being born outside

Table 5.23

FREQUENCY DISTRIBUTION OF DISTANCES BETWEEN THE BIRTHPLACES OF GRANDPARENTS AND PARENTS (ONLY GRANDPARENTS BORN IN SHAHRESTAN NOWSHAHR)

Distance	FF/F			FM/F			MF/M			MM/M		
(in km)	No	%	cf*	No	%	cf*	No	%	cf*	No	%	cf*
0 - 1	482	88.4	88.4	393	72.6	72.6	368	85.8	85.8	323	76.7	76.7
1 - 5		1.7	90.1		6.1	78.7		3.5	89.3		5.2	81.9
5 - 10		0.9	91.0		4.9	82.6		4.1	90.4		2.4	84.3
10 - 20		0.6	91.6		3.0	85.6		1.9	92.3		4.1	88.4
20 - 30		1.8	93.4		3.4	89.0		2.8	95.1		4.5	92.9
30 - 40		4.4	97.8		5.3	94.3		0.6	96.7		2.8	95.7
40 +		2.2	100.0		5.7	100.0		3.3	100.0		4.3	100.0
Total	545			541			429			421		
Mean		5.0			8.6			6.2			8.5	
Median		0.57			0.69			0.58			0.65	
Variance		1269.1			1455.3			1880.5			2106.2	
Range		769.0			768.0			763.5			763.2	
Skewness		18.6			15.6			14.4			12.8	
Kurtosis		391.6			301.8			233.9			190.2	

Figure 5.12
DISTRIBUTION OF DISTANCE OF BIRTHPLACE BETWEEN PARENT AND OFFSPRING IN SHAHRESTAN NOWSHAHR



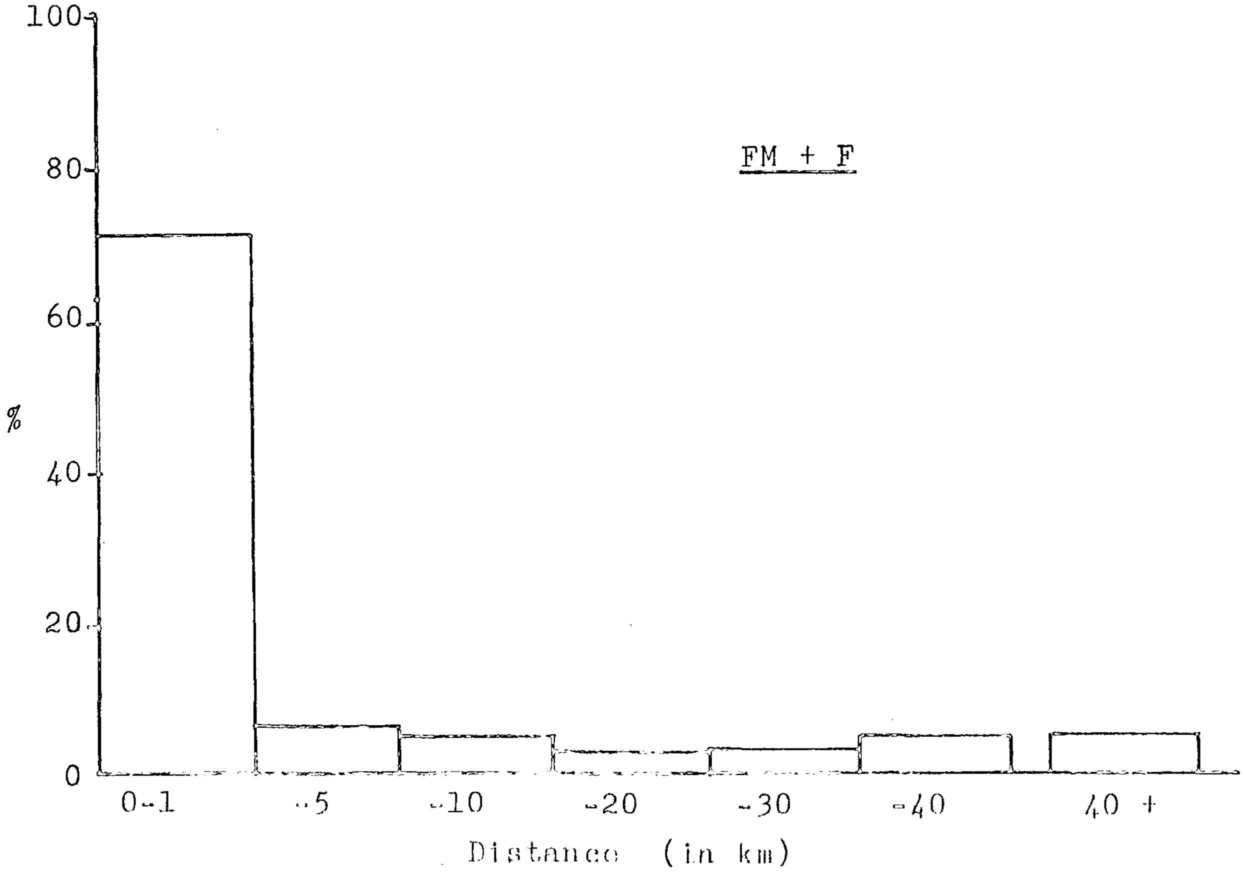
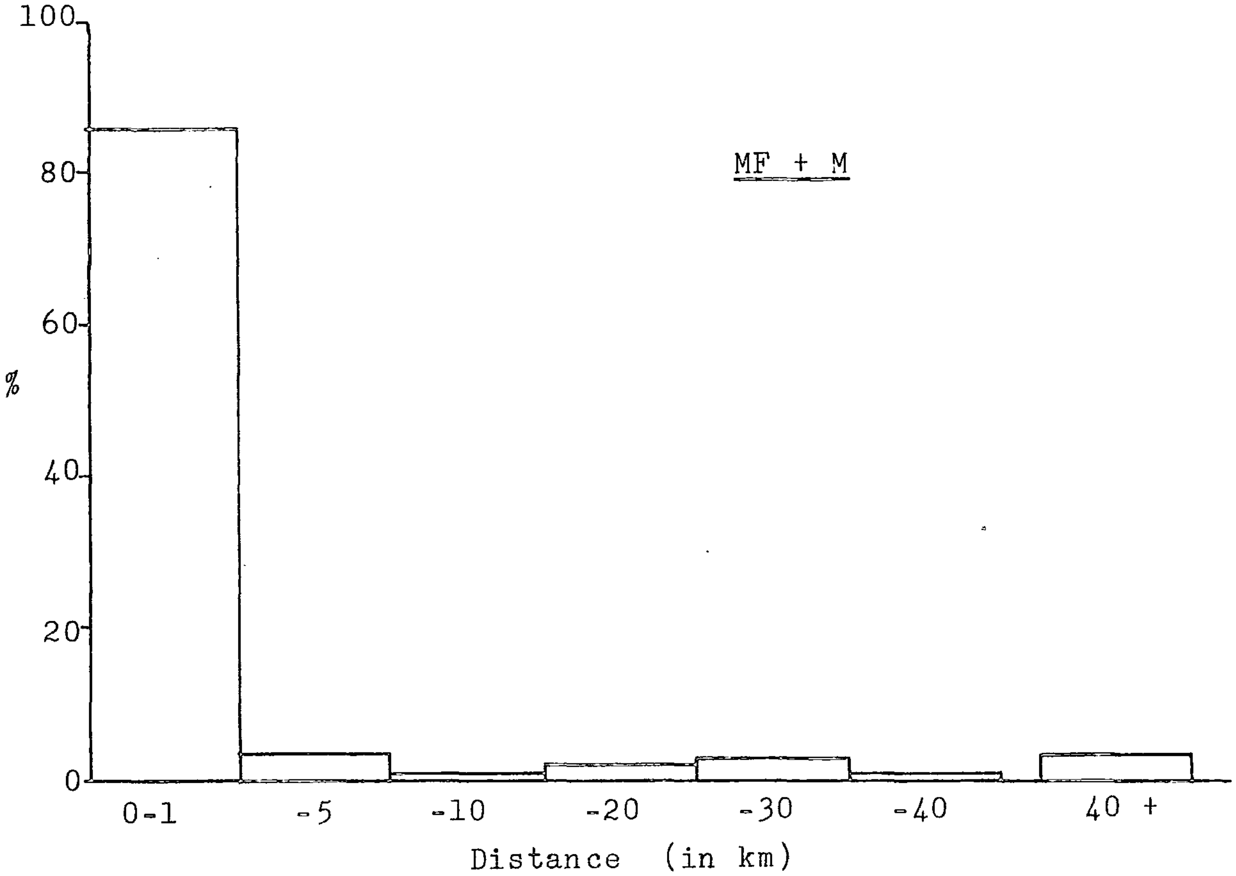
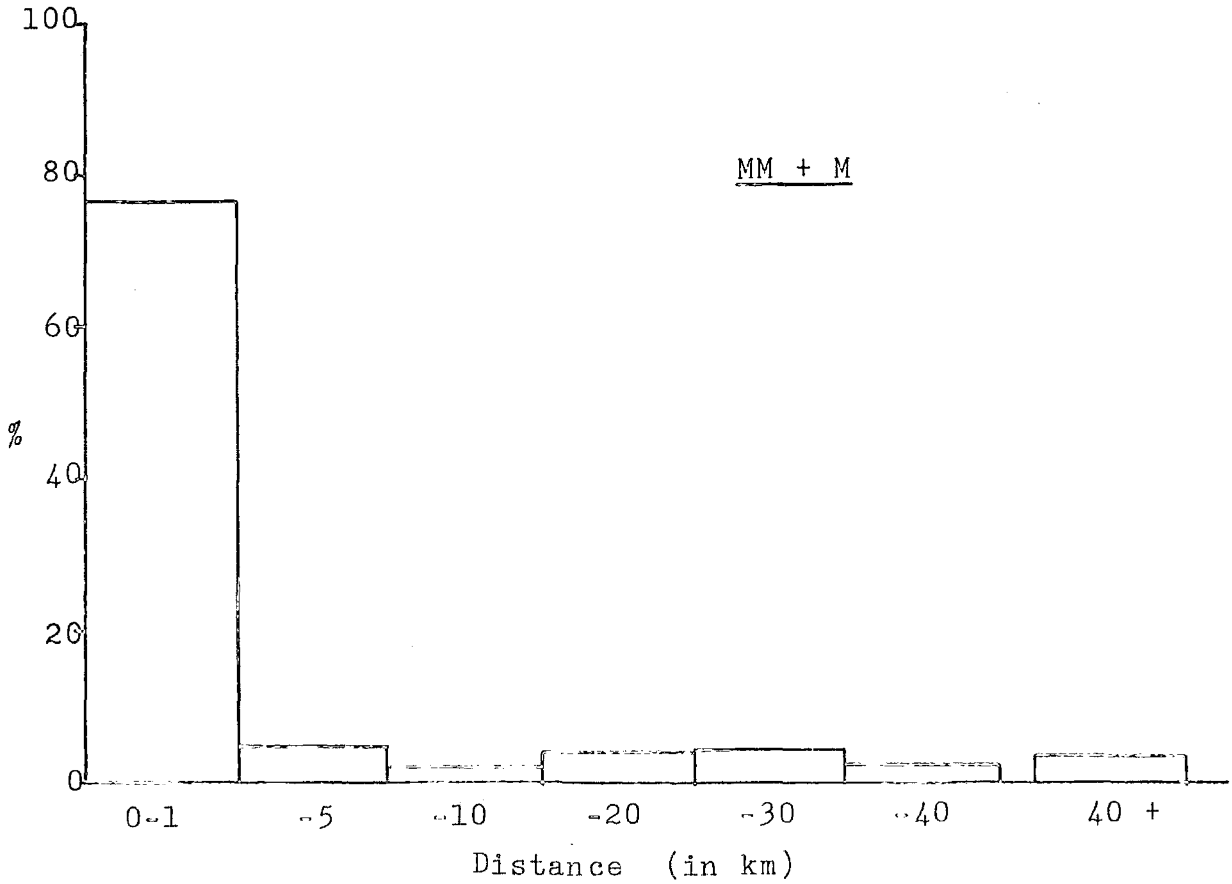


Figure 5.12 (continued)





the birthlocality of the parent, appears to be very small and confined to not more than 40 kms., and only between 2.2% and 5.7% of the genetic contribution in the form of offsping is beyond that limit.

The mean distance between the birthlocalities of the grandparents and parents ranges between 5 to 6.2 km for the male grandparents and their offspring, and between 8.5 to 8.6 km for the female grandparents and their offspring. In general, the distribution is very much skewed to the origin and limited to 40 km., but the range of the distances show long distances of up to 769 km. Therefore it seems appropriate to examine the median values which are more characteristic of the actual radius of movement, disregarding the few instances of long-range movement that distort and inflate the mean values. The median values show an average of just over one-half kilometer for all the four grandparents. These values indicate the extent of concentration of genes within the individual units of villages.

One interesting and informative characteristic of the population that has emerged from these results is the lower proportions in the concordance of the birthplaces of the female grandparents and their offspring. Both FM-F and MM-M show lower percentages in the '0' distance class; the X^2 test revealed statistical significance in the differences between the male and female grandparents, X^2=50.79 p=.0000. Sexual dimorphism is expected and is mainly attributed primarily to the socio-cultural and traditional elements of agricultural communities in the rural areas of Iran. It is mainly the son who inherits the land and is bound to it for subsistence, while the females are usually married away from home. Therefore in the majority of cases it is the female who moves to a new unit of habitation following the norm of patrilocality.

In the next generation, as observed from Table 5.24 and Figure 5.13, there still appears to be a preponderance of birthlocalities of parents and offspring in the '0' distance class. The results are based on parents and their first offspring (F-01 and M-01) and parents and all their offspring (F-0 and M-0). The results are very similar in both instances, indicating very little mobility of genetic significance after the first born offspring, namely that post-marital movement, if any, has not contributed genetically to other populations and is confined to the parents' birthlocalities.

The percentages of fathers and offspring being born in the '0' distance class or within the confines of the village is 73.1% for the first offspring and 69.9% for all offspring. These indices for the female parents are 62% and 59.3% respectively. Statistical differences were observed between the male and female parents in their birthplace concordance in the '0' class, X^2=118.3 p=.0000.

The distribution shows that for both sexes gene flow away from the village is small and confined to 40 km., and only 7 - 8% of the parents are contributing through their offspring to other populations. The mean values indicate a range of 11.2 and 12.5 km. for the male and female parent respectively. The median values give a more realistic range of movement and they range from 680 to 840 meters.

Table 5.24

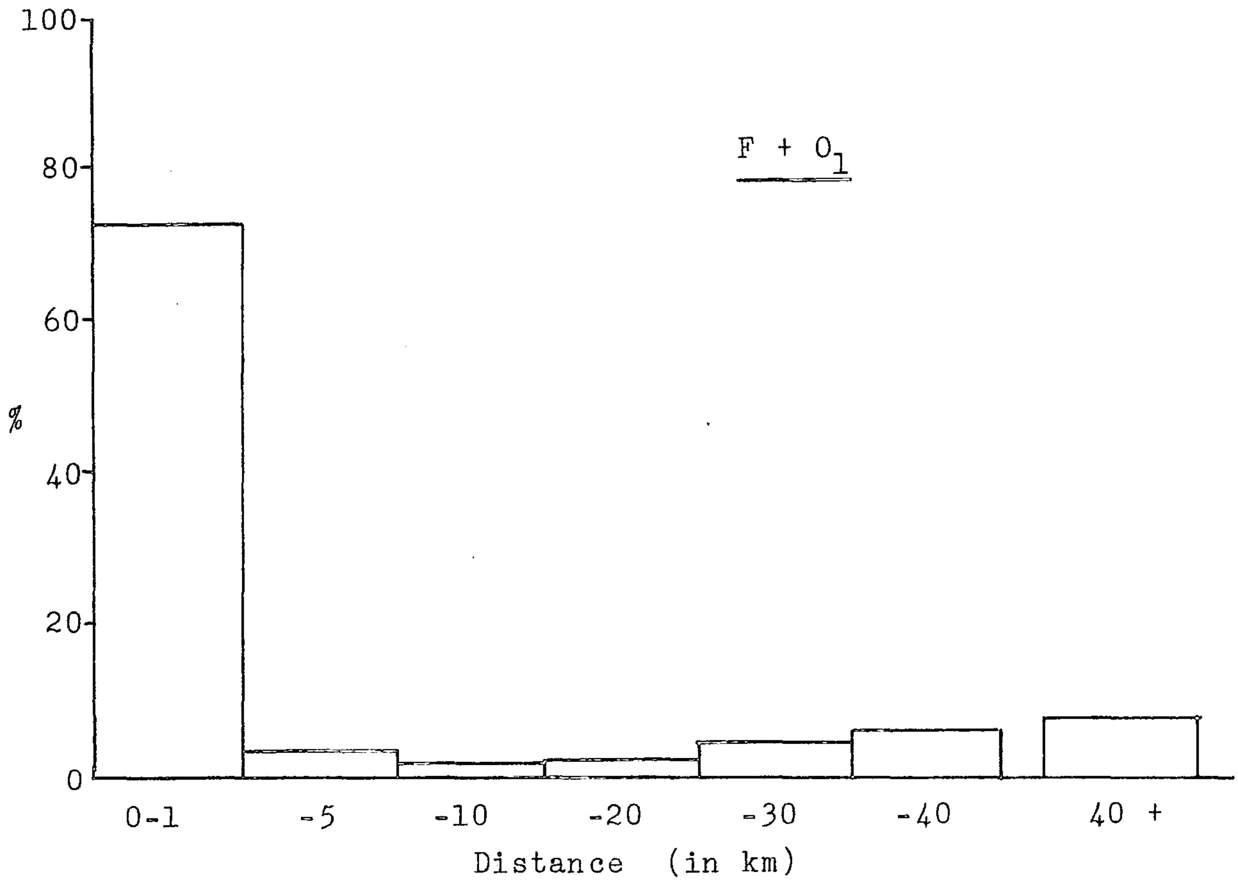
FREQUENCY DISTRIBUTION OF DISTANCES BETWEEN THE BIRTHPLACES OF PARENTS AND FIRST OFFSPRING, AND PARENTS AND ALL OFFSPRING IN SHAHRESTAN NOWSHAHR (ONLY PARENTS BORN IN SHAHRESTAN NOWSHAHR)

Distance (in km)	F-O1 No	F-O1 %	F-O1 cf*	M-O1 No	M-O1 %	M-O1 cf*	F-O No	F-O %	F-O cf*	M-O No	M-O %	M-O cf*
0 - 1	467	73.1	73.1	402	62.0	62.0	3395	69.9	69.9	2904	59.3	59.3
1 - 5		3.6	76.7		7.9	69.9		3.9	73.8		8.0	67.3
5 - 10		1.7	78.4		5.2	75.1		2.3	76.1		5.1	72.4
10 - 20		2.5	80.9		4.0	79.1		3.3	79.4		4.8	77.2
20 - 30		4.8	85.7		6.5	85.6		5.3	84.7		7.5	84.7
30 - 40		6.4	92.1		6.9	92.5		8.6	93.3		7.5	92.2
40 +		7.9	100.0		7.5	100.0		6.7	100.0		7.8	100.0
No of parents		639			648			642			652	
No of offspring		639			648			4859			4896	
Mean		11.2			12.5			11.2			12.6	
Median		0.68			0.81			0.72			0.84	
Variance		1166			1431			1424			1612	
Range		429			637			821			807	
Skewness		6.7			9.3			12.1			11.8	
Kurtosis		60.4			126.6			208.3			109.4	

* cf = cumulative frequency

Figure 5.13

DISTRIBUTION OF DISTANCE OF BIRTHPLACE BETWEEN PARENTS AND OFFSPRING IN SHAHRESTAN NOWSHAHR



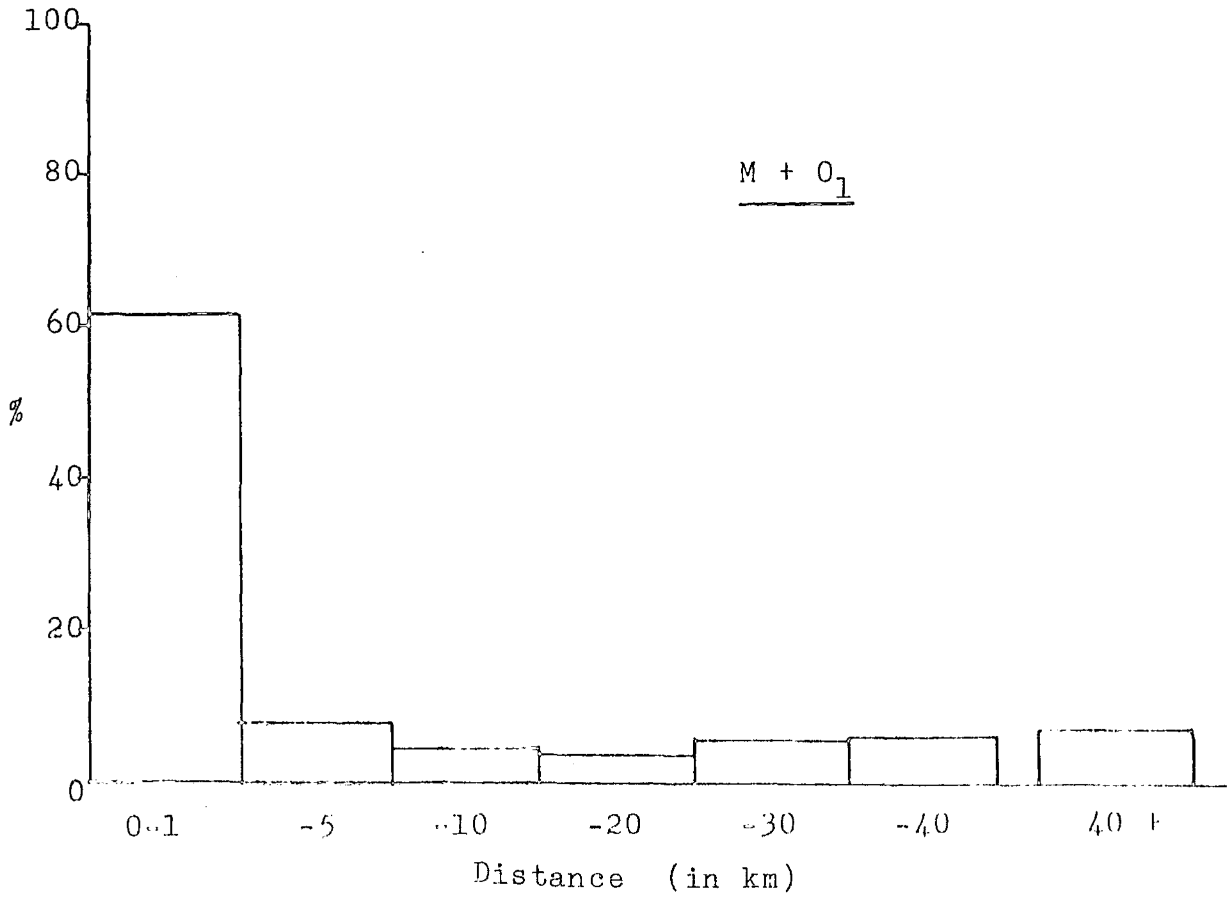
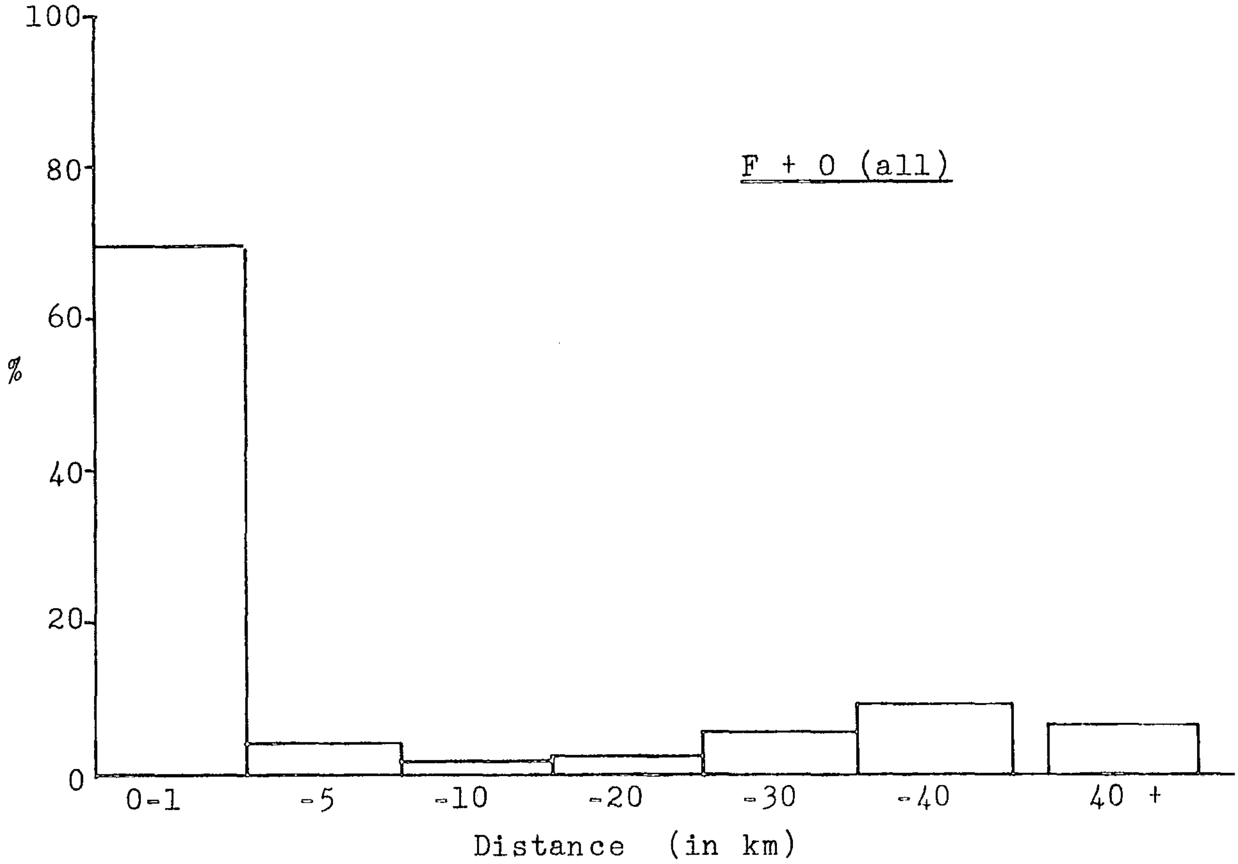
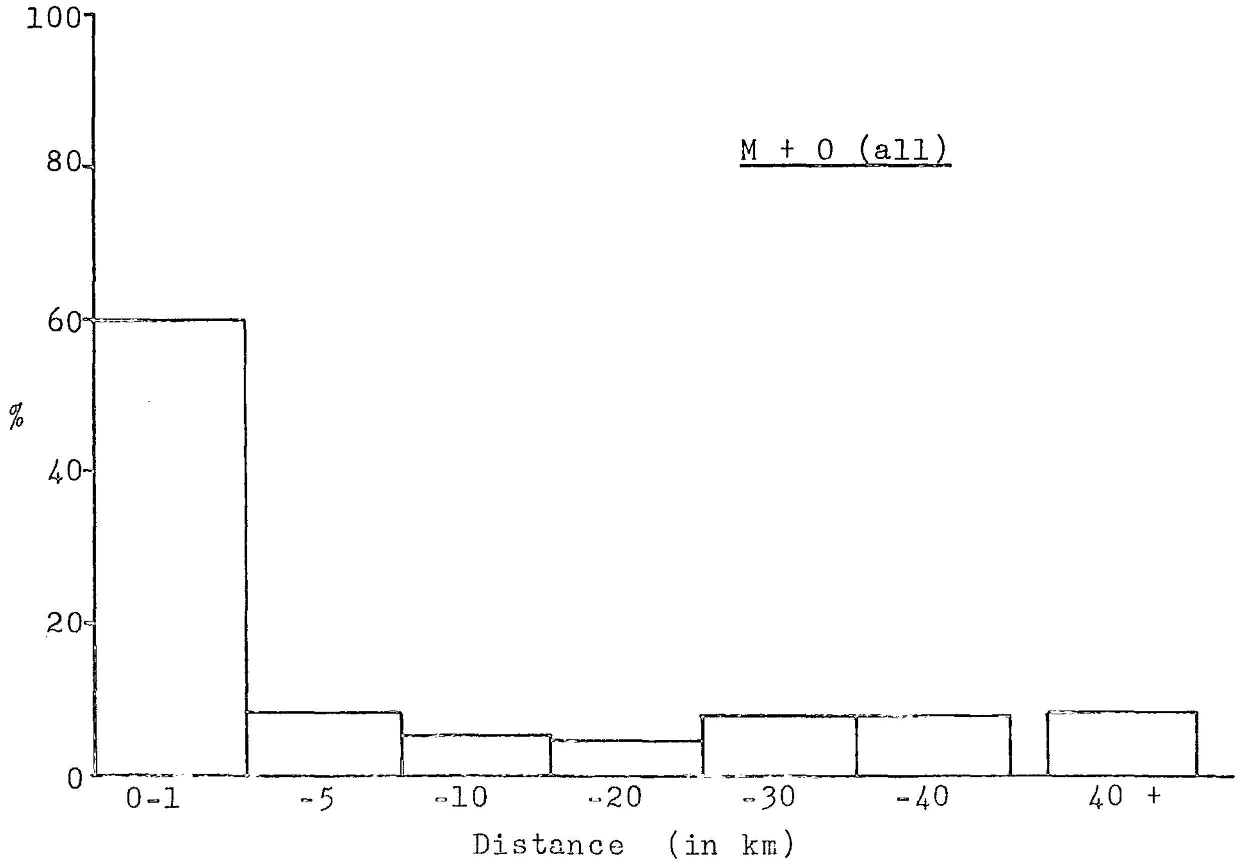


Figure 5.13 (continued)





In general, there does not appear to be a large reduction in the proportion of offspring being born in the same locality as those of the parents in the small territorial units of Sh. Nowshahr. The '0' distance class is still the predominant limit of the gene pool, indicating the constancy of the genetic structure and composition, and genetic movement is confined to short distances. But a comparison of the extent of genetic localization in the villages between the two generations yielded significant differences, $X^2=74.06$ $p=.0000$. Such secular changes most probably parallel the developmental and economical projects operational in the Shahrestan as a whole, in terms of creating more available routes for travelling and uniting the villages together, in addition to the introduction of transport facilities. These factors have allowed easier access to more distant places and increase in the range of movement.

From Table 5.25 it is seen that in the grandparental generation 80.9% of the total grandparents have their offspring born in the same village, while in the parental generation the proportion has decreased to 64.4%. The mean figures also indicate an increase from 7.1 to 11.9 km., although the median values do not show wide diferences. These differences indicate that the range of genetic movement is increasing and thus the size of the gene pool is expanding, since the genes are spreading and being distributed to a larger radius.

The frequency distribution of distances between the birth-localities of parents and offspring in both generations reveals the same pattern in the three Bakhshes of Markazi, Chalous and Kelardasht. In B.Markazi, the grandparent-parent birthplace

Table 5.25

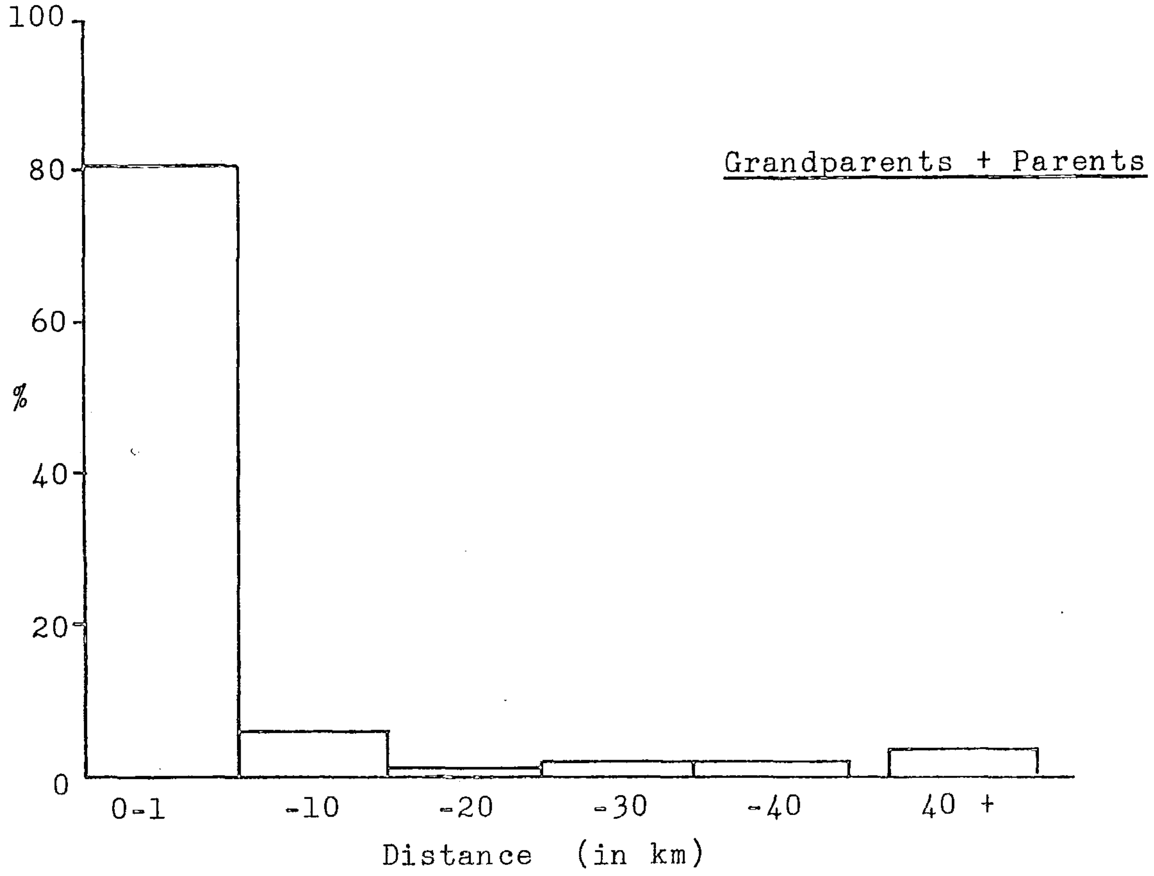
FREQUENCY DISTRIBUTION OF BIRTHPLACE DISTANCES BETWEEN ALL GRANDPARENTS AND PARENTS, AND BOTH PARENTS AND OFFSPRING IN SHAHRESTAN NOWSHAHR

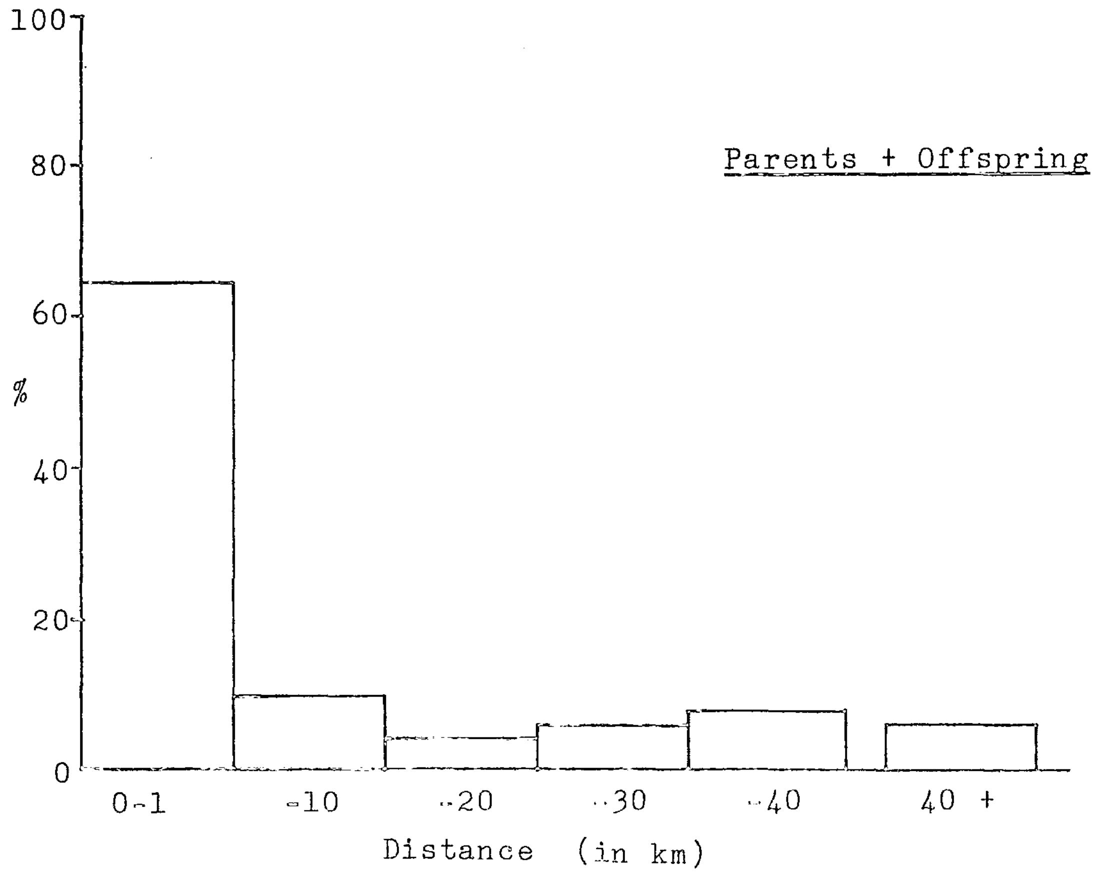
Distance (in km)	G'parents-parents No	%	cf*	Parents-Offspring No	%	cf*
0 - 1	1556	80.9	80.9	6299	64.6	64.6
1 - 10		6.4	87.3		9.6	74.2
10 - 20		2.4	89.7		4.1	78.3
20 - 30		3.1	92.8		6.4	84.7
30 - 40		3.3	96.1		8.0	92.7
40 +		3.9	100.0		7.3	100.0
No of parents	1936			1294		
No of offspring	1936			9755		
Mean		7.1			11.9	
Median		0.62			0.77	

* cf = cumulative frequency

Figure 5.14

DISTRIBUTION OF BIRTHPLACE DISTANCE OF ALL GRANDPARENTS AND PARENTS, AND BOTH PARENTS AND ALL OFFSPRING IN SHAHRESTAN NOWSHAHR





distance distribution reveals that between 82.9 - 86.9% of the male grandparents and between 72.5 - 77.5% of the female grandparents have offspring born in the '0' distance class. Statistical differences are observed between the grandfathers-parents and grandmothers-parents birthplace concordance, X^2=14.33 p=.0002.

The frequency distribution also reveals that the maternal grandparents' percentages are higher in the distance class of more than 40 km., the mean values being 4.5 and 5.1 km. for the paternal grandparents and 9.2 and 10.3 for the maternal ones. These mean values are associated with the range of the distances between the grandparents and their offspring, as it is seen that the range is higher for the female parents. On the other hand the median values reflect the actual limit of the gene flow, which is less than one kilometer, although the figures are higher for the female parents.

In the next generation there is an obvious reduction in the proportion of parents and offspring born in the same village, and statistical differences are observed, X^2=49.64 p=.0000. The father-offspring and mother-offspring proportions also show significant differences, X^2=11.84 p=.0006. Furthermore, the mean distances between the male parent and his offspring is around 13 km., while for the female parent and her offspring it is around 16 km. The median values range from 750 to 870 meters.

The sample in B.Chalous is small and some of the results may be biased and incorrect so need to be assessed with caution. Localization of genes is observed, and a large

Table 5.26

FREQUENCY DISTRIBUTION OF DISTANCES BETWEEN THE BIRTHPLACES OF PARENTS AND OFFSPRING IN BAKHSH MARKAZI (ONLY PARENTS BORN IN BAKHSH MARKAZI)

Distance (in km)	FF-F		FM-F		MF-M		MM-M		F-O		M-O		$F-O_1$		$M-O_1$	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
0 - 1	212	86.9	182	72.5	165	82.9	155	77.5	1312	62.7	1226	57.4	194	66.6	176	59.9
1 - 10		2.0		6.8		4.5		3.0		6.7		13.0		5.1		12.9
10 - 20		0.0		2.4		3.0		4.0		1.6		1.7		1.0		1.0
20 - 30		1.7		2.4		2.6		3.5		4.9		6.2		4.8		6.8
30 - 40		7.8		8.3		3.0		5.5		15.5		12.2		16.1		11.2
40 +		1.6		7.6		4.0		6.5		8.6		9.5		6.4		8.2
No of parents	244		251		199		200		291		295		291		294	
No of offspring	244		251		199		200		2094		2135		291		294	
Mean		4.5		9.2		5.1		10.3		13.7		15.2		13.0		17.0
Median		0.57		0.69		0.60		0.64		0.80		0.87		0.75		0.83
Variance	211		514		283		1454		1389		2050		681		2601	
Range	149		206		147		405		758		758		197		637	
Skewness		5.3		4.4		5.1		7.7		12.9		10.8		3.3		7.7
Kurtosis		41.2		28.4		33.4		70.2		239.1		154.0		16.0		80.6

Figure 5.15

DISTRIBUTION OF DISTANCES BETWEEN BIRTHPLACES OF PARENTS AND OFFSPRING IN BAKHSH MARKAZI

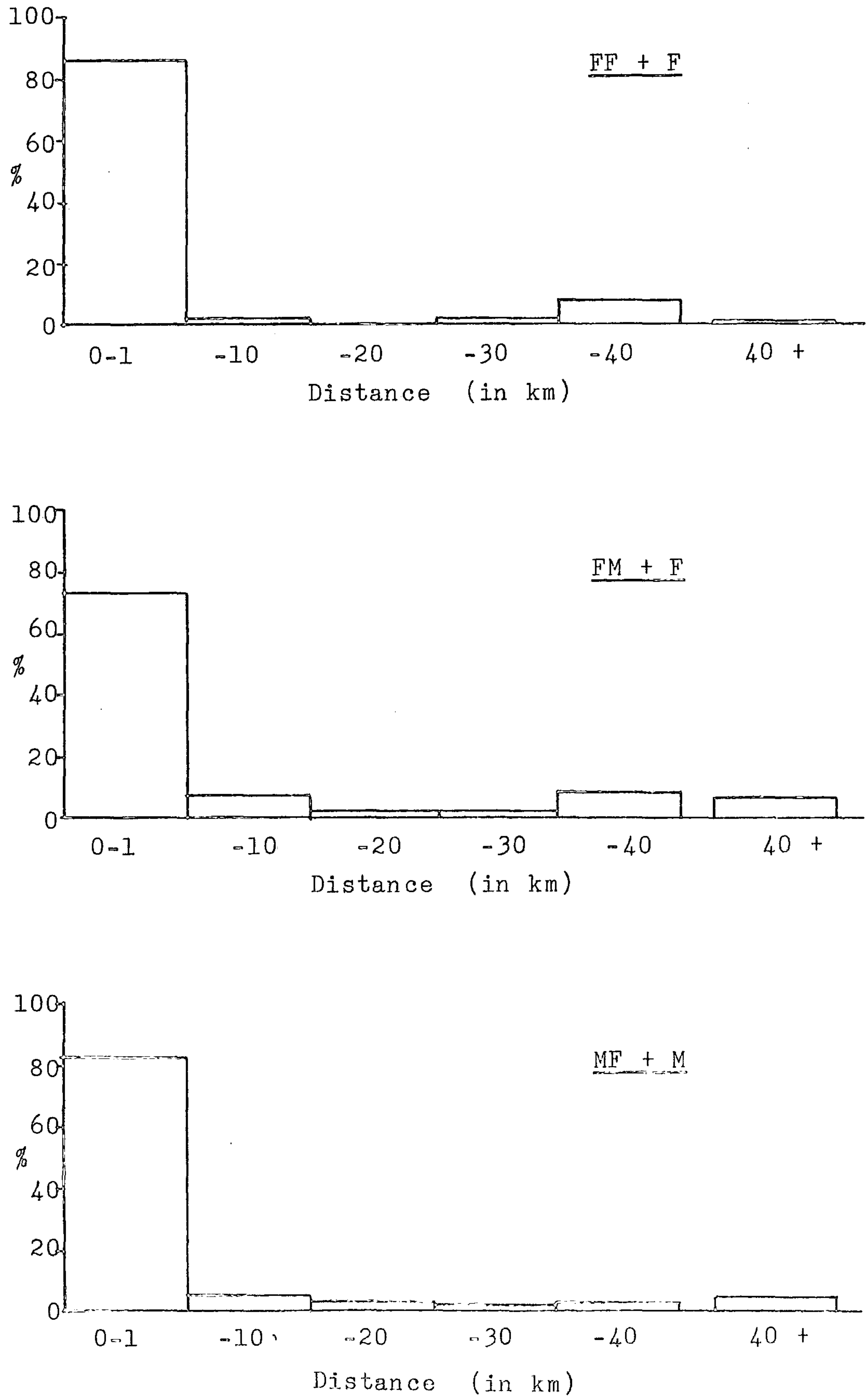
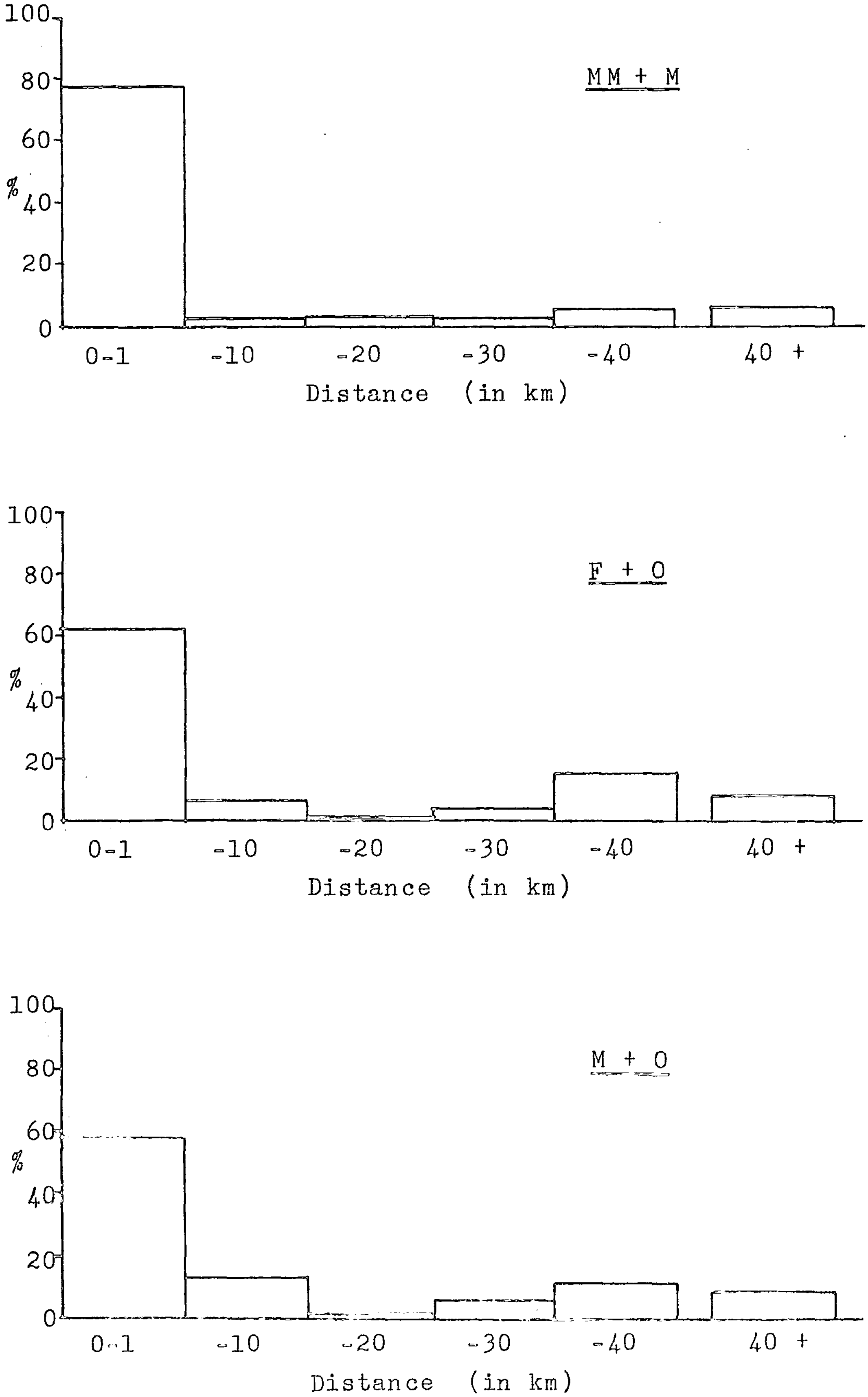


Figure 5.15 (continued)



proportions of the grandparents and their offspring show concordance of birthplaces, ie 86.7 and 91.7% for the male grandparents and 63.4 and 70.4% for the female grandparents. The distribution of the distances is uneven and there is little or no gene flow up to 30 km. The smallness of the sample and the heterogeneous distance classes are most probably causing the asymmetrical distribution. Both the mean and median measures show larger figures for the maternal grandparents, but no statistical significance is observed.

In the parental generation, statistical differences are observed between the father-offspring and mother-offspring '0' distance class proportions, X^2=48.28 p=.0000. The index for the F-0 concordance is 81.3% (83.3% for the father and his first offspring), and for the M-0 it is 61.6% (61.1% for the mother and her first offspring). The distance distribution reveals a larger proportion of M-0 (M-01) in the more than 40 km. distance class. The mean distances between the F-0 (F-01) are 6.9 (8.4) km., and for the M-0 (M-01) they are 16.9 (14.7) km. The median values are 200 meters longer for the maternal parents. In general, no statistical differences are observed between the two generations.

In B.Kelardasht high percentages are observed in terms of birthplace concordance between the grandparents and parents. The indices for the paternal grandparents are 90 and 88.1%, while for the maternal ones they are 73 and 76.7%. The X^2 value reveal significant differences between the male and female parents, X^2=33.44 p=.0000. The mean and median values do not show very large differences between the sexes.

Table 5.27

FREQUENCY DISTRIBUTION OF DISTANCES BETWEEN THE BIRTHPLACES OF GRANDPARENTS AND PARENTS, AND PARENTS AND OFFSPRING IN BAKHSH CHALOUS (ONLY PARENTS BORN IN BAKHSH CHALOUS)

Distance	FF-F		FM-F		MF-M		MM-M		F-O		M-O		F-O_1		M-O_1	
(in km)	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
0 - 1	26	86.7	19	70.4	11	91.7	7	63.4	408	81.3	333	61.6	50	83.3	44	61.1
1 - 10		2.3		0.0		0.0		0.0		8.6		13.9		8.4		13.9
10 - 20		0.0		0.0		0.0		9.2		5.6		7.7		5.0		6.9
20 - 30		0.0		0.0		0.0		9.2		0.0		3.9		0.0		2.8
30 - 40		6.7		3.7		0.0		0.0		0.0		1.7		0.0		4.2
40 +		3.3		25.9		8.2		18.2		4.5		11.2		3.3		11.1
No of parents	30		27		12		11		61		73		60		72	
No of offspring	30		27		12		11		502		541		60		72	
Mean		4.5		15.1		3.5		11.2		6.9		16.9		8.4		14.7
Median		0.58		0.71		0.54		0.79		0.61		0.81		0.60		0.82
Variance	171		792		149		285		1076		3539		1745		1231	
Range	51		109		42		42		479		807		304		224	
Skewness		2.9		1.9		3.5		1.1		8.9		8.5		6.5		3.9
Kurtosis		7.2		3.6		12.0		-0.31		102.7		92.3		44.9		18.5

Figure 5.16

DISTRIBUTION OF DISTANCE OF BIRTHPLACE BETWEEN GRANDPARENTS AND PARENTS, AND PARENTS AND OFFSPRING IN BAKHSH CHALOUS

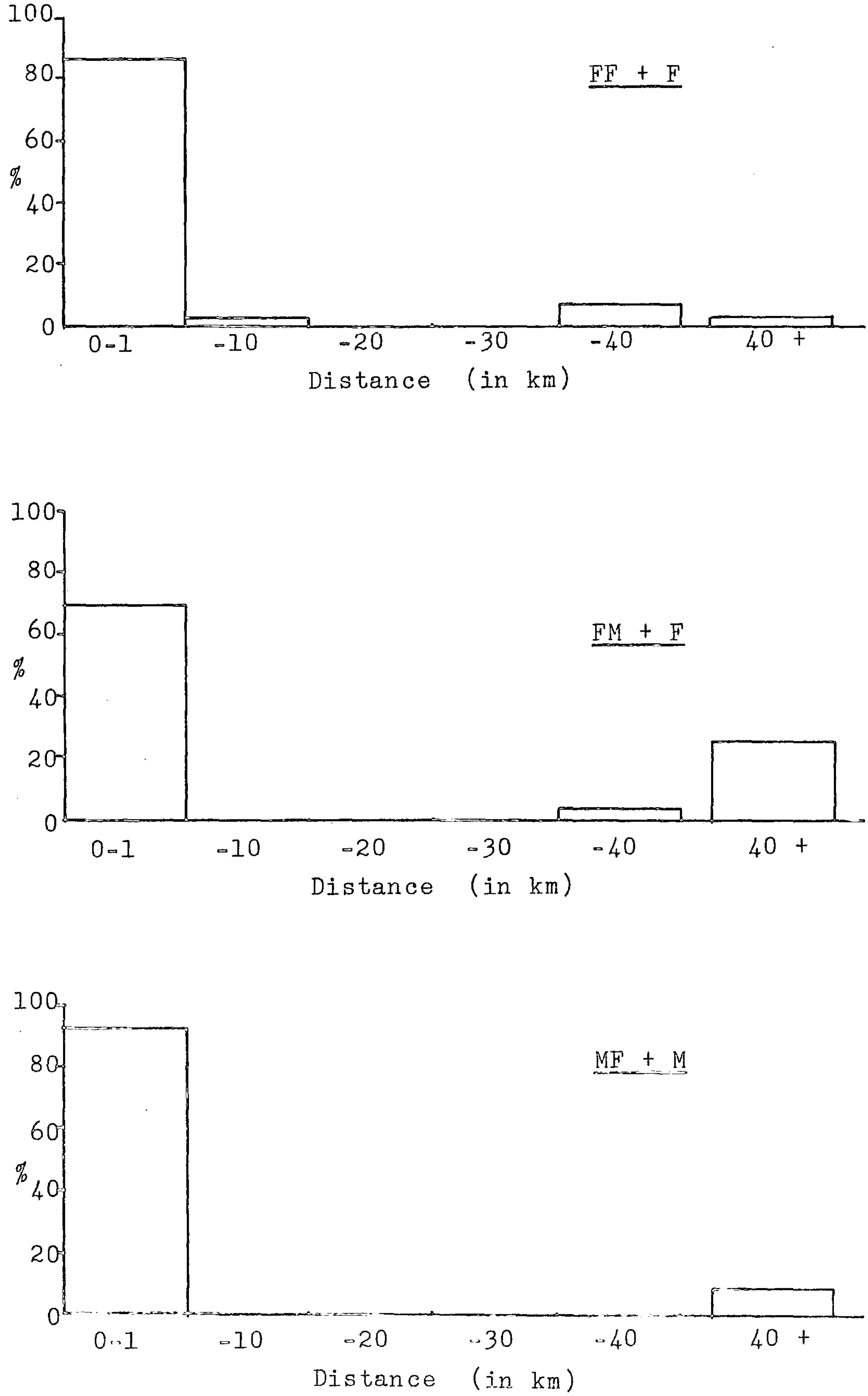
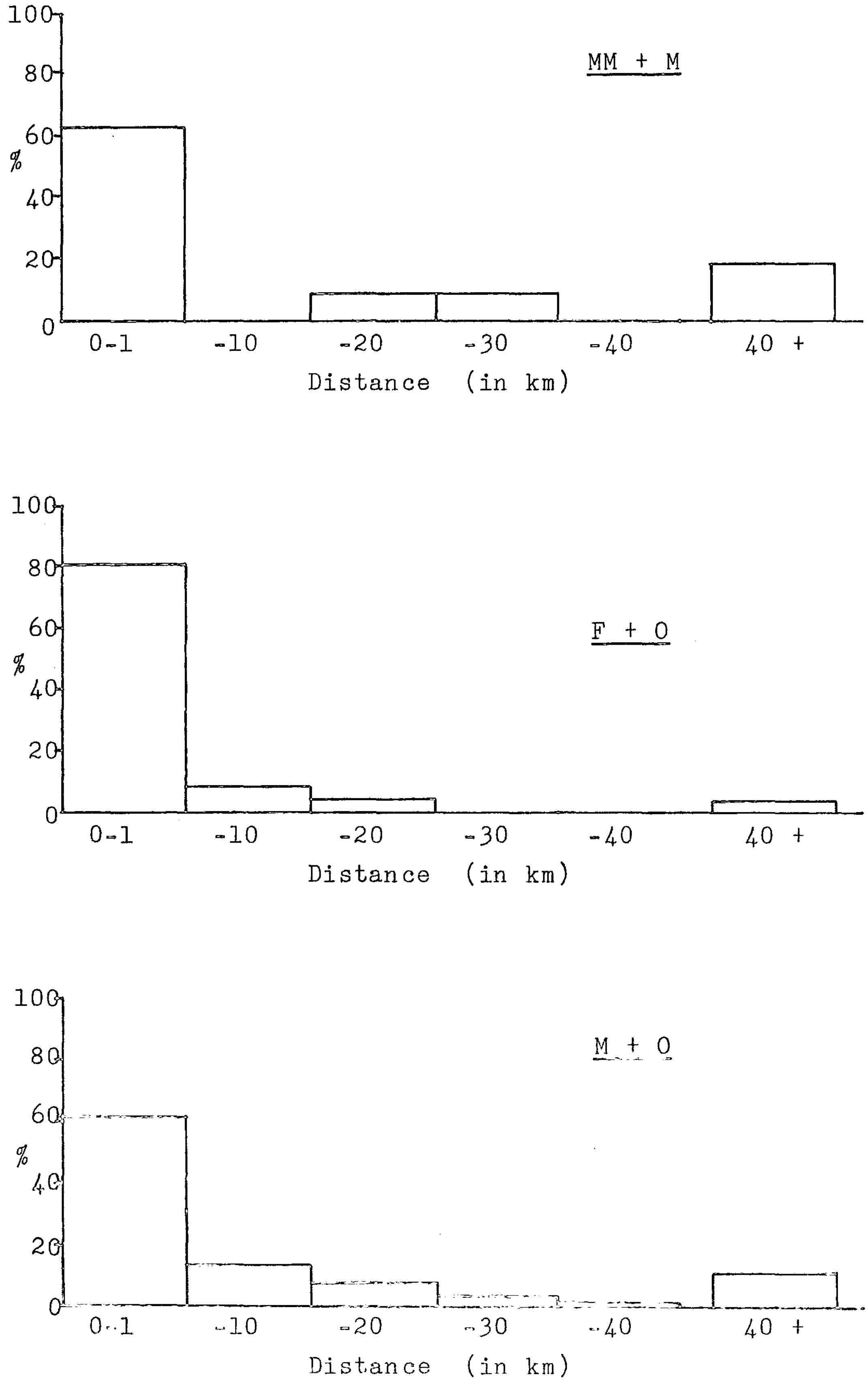


Figure 5.16 (continued)



In the next generation, the '0' distance class shows decreased percentages for both parents: F-0 concordance is 74% (77.4% for F-01), and M-0 concordance is 60.6% (64.5% for M-01). The differences between the sexes are significant, X^2=91.35 p=.0000. The mean distances show larger distances between the father and their offspring (including the first offspring), but this is not reflected in the median distances, where the mother-offspring (first offspring) show an increase of up to 120 meters.

Temporal differences between the two generations are also observed in the proportions of intra-village birthplace concordance, with significant differences, X^2=24.39 p=.0000.

In general, no spatial difference is observed between the three Bakhshes and the pattern of parental genetic movement is very much confined to within the unit of habitation, and the range is a maximum of forty kilometers. Statistical differences were observed between the two generations in the extent of village concordance of birthplaces and gene localization in Sh. Nowshahr as a whole and in the two Bakhshes of Markazi and Kelardasht. Genetic constancy appears to be the main characteristic of the population.

Table 5.29 shows the extent of genetic localization in the individual Dehestans for both generations. The figures for the '0' distance class range from 68.4 to 97.4%, with the exception of Kouhestan-Shargh, which shows a value of 40.9% in the first generation. In the second generation the percentages have decreased and range from 24.4% in Humeh to 79.5% in Panjak-Rostagh. In the majority of the Dehestans the

Table 5.28

FREQUENCY DISTRIBUTION OF DISTANCES BETWEEN THE BIRTHPLACES OF GRANDPARENTS AND PARENTS, AND PARENTS AND OFFSPRING IN BAKHSH KELARDASHT (ONLY PARENTS BORN IN BAKHSH KELARDASHT)

Distance (in km)	FF-F No	FF-F %	FM-F No	FM-F %	MF-M No	MF-M %	MM-M No	MM-M %	F-O No	F-O %	M-O No	M-O %	$F-O_1$ No	$F-O_1$ %	$M-O_1$ No	$M-O_1$ %
0 - 1	244	90.0	192	73.0	192	88.1	161	76.7	1675	74.0	1345	60.6	223	77.4	182	64.5
1 - 5		1.9		7.2		3.6		9.0		2.7		8.4		3.1		7.4
5 - 10		1.1		6.1		1.6		3.3		2.3		4.8		1.7		5.7
10 - 20		1.1		4.2		1.3		3.9		6.3		7.7		3.5		6.4
20 - 30		2.2		4.9		3.2		5.2		6.4		9.2		5.5		8.2
30 - 40		1.8		2.7		0.5		1.0		3.9		4.6		2.4		3.2
40 +		1.9		1.9		2.3		1.9		4.4		4.7		6.4		4.6
No of parents	271		263		218		210		290		284		288		282	
No of offspring	271		263		218		210		2263		2220		288		282	
Mean		5.6		7.4		7.3		6.7		9.9		9.0		10.0		7.3
Median		0.55		0.68		0.57		0.65		0.67		0.82		0.65		0.77
Variance	2348		2383		3441		2827		1523		699		1538		222	
Range	769		768		763		763		821		768		429		96	
Skewness		14.8		14.7		11.4		14.0		11.9		14.8		7.4		2.9
Kurtosis		230.9		227.5		137.4		198.8		195.8		351.8		64.6		10.5

Figure 5.17

DISTRIBUTION OF DISTANCE OF BIRTHPLACE BETWEEN GRANDPARENTS AND PARENTS, AND PARENTS AND OFFSPRING IN BAKHSH KELARDASHT

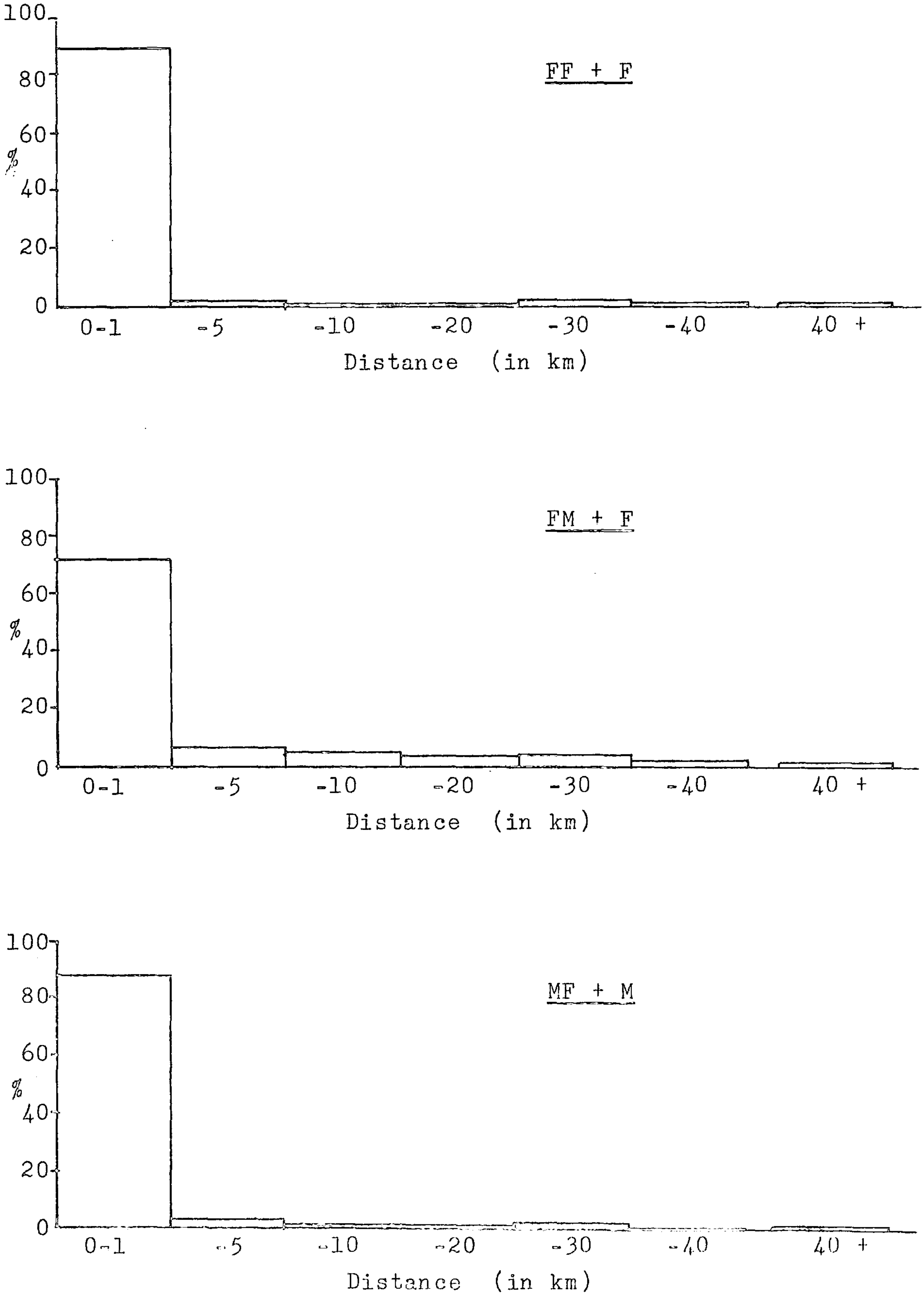
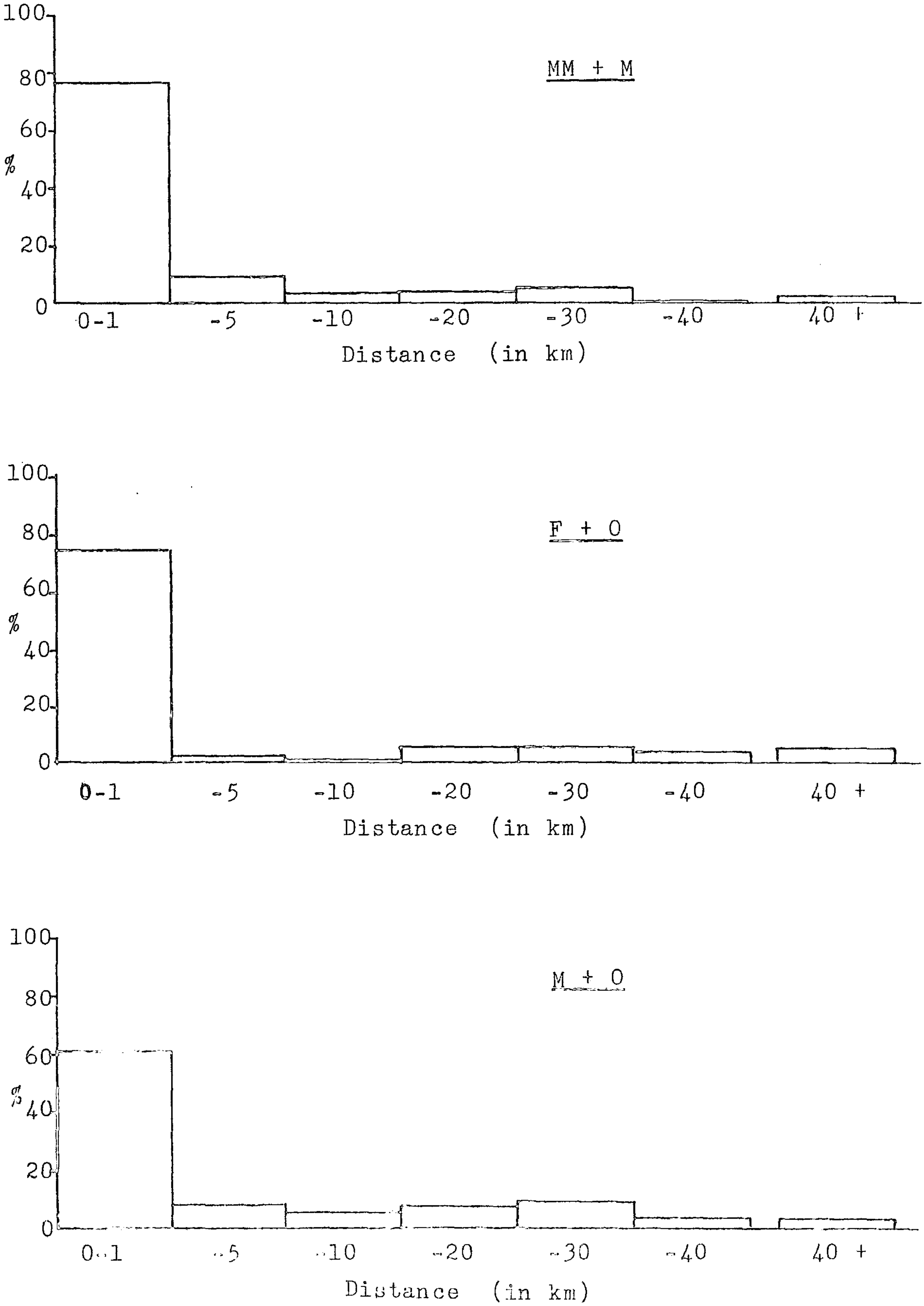


Figure 5.17 (continued)



females show smaller percentages than the males in both generations. The varied percentages observed between the Dehestans are caused by various factors, such as sample size, population size and density, local geography, kinship structure and the extent of isolation or vicinity to urban centres.

Another useful method of examining gene flow in Shahrestan Nowshahr is by studying the concordances of birthplaces between the sibs (Imaizumi and Furusho, 1972; Imaizumi, 1977). Table 5.30 shows that the proportion of sibs born in the same locality, ie the '0' distance class, is as high as 92.2% and the distribution is extremely skewed to the origin. Similar high percentages were also observed in the three Bakhshes. The median values revealed a distance of 540 meters, indicating short range movement. In general, these high percentages imply very small genetic mobility in association with post-marital movement, and demonstrate yet again genetic localization.

The analyses of distance between the birthplaces of the different classes of family pairs reveal many interesting and informative points regarding the genetic structure of the population of Sh. Nowshahr, but they have also brought to light some of the constraints with regard to interpretation, mainly because of the limitations of the data. Primarily, birthplace distances have been computed from longitude and latitude coordinates which do not reflect actual distances with high resolution and neither do they consider altitude. The '0' distance class could actually represent units of habitations from small settlements (hamlets) to larger villages, and small market centres. Population size and density varies

Table 5.29

PROPORTIONS OF PARENTS AND OFFSPRING BORN IN THE 0-1 KM CLASS IN THE 19 SUB-DIVISIONS OF SHAHRESTAN NOWSHAHR

Area	Grandparents-Parents Total	No	%	Parents-Offspring Total	No	(all) %
Kachrostagh	132	109	82.6	736	576	78.9
Kalej	171	137	80.1	676	485	71.7
Alavikola	19	13	68.4	63	35	55.5
Kalrudpey	44	35	79.5	224	139	62.0
Baladeh Kojour	73	58	79.4	234	149	63.7
Tavabe Kojour	84	61	72.6	319	167	52.3
Kuhparat	107	90	84.1	432	244	56.5
Chalandar	19	18	94.7	71	32	45.1
Kheyroud Kenar	24	18	75.0	197	99	50.2
Zanoussrostagh	133	106	79.7	554	152	27.4
Panjakrostagh	39	38	97.7	166	132	79.5
Nowshahr City	27	20	74.1	397	289	72.8
Humeh	22	18	81.8	160	39	24.4
Kelarostagh	66	51	77.3	768	549	71.5
Chalous City	14	12	85.7	275	192	69.8
Kelardasht	620	510	82.3	2705	1960	72.5
Kuhestan East	22	9	40.9	96	39	40.6
Kuhestan West	81	69	85.2	467	190	40.7
Birunbashm	239	201	84.1	1215	821	67.6

Table 5.30

SIB-PAIR DISTANCE DISTRIBUTION

Distance (in km)	Shahrestan Nowshahr	Bakhsh Markazi	Bakhsh Chalous	Bakhsh Kelardasht
0 - 1	3884	1641	406	1833
As % of total	92.2	91.4	92.5	92.8
Total	4213	1795	439	1975
Mean	5.0	4.5	4.0	5.7
Median	0.54	0.55	0.54	0.54
Variance	1356	637	1411	2000
Standard Error	0.6	0.6	1.8	1.0
Range	859	647	615	859
Skewness	15.6	14.4	13.6	14.5

in individual villages, ie the number of people in the villages range from 6 to over 1000 inhabitants. The pattern of settlement also is different in the coast, the plains and the mountains. Since the data are based on aggregate results, and sufficient samples are not available on the individual villages, in addition to information on their corresponding size and density, the nature of the terrain and area, various influential elements cannot be detected. These factors include variations in the ecology and geography, whether of an urban or rural nature and the actual distances between the units of habitation.

Although the limitations of the data and consequently the methods of analysis have not allowed a thorough study of genetic movement within the Shahrestan, in no way has it invalidated the results obtained, and many instructive, informative and practical elements of genetic importance have been discovered which can be used in further research.

5.5 SUMMARY

The analysis of the migration patterns in Shahrestan Nowshahr as inferred from the general movement pattern, matrimonial mobility, parent-offspring and sib-pair birthplace distribution and orientation of movement has elucidated the following points: 1) Movement is extremely orientated to within the Shahrestan; 2) The spatial range of mobility is very small and confined to the place of birth; 3) Movement is very much determined by marriage; 4) there is little post-marital movement; 5) The spatial range of movement has increased between the two generations; 6) Females are more mobile than males in marriage; 7) Movement to Sh. Nowshar is predominantly from the contiguous provinces of Mazandaran and Gilan, followed by Markazi; 8) The whole structure of the movement pattern is a reflection of the historical pattern of migration, the geographical and topographical features and the demographic structure of the area.

Results from matrimonial mobility indicate that a large proportion of the indigenous population is marrying locally, ie within the village of birth, and that mate selection is very much determined by propinquity and territorial proximity. The parent-offspring birthplace concordance also shows that the distances over which movement is occuring are extremely small and orientated to the place of origin. The birthplace distribution of offspring further reveals that there is very little post-marital movement. In general, the overall pattern of movement demonstrates the narrow geographical range of gene flow within the Shahrestan and between the villages and movement confined to the nearest villages.

It is apparent that distance and space have been a strong determinant of the spatial distribution of genes, although other factors such as cultural or linguistic affiliations could also have been conducive to small range of gene flow, but it is difficult to establish them at this point.

Temporal and secular changes in the components of genetic movement were also observed between the two generations. A decrease in the proportion of concordance of birthplaces between those of the spouses and those of the parents and their offspring was observed, concomitant with an increase in the range of the gene pool in the variances of the distances and the size of the neighborhood, although the mode of the distance distribution remained at the '0' distance class, with a large proportion of intra-village movement.

The genetic implication of the observed pattern of movements points to the constancy and localization of the genes in both generations, although there is an indication of an expansion in the geographical spread of the genes and a more heterogeneous gene pool within each village or unit of settlement. The overall pattern of mobility within Shahrestan Nowshahr indicates that the subdivisions comprising it have not been genetically open to complete admixture, and that rather is is composed of homogeneous units of settlements, and not a panmictic unit. These units are not discrete, but Mendelian units which are hierarchically structured.

The tendencies for movement to be confined and limited to short and local distances allows extrapolation on the level of relatedness between each population unit. The unimodal distribution of the distances as observed in the Shahrestan and the Bakhshes of Markazi and Kelardasht indicate that the 'Coefficient of Kinship' (Malecot, 1967) (ie the extent to which the genes within or between populations are common by descent) would decrease very rapidly with increasing distances. This situation is more pronounced when frequencies of marriages at very short distances are extremely large in comparison with those at longer distances. In B.Chalous, and most probably in the more urban areas, the distribution is multi-modal, indicating a slower and uneven rate of decrease in the probability of identity between genes from different subdivisions.

The overall structure in Sh. Nowshahr parallels a situation between the two extreme situations, one of complete isolation, where each village comprises distinct, equidistant units (Wright's Island Model), and that of complete admixture and panmixia with no barriers to movement. The intermediate situation would be a structure whereby movement is predominantly determined as a function of geographical distance. This would be a close approximation to Wright's Isolation by Distance Model.

The causes for the observed centralization and localization of movement are largely attributed to the geographical/ topographical features of the area and the communication network between the regions. Although socio-economic developments have decreased the constraints to movement through the construction of roads and bridges, the roadway network is still very crude and there are many instances of partially isolated villages or cluster of villages. Another influential factor are the two historic subdivisions, namely B. Markazi (ie ancient Kojour) and B. Kelardasht, which have been separated by the Chalous River, thus limiting movement between the regions. In addition to these two factors, the historic pattern of sttlement and migration, the agricultural economy, the sedentary lifestyle, the traditional system of marriages based on kinship, extended family networks and patrilocal residence, low age at marriage, low population density and the concentration of families in small areas have all been conducive to the constancy of the 'local' gene pools.

Various methods have been devised for quantifying the extent of the breeding isolation of population units and assessing the biological and genetic consequences in regards to the potential for drift to occur. Lasker and Kaplan (1964) devised a method to estimate the potential for genetic drift to occur in a population: the 'Coefficient of Breeding Isolation', calculated as the product of the 'effective' size of the population (the proportion of the population in the reproductive age group, with differential fertility accounted for) and the 'effective' migration rate (proportion of the migrant population in the reproductive age group). The census returns for Sh. Nowshahr do not give any demographic details on the individual dehestans or dehs (villages), other than population size, and no data are avilable on the age structure, sex ratio, family size, fertility and migration. The samples in the present study are insufficient to allow the calculation of the above parameters in the individual dehestans or villages. No absolute index can be calculated, but it can be extrapolated that in some of the villages (village size is extremely heterogeneous) which are geographically and partially isolated, population densities are low and migration is extremely small, and so the possibilities for stochastic processes such as genetic drift to operate is quite high.

In general, the parameters of movement have not changed substantially, but even small changes in movement patterns can be conducive to dissolution of former geographic isolates (Sheets, 1980), through an increasing admixture and affinities with neighboring populations and immigrants. But it must be emphasized that the dissolution and the inter-regional gene flow would be different and heterogeneous according to the urbane and rural nature of the units.

Further analyses conducive to more informative details on the pattern and structure of mobility within Sh. Nowshahr have been hampered by the limitations of the data. It has not been possible to detect differences in movement patterns and the range of gene flow between different ecological territories. This would have been an important variable to consider since the study area comprises varied ecological terrains. Cavalli-Sforza (1962) and Beckman and Cedergren (1971) found significant variances in the proportion of local breeding and movement between regions with different altitudes. Many authors have also found correlations between endogamy and mean marriage distance, endogamy and the coefficient of inbreeding, mean marriage distance and inbreeding (Malhotra, 1978c; Mukherjee et al, 1978; Majumdar and Malhotra, 1979). Others have recognized the associations between endogamy and the propensity to migrate (Coleman, 1973, 1977), and population size and density (Khazaneh, 1968). Another factor to be considered is the mobility differences between related and unrelated marriages. Imaizumi (1977) noticed a shorter range of movement between related spouses. No data is available on the relatedness of marriage partners in the census returns nor in the present study, but kin marriages and specifically cousin marriages of the first degree are quite common and frequent in Iran (Touba, 1972). This factor will be discussed in the next chapter.

It can be concluded that through the present study it has been possible to estimate indirectly, through migrational data, the amount of gene flow between the populations and dehestans in Shahrestan Nowshahr and into the Shahrestan, and to extrapolate its effect on the genetic structure.

CHAPTER SIX

MIGRATION AND KINSHIP

6.1 GENETIC EXCHANGE AND RELATEDNESS

The role of migration and genetic exchange between populations or the subdivisions within a population in the evolutionary process is to reduce the genetic diversity between them and counteract the effects of stochastic factors which increase the variance. The extent and magnitude of genetic flow can provide information about the genetic structure, by determining the extent of relatedness and genetic similarity within and between populations. The indices of genetic relatedness also provide estimates on the extent of departures from Hardy-Weinberg equilibrium, consequent breeding isolation and increased genetic variance.

Genetic similarity is defined in genealogical terms, ie the extent that the populations/subdivisions have the probability of sharing common ancestry. Malecot (1967), defined biological kinship as the probability of two individuals, tracing descent to a common ancestry. This probability is dependent upon the extent of gene flow or their cumulative effects between the subdivisions, and also on the geographic distance separating them, so that the coefficient of kinship decreases with increasing distance. These deterministic effects can be annulled if the pattern of genetic movement is structured on non-random factors such as assortative matings, socio-cultural and linguistic affiliations and geo-topographical features of the environment.

From the previous analyses on the pattern of gene flow in the Shahrestan, it was observed that the range of movement was extremely limited and gene localization was the primary feature of the area, with movement very narrowly distributed to nearby distances. On the basis of these observations, it was possible to extrapolate on the extent of relatedness and genetic similarity within and between the subdivisions of Sh. Nowshahr.

One method of estimating and ascertaining the effect of these observed patterns of genetic movement and exchange on the degree of biological relatedness between the units, and their subsequent effects on the genetic structure, is to incorporate the observed number of exchanges (based on marital or parental mobility) in the form of a migration matrix.

The migration model of Hiorns et al (1969), examines the extent of genetic exchange between populations, and from that determines the effect of these exchanges on the pattern of increasing relatedness that develops between them. It also estimates the amount of time (in generations) needed for the populations to achieve complete relatedness, ie to reach an equilibrium state; this is a state when two populations have become spatially similar. According to the authors, the state of genetic equilibrium is obtained when 95% of the ancestry is common to both populations.

This model is based on a number of assumptions: a) the population is divided into a number of subgroups, usually corresponding to geographical subdivisions, between which the exchange is measured; b) each subdivision is homogeneous to begin with, ie there is no common ancestry between them; c) no account is taken of factors like varying population size and density, different selective forces, mutation and genetic drift, the cultural structure can also affect the establishment of equilibrium affecting stochastic processes; d) migration is assumed to be constant in magnitude and direction, with time, (selective migration based on kinship may produce heterogeneity); e) family size and structure is assumed not to be differential; f) gene flow from outside the population system is assumed to be uniform in composition and acting uniformily on all subdivisions.

Although the matrix model is based on a number of assumptions, as are all other migration models, it has one main advantage, and that is it does not assume any migration laws, and the results are based on the actual exchanges between the subdivisions. The model is constructed in the following stages:
a) The initial exchange matrix is constructed by incorporating the actual number of exchanges between every pair of populations into a matrix 'M' of the order 'N', with elements (M_{ij}) representing the probability of a gene settling into population (i), but having originated in population (j). The diagonal values express the number of genes that have originated and remained in the same locality.
b) A second matrix 'P', the transition matrix, will represent the proportion of the genes (as a percentage of the row total), in population (i) who have had their origins in (j). This matrix will define the effective exchange rate (P_{ij}) between

the populations.

c) Since it is assumed that each subdivision is originally homogeneous within itself and completely unrelated to all other subdivisions, all the diagonal values will be equal to '1', and all the off-diagonal values equal to '0'. This will produce the 'Ancestor Matrix' (A_o).

d) The change from the initial stage of no ancestry to a stage where there is relatedness between the subdivisions is obtained by multiplying the ancestor matrix (A_o) by the exchange matrix (P). This matrix 'PA_o' will show the proportion of ancestry for the next generation.

e) For each succeeding generation, the ancestor matrix '$A_{(n-1)}$' is multiplied by the exchange matrix 'P' to obtain the next matrix of relatedness 'A_n', representing a further generation of migration. This process is repeated until a stage is reached when every pair of populations will have 95% of their ancestry in common.

f) In order to measure the pattern of increasing relatedness (ie the proportion of ancestry which is common to both) between every pair of populations which is dependent on the rate of exchanges between them, in addition to the contributions made to each of them from all other populations in the system, the least amount of contribution made to the two units from all other units is summed and taken to represent the proportion of ancestry common to both. This is mathematically expressed as:

$$r_{ij} = \sum_{s=1}^{N} \min (a_{is} , a_{js})$$

From this expression, a third matrix 'R' is obtained, equal to the relationship matrix. The final matrix 'H' will show the number of generations needed to reach complete ancestry with all other populations.

g) In order to examine the effects of systematic pressure from outside the population system, in this case long-range migration, an extra column of exchange will be added and an estimate of its effects on the pattern of relatedness, in terms of counteracting the trend towards fixation of genes, will be made.

This model was applied to the migration data in the survey area, administratively divided into seventeen dehestans and two cities, each comprising one unit of subdivision. The data incorporated into the model are the observed number of exchanges between the units based on the birthlocalities of parents and their offspring. The choice of parent-offspring data accounted for movement of individual spouses from birthplace, to marriage place to the birthplace of offspring, therefore accounting for differential fertlity and post-marital movement.

The rates of migration and the pattern of relatedness between the units were determined from the migration matrices constructed according to the model. Migration matrices were also constructed to look at temporal differences between the two generations, in terms of distribution and destinations of genes, and variability in gene flow. Matrices were also obtained separately for the male and female parents to examine for any differences in the pattern of migration between the sexes, and to determine which sex, if any, was contributing to the increasing relatedness and assimilation between the units. Finally the effects of migration into the Shahrestan were also examined.

Tables 6.1 a,b,c - 6.10 a,b,c present matrices on the numbers and proportions of parental movements, the similarity coefficients in terms of shared ancestry and the generation time needed for obtaining homogeneity for every pair of populations. These matrices are presented for the grandparental generation, the parental generation and for the whole time period (separate matrices are presented for the male and female parents). The matrices also present information on the pattern of relatedness within the Shahrestan when migration of parents and grandparents from outside the survey area is considered.

Figures 6.1 a,b,c,d - 6.3 a,b,c,d and 6.4 a,b - 6.6 a,b present dendrograms and MDS-plots on the observed pattern of genetic migration. Dendrograms and Non-Metric Multidimensional Scaling (Kruskal, 1964), are two principal groups of display methods demonstrating the spatial positions of the dehestans in terms of relatedness and rates of exchange: the 'Cluster Analysis shows the hierarchical pattern of relatedness between the units and groups together the most similar units in terms of common ancestry ; the MDS-scaling is a technique that analyzes the rank order of the coefficients and, by reducing the migration data to two dimensions, presents a single representation of the physical structure of the local movement. The stress or fitness value presented indicate whether the two dimensional display provide a good fit to the data; the values range from 0 (perfect fit) to 1. These two methods also allow one to consider the extent to which the structure of movement relates to the geographic distance or the physical properties of the communication network between the dehestans. This can be done by comparing a map of populations based on the geographic distance with one based on migration, and to observe their concordance in terms of spatial organization. Another means of considering the geographical component of movement is to correlate the relatedness coefficients with actual distances between the population units; this factor will be examined later in the chapter.

Matrices 'M' and 'P', which depict the numbers and proportions of exchanges between the units, reveal that the largest figures occur in the leading diagonals, ie movements of parents from their birthplaces is very small. This is observed in both generations and for both sexes.

In the grandparental generation, after one generation of exchanges between the units, the coefficient of relatedness (extent of ancestral similarity) ranges from a minimum of '0' to 31.6%, with a mean of 3.6%. The number of generations needed for every pair of units to assimilate shows a time period from 25 to 500 generations, the mode being at 500.

In the parental generation, the matrices were compounded by incorporating the birthplaces of parents with all their offspring, instead of the first or last child. Since this model deals with the actual number of links between the units, for every offspring the parent(s) are counted as well. The extent of ancestry shared between the 19 subdivisions demonstrated an increase in the coefficients compared with the last generation. The coefficients ranged from '0' to 64.5%, with a mean of 11.3%. The time needed to reach an equilibrium state between every pair of units also showed a temporal decrease, ie the generation time ranged from 8 to 50 generations, with a mean of 28.

The separate matrices for the male and female pattern of migration showed differences in both the proportion of common ancestry and the time to homogeneity in both generations. Matrices were not presented for the former generation owing to the smallness of the samples, but differences were observed and it was left to the latter generation's male and female matrices to substantiate the significance of the sex differences in migratory attributes. It is evident that female migration is contributing more often to the transference of genes and links between the populations. The mean coefficient of relatedness for both sexes revealed about 10% ancestry, but the time needed to converge the units showed far less time from the female side than the male counterpart; the time ranged from 8 to 52 generations for the females with a mean of 26, while for the males they ranged from 14 to 81 generations, with a mean of 48.

In general there was less concordance between the birth localities of the mothers and their offspring, in both periods. This is in accordance with the traditional custom of patrilocality, whereby males remain more often in their original locality, bound to the inherited land or trade of their fathers, and it is mainly the females who move and therefore contribute genetically to other populations.

Table 6.1a MIGRATION MATRIX: MOVEMENT FROM BIRTHPLACES OF GRANDPARENTS TO THOSE OF PARENTS (NUMBER OF EXCHANGES)

	Kac	Kal	Ala	Kpy	Bal	Tav	Kuh	Cha	Khe	Zan	Pan	N-C	Hum	Kel	C-C	Kld	K-E	K-W	Bir	Total
Kac	117	2	0	1	0	3	0	0	0	0	0	2	0	1	0	0	0	1	0	127
Kal	6	155	0	1	0	1	0	0	0	0	0	0	0	0	0	2	0	0	1	166
Ala	3	1	11	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	18
Kpy	3	1	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44
Bal	0	0	0	1	63	3	0	0	0	0	0	0	0	2	0	1	1	0	0	71
Tav	11	1	0	0	3	62	0	0	2	1	0	2	0	1	0	0	0	0	0	83
Kuh	1	0	0	2	2	0	90	0	3	0	0	4	2	0	0	2	0	0	0	106
Cha	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0	0	0	0	0	19
Khe	0	1	0	0	0	1	0	0	20	0	0	0	1	0	0	0	0	0	0	23
Zan	3	0	0	0	1	1	1	0	6	112	0	6	3	0	0	0	0	0	0	133
Pan	0	0	0	0	0	0	0	0	0	0	35	1	1	0	0	0	0	0	0	37
N-C	0	0	0	0	0	0	0	0	0	0	0	20	0	0	2	1	0	0	0	23
Hum	0	0	0	0	0	0	1	0	0	1	0	0	18	0	0	0	0	0	0	20
Kel	1	0	3	1	0	2	0	0	0	0	0	0	0	52	1	1	0	3	0	64
C-C	0	0	0	0	0	0	0	0	0	1	0	0	0	0	12	0	0	0	1	14
Kld	0	2	0	0	0	0	4	0	0	2	0	2	2	19	3	565	1	5	4	609
K-E	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	10	5	5	23
K-W	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	72	5	81
Bir	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	7	3	1	221	236
Total	146	163	14	46	69	73	96	19	31	117	35	39	27	83	19	580	16	87	237	1897

Table 6.1b MIGRATION MATRIX: MOVEMENT FROM BIRTHPLACES OF GRANDPARENTS TO THOSE OF PARENTS
(PROPORTION OF EXCHANGES)

	Kac	Kal	Ala	Kpy	Bal	Tav	Kuh	Cha	Khe	Zan	Pan	N-C	Hum	Kel	C-C	Kld	K-E	K-W	Bir	Total
Kac	.921	.016	.000	.008	.000	.024	.000	.000	.000	.000	.000	.016	.000	.008	.000	.000	.000	.008	.000	1.000
Kal	.036	.934	.000	.006	.000	.006	.000	.000	.000	.000	.000	.000	.000	.000	.000	.012	.000	.000	.006	1.000
Ala	.167	.056	.611	.000	.000	.000	.000	.000	.000	.000	.000	.111	.000	.056	.000	.000	.000	.000	.000	1.000
Kpy	.068	.023	.000	.909	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	1.000
Bal	.000	.000	.000	.014	.887	.042	.000	.000	.000	.000	.000	.000	.000	.028	.000	.014	.014	.000	.000	1.000
Tav	.133	.012	.000	.000	.036	.747	.000	.000	.024	.012	.000	.024	.000	.012	.000	.000	.000	.000	.000	1.000
Kuh	.009	.000	.000	.019	.019	.000	.849	.000	.028	.000	.000	.038	.019	.000	.000	.019	.000	.000	.000	1.000
Cha	.000	.000	.000	.000	.000	.000	.000	1.00	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	1.000
Khe	.000	.043	.000	.000	.000	.043	.000	.000	.870	.000	.000	.000	.043	.000	.000	.000	.000	.000	.000	1.000
Zan	.023	.000	.000	.000	.008	.008	.008	.000	.045	.842	.000	.045	.023	.000	.000	.000	.000	.000	.000	1.000
Pan	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.946	.027	.027	.000	.000	.000	.000	.000	.000	1.000
N-C	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.870	.000	.000	.087	.043	.000	.000	.000	1.000
Hum	.000	.000	.000	.000	.000	.000	.050	.000	.000	.050	.000	.000	.900	.000	.000	.000	.000	.000	.000	1.000
Kel	.016	.000	.047	.016	.000	.031	.000	.000	.000	.000	.000	.000	.000	.813	.016	.016	.000	.047	.000	1.000
C-C	.000	.000	.000	.000	.000	.000	.000	.000	.000	.071	.000	.000	.000	.000	.857	.000	.000	.000	.071	1.000
Kld	.000	.003	.000	.000	.000	.000	.007	.000	.000	.003	.000	.003	.003	.031	.005	.928	.002	.008	.007	1.000
K-E	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.087	.000	.043	.435	.217	.217	1.000
K-W	.012	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.025	.000	.000	.012	.889	.062	1.000
Bir	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.013	.004	.030	.013	.004	.936	1.000

Table 6.1c

UPPER MATRIX:
RELATEDNESS COEFFICIENTS AFTER ONE GENERATION OF MIGRATION (GRANDPARENT / PARENT)

LOWER MATRIX:
NUMBER OF GENERATIONS TO HOMOGENEITY BETWEEN EACH PAIR OF SUBDIVISIONS (GRANDPARENT/PARENT)

	Kac	Kal	Ala	Kpy	Bal	Tav	Kuh	Cha	Khe	Zan	Pan	N-C	Hum	Kel	C-C	Kld	K-E	K-W	Bir
Kac		.064	.206	.092	.039	.192	.033	.000	.039	.046	.016	.016	.000	.063	.000	.022	.016	.028	.012
Kal	43		.092	.065	.024	.054	.028	.000	.050	.029	.000	.012	.000	.040	.006	.021	.018	.018	.018
Ala	45	58		.091	.028	.181	.047	.000	.043	.068	.027	.111	.000	.118	.000	.038	.056	.037	.013
Kpy	57	46	68		.014	.080	.028	.000	.023	.023	.000	.000	.000	.031	.000	.003	.000	.012	.000
Bal	42	53	39	64		.090	.047	.000	.042	.015	.000	.014	.000	.088	.000	.044	.056	.037	.040
Tav	29	48	39	60	41		.076	.000	.080	.098	.024	.024	.012	.059	.012	.022	.012	.024	.012
Kuh	51	60	45	67	49	46		.000	.047	.109	.046	.057	.069	.041	.000	.032	.019	.009	.019
Cha	500	500	500	500	500	500	500		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Khe	54	56	62	58	60	51	52	500		.075	.027	.000	.043	.031	.000	.007	.000	.000	.000
Zan	55	62	51	68	54	51	32	500	52		.050	.045	.080	.023	.071	.016	.000	.012	.000
Pan	87	88	86	89	87	86	83	500	85	82		.027	.027	.000	.000	.007	.000	.000	.000
N-C	72	78	65	82	68	71	66	500	77	68	83		.000	.031	.087	.052	.043	.000	.034
Hum	64	67	63	69	64	62	54	500	55	48	78	75		.000	.050	.013	.000	.000	.000
Kel	53	64	35	72	39	52	52	500	69	57	87	60	67		.016	.060	.149	.084	.037
C-C	69	75	60	80	64	68	62	500	74	65	84	35	73	55		.015	.071	.062	.076
Kld	66	72	55	78	60	64	62	500	74	64	85	47	72	48	44		.091	.041	.059
K-E	75	80	69	84	71	75	75	500	83	77	87	53	82	63	53	53		.316	.277
K-W	76	81	71	85	73	76	77	500	84	78	88	56	83	66	57	57	25		.091
Bir	78	82	73	86	75	78	78	500	85	79	88	57	84	68	61	61	35	37	

Figure 6.1a

SINGLE LINK CLUSTERING OF SUBDIVISIONS BASED ON SIMILARITY COEFFICIENTS AFTER ONE GENERATION OF MIGRATION (GRANDPARENT/PARENT)

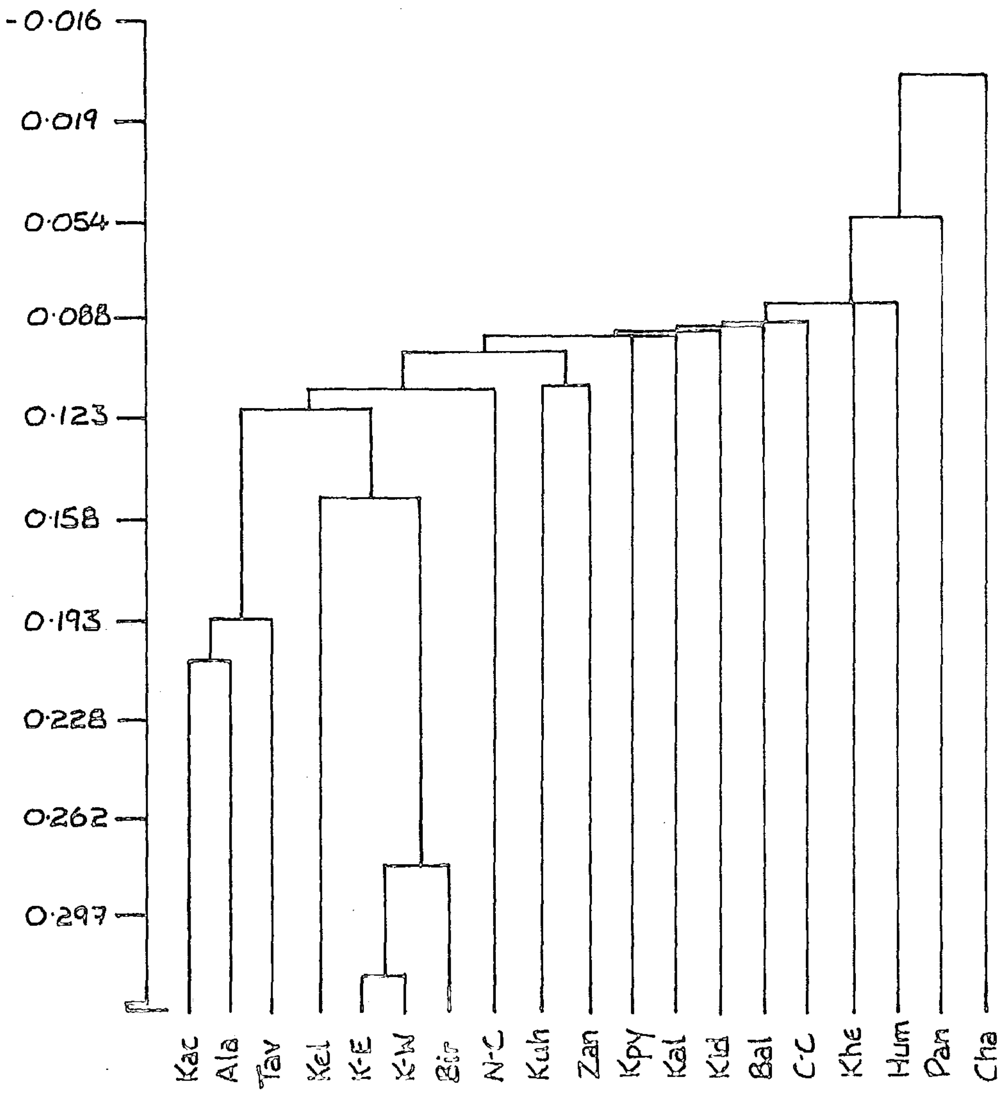


Figure 6.1b SPATIAL POSITION OF SUBDIVISIONS AFTER ONE GENERATION OF MIGRATION BY MD-SCAL (GRANDPARENT/PARENT)

Stress = 0.179

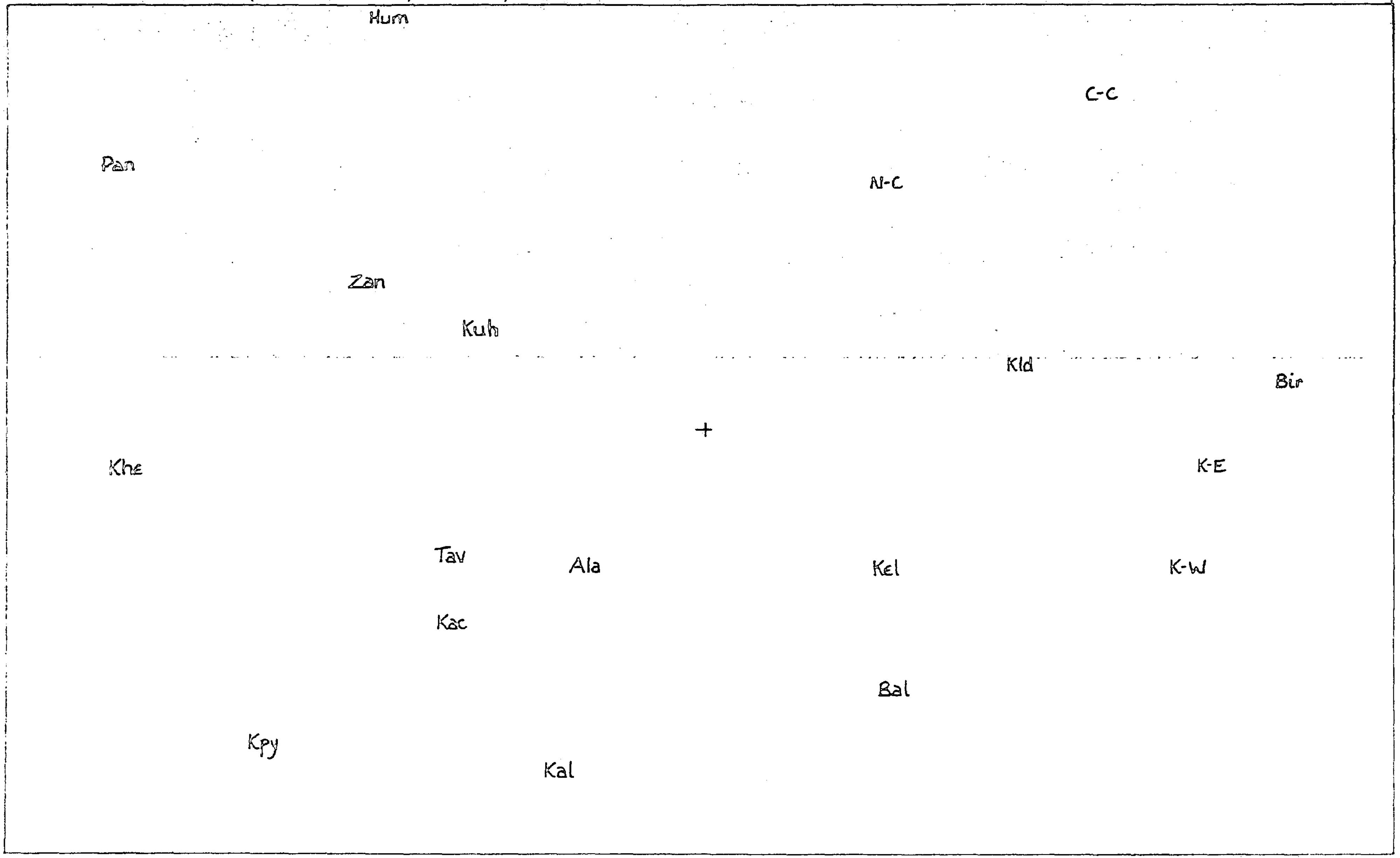


Figure 6.1c

SINGLE LINK CLUSTERING OF SUBDIVISIONS BASED ON SIMILARITY COEFFICIENTS AT HOMOGENEITY (GRANDPARENT/PARENT)

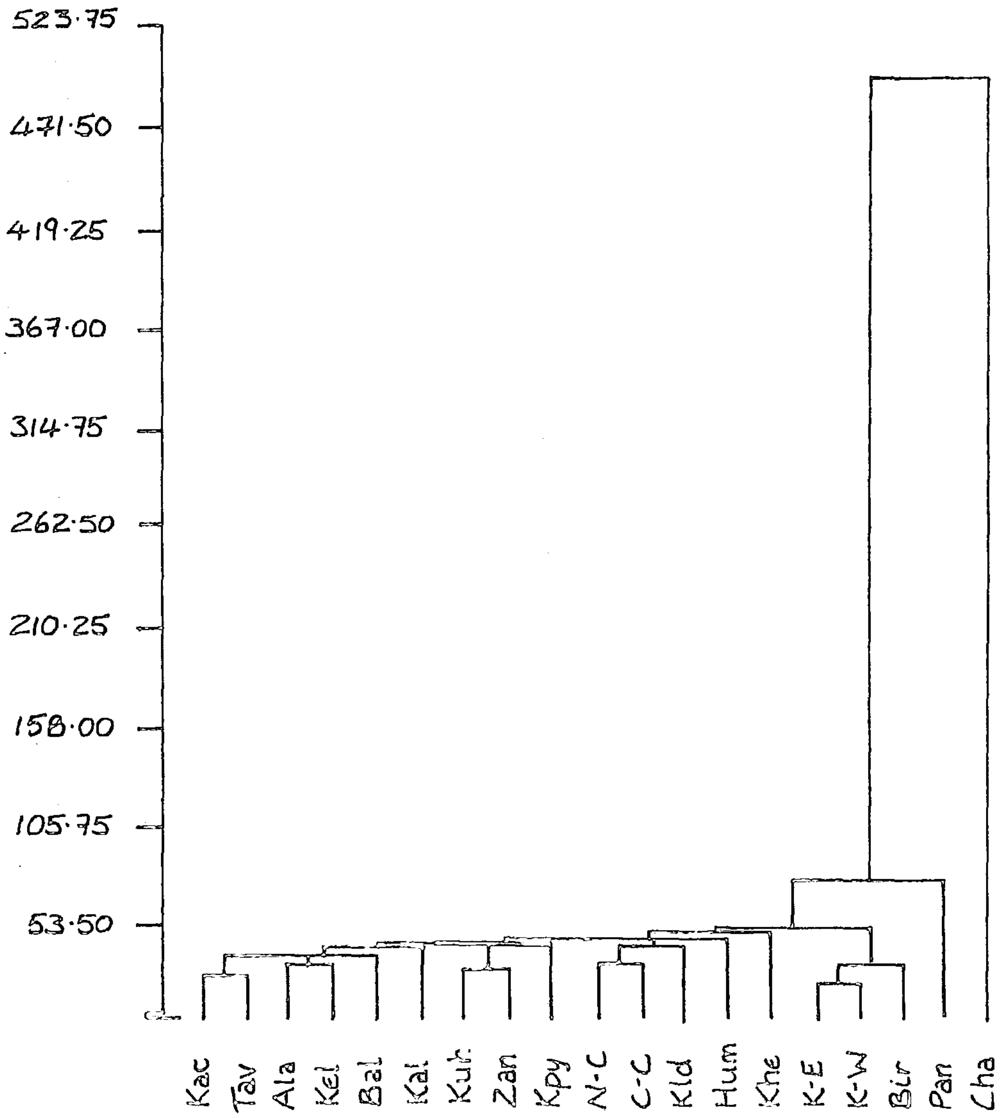


Figure 6.1d SPATIAL POSITION OF SUBDIVISIONS AT HOMOGENEITY BY MD-SCAL (GRANDPARENT/PARENT)
(Dehestan Chalander excluded)

Stress = 0.023

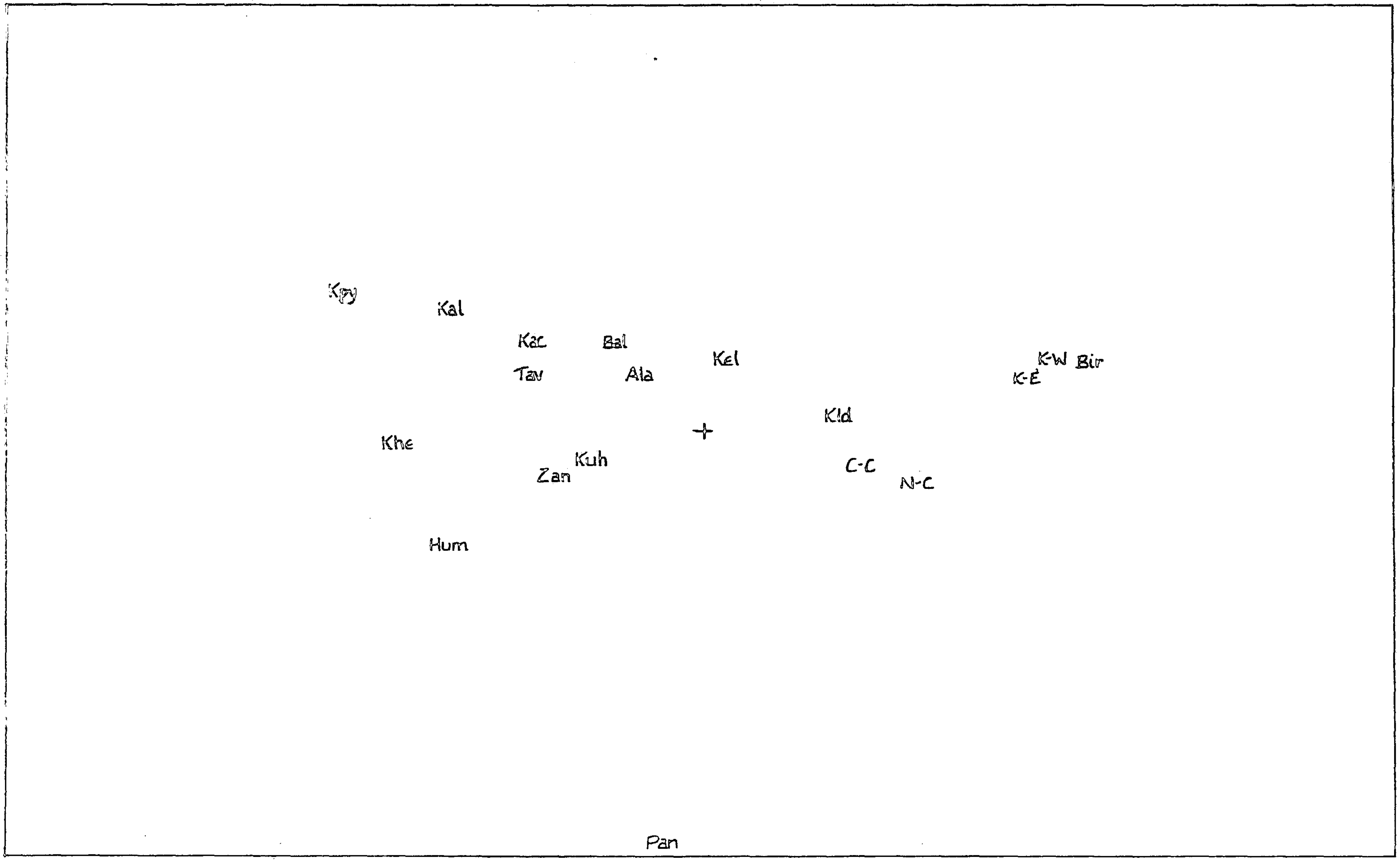


Table 6.2a MIGRATION MATRIX: MOVEMENT FROM BIRTHPLACES OF MOTHERS TO THOSE OF OFFSPRING (NUMBER OF EXCHANGES)

	Kac	Kal	Ala	Kpy	Bal	Tav	Kuh	Cha	Khe	Zan	Pan	N-C	Hum	Kel	C-C	Kld	K-E	K-W	Bir	Total
Kac	340	0	7	0	0	0	3	0	24	0	0	1	0	13	3	0	0	0	0	391
Kal	42	281	7	14	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	345
Ala	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
Kpy	12	0	0	78	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	90
Bal	3	0	0	0	89	4	0	0	0	0	0	19	0	0	3	0	0	0	0	118
Tav	17	1	6	1	0	76	0	0	1	11	0	16	0	13	0	0	0	0	0	142
Kuh	0	0	0	0	2	0	107	0	9	0	0	50	0	7	2	17	0	0	0	194
Cha	0	0	0	0	0	5	0	21	6	0	0	2	0	0	5	0	0	0	0	39
Khe	0	0	0	0	0	0	10	0	65	0	0	39	0	0	0	0	0	0	0	114
Zan	0	0	0	0	0	0	6	0	8	72	0	142	1	0	10	1	0	0	0	240
Pan	0	0	0	0	0	0	0	0	0	0	66	4	0	0	0	0	0	0	0	70
N-C	0	0	9	0	0	0	0	0	0	0	0	182	2	0	36	12	0	0	0	241
Hum	0	0	0	0	0	0	9	0	0	0	0	17	21	0	3	0	8	0	0	58
Kel	0	0	16	0	0	14	0	0	0	0	0	3	0	269	37	22	0	2	2	365
C-C	2	0	0	0	0	0	4	0	0	0	0	5	0	6	106	0	0	5	1	129
Kld	0	8	3	0	0	0	0	0	0	3	0	18	5	67	99	1062	0	21	5	1291
K-E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	22	0	10	35
K-W	0	0	0	0	9	0	0	0	0	0	0	0	0	29	43	10	0	104	23	218
Bir	0	0	0	0	0	0	0	0	0	0	11	1	1	19	47	26	17	18	485	625
Total	421	291	48	93	100	100	139	21	113	86	77	499	30	423	397	1150	47	150	526	4711

Table 6.2b MIGRATION MATRIX: MOVEMENT FROM BIRTHPLACES OF MOTHERS TO THOSE OF OFFSPRING (PROPORTION OF EXCHANGES)

	Kac	Kal	Ala	Kpy	Bal	Tav	Kuh	Cha	Khe	Zan	Pan	N-C	Hum	Kel	C-C	Kld	K-E	K-W	Bir	Total
Kac	.870	.000	.018	.000	.000	.000	.008	.000	.061	.000	.000	.003	.000	.033	.008	.000	.000	.000	.000	1.000
Kal	.122	.814	.020	.041	.000	.003	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	1.000
Ala	.833	.167	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	1.000
Kpy	.133	.000	.000	.867	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	1.000
Bal	.025	.000	.000	.000	.754	.034	.000	.000	.000	.000	.000	.161	.000	.000	.025	.000	.000	.000	.000	1.000
Tav	.120	.007	.042	.007	.000	.535	.000	.000	.007	.077	.000	.113	.000	.092	.000	.000	.000	.000	.000	1.000
Kuh	.000	.000	.000	.000	.010	.000	.552	.000	.046	.000	.000	.258	.000	.036	.010	.088	.000	.000	.000	1.000
Cha	.000	.000	.000	.000	.000	.128	.000	.538	.154	.000	.000	.051	.000	.000	.128	.000	.000	.000	.000	1.000
Khe	.000	.000	.000	.000	.000	.000	.088	.000	.570	.000	.000	.342	.000	.000	.000	.000	.000	.000	.000	1.000
Zan	.000	.000	.000	.000	.000	.000	.025	.000	.033	.300	.000	.592	.004	.000	.042	.004	.000	.000	.000	1.000
Pan	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.943	.057	.000	.000	.000	.000	.000	.000	.000	1.000
N-C	.000	.000	.037	.000	.000	.000	.000	.000	.000	.000	.000	.755	.008	.000	.149	.050	.000	.000	.000	1.000
Hum	.000	.000	.000	.000	.000	.000	.155	.000	.000	.000	.000	.293	.362	.000	.052	.000	.138	.000	.000	1.000
Kel	.000	.000	.044	.000	.000	.038	.000	.000	.000	.000	.000	.008	.000	.737	.101	.060	.000	.005	.005	1.000
C-C	.016	.000	.000	.000	.000	.000	.031	.000	.000	.000	.000	.039	.000	.047	.822	.000	.000	.039	.008	1.000
Kld	.000	.006	.002	.000	.000	.000	.000	.000	.000	.002	.000	.014	.004	.052	.077	.823	.000	.016	.004	1.000
K-E	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.086	.000	.629	.000	.286	1.000
K-W	.000	.000	.000	.000	.041	.000	.000	.000	.000	.000	.000	.000	.000	.133	.197	.046	.000	.477	.106	1.000
Bir	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.018	.002	.002	.030	.075	.042	.027	.029	.776	1.000

Table 6.2c (MOTHER/OFFSPRING)

UPPER MATRIX: RELATEDNESS COEFFICIENTS AFTER ONE GENERATION OF MIGRATION
LOWER MATRIX: NUMBER OF GENERATIONS TO HOMOGENEITY BETWEEN EACH PAIR OF SUBDIVISIONS

	Kac	Kal	Ala	Kpy	Bal	Tav	Kuh	Cha	Khe	Zan	Pan	N-C	Hum	Kel	C-C	Kld	K-E	K-W	Bir
Kac		.140	.833	.133	.036	.180	.098	.072	.072	.051	.003	.028	.018	.061	.067	.046	.008	.041	.040
Kal	31		.288	.162	.028	.157	.000	.003	.000	.000	.000	.020	.000	.023	.016	.009	.000	.000	.000
Ala	17	29		.133	.025	.127	.000	.000	.000	.000	.000	.000	.000	.000	.016	.006	.000	.000	.000
Kpy	32	17	30		.025	.127	.000	.000	.000	.000	.000	.000	.000	.000	.016	.000	.000	.000	.000
Bal	22	34	26	34		.172	.182	.111	.161	.186	.057	.186	.186	.068	.080	.039	.025	.067	.027
Tav	18	32	23	33	18		.156	.187	.120	.197	.057	.150	.113	.180	.101	.077	.000	.092	.032
Kuh	25	35	28	35	18	22		.108	.392	.331	.057	.318	.423	.115	.116	.148	.010	.103	.084
Cha	24	34	27	35	14	19	14		.205	.126	.051	.179	.103	.148	.167	.091	.086	.128	.077
Khe	25	25	28	35	17	21	11	11		.400	.057	.342	.381	.008	.070	.014	.000	.000	.002
Zan	25	34	28	35	17	21	10	12	10		.057	.642	.364	.054	.105	.066	.042	.046	.049
Pan	52	52	52	52	52	52	52	52	52	52		.057	.057	.008	.039	.014	.000	.000	.019
N-C	24	34	28	35	16	20	11	12	11	8	52		.353	.197	.188	.147	.086	.195	.120
Hum	26	35	29	36	20	24	13	17	14	13	51	12		.060	.121	.070	.190	.052	.082
Kel	23	34	26	34	16	18	16	15	17	16	52	15	18		.167	.209	.091	.291	.160
C-C	25	35	28	35	18	22	13	15	14	13	52	13	13	16		.157	.093	.290	.144
Kld	26	35	28	35	20	23	15	18	17	16	52	16	16	18	16		.081	.195	.171
K-E	30	37	32	37	25	28	22	24	23	23	50	23	20	25	22	22		.191	.388
K-W	26	35	29	35	19	23	14	17	15	15	51	14	12	16	13	15	20		.282
Bir	29	36	31	37	24	27	22	23	22	22	50	22	18	24	21	21	12	19	

Table 6.3a MIGRATION MATRIX: MOVEMENT FROM BIRTHPLACES OF FATHERS TO THOSE OF OFFSPRING (NUMBER OF EXCHANGES)

	Kac	Kal	Ala	Kpy	Bal	Tav	Kuh	Cha	Khe	Zan	Pan	N-C	Hum	Kel	C-C	Kld	K-E	K-W	Bir	Total
Kac	312	0	0	0	0	4	0	0	0	0	0	7	0	0	3	0	0	0	0	326
Kal	26	285	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	322
Ala	17	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	47
Kpy	10	1	0	87	0	1	0	0	0	0	0	24	0	6	0	0	0	0	0	129
Bal	0	0	0	0	84	0	0	0	0	0	0	15	0	5	1	0	0	0	0	105
Tav	29	1	6	1	0	99	0	0	0	0	0	11	7	13	5	0	0	0	0	177
Kuh	2	0	0	0	13	0	137	0	23	0	0	51	0	0	11	0	0	0	0	237
Cha	0	0	0	0	0	0	3	13	0	0	0	12	0	0	0	0	0	0	0	28
Khe	0	0	0	0	0	1	0	2	69	0	0	13	0	0	0	0	0	0	0	85
Zan	0	0	9	0	0	0	0	0	7	85	0	156	8	0	12	2	0	0	0	279
Pan	0	0	0	0	0	0	0	0	0	0	77	2	0	0	3	0	0	0	0	82
N-C	0	0	0	0	0	0	0	0	0	0	0	107	0	0	1	0	2	0	7	117
Hum	20	0	0	0	0	0	0	0	0	0	0	46	18	0	6	0	8	0	0	98
Kel	0	0	0	0	0	0	0	0	0	0	0	5	0	339	27	10	0	0	0	381
C-C	0	0	0	0	0	0	0	0	0	0	0	4	0	0	86	7	0	0	0	97
Kld	0	8	3	0	0	0	0	0	0	0	0	19	5	37	93	1158	0	0	3	1326
K-E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	10	30	16	9	68
K-W	10	0	0	0	9	0	0	0	0	0	0	0	8	15	49	8	0	111	29	239
Bir	0	0	0	0	0	0	0	0	0	0	0	0	1	22	12	19	7	10	488	559
Total	426	295	48	94	106	105	140	15	99	90	77	472	47	437	312	1214	47	137	541	4702

Table 6.3b MIGRATION MATRIX: MOVEMENT FROM BIRTHPLACES OF FATHERS TO THOSE OF OFFSPRING (PROPORTION OF EXCHANGES)

	Kac	Kal	Ala	Kpy	Bal	Tav	Kuh	Cha	Khe	Zan	Pan	N-C	Hum	Kel	C-C	Kld	K-E	K-W	Bir	Total
Kac	.957	.000	.000	.000	.000	.012	.000	.000	.000	.000	.000	.021	.000	.000	.009	.000	.000	.000	.000	1.000
Kal	.081	.885	.000	.019	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.016	1.000
Ala	.362	.000	.638	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	1.000
Kpy	.078	.008	.000	.674	.000	.008	.000	.000	.000	.000	.000	.186	.000	.047	.000	.000	.000	.000	.000	1.000
Bal	.000	.000	.000	.000	.800	.000	.000	.000	.000	.000	.000	.143	.000	.048	.010	.000	.000	.000	.000	1.000
Tav	.164	.006	.034	.006	.000	.559	.000	.000	.000	.028	.000	.062	.040	.073	.028	.000	.000	.000	.000	1.000
Kuh	.008	.000	.000	.000	.055	.000	.578	.000	.097	.000	.000	.215	.000	.000	.046	.000	.000	.000	.000	1.000
Cha	.000	.000	.000	.000	.000	.000	.107	.464	.000	.000	.000	.429	.000	.000	.000	.000	.000	.000	.000	1.000
Khe	.000	.000	.000	.000	.000	.012	.000	.024	.812	.000	.000	.153	.000	.000	.000	.000	.000	.000	.000	1.000
Zan	.000	.000	.032	.000	.000	.000	.000	.000	.025	.305	.000	.559	.029	.000	.043	.007	.000	.000	.000	1.000
Pan	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.939	.024	.000	.000	.037	.000	.000	.000	.000	1.000
N-C	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.915	.000	.000	.009	.000	.017	.000	.060	1.000
Hum	.204	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.469	.184	.000	.061	.000	.082	.000	.000	1.000
Kel	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.013	.000	.890	.071	.026	.000	.000	.000	1.000
C-C	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.041	.000	.000	.887	.072	.000	.000	.000	1.000
Kld	.000	.006	.002	.000	.000	.000	.000	.000	.000	.000	.000	.014	.004	.028	.070	.873	.000	.000	.002	1.000
K-E	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.044	.147	.441	.235	.132	1.000
K-W	.042	.000	.000	.000	.038	.000	.000	.000	.000	.000	.000	.000	.033	.063	.205	.033	.000	.464	.121	1.000
Bir	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.002	.039	.021	.034	.013	.018	.873	1.000

Table 6.3c (FATHER/OFFSPRING)

UPPER MATRIX: RELATEDNESS COEFFICIENTS AFTER ONE GENERATION OF MIGRATION
LOWER MATRIX: NUMBER OF GENERATIONS TO HOMOGENEITY BETWEEN EACH PAIR OF SUBDIVISIONS

	Kac	Kal	Ala	Kpy	Bal	Tav	Kuh	Cha	Khe	Zan	Pan	N-C	Hum	Kel	C-C	Kld	K-E	K-W	Bir
Kac		.081	.362	.107	.031	.207	.039	.021	.033	.031	.031	.030	.235	.022	.031	.024	.009	.051	.009
Kal	26		.081	.104	.000	.092	.008	.000	.000	.000	.000	.016	.081	.000	.000	.008	.016	.057	.016
Ala	22	30		.078	.000	.198	.008	.000	.000	.032	.000	.000	.204	.000	.000	.002	.000	.042	.000
Kpy	67	70	71		.189	.205	.194	.186	.161	.186	.024	.186	.264	.060	.041	.048	.000	.088	.039
Bal	76	79	79	48		.119	.207	.143	.143	.152	.034	.151	.152	.070	.051	.052	.010	.095	.049
Tav	56	61	62	41	62		.090	.062	.074	.180	.053	.071	.294	.115	.069	.082	.028	.166	.063
Kuh	75	78	78	45	22	60		.322	.250	.283	.061	.224	.270	.060	.088	.061	.044	.093	.021
Cha	76	78	78	47	20	61	14		.176	.429	.024	.429	.429	.013	.041	.014	.000	.000	.000
Khe	75	78	78	45	31	60	24	28		.178	.024	.153	.153	.013	.041	.014	.000	.000	.000
Zan	74	77	77	41	23	58	19	19	30		.061	.568	.541	.063	.091	.071	.050	.079	.030
Pan	78	80	81	54	49	65	49	49	49	49		.033	.061	.050	.061	.051	.037	.037	.021
N-C	76	78	78	47	21	61	23	18	33	15	49		.495	.022	.050	.025	.085	.068	.081
Hum	68	71	72	17	45	44	42	44	42	37	53	44		.074	.102	.079	.126	.137	.036
Kel	76	78	78	48	34	61	36	34	38	35	49	32	45		.110	.137	.070	.160	.087
C-C	75	77	78	45	33	60	34	33	37	33	49	31	42	26		.157	.116	.238	.055
Kld	73	76	76	42	36	56	36	36	38	33	49	34	40	24	22		.193	.138	.087
K-E	73	76	76	42	35	57	36	35	38	32	50	33	40	25	23	20		.434	.218
K-W	72	75	75	39	34	55	35	34	38	31	49	32	36	31	25	24	17		.235
Bir	75	77	77	46	36	59	36	36	39	35	50	33	44	24	25	26	21	30	

Table 6.4a MIGRATION MATRIX: MOVEMENT FROM BIRTHPLACES OF PARENTS TO THOSE OF OFFSPRING (NUMBER OF EXCHANGES)

	Kac	Kal	Ala	Kpy	Bal	Tav	Kuh	Cha	Khe	Zan	Pan	N-C	Hum	Kel	C-C	Kld	K-E	K-W	Bir	Total
Kac	652	0	7	0	0	4	3	0	24	0	0	0	0	13	6	0	0	0	0	717
Kal	68	566	7	20	0	1	0	0	0	0	0	0	0	0	0	0	0	0	5	667
Ala	22	1	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	53
Kpy	22	1	0	165	0	1	0	0	0	0	0	24	0	6	0	0	0	0	0	219
Bal	3	0	0	0	173	4	0	0	0	0	0	34	0	5	4	0	0	0	0	223
Tav	46	2	12	2	0	175	0	0	1	16	0	27	7	26	5	0	0	0	0	319
Kuh	2	0	0	0	15	0	244	0	32	0	0	101	0	7	13	17	0	0	0	431
Cha	0	0	0	0	0	5	3	34	6	0	0	14	0	0	5	0	0	0	0	67
Khe	0	0	0	0	0	1	10	2	134	0	0	52	0	0	0	0	0	0	0	199
Zan	0	0	9	0	0	0	6	0	15	157	0	298	9	0	22	3	0	0	0	591
Pan	0	0	0	0	0	0	0	0	0	0	143	6	0	0	3	0	0	0	0	152
N-C	0	0	9	0	0	0	0	0	0	0	0	289	2	0	37	12	2	0	7	358
Hum	20	0	0	0	0	0	9	0	0	0	0	63	39	0	9	0	16	0	0	156
Kel	0	0	16	0	0	14	0	0	0	0	0	8	0	608	64	32	0	2	2	746
C-C	2	0	0	0	0	0	4	0	0	0	0	9	0	6	192	7	0	5	1	226
Kld	0	16	6	0	0	0	0	0	0	3	0	37	10	104	192	2220	0	21	8	2617
K-E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	10	52	16	19	103
K-W	10	0	0	0	18	0	0	0	0	0	0	0	8	44	92	18	0	215	52	457
Bir	0	0	0	0	0	0	0	0	0	0	11	1	2	41	59	45	24	28	973	1184
Total	847	586	96	187	206	205	279	36	212	176	154	971	77	860	709	2364	94	287	1067	9413

Table 6.4b MIGRATION MATRIX: MOVEMENT FROM BIRTHPLACES OF PARENTS TO THOSE OF OFFSPRING (PROPORTION OF EXCHANGES)

	Kac	Kal	Ala	Kpy	Bal	Tav	Kuh	Cha	Khe	Zan	Pan	N-C	Hum	Kel	C-C	Kld	K-E	K-W	Bir	Total
Kac	.909	.000	.010	.000	.000	.006	.004	.000	.033	.000	.000	.011	.000	.018	.008	.000	.000	.000	.000	1.000
Kal	.102	.849	.010	.030	.000	.001	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.007	1.000
Ala	.415	.019	.566	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	1.000
Kpy	.100	.005	.000	.753	.000	.005	.000	.000	.000	.000	.000	.110	.000	.027	.000	.000	.000	.000	.000	1.000
Bal	.013	.000	.000	.000	.776	.018	.000	.000	.000	.000	.000	.152	.000	.022	.018	.000	.000	.000	.000	1.000
Tav	.144	.006	.038	.006	.000	.549	.000	.000	.003	.050	.000	.085	.022	.082	.016	.000	.000	.000	.000	1.000
Kuh	.005	.000	.000	.000	.035	.000	.566	.000	.074	.000	.000	.234	.000	.016	.030	.039	.000	.000	.000	1.000
Cha	.000	.000	.000	.000	.000	.075	.045	.507	.090	.000	.000	.209	.000	.000	.075	.000	.000	.000	.000	1.000
Khe	.000	.000	.000	.000	.000	.005	.050	.010	.673	.000	.000	.261	.000	.000	.000	.000	.000	.000	.000	1.000
Zan	.000	.000	.017	.000	.000	.000	.012	.000	.029	.303	.000	.574	.017	.000	.042	.006	.000	.000	.000	1.000
Pan	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.941	.039	.000	.000	.020	.000	.000	.000	.000	1.000
N-C	.000	.000	.025	.000	.000	.000	.000	.000	.000	.000	.000	.807	.006	.000	.103	.034	.006	.000	.020	1.000
Hum	.128	.000	.000	.000	.000	.000	.058	.000	.000	.000	.000	.404	.250	.000	.058	.000	.103	.000	.000	1.000
Kel	.000	.000	.021	.000	.000	.019	.000	.000	.000	.000	.000	.011	.000	.815	.086	.043	.000	.003	.003	1.000
C-C	.009	.000	.000	.000	.000	.000	.018	.000	.000	.000	.000	.040	.000	.027	.850	.031	.000	.022	.004	1.000
Kld	.000	.006	.002	.000	.000	.000	.000	.000	.000	.001	.000	.014	.004	.040	.073	.848	.000	.008	.003	1.000
K-E	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.058	.097	.505	.155	.184	1.000
K-W	.022	.000	.000	.000	.039	.000	.000	.000	.000	.000	.000	.000	.018	.096	.201	.039	.000	.470	.114	1.000
Bir	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.009	.001	.002	.035	.050	.038	.020	.024	.822	1.000

Table 6.4c (PARENT/OFFSPRING)

UPPER MATRIX: RELATEDNESS COEFFICIENTS AFTER ONE GENERATION OF MIGRATION
LOWER MATRIX: NUMBER OF GENERATIONS TO HOMOGENEITY BETWEEN EACH PAIR OF SUBDIVISIONS

	Kac	Kal	Ala	Kpy	Bal	Tav	Kuh	Cha	Khe	Zan	Pan	N-C	Hum	Kel	C-C	Kld	K-E	K-W	Bir
Kac		.113	.425	.134	.057	.200	.078	.063	.054	.062	.020	.029	.152	.053	.051	.040	.008	.048	.027
Kal	31		.131	.137	.015	.126	.005	.001	.001	.010	.000	.018	.102	.015	.013	.011	.007	.029	.007
Ala	18	26		.105	.013	.188	.005	.000	.000	.017	.000	.025	.128	.021	.009	.008	.000	.022	.000
Kpy	24	36	30		.150	.228	.130	.114	.114	.110	.039	.110	.210	.043	.075	.046	.000	.049	.028
Bal	34	41	37	28		.154	.226	.188	.157	.170	.057	.170	.184	.069	.089	.054	.018	.093	.041
Tav	26	37	31	13	25		.124	.178	.093	.188	.055	.131	.250	.148	.091	.083	.016	.137	.053
Kuh	35	41	38	30	16	39		.358	.359	.311	.059	.298	.327	.097	.140	.100	.070	.125	.085
Cha	34	41	37	39	14	27	9		.358	.292	.059	.284	.311	.104	.132	.088	.058	.075	.051
Khe	35	41	38	30	16	29	12	12		.302	.039	.261	.312	.016	.058	.014	.000	.000	.001
Zan	35	41	37	30	16	28	11	11	14		.059	.645	.475	.076	.100	.070	.048	.066	.051
Pan	50	50	50	50	50	50	50	50	50	50		.059	.059	.030	.059	.034	.020	.020	.030
N-C	35	41	47	30	18	28	13	13	15	8	50		.473	.154	.179	.130	.117	.162	.111
Hum	33	40	36	27	16	25	16	14	17	14	50	13		.068	.124	.076	.160	.097	.073
Kel	34	40	36	28	19	27	19	18	20	18	50	17	18		.159	.174	.107	.227	.129
C-C	36	42	38	31	31	30	16	18	18	17	50	15	20	19		.156	.116	.294	.135
Kld	36	42	38	32	23	30	20	21	21	20	50	19	23	19	17		.166	.167	.136
K-E	37	43	39	33	25	33	21	23	22	22	49	21	25	22	19	17		.367	.316
K-W	36	42	28	31	21	30	16	18	17	16	50	15	19	17	14	17	16		.262
Bir	38	43	40	35	26	34	23	25	23	24	49	23	26	25	22	21	14	20	

Figure 6.2a

SINGLE LINK CLUSTERING OF SUBDIVISIONS BASED ON SIMILARITY COEFFICIENTS AFTER ONE GENERATION OF MIGRATION (PARENT/OFFSPRING)

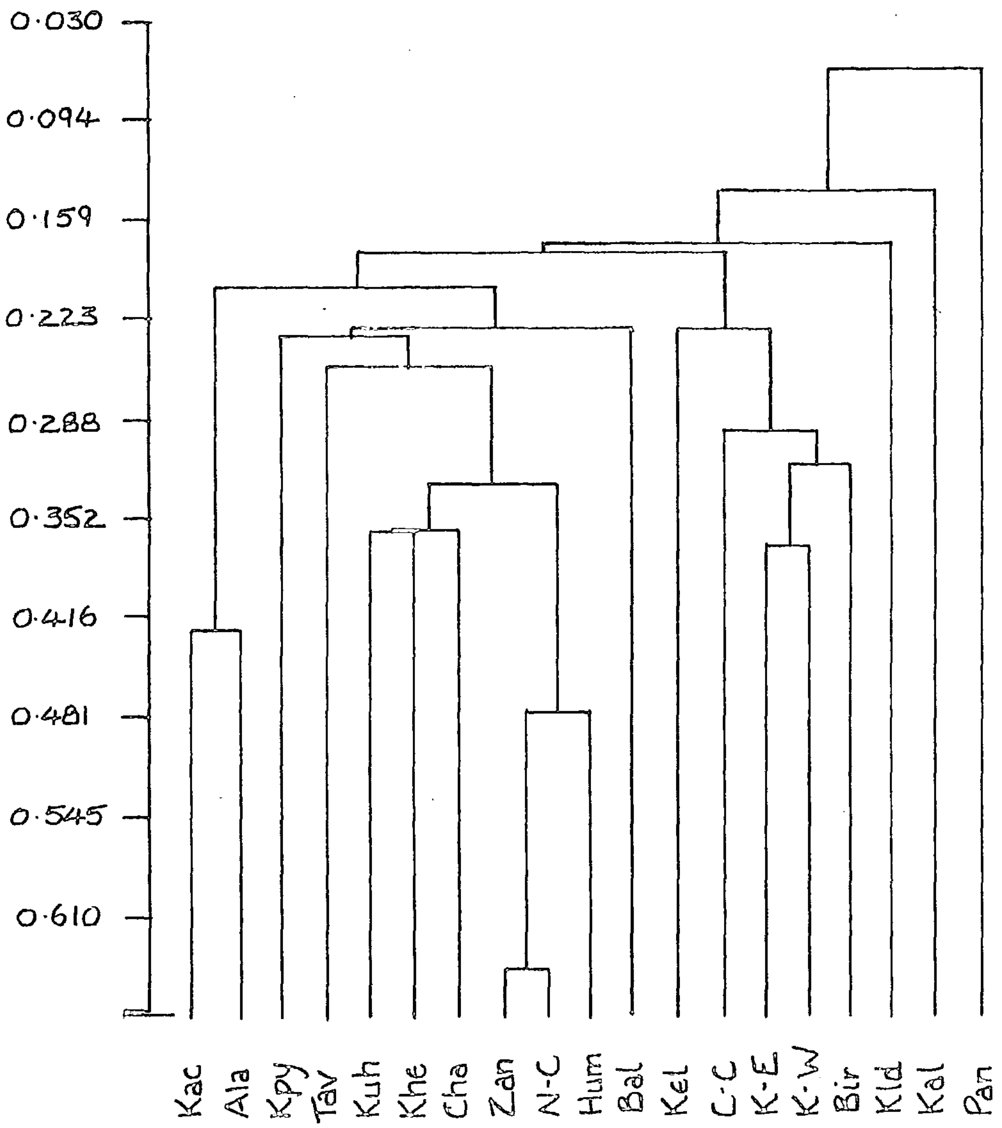


Figure 6.2b SPATIAL POSITION OF SUBDIVISIONS AFTER ONE GENERATION OF MIGRATION BY MD-SCAL (PARENT/OFFSPRING) Stress = 0.152

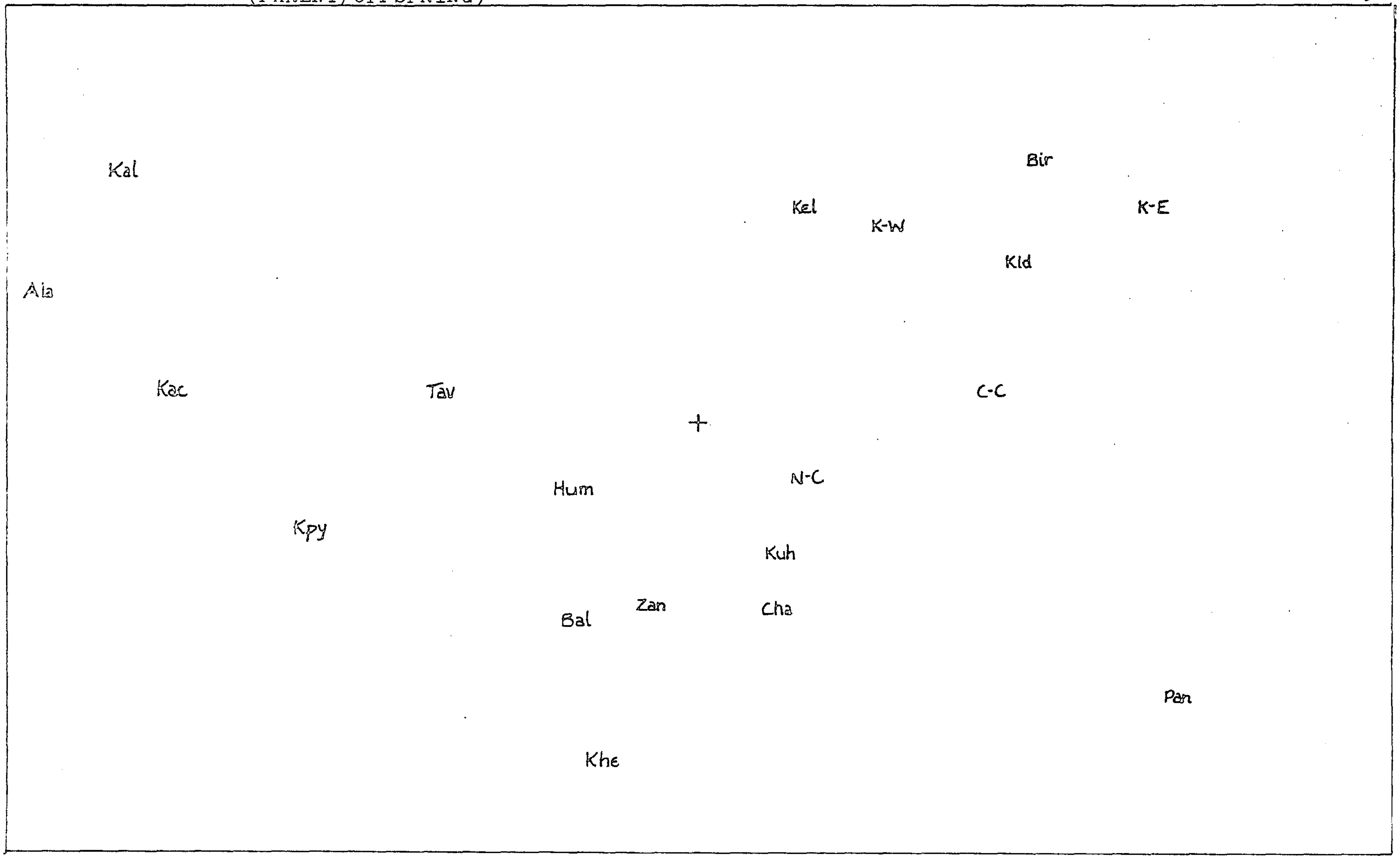


Figure 6.2c

SINGLE LINK CLUSTERING OF SUBDIVISIONS BASED ON SIMILARITY COEFFFICIENTS AT HOMOGENEITY (PARENT/OFFSPRING)

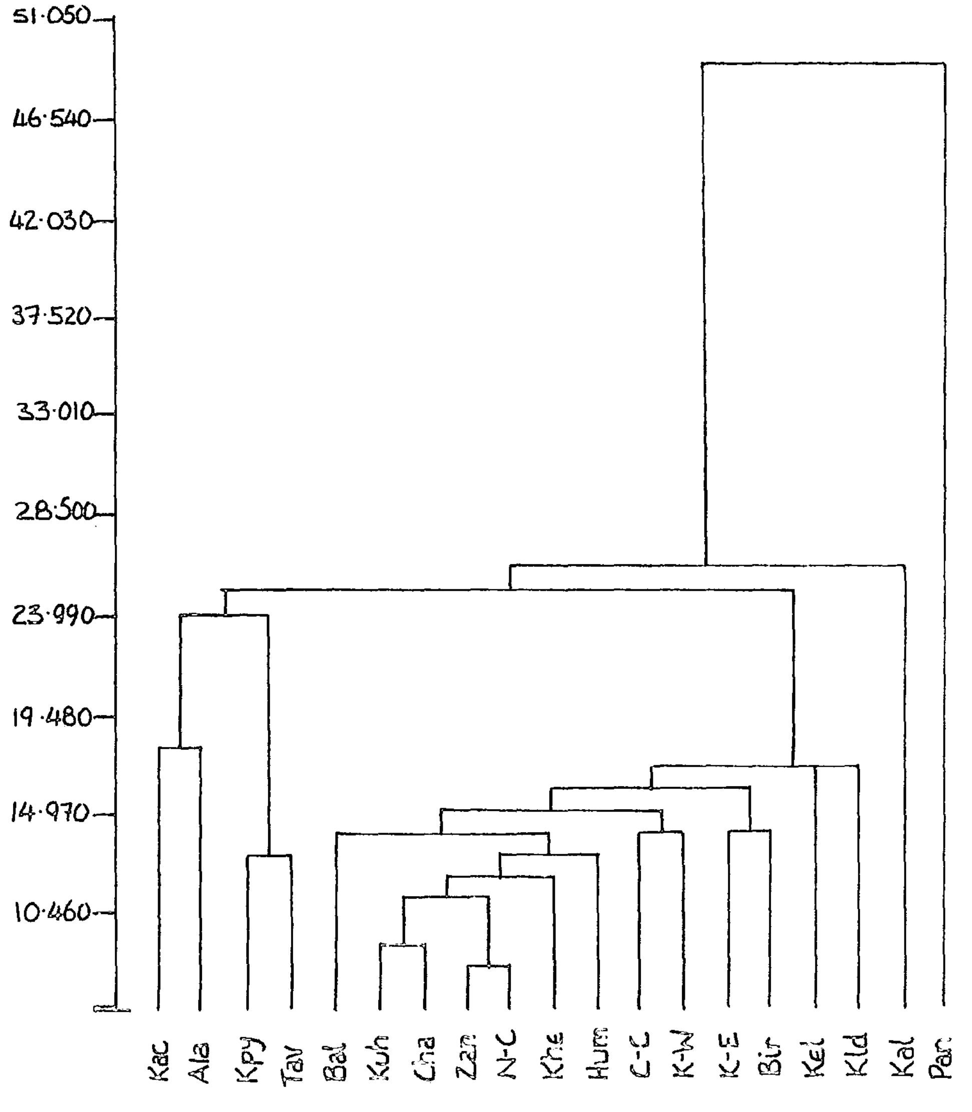


Figure 6.2d SPATIAL POSITION OF SUBDIVISIONS AT HOMOGENEITY BY MD-SCAL (PARENT/OFFSPRING)
(Dehestan Panjakrostagh excluded) Stress = 0.258

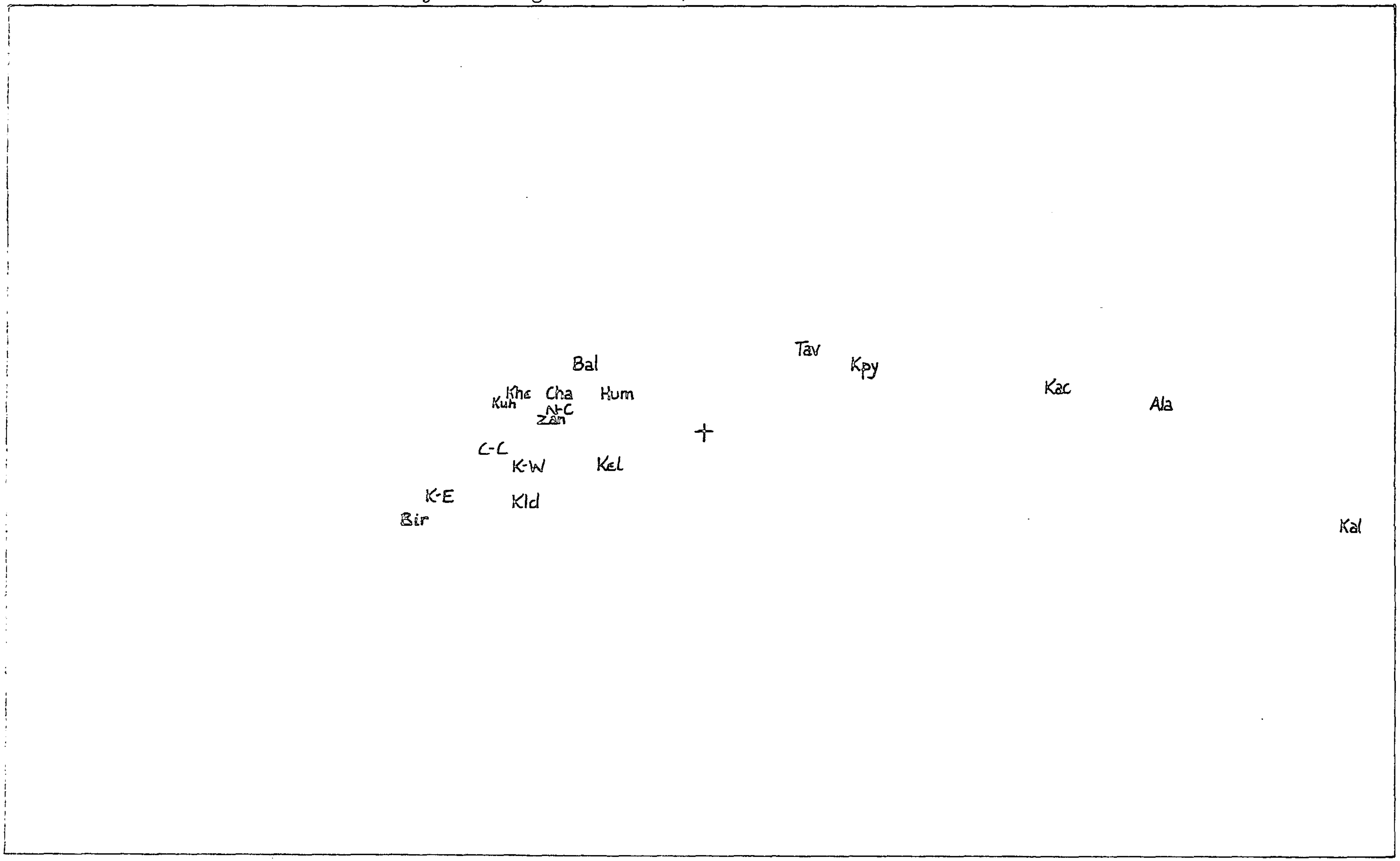


Table 6.5a MIGRATION MATRIX: INTER-SUBDIVISIONAL MOVEMENT FOR BOTH GENERATIONS (NUMBER OF EXCHANGES)

	Kac	Kal	Ala	Kpy	Bal	Tav	Kuh	Cha	Khe	Zan	Pan	N-C	Hum	Kel	C-C	Kld	K-E	K-W	Bir	Total
Kac	769	2	7	1	0	7	3	0	24	0	0	10	0	14	6	0	0	1	0	844
Kal	74	721	7	21	0	2	0	0	0	0	0	0	0	0	0	2	0	0	6	833
Ala	25	2	41	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	71
Kpy	25	2	0	205	0	1	0	0	0	0	0	24	0	6	0	0	0	0	0	263
Bal	3	0	0	1	236	7	0	0	0	0	0	34	0	7	4	1	1	0	0	294
Tav	57	3	12	2	3	237	0	0	3	17	0	29	7	27	5	0	0	0	0	402
Kuh	3	0	0	2	17	0	334	0	35	0	0	105	2	7	13	19	0	0	0	537
Cha	0	0	0	0	0	5	3	53	6	0	0	14	0	0	5	0	0	0	0	86
Khe	0	1	0	0	0	2	10	2	154	0	0	52	1	0	0	0	0	0	0	222
Zan	3	0	9	0	1	1	7	0	21	269	0	304	12	0	22	3	0	0	0	652
Pan	0	0	0	0	0	0	0	0	0	0	178	7	1	0	3	0	0	0	0	189
N-C	0	0	9	0	0	0	0	0	0	0	0	309	2	0	39	13	2	0	7	381
Hum	20	0	0	0	0	0	10	0	0	1	0	63	57	0	9	0	16	0	0	176
Kel	1	0	19	1	0	16	0	0	0	0	0	8	0	660	65	33	0	5	2	810
C-C	2	0	0	0	0	0	4	0	0	1	0	9	0	6	204	7	0	5	2	240
Kld	0	18	6	0	0	0	4	0	0	5	0	39	12	123	195	2785	1	26	12	3226
K-E	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	11	62	21	24	126
K-w	11	0	0	0	18	0	0	0	0	0	0	0	8	42	92	18	1	287	57	538
Bir	0	0	0	0	0	0	0	0	0	0	11	1	2	44	60	52	27	29	1194	1420
Total	993	749	110	233	275	278	375	55	243	293	189	1010	104	943	728	2944	110	374	1304	11310

Table 6.5b MIGRATION MATRIX: INTER-SUBDIVISIONAL MOVEMENT FOR BOTH GENERATIONS (PROPORTION OF EXCHANGES)

	Kac	Kal	Ala	Kpy	Bal	Tav	Kuh	Cha	Khe	Zan	Pan	N-C	Hum	Kel	C-C	Kld	K-E	K-W	Bir	Total
Kac	.911	.002	.008	.001	.000	.008	.004	.000	.028	.000	.000	.012	.000	.017	.007	.000	.000	.001	.000	1.000
Kal	.089	.866	.008	.025	.000	.002	.000	.000	.000	.000	.000	.000	.000	.000	.000	.002	.000	.000	.007	1.000
Ala	.352	.028	.577	.000	.000	.000	.000	.000	.000	.000	.000	.028	.000	.014	.000	.000	.000	.000	.000	1.000
Kpy	.095	.008	.000	.779	.000	.004	.000	.000	.000	.000	.000	.091	.000	.023	.000	.000	.000	.000	.000	1.000
Bal	.010	.000	.000	.003	.803	.024	.000	.000	.000	.000	.000	.116	.000	.024	.014	.003	.003	.000	.000	1.000
Tav	.142	.007	.030	.005	.007	.590	.000	.000	.007	.042	.000	.072	.017	.067	.012	.000	.000	.000	.000	1.000
Kuh	.006	.000	.000	.004	.032	.000	.622	.000	.065	.000	.000	.196	.004	.013	.024	.035	.000	.000	.000	1.000
Cha	.000	.000	.000	.000	.000	.058	.035	.616	.070	.000	.000	.163	.000	.000	.058	.000	.000	.000	.000	1.000
Khe	.000	.005	.000	.000	.000	.009	.045	.009	.694	.000	.000	.234	.005	.000	.000	.000	.000	.000	.000	1.000
Zan	.005	.000	.014	.000	.002	.002	.011	.000	.032	.413	.000	.466	.018	.000	.034	.005	.000	.000	.000	1.000
Pan	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.942	.037	.005	.000	.016	.000	.000	.000	.000	1.000
N-C	.000	.000	.024	.000	.000	.000	.000	.000	.000	.000	.000	.811	.005	.000	.102	.034	.005	.000	.018	1.000
Hum	.114	.000	.000	.000	.000	.000	.057	.000	.000	.006	.000	.358	.324	.000	.051	.000	.091	.000	.000	1.000
Kel	.001	.000	.023	.001	.000	.020	.000	.000	.000	.000	.000	.010	.000	.815	.080	.041	.000	.006	.002	1.000
C-C	.008	.000	.000	.000	.000	.000	.017	.000	.000	.004	.000	.037	.000	.025	.850	.029	.000	.021	.008	1.000
Kld	.000	.006	.002	.000	.000	.000	.001	.000	.000	.002	.000	.012	.004	.038	.060	.863	.000	.008	.004	1.000
K-E	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.016	.048	.087	.492	.167	.190	1.000
K-W	.020	.000	.000	.000	.033	.000	.000	.000	.000	.000	.000	.000	.015	.086	.171	.033	.022	.533	.106	1.000
Bir	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.008	.001	.001	.031	.042	.037	.019	.020	.841	1.000

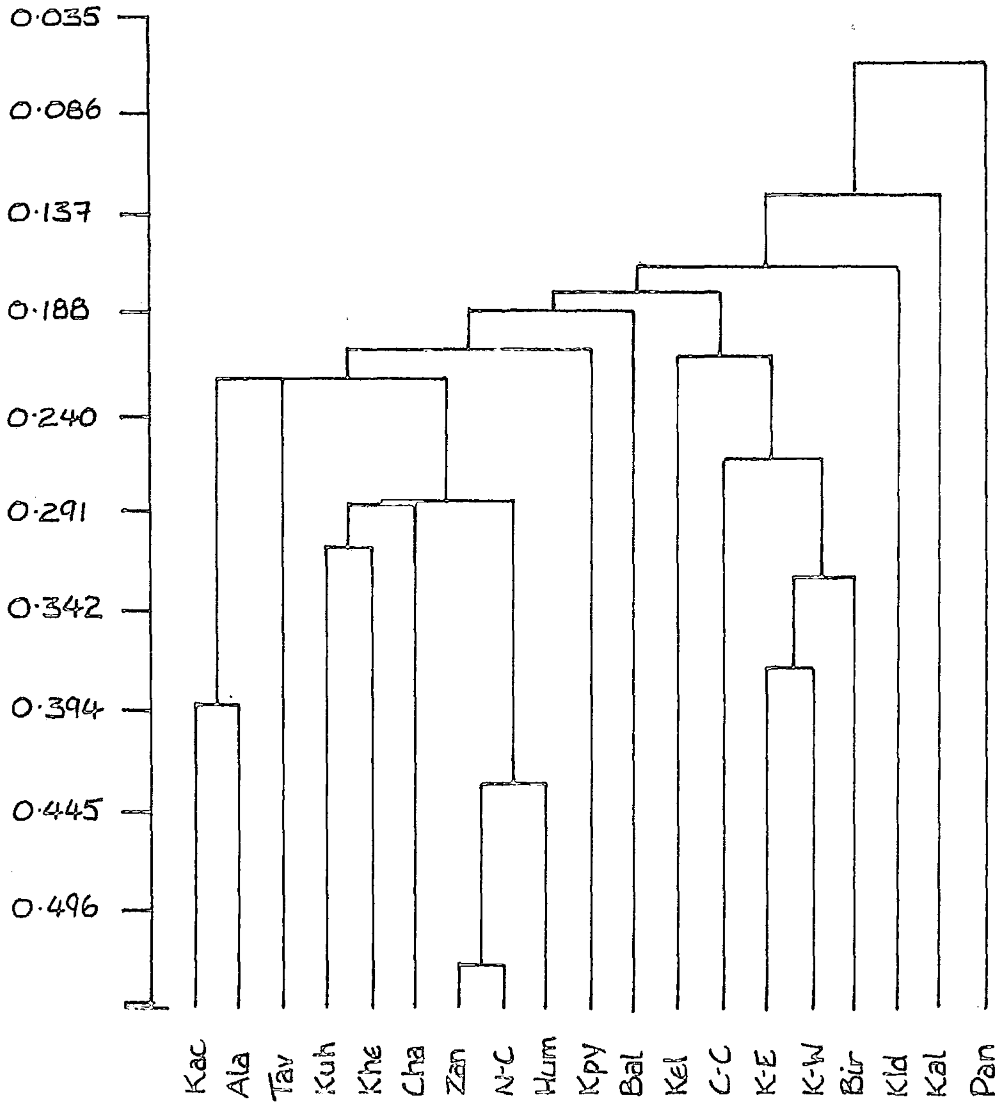
Table 6.5c (BOTH GENERATIONS)

UPPER MATRIX: RELATEDNESS COEFFICIENTS AFTER ONE GENERATION OF MIGRATION
LOWER MATRIX: NUMBER OF GENERATIONS TO HOMOGENEITY BETWEEN EACH PAIR OF SUBDIVISIONS

	Kac	Kal	Ala	Kpy	Bal	Tav	Kuh	Cha	Khe	Zan	Pan	N-C	Hum	Kel	C-C	Kld	K-E	K-W	Bir
Kac		.103	.389	.131	.055	.205	.071	.059	.055	.065	.019	.027	.136	.054	.049	.042	.024	.045	.026
Kal	34		.125	.124	.018	.112	.012	.002	.007	.017	.000	.018	.089	.018	.018	.014	.010	.030	.010
Ala	10	31		.145	.052	.221	.047	.028	.033	.047	.028	.052	.142	.049	.051	.034	.014	.035	.015
Kpy	23	38	27		.131	.206	.114	.095	.100	.097	.037	.091	.186	.039	.069	.040	.016	.043	.024
Bal	36	44	38	31		.153	.186	.153	.125	.140	.051	.136	.143	.073	.087	.053	.036	.086	.045
Tav	27	39	30	16	27		.126	.150	.098	.173	.055	.113	.221	.135	.087	.075	.028	.122	.046
Kuh	38	45	39	34	18	31		.287	.309	.277	.057	.258	.286	.085	.126	.090	.073	.112	.075
Cha	37	44	39	32	16	29	11		.285	.241	.053	.221	.249	.088	.112	.071	.048	.058	.043
Khe	38	35	39	33	18	31	12	11		.283	.042	.239	.284	.019	.054	.022	.000	.005	.002
Zan	37	44	39	33	19	31	12	13	14		.058	.524	.431	.065	.095	.059	.038	.059	.040
Pan	51	53	51	51	51	51	51	51	51	51		.058	.058	.026	.053	.032	.016	.021	.026
N-C	38	45	39	34	20	31	14	16	16	10	51		.420	.150	.177	.116	.105	.161	.102
Hum	36	44	38	31	17	28	17	15	17	15	51	14		.062	.118	.070	.139	.088	.063
Kel	35	43	37	31	20	28	20	20	21	19	51	19	17		.154	.160	.113	.209	.119
C-C	38	45	40	35	23	32	17	19	19	16	51	15	20	21		.141	.122	.263	.126
Kld	38	45	40	34	24	32	21	22	22	21	51	20	23	21	19		.163	.148	.124
K-E	40	46	41	36	36	35	22	24	23	22	51	21	25	25	20	19		.371	.325
K-W	38	45	40	34	22	32	17	19	19	17	51	15	19	18	16	19	17		.236
Bir	41	46	42	38	29	36	25	26	25	25	50	24	28	28	23	23	15	22	

Figure 6.3a

SINGLE LINK CLUSTERING OF SUBDIVISIONS BASED ON SIMILARITY COEFFICIENTS AFTER ONE GENERATION OF MIGRATION (BOTH GENERATIONS)



SPATIAL POSITION OF SUBDIVISIONS AFTER ONE GENERATION OF MIGRATION BY MD-SCAL (BOTH GENERATIONS)

Stress = 0.148

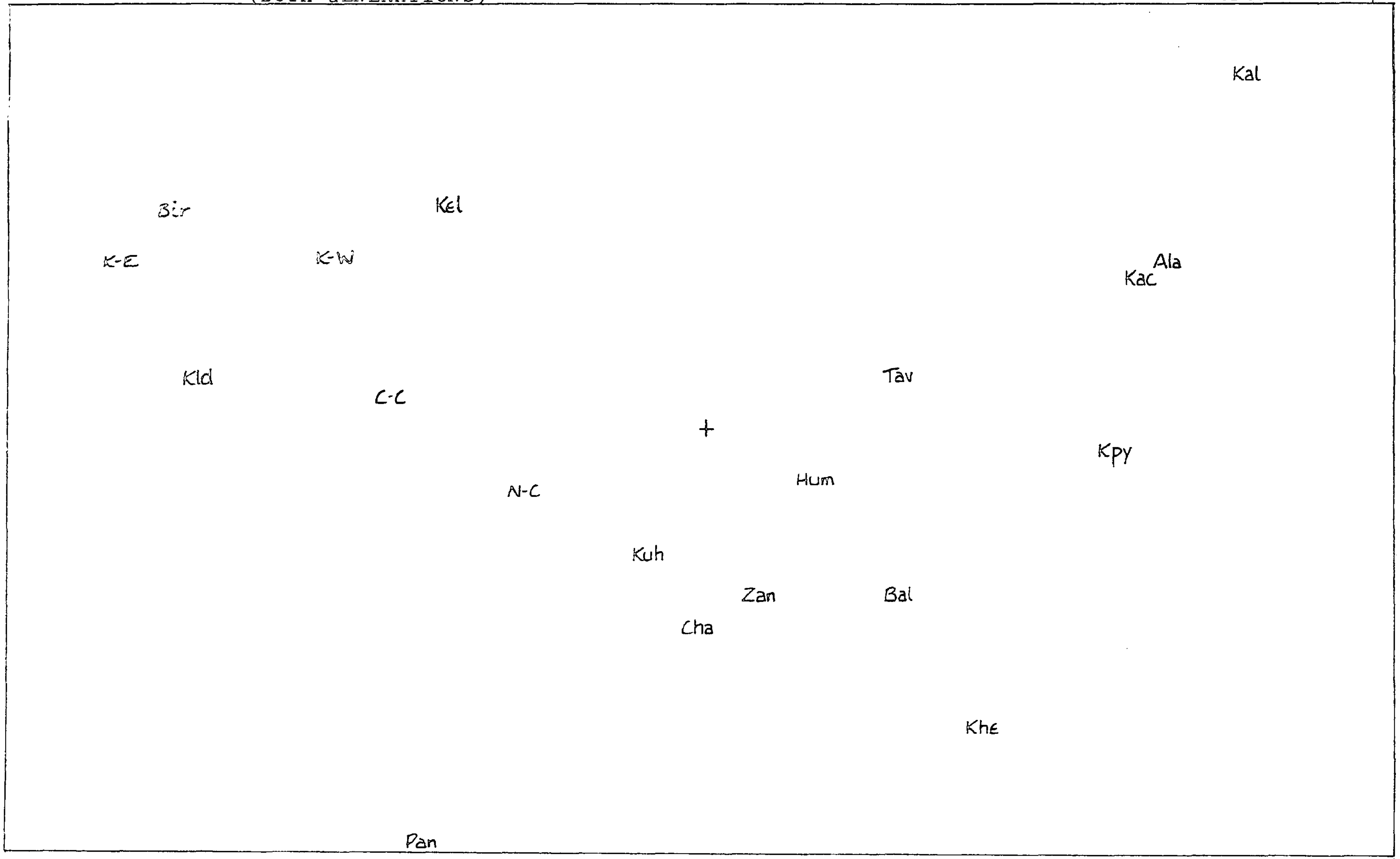


Figure 6.3c

SINGLE LINK CLUSTERING OF SUBDIVISIONS BASED ON SIMILARITY COEFFICIENTS AT HOMOGENEITY (BOTH GENERATIONS)

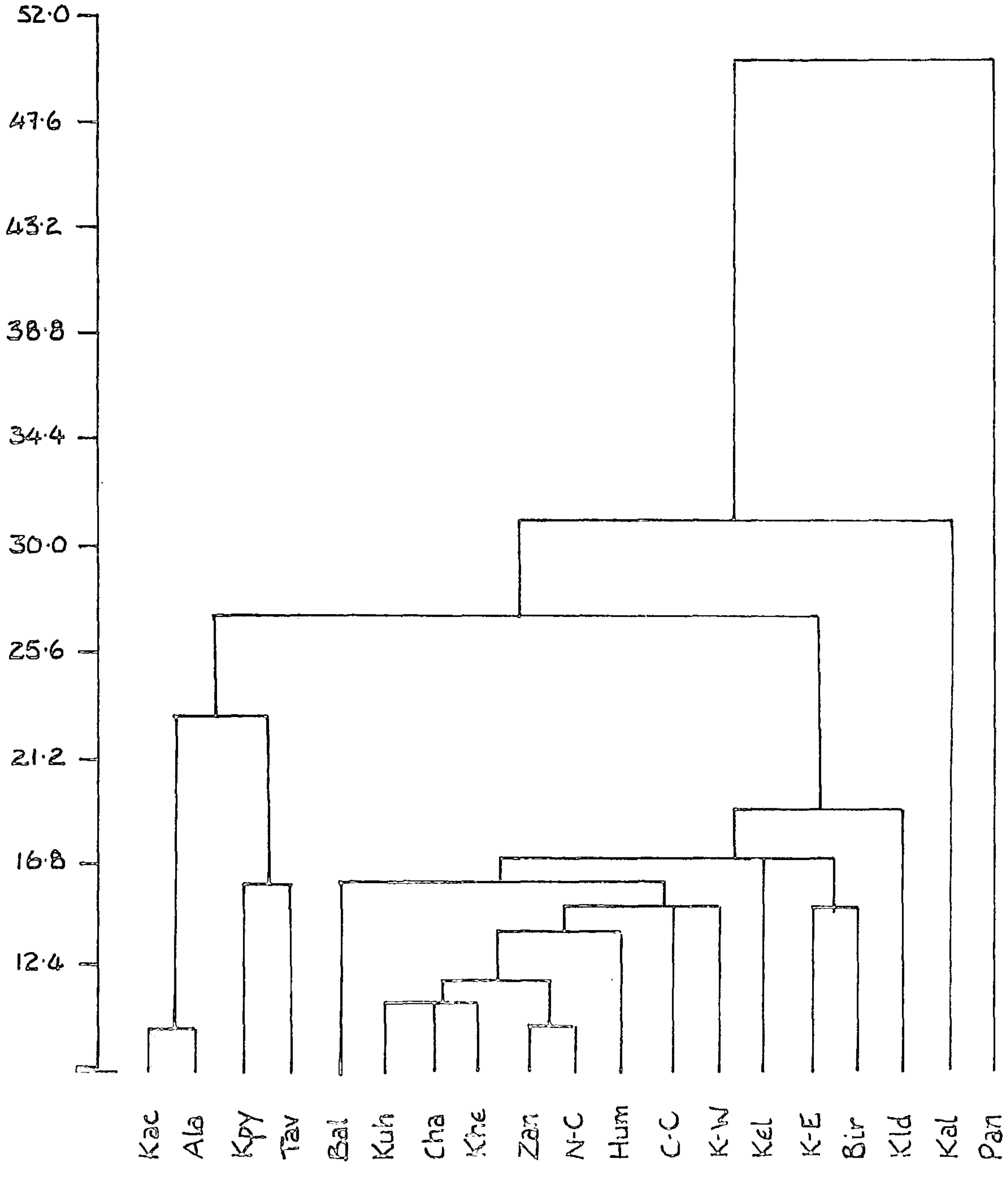
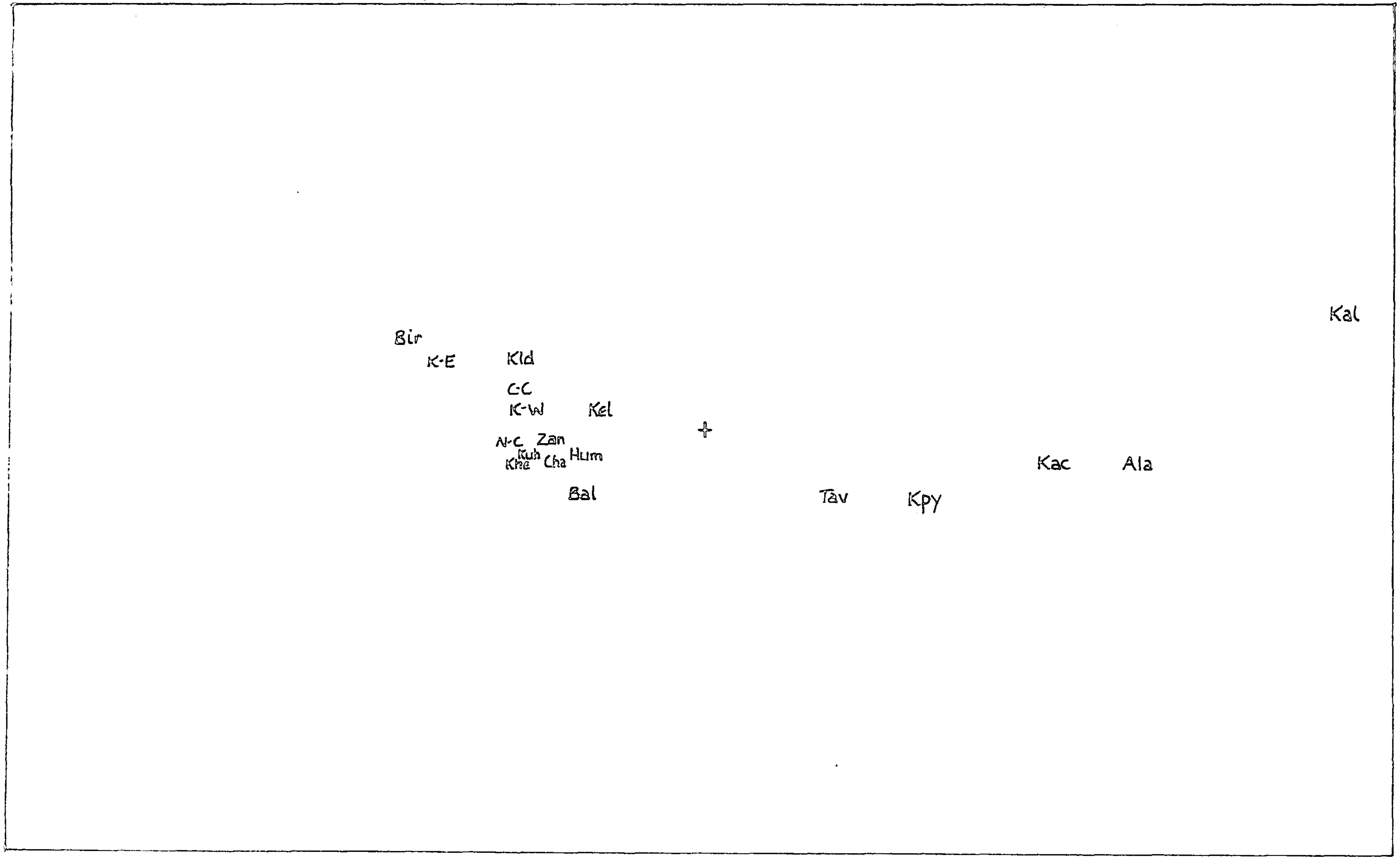


Figure 6.3d SPATIAL POSITION OF SUBDIVISIONS AT HOMOGENEITY BY MD-SCAL (BOTH GENERATIONS)
(Dehestan Panjakrostagh excluded) Stress = 0.026



Observations on the pattern of relatedness between the dehestans, as inferred from the relatedness and homogeneity matrices, reveal some interesting points. Three main clusters emerge in both generations and both sexes, although with some peculiarities in the former generation. Each major cluster is primarily composed of two or more smaller clusters. The existence of these three clusters does not correspond exactly with the administrative subdivision of the Shahrestan or the pattern of migration. Secondly, it is evident that there is no main population unit which acts as the central unit and exchanges genes with all the others. The structure is mainly in the form of three assemblages of populations, within which migration and exchange take place more frequently.

These clusters are as follows:

1) The Central Cluster, comprising most of the dehestans in B. Markazi running due south from the coast to the valleys of the Alborz ranges, namely Zanouss-restagh, Kouhparat, Nowshahr City, Humeh, Kheyroud-Kenar, Chalandar and Baladeh-Kojour.

2) The Western Cluster, composed of B. Kelardasht and B. Chalous, and comprising the dehestans of Kelardasht, Biroun-Bashm, Kouhestan-Shargh, Kouhestan-Gharb, Kelarestagh and Chalous City, all mountainous regions but for Chalous City, and places where the Kurdish and Lurish tribes are settled.

3) The Eastern Cluster, comprising the eastern and south-eastern dehestans of B. Markazi, namely Kachrestagh, Alavikola, Kalrudpey and Tavabe-Kojour. The dehestans of Kalej and Panjak-restagh do not form any links with the others, and are the last to unite within the Shahrestan.

The observed pattern of clustering is interesting, since it very closely resembles and parallels the historic divisions of the western region of the Province of Mazandaran. Historically B.Chalous was united with B.Kelardasht, and formed the western district of the area, and most of the settlements were concentrated on the western side of the Chalous River. Bakhsh of Markazi was composed of its present divisions and territories, but extended far less than its present eastern limits. The region on the eastern side of the Chalous River was subdivided into two principalities, those of Nour and Kojour, of which Nour contained more of the eastern areas. The coastal dehestans were not greatly settled as they are presently, and most of the settlements occured in the Kojour territories situated between the first and second ranges of the Alborz.

In general the pattern of migration and gene flow between the dehestans follows the same historic pattern. Exact demarcation of gene flow is not possible since primarily historic documents on the spatial organization of the area are unclear and fragmentary, and secondly the data deal with inter-dehestan rather than inter-village mobility. Therefore it is only possible to make indirect speculations, but the overall pattern shows a structure based on geographic components and historic migration patterns.

Differences are also observed between the rate of relatedness within and between the clusters. In the grandparental generation the process of clustering shows a longer period to homogeneity within each cluster. After one generation of exchange, the Western cluster shares 32% of its genes, the Eastern cluster 21% and the Central cluster 11%. The minimum number of generations needed for each cluster to establish equilibrium is 25, 29 and 32 generations respectively.

In the parental generation, the process of convergence within each cluster is faster and shorter. After one generation of exchanges, the Central cluster has 64% common ancestry within it, the Eastern cluster has 42%, and the Western cluster 37%. The number of generations required for each, is 8, 18 and 14 generations respectively.

The pattern of relatedness between the three clusters also shows a shorter generational time between the two periods. In the former generation it takes up to 53 generations for all the subdivisions within the Shahrestan to converge, while in the recent period only 24 generations is necessary.

For the individual sexes in the parental time, the three clusters unite and form one homogeneous population in 56 generations if only the males were the movers, while this is reduced to 18 for the females. Amalgamation of the total samples, covering both time periods and both sexes reveal that as many as 27 generations are needed to homogenize all the population units in the Shahrestan. The Central cluster is the central link, with which the other two clusters unite. Finally the Western cluster links to the Central much faster than the Eastern, and therefore more genetic similarity and shared ancestry is expected between them.

The causes for the observed pattern is most probably attributed to the presence of Chalous and Nowshahr cities. They are both heterogeneous in comparison with other dehestans, and they may act as the third party which is contributing to the increase in the process of convergence within and between the clusters.

The effect of migration into Sh. Nowshahr from outside the system was also considered, to examine whether there is any variation in the extent of common ancestry between the dehestans, and also to observe any change in the pattern of clustering. Genes entering the system, ie long-range migration are assumed to reduce the genetic diversity between the units, and decrease the time needed for them to become panmictic. Primarily it has to be noted that the migrant genes are not necessarily homogeneous or random samples, that they may have been subject to drift themselves, and finally that they are frequently from neighboring areas. These factors allow speculation on the fact that selective migration in terms of kinship, sex, age and social class in addition to the differential contribution to each subdivision, might induce genetic differentiation rather than similarity.

Within the Shahrestan, the effect of migration shows a heterogeneous pattern of relatedness between the dehestans. Some of the units show an increase in the coefficient of similarity, while others show a decrease, and some no change at all. Assuming a constant rate of migration between the subdivisions and the population outside the system, it becomes apparent that the process of assimilation has increased, and less time is needed for every pair of units to homogenize. The extent of decrease is also heterogeneous, ie some units show a notably faster rate of reaching equilibrium than do others. These observations are valid for both generations and both sexes.

Table 6.6a MIGRATION MATRIX: MOVEMENT FROM BIRTHPLACES OF GRANDPARENTS TO THOSE OF PARENTS, INCLUDING OUTSIDE WORLD (NUMBER OF EXCHANGES)

	Kac	Kal	Ala	Kpy	Bal	Tav	Kuh	Cha	Khe	Zan	Pan	N-C	Hum	Kel	C-C	Kld	K-E	K-W	Bir	O.W	Total
Kac	117	2	0	1	0	3	0	0	0	0	0	2	0	1	0	0	0	1	0	5	132
Kal	6	155	0	1	0	1	0	0	0	0	0	0	0	0	0	2	0	0	1	5	171
Ala	3	1	11	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	1	19
Kpy	3	1	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44
Bal	0	0	0	1	63	3	0	0	0	0	0	0	0	2	0	1	1	0	0	2	73
Tav	11	1	0	0	3	62	0	0	2	1	0	2	0	1	0	0	0	0	0	1	84
Kuh	1	0	0	2	2	0	90	0	3	0	0	4	2	0	0	2	0	0	0	1	107
Cha	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0	0	0	0	0	0	19
Khe	0	1	0	0	0	1	0	0	20	0	0	0	1	0	0	0	0	0	0	1	24
Zan	3	0	0	0	1	1	1	0	6	112	0	6	3	0	0	0	0	0	0	0	133
Pan	0	0	0	0	0	0	0	0	0	0	35	1	1	0	0	0	0	0	0	2	39
N-C	0	0	0	0	0	0	0	0	0	0	0	20	0	0	2	1	0	0	0	4	27
Hum	0	0	0	0	0	0	1	0	0	1	0	0	18	0	0	0	0	0	0	2	22
Kel	1	0	3	1	0	2	0	0	0	0	0	0	0	52	1	1	0	3	0	2	66
C-C	0	0	0	0	0	0	0	0	0	1	0	0	0	0	12	0	0	0	1	0	14
Kld	0	2	0	0	0	0	4	0	0	2	0	2	2	19	3	565	1	5	4	11	620
K-E	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	10	5	5	1	24
K-W	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	72	5	1	82
Bir	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	7	3	1	221	4	240
O.W	29	19	1	6	2	7	1	1	4	10	1	24	8	31	36	46	0	3	17	979	1225
Tot	175	182	15	52	71	80	97	20	35	127	36	63	35	114	55	626	16	90	254	1022	3165

Table 6.6b MIGRATION MATRIX: MOVEMENT FROM BIRTHPLACES OF GRANDPARENTS TO THOSE OF PARENTS, INCLUDING OUTSIDE WORLD (PROPORTION OF EXCHANGES)

	Kac	Kal	Ala	Kpy	Bal	Tav	Kuh	Cha	Khe	Zan	Pan	N-C	Hum	Kel	C-C	Kld	K-E	K-W	Bir	O.W	Total
Kac	.886	.015	.000	.008	.000	.023	.000	.000	.000	.000	.000	.015	.000	.008	.000	.000	.000	.008	.000	.038	1.000
Kal	.035	.906	.000	.006	.000	.006	.000	.000	.000	.000	.000	.000	.000	.000	.000	.012	.000	.000	.006	.029	1.000
Ala	.158	.053	.579	.000	.000	.000	.000	.000	.000	.000	.000	.105	.000	.053	.000	.000	.000	.000	.000	.053	1.000
Kpy	.068	.023	.000	.909	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	1.000
Bal	.000	.000	.000	.014	.863	.041	.000	.000	.000	.000	.000	.000	.000	.027	.000	.014	.014	.000	.000	.027	1.000
Tav	.131	.012	.000	.000	.036	.738	.000	.000	.024	.012	.000	.024	.000	.012	.000	.000	.000	.000	.000	.012	1.000
Kuh	.009	.000	.000	.019	.019	.000	.841	.000	.028	.000	.000	.037	.019	.000	.000	.019	.000	.000	.000	.009	1.000
Cha	.000	.000	.000	.000	.000	.000	.000	1.00	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	1.000
Khe	.000	.042	.000	.000	.000	.042	.000	.000	.833	.000	.000	.000	.042	.000	.000	.000	.000	.000	.000	.042	1.000
Zan	.023	.000	.000	.000	.008	.008	.008	.000	.045	.842	.000	.045	.023	.000	.000	.000	.000	.000	.000	.000	1.000
Pan	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.897	.026	.026	.000	.000	.000	.000	.000	.000	.051	1.000
N-C	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.741	.000	.000	.074	.037	.000	.000	.000	.148	1.000
Hum	.000	.000	.000	.000	.000	.000	.045	.000	.000	.045	.000	.000	.818	.000	.000	.000	.000	.000	.000	.091	1.000
Kel	.015	.000	.045	.015	.000	.030	.000	.000	.000	.000	.000	.000	.000	.788	.015	.015	.000	.045	.000	.030	1.000
C-C	.000	.000	.000	.000	.000	.000	.000	.000	.000	.071	.000	.000	.000	.000	.857	.000	.000	.000	.071	.000	1.000
Kld	.000	.003	.000	.000	.000	.000	.006	.000	.000	.003	.000	.003	.003	.031	.051	.911	.002	.008	.006	.018	1.000
K-E	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.083	.000	.042	.417	.208	.208	.042	1.000
K-W	.012	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.024	.000	.000	.012	.878	.061	.012	1.000
Bir	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.012	.004	.029	.012	.004	.921	.017	1.000
O.W	.024	.016	.001	.005	.002	.006	.001	.001	.003	.008	.001	.020	.007	.025	.029	.038	.000	.002	.014	.799	1.000

Table 6.6c (GRANDPARENT/PARENT) MIGRATION, INCLUDING OUTSIDE WORLD

UPPER MATRIX: RELATEDNESS COEFFICIENTS AFTER ONE GENERATION OF MIGRATION
LOWER MATRIX: NUMBER OF GENERATIONS TO HOMOGENEITY BETWEEN EACH PAIR OF SUBDIVISIONS

	Kac	Kal	Ala	Kpy	Bal	Tav	Kuh	Cha	Khe	Zan	Pan	N-C	Hum	Kel	C-C	Kld	K-E	K-W	Bir	O.W
Kac		.091	.234	.091	.065	.200	.041	.000	.076	.045	.053	.053	.038	.091	.000	.039	.053	.040	.028	.112
Kal	29		.117	.064	.051	.065	.036	.000	.077	.028	.029	.041	.029	.068	.006	.039	.047	.030	.034	.097
Ala	26	34		.091	.055	.190	.056	.000	.083	.068	.077	.158	.053	.144	.000	.055	.094	.049	.029	.138
Kpy	48	44	51		.014	.080	.028	.000	.023	.023	.000	.000	.000	.030	.000	.003	.000	.012	.000	.044
Bal	30	33	29	49		.101	.055	.000	.068	.015	.027	.041	.027	.112	.000	.060	.082	.049	.055	.079
Tav	19	30	26	48	30		.085	.000	.089	.097	.036	.036	.024	.069	.012	.033	.024	.036	.024	.098
Kuh	32	34	30	49	32	30		.000	.056	.108	.054	.065	.073	.049	.000	.041	.028	.019	.028	.074
Cha	500	500	500	500	500	500	500		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.001
Khe	31	33	31	47	35	39	38	500		.075	.067	.042	.083	.061	.000	.024	.042	.012	.017	.073
Zan	34	37	33	49	36	32	27	500	26		.048	.045	.076	.023	.071	.016	.000	.012	.000	.068
Pan	43	45	41	55	43	43	40	500	42	38		.077	.077	.030	.000	.024	.042	.012	.017	.078
N-C	42	45	36	56	40	42	40	500	43	41	38		.091	.061	.074	.063	.079	.012	.050	.234
Hum	35	38	33	51	36	33	35	500	31	34	35	37		.030	.045	.031	.042	.012	.017	.106
Kel	33	38	36	53	28	34	34	500	38	38	43	34	36		.015	.076	.174	.094	.053	.115
C-C	46	49	42	58	44	46	44	500	47	44	41	29	42	39		.015	.071	.061	.076	.051
Kld	43	46	39	56	41	43	43	500	45	44	42	31	42	35	36		.106	.053	.075	.108
K-E	50	52	47	60	49	51	51	500	52	52	49	40	50	43	37	36		.318	.283	.121
K-W	52	54	50	61	51	53	53	500	54	54	52	44	53	46	40	41	23		.102	.065
Bir	53	54	51	61	52	53	54	500	55	54	52	45	53	47	41	41	27	29		.079
O.W	37	41	28	54	35	37	35	500	39	38	40	36	33	37	35	32	44	47	48	

Figure 6.4a

SINGLE LINK CLUSTERING OF SUBDIVISIONS, INCLUDING OUTSIDE WORLD, BASED ON SIMILARITY COEFFICIENTS AFTER ONE GENERATION OF MIGRATION (GRANDPARENT/PARENT)

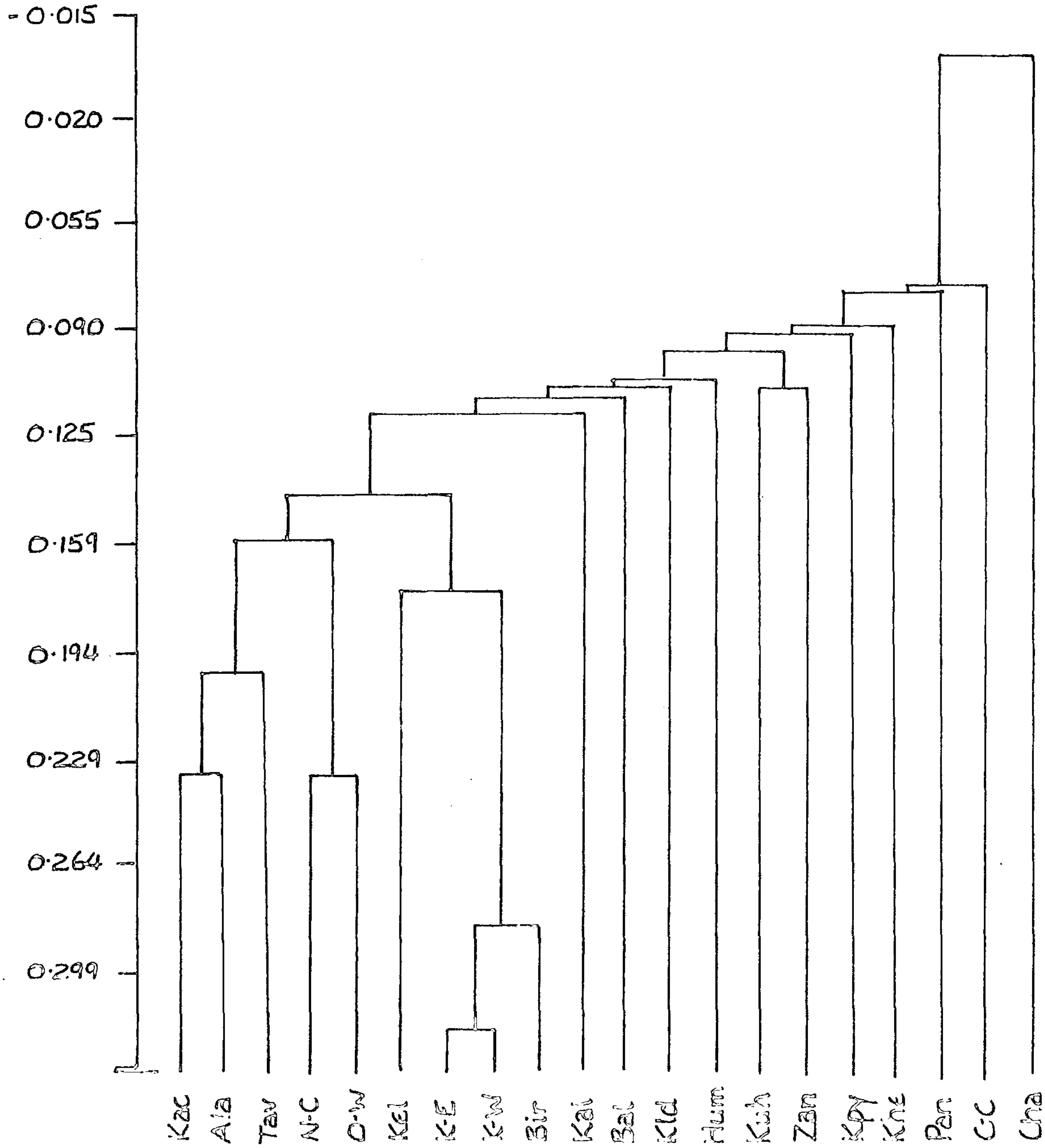


Figure 6.4b SPATIAL POSITON OF SUBDIVISIONS, INCLUDING OUTSIDE WORLD, AFTER ONE GENERATION OF MIGRATION BY MD-SCAL (GRANDPARENT/PARENT)

(Dehestan Chalandar excluded) Stress = 0.184

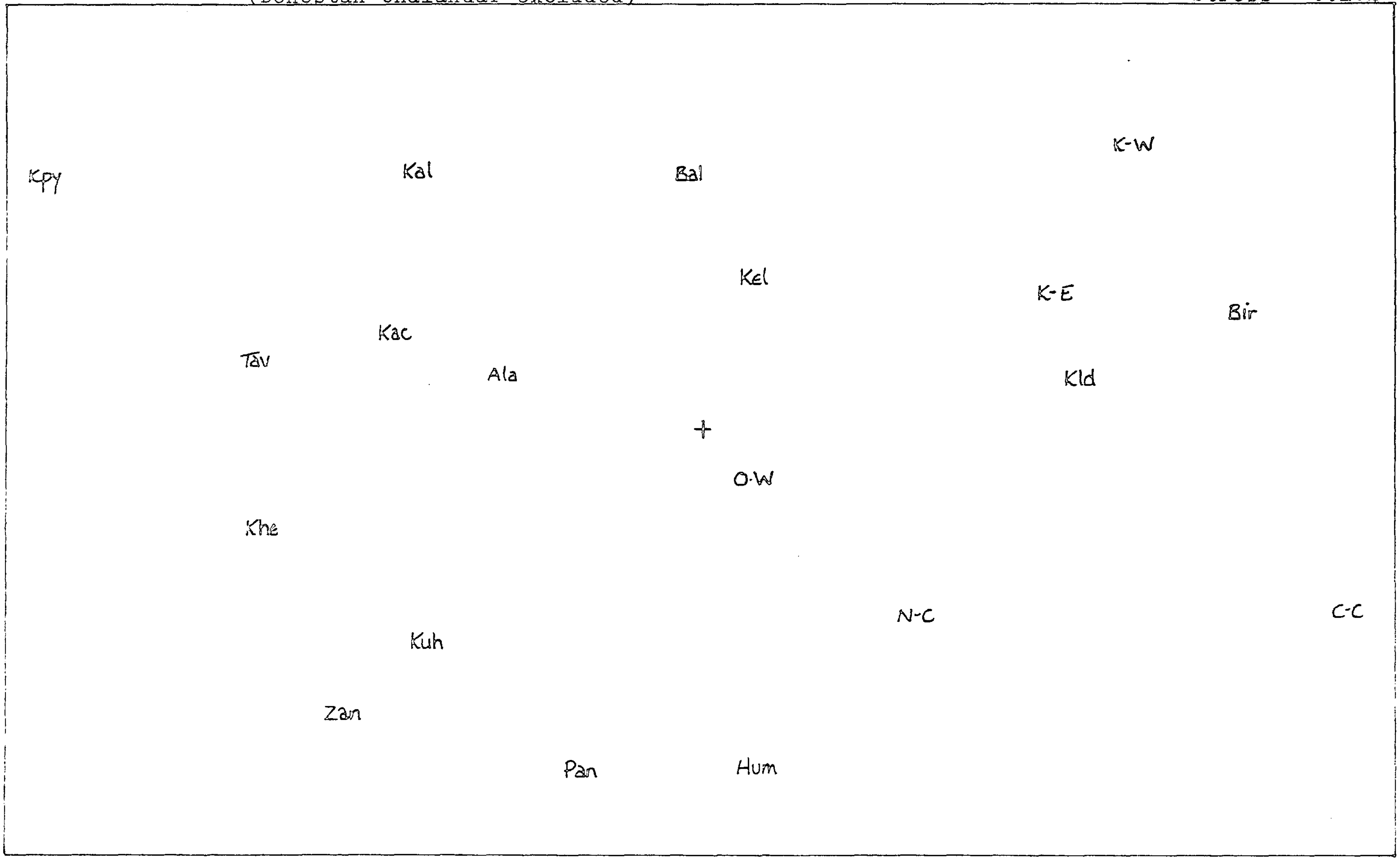


Table 6.7a MIGRATION MATRIX: MOVEMENT FROM BIRTHPLACES OF MOTHERS TO THOSE OF OFFSPRING, INCLUDING OUTSIDE WORLD (NUMBER OF EXCHANGES)

	Kac	Kal	Ala	Kpy	Bal	Tav	Kuh	Cha	Khe	Zan	Pan	N-C	Hum	Kel	C-C	Kld	K-E	K-W	Bir	O.W	Total
Kac	340	0	7	0	0	0	3	0	24	0	0	1	0	13	3	0	0	0	0	10	401
Kal	42	281	7	14	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	348
Ala	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	16
Kpy	12	0	0	78	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	90
Bal	3	0	0	0	89	4	0	0	0	0	0	19	0	0	3	0	0	0	0	10	128
Tav	17	1	6	1	0	76	0	0	1	11	0	16	0	13	0	0	0	0	0	0	142
Kuh	0	0	0	0	2	0	107	0	9	0	0	50	0	7	2	17	0	0	0	0	194
Cha	0	0	0	0	0	5	0	21	6	0	0	2	0	0	5	0	0	0	0	2	41
Khe	0	0	0	0	0	0	10	0	65	0	0	39	0	0	0	0	0	0	0	0	114
Zan	0	0	0	0	0	0	6	0	8	72	0	142	1	0	10	1	0	0	0	16	256
Pan	0	0	0	0	0	0	0	0	0	0	66	4	0	0	0	0	0	0	0	11	81
N-C	0	0	9	0	0	0	0	0	0	0	0	182	2	0	36	12	0	0	0	25	266
Hum	0	0	0	0	0	0	9	0	0	0	0	17	21	0	3	0	8	0	0	3	61
Kel	0	0	16	0	0	14	0	0	0	0	0	3	0	269	37	22	0	2	2	24	389
C-C	2	0	0	0	0	0	4	0	0	0	0	5	0	6	106	0	0	5	1	29	158
Kld	0	8	3	0	0	0	0	0	0	3	0	18	5	67	99	1062	0	21	5	28	1319
K-E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	22	0	10	1	36
K-W	0	0	0	0	9	0	0	0	0	0	0	0	0	29	43	10	0	104	23	7	225
Bir	0	0	0	0	0	0	0	0	0	0	11	1	1	19	47	26	17	18	485	15	640
O.W	57	10	5	1	8	10	4	4	9	4	0	489	34	191	638	103	0	5	44	726	2342
Tot	478	301	53	94	108	110	143	25	122	90	77	988	64	614	1035	1253	47	155	570	920	7247

Table 6.7b MIGRATION MATRIX: MOVEMENT FROM BIRTHPLACES OF MOTHERS TO THOSE OF OFFSPRING, INCLUDING OUTSIDE WORLD (PROPORTION OF EXCHANGES)

	Kac	Kal	Ala	Kpy	Bal	Tav	Kuh	Cha	Khe	Zan	Pan	N-C	Hum	Kel	C-C	Kld	K-E	K-W	Bir	O.W	Total
Kac	.848	.000	.017	.000	.000	.000	.007	.000	.060	.000	.000	.002	.000	.032	.007	.000	.000	.000	.000	.025	1.000
Kal	.121	.807	.020	.040	.000	.003	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.009	1.000
Ala	.313	.063	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.625	1.000
Kpy	.133	.000	.000	.867	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	1.000
Bal	.023	.000	.000	.000	.695	.031	.000	.000	.000	.000	.000	.148	.000	.000	.023	.000	.000	.000	.000	.078	1.000
Tav	.120	.007	.042	.007	.000	.535	.000	.000	.007	.077	.000	.113	.000	.092	.000	.000	.000	.000	.000	.000	1.000
Kuh	.000	.000	.000	.000	.010	.000	.552	.000	.046	.000	.000	.258	.000	.036	.010	.088	.000	.000	.000	.000	1.000
Cha	.000	.000	.000	.000	.000	.122	.000	.512	.146	.000	.000	.049	.000	.000	.122	.000	.000	.000	.000	.049	1.000
Khe	.000	.000	.000	.000	.000	.000	.088	.000	.570	.000	.000	.342	.000	.000	.000	.000	.000	.000	.000	.000	1.000
Zan	.000	.000	.000	.000	.000	.000	.023	.000	.031	.281	.000	.555	.004	.000	.039	.004	.000	.000	.000	.063	1.000
Pan	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.815	.049	.000	.000	.000	.000	.000	.000	.000	.136	1.000
N-C	.000	.000	.034	.000	.000	.000	.000	.000	.000	.000	.000	.684	.008	.000	.135	.045	.000	.000	.000	.094	1.000
Hum	.000	.000	.000	.000	.000	.000	.148	.000	.000	.000	.000	.279	.344	.000	.049	.000	.131	.000	.000	.049	1.000
Kel	.000	.000	.041	.000	.000	.036	.000	.000	.000	.000	.000	.008	.000	.692	.095	.057	.000	.005	.005	.062	1.000
C-C	.013	.000	.000	.000	.000	.000	.025	.000	.000	.000	.000	.032	.000	.038	.671	.000	.000	.032	.006	.184	1.000
Kld	.000	.006	.002	.000	.000	.000	.000	.000	.000	.002	.000	.014	.004	.051	.075	.805	.000	.016	.004	.021	1.000
K-E	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.083	.000	.611	.000	.278	.028	1.000
K-W	.000	.000	.000	.000	.040	.000	.000	.000	.000	.000	.000	.000	.000	.129	.191	.044	.000	.462	.102	.031	1.000
Bir	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.017	.002	.002	.030	.073	.041	.027	.028	.758	.023	1.000
O.W	.024	.004	.002	.000	.003	.004	.002	.002	.004	.002	.000	.209	.015	.082	.272	.044	.000	.002	.019	.310	1.000

Table 6.7c (MOTHER/OFFSPRING) MIGRATION, INCLUDING OUTSIDE WORLD

UPPER MATRIX: RELATEDNESS COEFFICIENTS AFTER ONE GENERATION OF MIGRATION
LOWER MATRIX: NUMBER OF GENERATIONS TO HOMOGENEITY BETWEEN EACH PAIR OF SUBDIVISIONS

	Kac	Kal	Ala	Kpy	Bal	Tav	Kuh	Cha	Khe	Zan	Pan	N-C	Hum	Kel	C-C	Kld	K-E	K-W	Bir	O.W
Kac		.147	.337	.133	.058	.179	.096	.095	.070	.074	.027	.052	.042	.085	.087	.066	.032	.065	.062	.099
Kal	28		.192	.161	.035	.157	.000	.011	.000	.009	.009	.029	.009	.032	.021	.017	.009	.009	.009	.043
Ala	16	28		.133	.102	.127	.000	.049	.000	.063	.136	.094	.049	.062	.196	.027	.028	.031	.023	.339
Kpy	30	20	31		.023	.127	.000	.000	.000	.000	.000	.000	.000	.000	.013	.000	.000	.000	.000	.025
Bal	18	29	14	31		.167	.169	.152	.148	.234	.128	.250	.221	.124	.146	.058	.051	.095	.048	.281
Tav	16	28	8	31	14		.156	.178	.120	.197	.049	.147	.113	.176	.082	.075	.000	.092	.031	.235
Kuh	20	29	17	31	13	17		.105	.392	.327	.049	.313	.416	.111	.103	.148	.010	.101	.082	.308
Cha	19	29	15	31	9	14	12		.195	.168	.098	.220	.147	.188	.202	.110	.111	.153	.098	.229
Khe	20	29	17	31	12	17	10	10		.397	.049	.342	.366	.008	.057	.014	.000	.000	.002	.214
Zan	20	29	16	31	12	16	9	11	9		.112	.664	.394	.112	.157	.084	.067	.074	.070	.325
Pan	20	30	18	32	16	18	16	16	16	16		.143	.099	.069	.167	.035	.028	.031	.042	.185
N-C	20	29	16	31	12	16	9	11	10	7	16		.385	.243	.261	.161	.111	.211	.141	.492
Hum	21	30	18	32	14	18	11	13	11	10	17	10		.106	.155	.088	.208	.080	.102	.323
Kel	19	29	15	31	13	15	12	12	13	12	17	11	13		.213	.223	.116	.310	.179	.304
C-C	20	29	16	31	12	16	11	11	11	9	16	8	10	11		.168	.117	.298	.163	.548
Kld	20	29	18	31	16	18	13	15	15	14	18	14	14	13	14		.100	.211	.188	.223
K-E	22	30	20	32	18	20	17	18	17	17	18	16	15	17	16	17		.213	.401	.130
K-W	20	30	17	31	14	17	12	13	13	12	17	11	10	11	11	13	15		.298	.372
Bir	22	30	20	32	17	19	15	17	16	16	17	15	14	15	15	15	10	14		.191
O.W	19	29	16	31	12	16	10	11	11	9	17	7	10	10	7	14	16	11	15	

Table 6.8a MIGRATION MATRIX: MOVEMENT FROM BIRTHPLACES OF FATHERS TO THOSE OF OFFSPRING, INCLUDING OUTSIDE WORLD (NUMBER OF EXCHANGES)

	Kac	Kal	Ala	Kpy	Bal	Tav	Kuh	Cha	Khe	Zan	Pan	N-C	Hum	Kel	C-C	Kld	K-E	K-W	Bir	O.W	Total
Kac	312	0	0	0	0	4	0	0	0	0	0	7	0	0	3	0	0	0	0	10	336
Kal	26	285	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	6	328
Ala	17	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	47
Kpy	10	1	0	87	0	1	0	0	0	0	0	24	0	6	0	0	0	0	0	5	134
Bal	0	0	0	0	84	0	0	0	0	0	0	15	0	5	1	0	0	0	0	1	106
Tav	29	1	6	1	0	99	0	0	0	5	0	11	7	13	5	0	0	0	0	0	177
Kuh	2	0	0	0	13	0	137	0	23	0	0	51	0	0	11	0	0	0	0	4	241
Cha	0	0	0	0	0	0	3	13	0	0	0	12	0	0	0	0	0	0	0	2	30
Khe	0	0	0	0	0	1	0	2	69	0	0	13	0	0	0	0	0	0	0	0	85
Zan	0	0	9	0	0	0	0	0	7	85	0	156	8	0	12	2	0	0	0	19	298
Pan	0	0	0	0	0	0	0	0	0	0	77	2	0	0	3	0	0	0	0	3	85
N-C	0	0	0	0	0	0	0	0	0	0	0	107	0	0	1	0	2	0	7	14	131
Hum	20	0	0	0	0	0	0	0	0	0	0	46	18	0	6	0	8	0	0	1	99
Kel	0	0	0	0	0	0	0	0	0	0	0	5	0	339	27	10	0	0	0	4	385
C-C	0	0	0	0	0	0	0	0	0	0	0	4	0	0	86	7	0	0	0	26	123
Kld	0	8	3	0	0	0	0	0	0	0	0	19	5	37	93	1158	0	0	3	60	1386
K-E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	10	30	16	9	1	69
K-W	10	0	0	0	9	0	0	0	0	0	0	0	8	15	49	8	0	111	29	3	242
Bir	0	0	0	0	0	0	0	0	0	0	0	0	1	22	12	19	7	10	488	16	575
O.W	52	17	5	0	2	7	3	10	22	0	0	518	24	177	753	38	0	13	29	764	2434
Tot	478	312	53	94	108	112	143	25	121	90	77	990	71	614	1065	1252	47	150	570	939	7311

Table 6.8b MIGRATION MATRIX: MOVEMENT FROM BIRTHPLACES OF FATHERS TO THOSE OF OFFSPRING, INCLUDING OUTSIDE WORLD (PROPORTION OF EXCHANGES)

	Kac	Kal	Ala	Kpy	Bal	Tav	Kuh	Cha	Khe	Zan	Pan	N-C	Hum	Kel	C-C	Kld	K-E	K-W	Bir	O.W	Total
Kac	.929	.000	.000	.000	.000	.012	.000	.000	.000	.000	.000	.021	.000	.000	.009	.000	.000	.000	.000	.030	1.000
Kal	.079	.869	.000	.018	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.015	.018	1.000
Ala	.362	.000	.638	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	1.000
Kpy	.075	.007	.000	.649	.000	.007	.000	.000	.000	.000	.000	.179	.000	.045	.000	.000	.000	.000	.000	.037	1.000
Bal	.000	.000	.000	.000	.792	.000	.000	.000	.000	.000	.000	.142	.000	.047	.009	.000	.000	.000	.000	.009	1.000
Tav	.164	.006	.034	.006	.000	.559	.000	.000	.000	.028	.000	.062	.040	.073	.028	.000	.000	.000	.000	.000	1.000
Kuh	.008	.000	.000	.000	.054	.000	.568	.000	.095	.000	.000	.212	.000	.000	.046	.000	.000	.000	.000	.017	1.000
Cha	.000	.000	.000	.000	.000	.000	.100	.433	.000	.000	.000	.400	.000	.000	.000	.000	.000	.000	.000	.067	1.000
Khe	.000	.000	.000	.000	.000	.012	.000	.024	.812	.000	.000	.153	.000	.000	.000	.000	.000	.000	.000	.000	1.000
Zan	.000	.000	.030	.000	.000	.000	.000	.000	.023	.285	.000	.523	.027	.000	.040	.007	.000	.000	.000	.064	1.000
Pan	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.906	.024	.000	.000	.035	.000	.000	.000	.000	.035	1.000
N-C	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.817	.000	.000	.008	.000	.050	.000	.053	.107	1.000
Hum	.202	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.465	.182	.000	.061	.000	.081	.000	.000	.010	1.000
Kel	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.013	.000	.881	.070	.026	.000	.000	.000	.010	1.000
C-C	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.033	.000	.000	.699	.057	.000	.000	.000	.211	1.000
Kld	.000	.006	.002	.000	.000	.000	.000	.000	.000	.000	.000	.014	.004	.027	.067	.835	.000	.000	.002	.043	1.000
K-E	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.043	.145	.435	.232	.130	.014	1.000
K-W	.041	.000	.000	.000	.037	.000	.000	.000	.000	.000	.000	.000	.033	.062	.202	.033	.000	.459	.120	.012	1.000
Bir	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.002	.038	.021	.033	.012	.017	.849	.028	1.000
O.W	.021	.007	.002	.000	.001	.003	.001	.004	.009	.000	.000	.213	.010	.073	.309	.016	.000	.005	.012	.314	1.000

Table 6.8c (FATHER/OFFSPRING) MIGRATION, INCLUDING OUTSIDE WORLD

UPPER MATRIX: RELATEDNESS COEFFICIENTS AFTER ONE GENERATION OF MIGRATION
LOWER MATRIX: NUMBER OF GENERATIONS TO HOMOGENEITY BETWEEN EACH PAIR OF SUBDIVISIONS

	Kac	Kal	Ala	Kpy	Bal	Tav	Kuh	Cha	Khe	Zan	Pan	N-C	Hum	Kel	C-C	Kld	K-E	K-W	Bir	O.W
Kac		.098	.362	.133	.039	.206	.055	.051	.033	.060	.060	.058	.242	.032	.060	.052	.023	.063	.037	.084
Kal	23		.079	.119	.009	.091	.025	.018	.000	.018	.018	.034	.089	.010	.018	.026	.030	.069	.034	.059
Ala	21	25		.075	.000	.198	.008	.000	.000	.030	.000	.000	.202	.000	.000	.002	.000	.041	.000	.023
Kpy	38	42	42		.196	.200	.204	.216	.160	.216	.059	.216	.264	.068	.070	.083	.014	.098	.066	.292
Bal	44	46	46	28		.119	.214	.151	.142	.160	.042	.159	.160	.079	.051	.059	.019	.103	.057	.208
Tav	31	37	36	26	37		.099	.062	.074	.176	.052	.070	.294	.115	.061	.080	.028	.165	.061	.205
Kuh	43	46	45	25	18	35		.328	.248	.292	.075	.236	.276	.069	.095	.076	.058	.104	.037	.293
Cha	43	46	45	26	17	35	14		.176	.464	.059	.467	.410	.023	.099	.057	.014	.012	.028	.285
Khe	43	46	45	26	23	35	17	20		.176	.024	.153	.153	.013	.033	.014	.000	.000	.000	.169
Zan	42	45	45	22	19	34	16	10	22		.094	.595	.542	.070	.143	.110	.061	.086	.057	.345
Pan	44	47	46	33	31	37	31	31	31	31		.066	.069	.059	.094	.084	.050	.048	.049	.094
N-C	43	46	45	25	18	35	17	12	22	10	31		.498	.031	.147	.067	.091	.073	.101	.339
Hum	38	42	42	12	27	27	24	25	25	21	33	24		.084	.103	.088	.134	.145	.045	.315
Kel	43	46	46	29	23	36	26	24	27	25	32	23	29		.119	.143	.080	.168	.095	.182
C-C	42	45	45	23	20	34	20	18	24	17	31	16	23	23		.181	.115	.248	.082	.569
Kld	42	45	44	25	23	34	23	22	25	21	31	20	25	21	17		.205	.145	.112	.180
K-E	42	45	45	24	21	34	22	21	25	19	32	19	24	21	17	16		.441	.228	.091
K-W	41	44	44	21	21	33	22	20	25	18	32	18	21	23	16	18	13		.244	.342
Bir	43	46	46	27	21	36	24	22	26	22	32	19	27	21	21	21	17	21		.122
O.W	42	45	45	22	20	34	20	18	24	15	31	15	22	23	12	18	15	14	21	

Table 6.9a MIGRATION MATRIX: MOVEMENT FROM BIRTHPLACES OF PARENTS TO THOSE OF OFFSPRING, INCLUDING OUTSIDE WORLD (NUMBER OF EXCHANGES)

	Kac	Kal	Ala	Kpy	Bal	Tav	Kuh	Cha	Khe	Zan	Pan	N-C	Hum	Kel	C-C	Kld	K-E	K-W	Bir	O.W	Total
Kac	652	0	7	0	0	4	3	0	24	0	0	8	0	13	6	0	0	0	0	20	737
Kal	68	566	7	20	0	1	0	0	0	0	0	0	0	0	0	0	0	0	5	9	676
Ala	22	1	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	63
Kpy	22	1	0	165	0	1	0	0	0	0	0	24	0	6	0	0	0	0	0	5	224
Bal	3	0	0	0	173	4	0	0	0	0	0	34	0	5	4	0	0	0	0	11	234
Tav	46	2	12	2	0	175	0	0	1	16	0	27	7	26	5	0	0	0	0	0	319
Kuh	2	0	0	0	15	0	244	0	32	0	0	101	0	7	13	17	0	0	0	4	435
Cha	0	0	0	0	0	5	3	34	6	0	0	14	0	0	5	0	0	0	0	4	71
Khe	0	0	0	0	0	1	10	2	134	0	0	52	0	0	0	0	0	0	0	0	199
Zan	0	0	9	0	0	0	6	0	15	157	0	298	9	0	22	3	0	0	0	35	554
Pan	0	0	0	0	0	0	0	0	0	0	143	6	0	0	3	0	0	0	0	14	166
N-C	0	0	9	0	0	0	0	0	0	0	0	289	2	0	37	12	2	0	7	39	397
Hum	20	0	0	0	0	0	9	0	0	0	0	63	39	0	9	0	16	0	0	4	160
Kel	0	0	16	0	0	14	0	0	0	0	0	8	0	608	64	32	0	2	2	28	774
C-C	2	0	0	0	0	0	4	0	0	0	0	9	0	6	192	7	0	5	1	55	281
Kld	0	16	6	0	0	0	0	0	0	3	0	37	10	104	192	2220	0	21	8	88	2705
K-E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	10	52	16	19	2	105
K-W	10	0	0	0	18	0	0	0	0	0	0	0	8	44	92	18	0	215	52	10	467
Bir	0	0	0	0	0	0	0	0	0	0	11	1	2	41	59	45	24	28	973	31	1215
O.W	109	27	10	1	10	17	7	14	31	4	0	1007	58	368	1391	141	0	18	73	1490	4776
Tot	956	613	106	188	216	222	286	50	243	180	154	1978	135	1228	2100	2505	94	305	1140	1859	14558

Table 6.9b MIGRATION MATRIX: MOVEMENT FROM BIRTHPLACES OF PARENTS TO THOSE OF OFFSPRING, INCLUDING OUTSIDE WORLD (PROPORTION OF EXCHANGES)

	Kac	Kal	Ala	Kpy	Bal	Tav	Kuh	Cha	Khe	Zan	Pan	N-C	Hum	Kel	C-C	Kld	K-E	K-W	Bir	O.W	Total
Kac	.885	.000	.009	.000	.000	.005	.004	.000	.033	.000	.000	.011	.000	.018	.008	.000	.000	.000	.000	.027	1.000
Kal	.101	.837	.010	.030	.000	.001	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.007	.013	1.000
Ala	.349	.016	.476	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.159	1.000
Kpy	.098	.004	.000	.737	.000	.004	.000	.000	.000	.000	.000	.107	.000	.027	.000	.000	.000	.000	.000	.022	1.000
Bal	.013	.000	.000	.000	.739	.017	.000	.000	.000	.000	.000	.145	.000	.021	.017	.000	.000	.000	.000	.047	1.000
Tav	.144	.006	.038	.006	.000	.549	.000	.000	.003	.050	.000	.085	.022	.082	.016	.000	.000	.000	.000	.000	1.000
Kuh	.005	.000	.000	.000	.034	.000	.561	.000	.074	.000	.000	.232	.000	.016	.030	.039	.000	.000	.000	.009	1.000
Cha	.000	.000	.000	.000	.000	.070	.042	.479	.085	.000	.000	.197	.000	.000	.070	.000	.000	.000	.000	.056	1.000
Khe	.000	.000	.000	.000	.000	.005	.050	.010	.673	.000	.000	.261	.000	.000	.000	.000	.000	.000	.000	.000	1.000
Zan	.000	.000	.016	.000	.000	.000	.011	.000	.027	.283	.000	.538	.016	.000	.040	.005	.000	.000	.000	.063	1.000
Pan	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.861	.036	.000	.000	.018	.000	.000	.000	.000	.084	1.000
N-C	.000	.000	.023	.000	.000	.000	.000	.000	.000	.000	.000	.728	.005	.000	.093	.030	.005	.000	.018	.098	1.000
Hum	.125	.000	.000	.000	.000	.000	.056	.000	.000	.000	.000	.394	.244	.000	.056	.000	.100	.000	.000	.025	1.000
Kel	.000	.000	.021	.000	.000	.018	.000	.000	.000	.000	.000	.010	.000	.786	.083	.041	.000	.003	.003	.036	1.000
C-C	.007	.000	.000	.000	.000	.000	.014	.000	.000	.000	.000	.032	.000	.021	.683	.025	.000	.018	.004	.196	1.000
Kld	.000	.006	.002	.000	.000	.000	.000	.000	.000	.001	.000	.014	.004	.038	.071	.821	.000	.008	.003	.033	1.000
K-E	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.057	.095	.495	.152	.181	.019	1.000
K-W	.021	.000	.000	.000	.039	.000	.000	.000	.000	.000	.000	.000	.017	.094	.197	.039	.000	.460	.111	.021	1.000
Bir	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.009	.001	.002	.034	.049	.037	.020	.023	.801	.026	1.000
O.W	.023	.006	.002	.000	.002	.004	.001	.003	.006	.001	.000	.211	.012	.077	.291	.030	.000	.004	.015	.312	1.000

Table 6.9c (PARENTS/OFFSPRING) MIGRATION, INCLUDING OUTSIDE WORLD

UPPER MATRIX: RELATEDNESS COEFFFICIENTS AFTER ONE GENERATION OF MIGRATION
LOWER MATRIX: NUMBER OF GENERATIONS TO HOMOGENEITY BETWEEN EACH PAIR OF SUBDIVISIONS

	Kac	Kal	Ala	Kpy	Bal	Tav	Kuh	Cha	Khe	Zan	Pan	N-C	Hum	Kel	C-C	Kld	K-E	K-W	Bir	O.W
Kac		.125	.386	.153	.082	.199	.086	.088	.053	.087	.046	.056	.173	.078	.075	.066	.027	.069	.052	.100
Kal	26		.140	.147	.028	.125	.014	.015	.001	.024	.013	.031	.114	.028	.024	.024	.021	.042	.021	.053
Ala	11	27		.125	.060	.188	.014	.056	.000	.079	.084	.121	.150	.057	.166	.041	.019	.043	.026	.189
Kpy	18	28	16		.168	.225	.137	.134	.112	.129	.058	.129	.228	.064	.083	.067	.019	.070	.050	.187
Bal	25	31	24	21		.152	.227	.226	.150	.209	.100	.209	.200	.102	.125	.085	.036	.111	.065	.249
Tav	19	29	17	11	20		.124	.174	.093	.186	.052	.128	.247	.146	.076	.081	.016	.136	.052	.228
Kuh	26	32	25	23	12	21		.352	.356	.315	.063	.301	.332	.105	.131	.108	.078	.133	.093	.310
Cha	25	31	24	21	11	20	8		.339	.331	.111	.324	.321	.135	.173	.117	.076	.092	.075	.338
Khe	26	32	25	23	14	22	10	11		.299	.036	.261	.312	.015	.046	.014	.000	.000	.001	.225
Zan	26	31	25	22	13	21	10	10	12		.117	.667	.486	.108	.151	.098	.064	.083	.073	.342
Pan	28	33	27	25	21	25	21	21	21	21		.139	.079	.065	.134	.064	.037	.039	.053	.139
N-C	26	31	25	22	13	21	11	11	13	7	22		.485	.183	.252	.156	.129	.168	.129	.454
Hum	25	31	23	20	13	18	13	12	14	12	22	11		.092	.135	.099	.175	.116	.096	.329
Kel	25	31	24	22	15	20	15	15	17	15	22	14	15		.181	.201	.123	.242	.151	.247
C-C	26	31	25	22	14	21	12	12	13	10	22	9	13	14		.174	.122	.293	.143	.581
Kld	26	32	26	23	17	22	16	17	17	16	22	15	17	14	15		.182	.184	.158	.204
K-E	27	32	27	25	18	24	17	18	18	17	22	16	18	16	16	14		.378	.328	.125
K-W	26	32	25	23	15	22	14	14	15	13	22	12	14	13	12	14	13		.277	.380
Bir	28	32	27	25	20	24	18	19	19	18	22	18	19	18	18	17	11	16		.159
O.W	25	31	25	22	13	20	12	11	14	9	22	8	12	13	7	15	16	12	10	

Figure 6.5a

SINGLE LINK CLUSTERING OF SUBDIVISIONS, INCLUDING OUTSIDE WORLD, BASED ON SIMILARITY COEFFICIENTS AFTER ONE GENERATION OF MIGRATION (PARENTS/OFFSPRING)

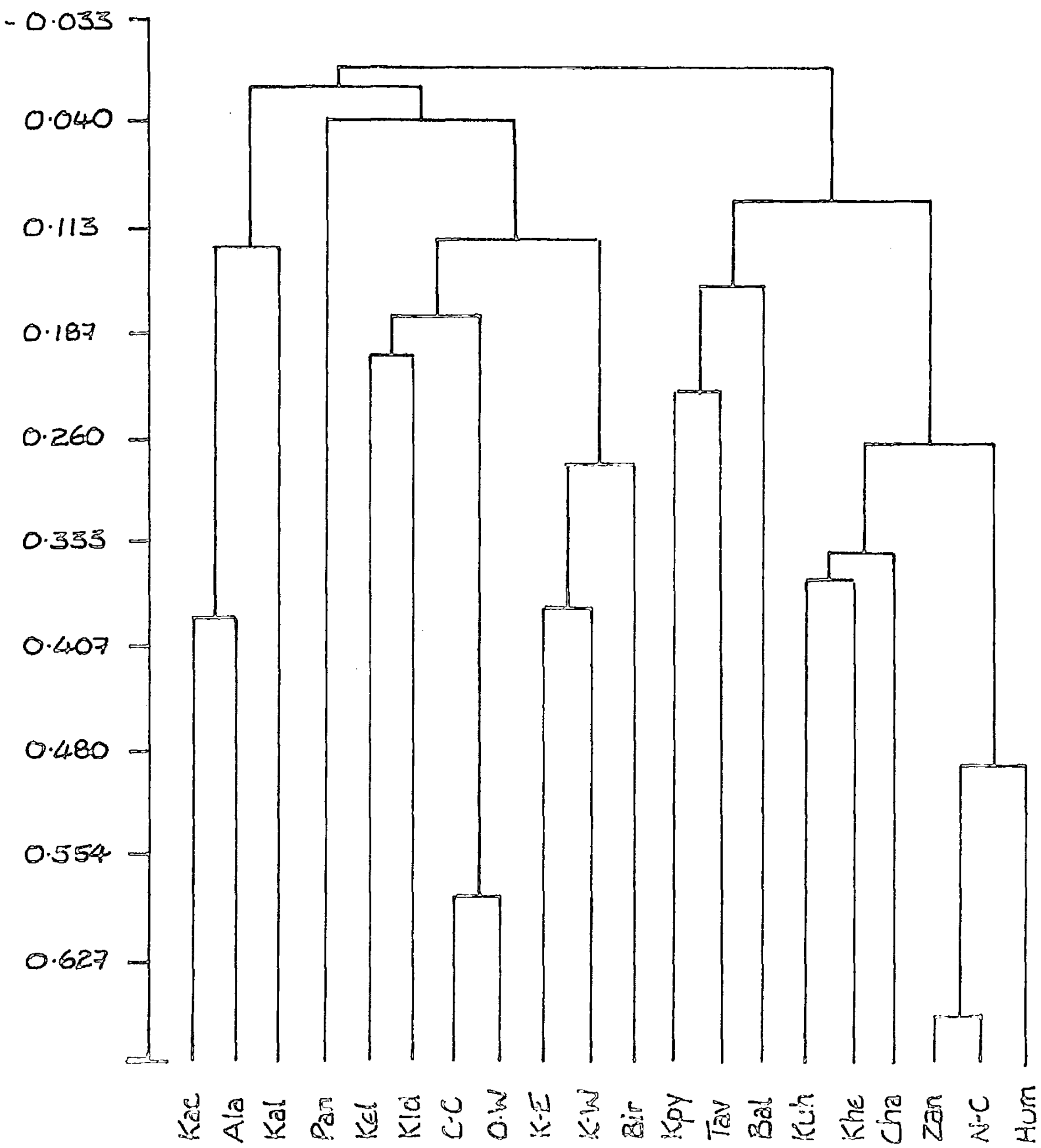


Figure 6.5b SPATIAL POSITION OF SUBDIVISIONS, INCLUDING OUTSIDE WORLD, AFTER ONE GENERATION OF MIGRATION (PARENTS/OFFSPRING)

Stress =0.191

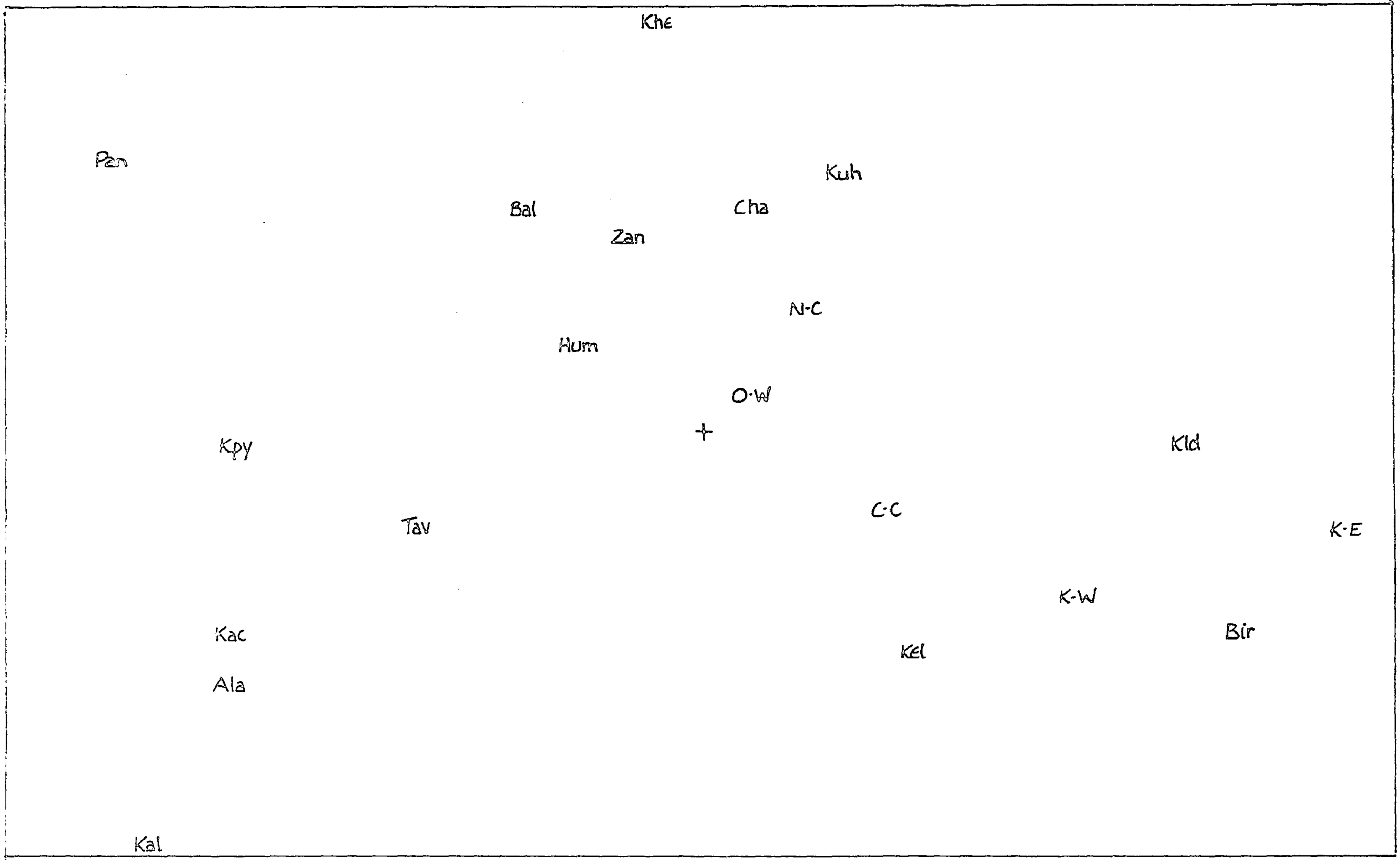


Table 6.10a MIGRATION MATRIX: INTER-SUBDIVISIONAL MOVEMENT FOR BOTH GENERATIONS, INCLUDING OUTSIDE WORLD (NUMBER OF EXCHANGES)

	Kac	Kal	Ala	Kpy	Bal	Tav	Kuh	Cha	Khe	Zan	Pan	N-C	Hum	Kel	C-C	Kld	K-E	K-W	Bir	O.W	Total
Kac	769	2	7	1	0	7	3	0	24	0	0	10	0	14	6	0	0	1	0	25	869
Kal	74	721	7	21	0	2	0	0	0	0	0	0	0	0	0	2	0	0	6	14	847
Ala	25	2	41	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	11	82
Kpy	25	2	0	205	0	1	0	0	0	0	0	24	0	6	0	0	0	0	0	5	268
Bal	3	0	0	1	236	7	0	0	0	0	0	34	0	7	4	1	1	0	0	13	307
Tav	57	3	12	2	3	237	0	0	3	17	0	29	7	27	5	0	0	0	0	1	403
Kuh	3	0	0	2	17	0	334	0	35	0	0	105	2	7	13	19	0	0	0	5	542
Cha	0	0	0	0	0	5	3	53	6	0	0	14	0	0	5	0	0	0	0	4	90
Khe	0	1	0	0	0	2	10	2	154	0	0	52	1	0	0	0	0	0	0	1	223
Zan	3	0	9	0	1	1	7	0	21	269	0	304	12	0	22	3	0	0	0	35	687
Pan	0	0	0	0	0	0	0	0	0	0	178	7	1	0	3	0	0	0	0	16	205
N-C	0	0	9	0	0	0	0	0	0	0	0	309	2	0	39	13	2	0	7	43	424
Hum	20	0	0	0	0	0	10	0	0	1	0	63	57	0	9	0	16	0	0	6	182
Kel	1	0	19	1	0	16	0	0	0	0	0	8	0	660	65	33	0	5	2	30	840
C-C	2	0	0	0	0	0	4	0	0	1	0	9	0	6	204	7	0	5	2	55	295
Kld	0	18	6	0	0	0	4	0	0	5	0	39	12	123	195	2785	1	26	12	99	3325
K-E	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	11	62	21	24	3	129
K-W	11	0	0	0	18	0	0	0	0	0	0	0	8	46	92	18	1	287	57	11	549
Bir	0	0	0	0	0	0	0	0	0	0	11	1	2	44	60	52	27	29	1194	35	1455
O.W	138	46	11	7	12	24	8	15	35	14	1	1031	66	399	1427	187	0	21	90	2469	6001
Tot	1131	795	121	240	287	302	383	70	278	307	190	2041	170	1342	2155	3131	110	395	1394	2881	17723

Table 6.10b MIGRATION MATRIX: INTER-SUBDIVISIONAL MOVEMENT FOR BOTH GENERATIONS, INCLUDING OUTSIDE WORLD (PROPORTION OF EXCHANGES)

	Kac	Kal	Ala	Kpy	Bal	Tav	Kuh	Cha	Khe	Zan	Pan	N-C	Hum	Kel	C-C	Kld	K-E	K-W	Bir	O.W	Total
Kac	.885	.002	.008	.001	.000	.008	.003	.000	.028	.000	.000	.012	.000	.016	.007	.000	.000	.001	.000	.029	1.000
Kal	.087	.851	.008	.025	.000	.002	.000	.000	.000	.000	.000	.000	.000	.000	.000	.002	.000	.000	.007	.017	1.000
Ala	.305	.024	.500	.000	.000	.000	.000	.000	.000	.000	.000	.024	.000	.012	.000	.000	.000	.000	.000	.134	1.000
Kpy	.093	.007	.000	.765	.000	.004	.000	.000	.000	.000	.000	.090	.000	.022	.000	.000	.000	.000	.000	.019	1.000
Bal	.010	.000	.000	.003	.769	.023	.000	.000	.000	.000	.000	.111	.000	.023	.013	.003	.003	.000	.000	.042	1.000
Tav	.141	.007	.030	.005	.007	.588	.000	.000	.007	.042	.000	.072	.017	.067	.012	.000	.000	.000	.000	.002	1.000
Kuh	.006	.000	.000	.004	.031	.000	.616	.000	.065	.000	.000	.194	.004	.013	.024	.035	.000	.000	.000	.009	1.000
Cha	.000	.000	.000	.000	.000	.056	.033	.589	.067	.000	.000	.156	.000	.000	.056	.000	.000	.000	.000	.044	1.000
Khe	.000	.004	.000	.000	.000	.009	.045	.009	.691	.000	.000	.233	.004	.000	.000	.000	.000	.000	.000	.004	1.000
Zan	.004	.000	.013	.000	.001	.001	.010	.000	.031	.392	.000	.443	.017	.000	.032	.004	.000	.000	.000	.051	1.000
Pan	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.868	.034	.005	.000	.015	.000	.000	.000	.000	.078	1.000
N-C	.000	.000	.021	.000	.000	.000	.000	.000	.000	.000	.000	.729	.005	.000	.092	.031	.005	.000	.017	.101	1.000
Hum	.110	.000	.000	.000	.000	.000	.055	.000	.000	.005	.000	.346	.313	.000	.049	.000	.088	.000	.000	.033	1.000
Kel	.001	.000	.023	.001	.000	.019	.000	.000	.000	.000	.000	.010	.000	.786	.077	.039	.000	.006	.002	.036	1.000
C-C	.007	.000	.000	.000	.000	.000	.014	.000	.000	.003	.000	.031	.000	.020	.692	.024	.000	.017	.007	.186	1.000
Kld	.000	.005	.002	.000	.000	.000	.001	.000	.000	.002	.000	.012	.004	.037	.059	.838	.000	.008	.004	.030	1.000
K-E	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.016	.047	.085	.481	.163	.186	.023	1.000
K-W	.020	.000	.000	.000	.033	.000	.000	.000	.000	.000	.000	.000	.015	.084	.168	.033	.002	.523	.104	.020	1.000
Bir	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.008	.001	.001	.030	.041	.036	.019	.020	.821	.024	1.000
O.W	.023	.008	.002	.001	.002	.004	.001	.002	.006	.002	.000	.172	.011	.066	.238	.031	.000	.003	.015	.411	1.000

Table 6.10c (BOTH GENERATIONS) MIGRATION, INCLUDING OUTSIDE WORLD

UPPER MATRIX: RELATEDNESS COEFFFICIENTS AFTER ONE GENERATION OF MIGRATION
LOWER MATRIX: NUMBER OF GENERATIONS TO HOMOGENEITY BETWEEN EACH PAIR OF SUBDIVISIONS

	Kac	Kal	Ala	Kpy	Bal	Tav	Kuh	Cha	Khe	Zan	Pan	N-C	Hum	Kel	C-C	Kld	K-E	K-W	Bir	O.W
Kac		.118	.368	.147	.082	.205	.078	.086	.057	.092	.047	.055	.161	.081	.075	.070	.047	.064	.049	.104
Kal	27		.137	.139	.034	.113	.021	.019	.011	.033	.017	.034	.104	.034	.032	.030	.026	.046	.026	.062
Ala	13	28		.156	.089	.218	.051	.069	.033	.093	.102	.147	.167	.081	.178	.061	.035	.052	.037	.203
Kpy	17	29	14		.147	.206	.121	.112	.102	.114	.053	.108	.201	.057	.076	.058	.034	.061	.042	.166
Bal	26	33	24	23		.153	.189	.189	.124	.177	.090	.173	.170	.106	.116	.081	.058	.104	.067	.209
Tav	19	30	16	13	21		.128	.150	.100	.174	.054	.113	.220	.135	.076	.076	.030	.124	.047	.212
Kuh	27	33	26	25	14	22		.287	.311	.282	.062	.261	.291	.093	.119	.098	.081	.120	.083	.269
Cha	26	33	25	24	13	21	10		.278	.274	.093	.256	.271	.120	.144	.098	.070	.076	.066	.269
Khe	27	33	26	24	15	22	11	10		.284	.043	.242	.287	.023	.049	.026	.004	.009	.007	.199
Zan	27	33	26	24	14	22	11	11	13		.105	.548	.449	.097	.136	.086	.060	.077	.063	.289
Pan	29	34	28	27	23	26	23	23	22	23		.132	.087	.060	.123	.060	.038	.040	.048	.132
N-C	27	33	26	25	15	22	12	13	14	8	23		.438	.177	.254	.140	.122	.166	.119	.417
Hum	26	32	24	23	14	20	14	13	15	12	23	12		.093	.137	.098	.158	.106	.086	.292
Kel	26	32	24	23	16	21	16	16	17	15	24	15	14		.176	.184	.133	.224	.140	.234
C-C	27	33	26	25	15	22	12	13	14	11	23	9	13	14		.158	.133	.262	.134	.520
Kld	27	33	26	25	19	24	17	18	18	17	24	17	18	16	16		.182	.164	.145	.189
K-E	29	34	28	27	20	25	18	19	19	18	24	17	19	18	17	16		.383	.340	.135
K-W	27	33	26	25	17	23	15	16	16	14	23	13	15	13	13	16	14		.251	.337
Bir	29	34	28	28	21	26	20	21	20	20	24	19	21	20	19	18	12	17		.147
O.W	26	33	25	24	15	21	13	13	14	10	23	9	12	13	7	16	18	13	20	

Figure 6.6a

SINGLE LINK CLUSTERING OF SUBDIVISIONS, INCLUDING OUTSIDE WORLD, BASED ON SIMILARITY COEFFFICIENTS AFTER ONE GENERATION OF MIGRATION (BOTH GENERATIONS)

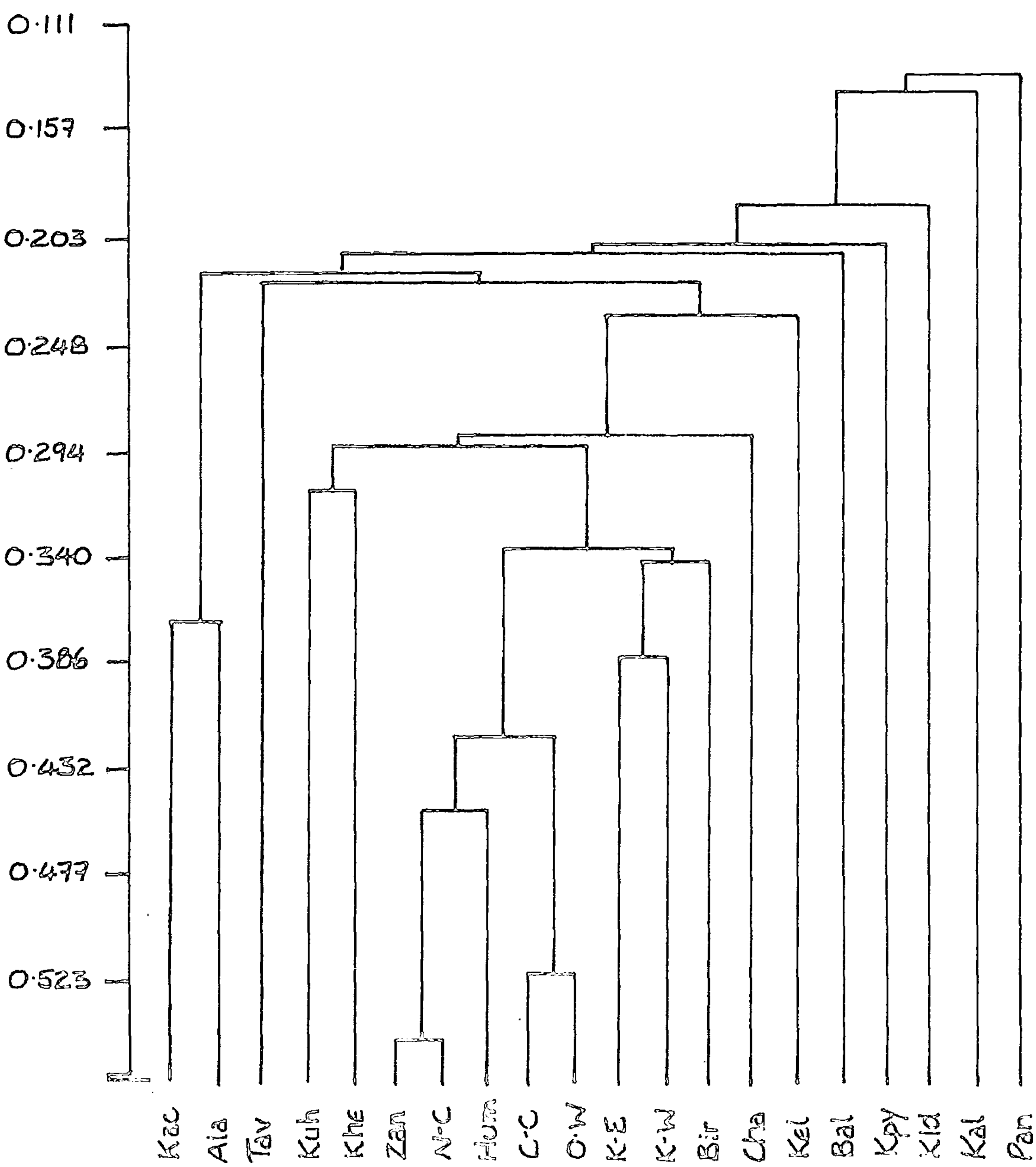
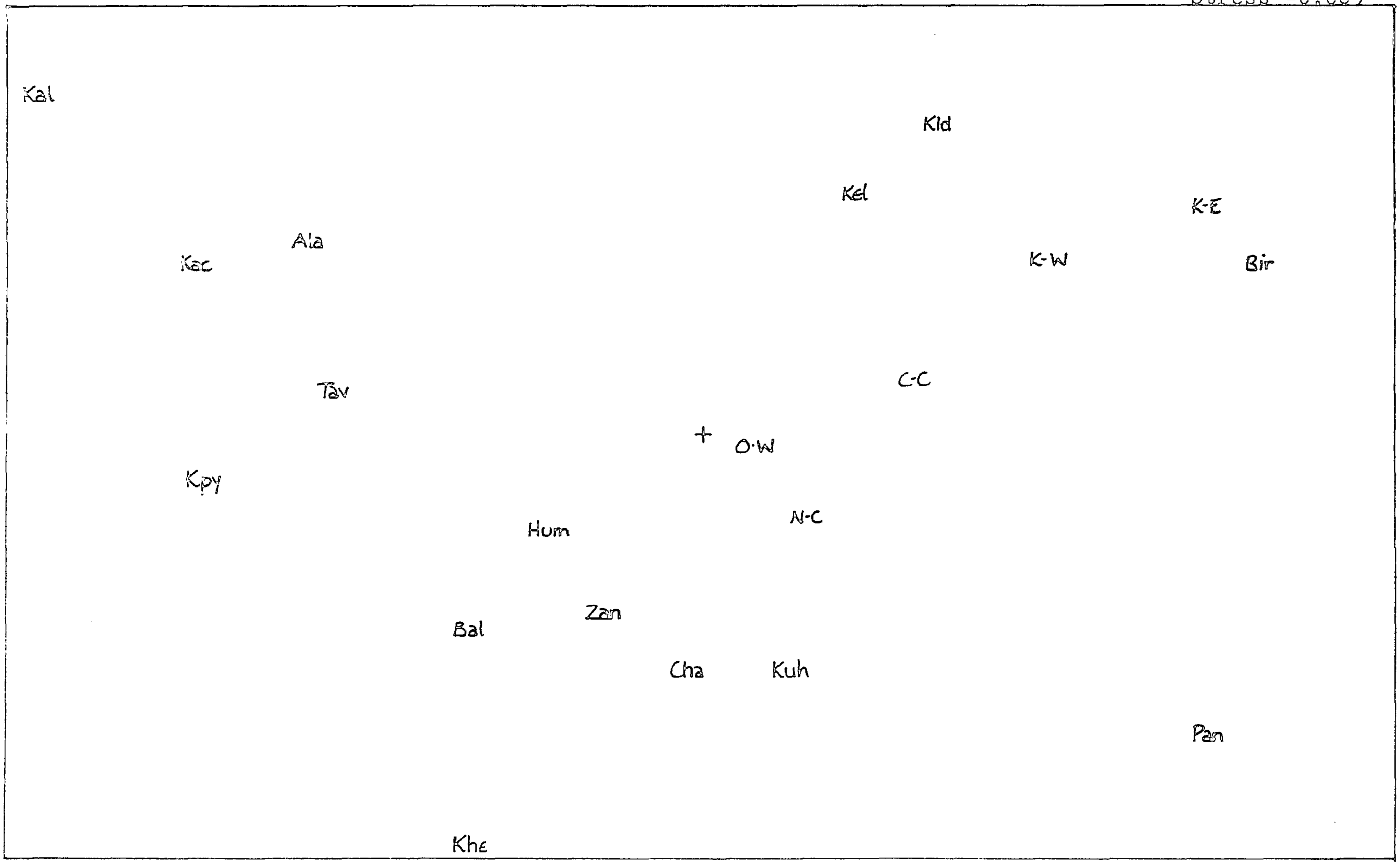


Figure 6.6b SPATIAL POSITION OF SUBDIVISIONS, INCLUDING OUTSIDE WORLD, AFTER ONE GENERATION OF MIGRATION BY MD-SCAL (BOTH GENERATIONS)

Stress =0.089



The pattern of subdivision clustering is very similar to the pattern when the migration from outside the system is excluded. The dehestans in the Central cluster are the areas that become related first, taking a minimum of 11 generations to homogenize, followed by the Western cluster taking 14 generations and finally the Eastern cluster that takes 16 generations. The Central cluster is also the first to show links with the migrant genes; this is due to Nowshahr city being the main recipient, and this factor is quickening the process of convergence. This same factor is operating in the Western cluster, where the existence of Chalous city , another recipient of migrants, is hastening convergence between the units. Inevitably they are the two clusters that unite together first, followed by the Eastern cluster.

The extent of ancestry with the 'outside world' shows a large increase between the two generations, in addition to shorter time to homogenize. It is also observed that the females are contributing considerably to the admixture between the units and the lowering of the differentiation.

A final analysis examined the pattern of exchange and relatedness between the three Bakhshes, and the effects of the new genes entering the system (Tables 6.11 a,b,c - 6.14 a,b,c). Inter-generational increase in spatial relatedness was observed mainly between B.Kelardasht with the other bakhshes of Markazi and Chalous. It was also observed that relatedness and the pattern of clustering was more pronounced between B.Kelardasht and B.Chalous first, followed by B.Chalous and B.Markazi, and finally between B.Markazi and B.Kelardasht. This same pattern

Table 6.11 MIGRATION MATRICES: GRANDPARENTS/PARENTS

MOVEMENT FROM BIRTHPLACES OF GRANDPARENTS TO THOSE OF PARENTS (NUMBER OF EXCHANGES)

	Markazi	Chalous	Kelardasht	O/World	Total
Markazi	854	7	9	24	894
Chalous	8	65	5	2	80
Kelardasht	13	30	906	17	966
O/World	113	67	66	979	1225
Total	988	169	986	1022	3165

MOVEMENT FROM BIRTHPLACES OF GRANDPARENTS TO THOSE OF PARENTS (PROPORTION OF EXCHANGES)

	Markazi	Chalous	Kelardasht	O/World	Total
Markazi	.955	.008	.010	.027	1.000
Chalous	.100	.813	.063	.025	1.000
Kelardasht	.013	.031	.938	.018	1.000
O/World	.092	.055	.054	.799	1.000

UPPER MATRIX: RELATEDNESS COEFFICIENTS AFTER ONE GENERATION OF MIGRATION

LOWER MATRIX: NUMBER OF GENERATIONS TO HOMOGENEITY BETWEEN EACH PAIR OF BAKHSHES AND THE OUTSIDE WORLD

	Markazi	Chalous	Kelardasht	O/World
Markazi		.143	.049	.137
Chalous	32		.125	.226
Kelardasht	46	38		.116
O/World	32	12	38	

Table 6.12 MIGRATION MATRICES: MOTHERS/OFFSPRING

MOVEMENT FROM BIRTHPLACES OF MOTHERS TO THOSE OF OFFSPRING (NUMBER OF EXCHANGES)

	Markazi	Chalous	Kelardasht	O/World	Total
Markazi	1915	95	38	90	2138
Chalous	44	418	32	53	547
Kelardasht	59	307	1803	51	2220
O/World	635	829	152	726	2342
Total	2653	1649	2025	920	7247

MOVEMENT FROM BIRTHPLACES OF MOTHERS TO THOSE OF OFFSPRING (PROPORTION OF EXCHANGES)

	Markazi	Chalous	Kelardasht	O/World	Total
Markazi	.896	.044	.018	.042	1.000
Chalous	.080	.764	.059	.097	1.000
Kelardasht	.027	.138	.812	.023	1.000
O/World	.271	.354	.065	.310	1.000

UPPER MATRIX: RELATEDNESS COEFFICIENTS AFTER ONE GENERATION OF MIGRATION

LOWER MATRIX: NUMBER OF GENERATIONS TO HOMOGENEITY BETWEEN EACH PAIR OF BAKHSHES AND THE OUTSIDE WORLD

	Markazi	Chalous	Kelardasht	O/World
Markazi		.185	.112	.375
Chalous	15		.246	.590
Kelardasht	19	14		.253
O/World	14	9	16	

Table 6.13 MIGRATION MATRICES: FATHERS/OFFSPRING

MOVEMENT FROM BIRTHPLACES OF FATHERS TO THOSE OF OFFSPRING (NUMBER OF EXCHANGES)

	Markazi	Chalous	Kelardasht	O/World	Total
Markazi	1942	66	24	65	2097
Chalous	9	452	17	30	508
Kelardasht	63	231	1898	80	2272
O/World	660	930	80	764	2434
Total	2674	1679	2019	939	7311

MOVEMENT FROM BIRTHPLACES OF FATHERS TO THOSE OF OFFSPRING (PROPORTION OF EXCHANGES)

	Markazi	Chalous	Kelardasht	O/World	Total
Markazi	.926	.031	.011	.031	1.000
Chalous	.018	.890	.033	.059	1.000
Kelardasht	.028	.102	.835	.035	1.000
O/World	.271	.382	.033	.314	1.000

UPPER MATRIX: RELATEDNESS COEFFICIENTS AFTER ONE GENERATION OF MIGRATION

LOWER MATRIX: NUMBER OF GENERATIONS TO HOMOGENEITY BETWEEN EACH PAIR OF BAKHSES AND OUTSIDE WORLD

	Markazi	Chalous	Kelardasht	O/World
Markazi		.092	.102	.345
Chalous	28		.188	.492
Kelardasht	28	14		.197
O/World	24	20	20	

Table 6.14 MIGRATION MATRICES: PARENTS/OFFSPRING

MOVEMENT FROM BIRTHPLACES OF PARENTS TO THOSE OF OFFSPRING (NUMBER OF EXCHANGES)

	Markazi	Chalous	Kelardasht	O/World	Total
Markazi	3857	161	62	155	4235
Chalous	53	870	49	83	1055
Kelardasht	122	538	3701	131	4492
O/World	1295	1759	232	1490	4776
Total	5327	3328	4044	1859	14558

MOVEMENT FROM BIRTHPLACES OF PARENTS TO THOSE OF OFFSPRING (PROPORTION OF EXCHANGES)

	Markazi	Chalous	Kelardasht	O/World	Total
Markazi	.911	.038	.015	.037	1.000
Chalous	.050	.825	.046	.079	1.000
Kelardasht	.027	.120	.824	.029	1.000
O/World	.271	.368	.049	.312	1.000

UPPER MATRIX: RELATEDNESS COEFFICIENTS AFTER ONE GENERATION OF MIGRATION

LOWER MATRIX: NUMBER OF GENERATIONS TO HOMOGENEITY BETWEEN EACH PAIR OF BAKHSHES AND THE OUTSIDE WORLD

	Markazi	Chalous	Kelardasht	O/World
Markazi		.139	.109	.360
Chalous	20		.223	.544
Kelardasht	22	13		.225
O/World	17	13	18	

also emerged in the parental generation, but with increased coefficients. The increase between the generations and within each generation was more pronounced in the relationship between the individual Bakhshes and the 'outside world'. B.Chalous showed the highest relatedness in terms of admixture with the migrants, in both generations, followed by B.Markazi and B. Kelardasht. This is again attributed to the existence of the two cities of Chalous and Nowshahr and the partial isolation of the other dehestans. This reflects the heterogeneous contribution that the 'outside world' makes to the individual subdivision in the system. Finally, the sex differences observed in the extent of exchanges within and between the Bakhshes and the 'outside world' indicate that the females mainly contribute to the admixture.

The parallelism between the geographic map of the subdivisions (See Figure 1.3) and the MDS map of migration demonstrate the extent to which geographic factors such as topography, pattern of settlements, communication network and proximity determine the pattern of movement and relatedness within the Shahrestan. A correlation between geographic distance and relatedness coefficients revealed significant association between the two variables: r= -.446 p=.000 (Fig. 6.7). Geographic distances between the dehestans were taken as straight line distances between the midpoint of clusters of villages within each subdivision. The distances are approximates since distribution of villages in the dehestans is not regular or continuous (Table 7.15).

Figure 6.7 CORRELATION OF GEOGRAPHIC DISTANCES AND RELATEDNESS COEFFICIENTS OF THE NINETEEN SUBDIVISIONS IN SHAHRESTAN NOWSHAHR

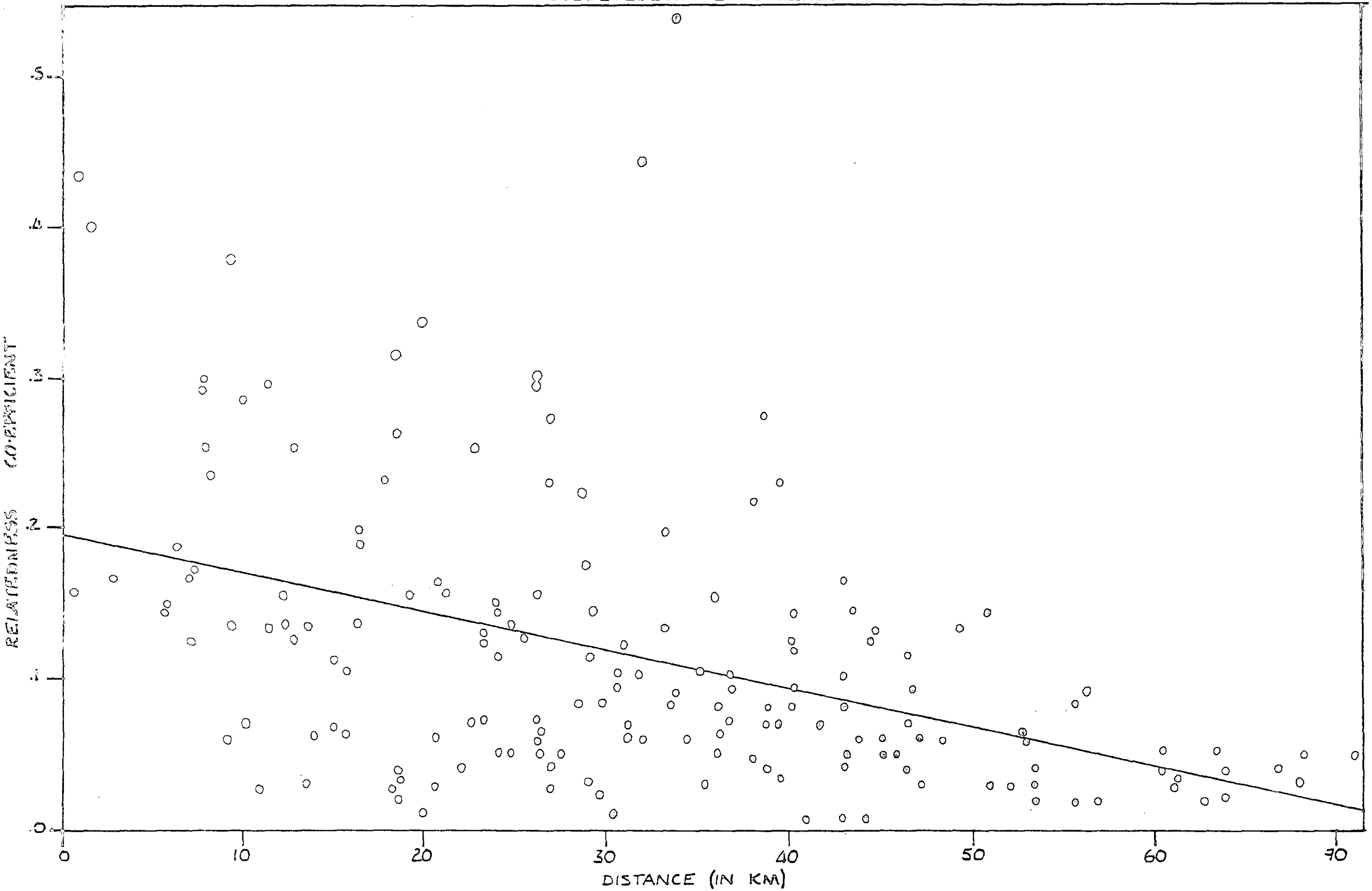


Table 6.15

APPROXIMATE GEOGRAPHIC STRAIGHT-LINE DISTANCES BETWEEN THE 19 ADMINISTRATIVE SUB-DIVISIONS (IN KM)

	Kachrostagh	Kalej	Alavikola	Kalrudpey	Baladeh-Kojour	Tavabe-Kojour	Kuhparat	Chalandar	Kheyroud-Kenar	Zanouss Rostagh	Panjakrostagh	Nowshahr City	Humeh	Kelarostagh	Chalous City	Kelardasht	Kuhestan East	Kuhestan West
Kal	16.3																	
Ala	4.0	15.0																
Kpy	7.5	14.0	3.3															
Bal	15.0	15.3	11.0	7.5														
Tav	30.0	14.3	27.8	25.8	9.2													
Kuh	30.8	19.8	27.3	24.3	18.0	13.0												
Cha	24.0	21.0	20.0	16.8	9.3	22.5	13.0											
Khe	31.8	30.8	27.5	24.8	17.5	31.3	19.5	9.8										
Zan	42.0	29.5	38.8	35.8	29.8	17.8	11.8	23.5	27.3									
Pan	50.5	41.5	46.5	43.3	36.3	32.8	22.0	27.3	24.8	16.3								
N-C	39.0	40.0	35.0	32.5	25.0	40.8	28.0	19.3	9.5	34.3	27.0							
Hum	40.8	40.5	36.8	34.0	27.0	40.0	27.3	19.5	10.0	32.5	24.5	3.0						
Kel	52.3	52.0	48.8	45.8	39.0	50.3	37.5	31.3	21.8	40.0	28.0	13.5	11.8					
C-C	47.5	47.5	43.8	40.8	34.3	46.5	33.8	26.5	16.8	37.3	27.0	8.3	9.0	5.0				
Kld	67.0	62.0	63.0	60.0	52.5	55.0	43.0	43.3	36.0	39.3	22.8	31.8	29.0	21.8	25.3			
K-E	67.3	55.5	63.5	60.5	53.3	43.3	36.8	45.5	44.3	26.0	19.5	46.3	43.8	44.5	44.5	29.8		
K-W	70.0	60.0	65.8	62.8	55.8	49.3	40.5	46.5	43.3	31.5	19.5	43.3	40.5	38.3	39.3	20.5	10.8	
Bir	60.3	53.0	56.3	53.0	45.5	45.0	33.8	36.3	31.0	28.5	12.3	30.0	37.0	24.5	25.5	11.3	21.0	14.5

The application of the migration model of Hiorns et al (1969), has proved to be a useful tool in terms of predicting and estimating the potential for genetic relatedness between the subdivisions of Sh. Nowshahr. The results have elucidated the following points: a) Inter-dehestan migration and genetic exchange is very small and non-random, showing an average of 10% shared ancestry, with many generations needed to establish equilibrium between every pair of populations. b) Temporal differences are observed between the two generations, reflecting more mobility and interchange, and consequently requiring shorter time to become homogeneous. c) Female migration is the predominant cause of the increased relatedness. d) Three main clusters are recognized, demonstrating the extent to which mobility and relatedness are dependent upon geographic proximity and hitoric patterns of settlements. e) Panjakrestagh and Kalej are the two regions that remain more isolated. f) Migration into the Shahrestan is heterogeneous, but invariably it is reducing the time for the whole system to reach equilibrium. g) Chalous and Nowshahr cities are the first areas to unite with the 'outside world'.

Although the model shows that it is applicable to the study area and the results are substantiated by historic references, it has not taken into account the effects of some stochastic factors that might have slightly altered the pattern observed. These factors are: the varying population sizes, demographic structure, kinship structure, consanguinity, linguistic and religious affiliations, geographic isolation, and selective migration. In addition, differential selective pressures operating in the highland and lowland areas and differential contribution from outside the Shahrestan might have all increased the probability of genetic differentiation and slowed down the process of convergence.

The migration matrix model has also been applied by other researchers in Oxfordshire (Harrison et al, 1970, 1971; Hiorns et al, 1977), in Reading (Coleman, 1979, 1980), in Pocklington (Constable, 1980), in the Isle of Wight (Smith, 1981) and in Durham (Fowler, 1982). Comparison of these works with the present study would not be applicable due to the differential characteristics of the study area in terms of administrative divisions, population sizes, distribution of settlements, demographic structure, geographic setting, kinship structure and linguistic and ethnic heterogeneity.

6.2 SURNAMES AND GENE FLOW

6.2.1 History of surnames in Iran

Surnames and afternames became mandatory in Iran in 1925, when the Civil Registration Office was established. The establishment carried out a nationwide system of registration (mainly for military service) and each inhabitant was issued with an Identity Card. In conjunction with the Identity Cards, the adoption of a surname was also required.

Before 1925, names or family names were limited to a minority: some traced their origin in the Prophet's line; others were ascribed by kings in accordance with their services; the "Hezarfamil" referred to various hereditary families that numbered one thousand; finally, the numerous clans or tribes that inhabited the more remote regions of the country, called 'Taifeh'. Taifeh comprised a network of relatives which originated as an assemblage of families linked by geographic proximity or loyalty to a common chief; due to isolation, these families eventually intermarried and the kinship group was enlarged.

When surnames became mandatory, the choice of name was based on various factors. Some chose the name of their village, others followed their tradename, eg 'khatat', meaning 'scribe'; some forenames were given the suffix 'zadeh' meaning 'born to', eg 'Hosseinzadeh'; others just added a 'y' to the name, implying belonging to, eg 'Rassouly'.

Since 1925 names have been regularly transmitted from the male parent to child. Since birth registration is mandatory, a child takes the name of the father. Illegitimate children are usually not given a name, unless required by either parent. The wife usually takes the name of her husband at marriage.

Shahrestan Nowshahr, as well as other parts of the Caspian provinces, had remained isolated for long periods of time due to inaccesibility and the lack of a communication network. Many of the small localities were inhabited by small, extended families, with marriages confined to the villages or settlements. Many of these families had united and intermarried with contiguous families and consequently formed a larger network of kinship. In some of these remote areas, ancestral names have persisted, and the number varies according to the size of the village, its geographic location and its traditional system of beliefs based on the economic structure. In certain instances double-surnames are observed which might indicate the union of two families. Detailed research is necessary to investigate the preponderance of family names in Sh. Nowshahr, and to examine the continuity or localization of names within and between the villages. In the present study the samples are insufficient for a detailed analysis and names have been analyzed only at dehestan level, which necessarily reduces the frequency and significance of the extent of localization of names. Additionally, it will be very difficult to observe for any distinct clines in surname flow between the dehestans, since settlement distribution is extremely irregular within each dehestan, and in general surnames are not very mobile due to the low mobility of the population.

An analysis was carried out by compiling a list of the incidence and frequencies of surnames in each of the nineteen subdivisions of Sh. Nowshahr. It was possible to examine and observe the preponderance (if any) of specific surnames particular to the subdivision. This analysis further allowed extrapolation on the extent of genetic isolation and surname localization within each area, and speculation on the consequences in terms of consanguinity and inbreeding.

Table 6.16 presents a rank order of occurrences of surnames in each dehestan for both sexes. Some of the units are represented by very few samples which makes the interpretation difficult. Primarily it is observed that unique names , ie names that occur only once, are the most frequent in all the units, except for Kalej. Other than Kalej, the dehestans of

Table 6.16 SURNAMES RANKED IN FREQUENCY OF OCCURRENCE

[illegible]	Occurrences 1	2	3	4	5	6	7	8	9	10	11	12	13	15	16	18	19	20	21	24	25	27	28	41	No*	S*	M*	F*
[illegible]																												
[illegible]rostagh	35	9	5	2		2																			88	53	41	47
[illegible]	21	3		1						1		1					2		1						93	29	47	46
[illegible]ikola	6	1																							8	7	6	2
[illegible]udpey	16	2		1	1																				29	20	18	11
[illegible]-Kojour	21	2		1						1															42	26	20	22
[illegible]-Kojour	17	9		1																					43	29	24	18
[illegible]	19	3	3	1				1																	58	29	32	25
[illegible]ndar	9	1																							11	10	5	6
[illegible]oud-Konar	22			1																					25	23	12	14
[illegible] Rostagh	32	4	4	1	2													1							86	44	46	40
[illegible]krostagh	10	2	1	1																					21	14	11	10
[illegible] Shahr City	50	4	1																						61	55	22	39
[illegible]	40	2	1																						21	17	12	9
[illegible]	210	32	17	11	5	3	2	2		1	1					1	1	1			1			1	585	289	296	290
[illegible]																												
[illegible]rostagh	53	7	7	1																					92	68	44	48
[illegible] City	40	3																							46	43	19	27
[illegible] Chalous	87	12	5	3																					138	107	63	75
[illegible]																												
[illegible]	133	25	14	5	3	2		1	1	1		1		1						1					347	185	179	168
[illegible] East	7		1																						12	10	8	4
[illegible] West	35	8	1		1																				59	45	33	26
[illegible]	53	15	2	2	13					1	1					1									151	78	73	78
[illegible] Kelardasht	231	49	16	7	10	4			2	2	1	1		1		1				1					569	325	243	276
[illegible] SHAHR	422	204	33	20	16	10	4	4	4	3	2		1		1	2		1	1	1	1			1	1293	631	662	641
[illegible]AL SAMPLES	796	175	43	18	17	15	13	3	5	5	4	1	4		2	1		2		1		1	1	1	2050	1108	1037	1013

No = Number of Samples
S = Number of Surnames
M = Number of Males
F = Number of Females

Kelardasht, Baladeh-Kojour, Zanouss-restagh and Biroun-bashm, also show occurences of particular surnames at high frequencies.

In Kalej, the surname 'Divsalar' occurs 21 times and comprises 22.6% of the total surnames. Other surnames which are frequent, including 'Salarian' (20.4%) and 'Salar' (10.7%), indicate interrelationship between the three names, and possibly a similar ancestral origin for them. The name 'Div', refers to one of the most original and indigenous peoples of western Mazandaran, if not the first. The surname 'Div' occurs only once, and the reason for its low occurrence might be due to its meaning implying 'giant', and therefore it is expected that some variation might have taken place. 'Salar' signifies the 'headman', and most probably indicates the tribal leader, and the derivation or the origin of the surname. 'Salarian', could possibly imply a number of Salar families, ie a plural form, a joining of these families. Finally 'Divsalar' is possibly the unification of two families of 'Div' and 'Salar'. If these speculations are correct, and these three surnames are ancestrally related, then they would comprise over 50% of the total inhabitants of the dehestan, indicating the extent of inbreeding and intermarriage within the taifeh of Salars. It is also interesting to point out that, in the earlier section on migration and relatedness, it was observed that the Dehestan of Kalej did not show any links with other populations and was usually the last to unite. Another name that is very frequent in Kalej is 'Kavianpour', comprising 12.9% of the total surnames.

The 'Khazaii' tribe/family are the main inhabitants of the dehestan of Zanouss-restagh, comprising 23.3% of the total inhabitants. They are also distributed in the contiguous dehestans of Baladeh-Kojour (23.8%), Kheyroud-kenar (13.8%), Nowshahr city and Kouhparat. The Khazaii family are one of the numerous families of the Khajevand and Lak tribes, who originated from the Zagros regions of Azarbaijan, Kurdistan and Luristan, and were later resettled in Mazandaran. One of the main strongholds of the Khajevand tribe is in the yelaghs (summer quarters) of Kojour territory (ancient name of the central region of the present B.Markazi). Presently Poul, the capital of Zanouss-restagh, is inhabited almost entirely by the Khazaii family. Both the surname analysis and the migration patterns reveal genetic contact between Poul, Baladeh-Kojour, Kheyroud-kenar and Nowshahr city. One main reason may be due to summer and winter migration practises of the Caspian people. Poul is one of the yelagh section of B.Markazi.

The predominant surname in D.Kelardasht, another stronghold of the Khajevand and Lak tribes, is 'Faghieabdollahy'. It comprises 6.9% of the total surnames. Other surnames also appear that show variation in the second part of the surname: Faghiemaleky, Faghiemarzban and Faghienasseri. To what extent these surnames are interrelated is difficult to say, but they could signify the joining of the 'Faghieh' family name with other different family names. The fact that double-surnames often occur in the various patronyms and matronyms is very interesting, and most importantly that it is not characteristic of modern names in the way they have been formed. Another family name in Kelardasht is 'Delfan'. The Delfan family was originally a subdivision of the Lak tribe, another Kurdish tribe resettled in Mazandaran. Variations on the surname Delfan are: Delafanazari, Delafanhosseini, Delfani and Delfanian. This is yet again another example of double-surnames. The Delfanazari are found in Kelardasht (4.3%). These names are also seen in the dehestans of Kouhestan-gharb and Kelarestagh.

Other surnames directly derived from the Lak tribe are Lakelayeh, Lakpour and Lakourej-Manssouri. They are distributed in Kelardasht, Kelarestagh and Biroun-bashm. The surname Manssouri also appears frequently in Kelardasht. In Biroun-bashm the surname 'Radaii' often appears, comprising 11.9% of the total surnames, while 'Vissy' comprises 6.6%. It is not certain to what extent the name 'Vissy' relates to the ancient tribe of 'Vitti' in western Mazandaran.

Other smaller families, which are mainly extended families are the 'Kia' who are numerous in the Dehestan of Humeh, mainly in the village of Kordkroudsar, and in Nowshahr city. Extension of the surname also exist, again as double-surnames: Kia-kojouri, Kia-heyrati, Kia-lashaki, Kia-mahamadi, Kia-manssouri and Lashaki.

In D.Kalrudpey, the small family network of 'Darvish' are settled. The 'Mataji' family are in Kouhparat, comprising 10.3%, and in Kheyroud-kenar. The 'Jahandars' reside in Humeh and Kouhparat. Finally the family names 'Sam', 'Samdaliri' and 'Dalir' are distributed in Kelarestagh, Biroun-bashm, Kouhestan-gharb and Chalous city.

From this analysis it is evident that certain surnames reflect family and tribal names are localized in particular regions. Not only are surnames specific to a dehestan, but they are also specific to the Bakhshes of Markazi and Kelardasht. Although analysis of surnames in individual villages would have been more informative and instructive in the interpretation, it is evident that even in larger territorial units surname localization is demonstratable. Surnames are either localized in one dehestan, or if there is surname flow, then it is limited to the contiguous dehestans. The surname analysis appears to reflect the migration pattern and direction of gene flow as well as demonstrating the short range of movement.

It would be very interesting to examine and demonstrate the interrelationship of the above parameters, namely surname flow, the pattern of exogamy and the distribution and range of movement to the languages and dialects particular to the regions, where sufficient samples are available.

6.2.2 <u>Surnames as genetic markers</u>

6.2.2.1 The method of isonymy

Another means of examining the degree of biological kinship within a population or between the subdivisions of a population is to measure the occurrence of common surnames (Lasker, 1977). The method of measuring genetic lineages and population isolation through surnames is useful in studies where information on kinship based on pedigree and genetic markers (serological) is not available. Pedigrees and genealogies can extend back to only five or six generations, and genetic data refer to long spans of time where natural selection and random genetic drift make it difficult to compare gene frequencies to trace common descent. Surname analysis on the other hand can delineate breeding populations over the period since surnames were ascribed (Lasker, 1977).

Surnames are inherited like genes, and in each generation offspring receive half of their parents' surnames and autosomal genes, thus surname transmission resembles genetic inheritance and they can be analyzed to indicate the origins of the genes. Surnames can become extinct and disappear just like genes, depending on the environmental factors such as name frequency, family size, differential fertility and mortality, sex ratio and genetic drift (Dobson and Roberts, 1971; Roberts, 1980). Surnames could be common in an area and rare elsewhere, and those with widely varying regional frequencies provide information on the relationship between populations. Communities with a few surnames at high frequencies indicate greater localization of genes and consequently high inbreeding, and estimates of rates of inbreeding can be obtained through marriages between persons of the same surname.

Darwin (1875) observed the parallelism between paternally inherited genetic characteristics and names, and estimated the frequency of cousin marriages from the proportions of names that were similar. He observed that a certain proportion of marriages between persons of the same surname would be by chance and he attributed this to population size, settlement patterns and degree of distribution and isolation of the surname, while the remaining fraction of the marriages with similar surnames would depend on the special proclivity of individuals to marry their own cousins. Crow and Mange (1965) further elaborated this idea and examined the two components of inbreeding, the random and the non-random aspects, which are important in terms of their effects on the genetic structure.

Several studies have estimated inbreeding coefficients from surname analysis, while others have extrapolated on the evolution and extinction of surnames and the problem of racial origins and ethnic composition (Watson and Galton, 1874; Roberts, 1942; Yasuda et al, 1974; cited by Kashyap and Tiwari, 1980).

Lasker (1977) extended the method of isonymy from intra-community inbreeding to inter-population relationships to show how it was possible to examine the relative linkages of two or more populations by surname analysis. He introduced the concept of 'Coefficient of Relationship' by isonymy, referred to as 'Ri', as the proportion of individuals with common surnames within or between populations. Ri is a means of examining the pattern of surname localization referring to the extent of shared lines of descent between spouses and the extent to which surname flow between populations reflect genetic flow and underlie the genetic structure (Lasker, 1978; Lasker and Roberts, 1982).

The coefficient of Relationship by isonymy is mathematically expressed as

$$R_i = \sum (S_{i1} \; S_{i2}) \; / \; 2 \; N_1 \; N_2$$

where S_{i1} and S_{i2} are the respective frequencies of the i^{th} surname in the males and females of a population (or individuals from two populations), and N_1 and N_2 are the corresponding sample sizes.

The model is based on two assumptions: a) Unilineal descent of surnames, ie the probability that the occurrence of the same surname in two individuals or two populations trace descent from a common progenitor; polyphyletism or multiple ancestral origin of surnames can violate this assumption. b) The exchange of surnames is proportional to the flow of migrants, so that the relationship established between two populations is based on equal virilocal (patrilocal residence) and uxorilocal (matrilocal residence) migration. Differential migration of the sexes will not distribute the surnames equally, and will tend to overestimate the isonymy rate.

The coefficient of relationship by commonality of surnames is also used to estimate the average genetic relationship in historical populations (Roberts and Rawling, 1974; Lasker, 1978; Souden and Lasker, 1978; Kuchemann et al, 1979; Lasker et al, 1979; Raspe and Lasker, 1980).

6.2.2.2 Application of the Isonymy Model

The purpose of the present analysis is to study the data on surnames, their frequency and distribution, and, by applying Lasker's method, determine how genetically isolated the people of each individual dehestan are and whether a pattern of surname localization exists, and finally to look for any cline in surname flow between every pair of dehestans. It was also considered useful to assess the possibility of applying this technique to a population in Iran.

The population under study has a system of patrilineally descending surnames, thus fulfilling one of the essential assumptions of the model. Furthermore it has been assumed that surnames are monophyletic, based on the relative geographic isolation of the dehestans and their kinship structure, although the validity of this assumption is open to question and requires more research. The third assumption of uniform migration of the sexes has been considered with caution. In general, patrilocality appears to be more frequent and more of the genetic exchange and intermarriage between the settlements is based on female migration; However some factors must be considered. Firstly, movement is extremely limited, inhibiting free mobility of either sex, and furthermore marriage with members of the same unit is the predominant pattern, therefore mobility on the sides of the females must be very small. Secondly, it is erroneous to generalize on the pattern of movement within each dehestan, since it is very much determined by the structure of the distribution of the villages, the extent of urban and rural settlement, the demographic structure and the communication network. Thirdly, the local custom of 'Khaneh-Damad' meaning 'house-groom' is a situation when a man moves to a wife's residence at marriage, and this is practised throughout Iran. A final, essential point is the traditional summer and winter migration of the people which comprises mainly males who come down to the coast in the winter looking for jobs, and migrate back to the mountains for the summer; it has been observed that some proportion of these people remain in the lowlands because of better prospects of living.

The average coefficient of relationship , Ri, within each of the dehestans based on the surnames of males and females, and between the dehestans based on both sexes of each subdivision is presented in Table 6.17. Some of the units have very few samples and show large coefficients which do not reflect the actual isonymic relationship within and between the units; these large coefficients may also have been produced by the inclusion of members of close relatives living in the same household or by duplication of surnames if female's married name is given instead of the maiden name. In general, large sample sizes are needed to yield values of Ri which are not dominated by stochastic factors which invariably effect small populations.

The Ri coefficients are based on the sample of 1293 individuals (652 males and 641 females), who have been born and reside in the nineteen subdivisions of Sh. Nowshahr. Estimation of the kinship coefficients are based upon 2586 patronyms and matronyms.

The average Ri within each unit ranges from .00735 in D.Kelardasht to .06330 in D.Kalej. The mean within Ri is around .03290 . Excluding three of the units (Alavikola, Chalandar and Kouhestan-shargh) which have inflated the coefficients, it yields a lower mean of .02695 . The coefficients appear to be very much a function of the size of the dehestan, which varies greatly, and the number of villages, their size and density and the structure of the distribution. Another important influential factor is the number of Taifehs (clans) residing in each dehestan.

Dehestans of Kalej, Baladeh-Kojour, Zanouss-restagh and Biroun-bashm show relatively large coefficients as expected, while the two cities of Nowshahr and Chalous exhibit lower values, reflecting the heterogeneous composition of surnames. Dehestan of Kelardasht shows the least coefficient and this is possibly attributed to its large size and the existence of some ethnic

Table 6.17 COEFFICIENTS OF RELATEDNESS (Ri) BY ISONYMY BETWEEN THE NINETEEN SUBDIVISIONS OF SHAHRESTAN NOWSHAHR

	KAC	KAL	ALA	KPY	BAL	TAV	KUH	CHA	KHE	ZAN	PAN	N-C	HUM	KEL	C-C	KLD	K-E	K-W	BIR
KAC	.01420																		
KAL	.01175	.06330																	
ALA	.00140	.00000	.07815																
KPY	.00100	.00000	.00000	.03865															
BAL	.00110	.00050	.00000	.00125	.04365														
TAV	.00230	.00155	.00000	.00165	.00200	.02040													
KUH	.00125	.00010	.00000	.00000	.01640	.00000	.03120												
CHA	.00050	.00000	.00000	.00155	.01300	.00540	.00625	.05370											
KHE	.00195	.00085	.00000	.00065	.00550	.00230	.01095	.00175	.02810										
ZAN	.00080	.00055	.00000	.00100	.03045	.00110	.01605	.01110	.00535	.03665									
PAN	.00435	.00305	.00000	.00000	.00455	.01190	.00000	.00000	.00275	.00250	.04875								
N-C	.00065	.00045	.00000	.00200	.00235	.00100	.00170	.00075	.00095	.00360	.00165	.01010							
HUM	.00160	.00000	.00000	.00165	.00115	.00000	.00125	.00000	.00275	.00000	.00000	.00040	.03515						
KEL	.00006	.00000	.00000	.00020	.00000	.00015	.00045	.00000	.00000	.00025	.00000	.00020	.00000	.00945					
C-C	.00110	.00045	.00000	.00000	.00025	.00080	.00035	.00100	.00040	.00040	.00165	.00020	.00050	.00085	.01275				
KLD	.00040	.00010	.00070	.00015	.00025	.00035	.00020	.00000	.00110	.00025	.00070	.00005	.00000	.00075	.00025	.00735			
K-E	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.06250		
K-W	.00040	.00010	.00000	.00000	.00020	.00000	.00030	.00000	.00000	.00060	.00040	.00055	.00080	.00035	.00055	.00010	.00070	.01450	
BIR	.00025	.00005	.00085	.00010	.00025	.00030	.00005	.00030	.00040	.00045	.00015	.00015	.00030	.00045	.00080	.00035	.00110	.00040	.01700

Kurds in the different isolated localities.

The Ri coefficients within each subdivision are larger than the Ri coefficients between them, indicating some degree of localization of surnames and genes. The mean coefficient of relationship between the subdivisions yields a value of .00150, ranging from 0 to .03045. The standard deviation is .007, indicating high variability in Ri values.

The largest between Ri coefficients occur between the contiguous dehestans of B.Markazi, where they form small and large clusters in terms of common surnames. Dehestans of Baladeh-Kojour, Zanouss-restagh, Kouhparat, Kheyroud-kenar and Chalandar form a cluster, and excluding Chalandar, which has very few samples, the Ri between them ranges from .03045 to .01095. Two small clusters also emerge independently: these are the dehestans of Tavabeh and Panjak-restagh, which link to the main cluster; dehestans of Kachrestagh and Kalej is another cluster which links with the main cluster. Other dehestans show far smaller Ri values, but those in B.Markazi are the first to unite with the main cluster, followed by the dehestans in B.Kelardasht and B.Chalous (Fig. 6.8a and 6.8b).

The coefficients between the subdivisions vary according to the region, and the nature of the region. There appears to be some geographic element to the distribution and flow of the surnames. In accordance with the assumption that relatedness and kinship between individuals or populations decline as the distance between them increase (Malecot, 1967, 1969), a larger Ri is expected between contiguous areas. The correlation coefficient of Ri with geographic distance (Fig. 6.9) shows a

Figure 6.8a SINGLE LINK CLUSTERING OF SUBDIVISIONS BASED ON COEFFICIENTS OF RELATEDNESS (Ri) BY ISONYMY

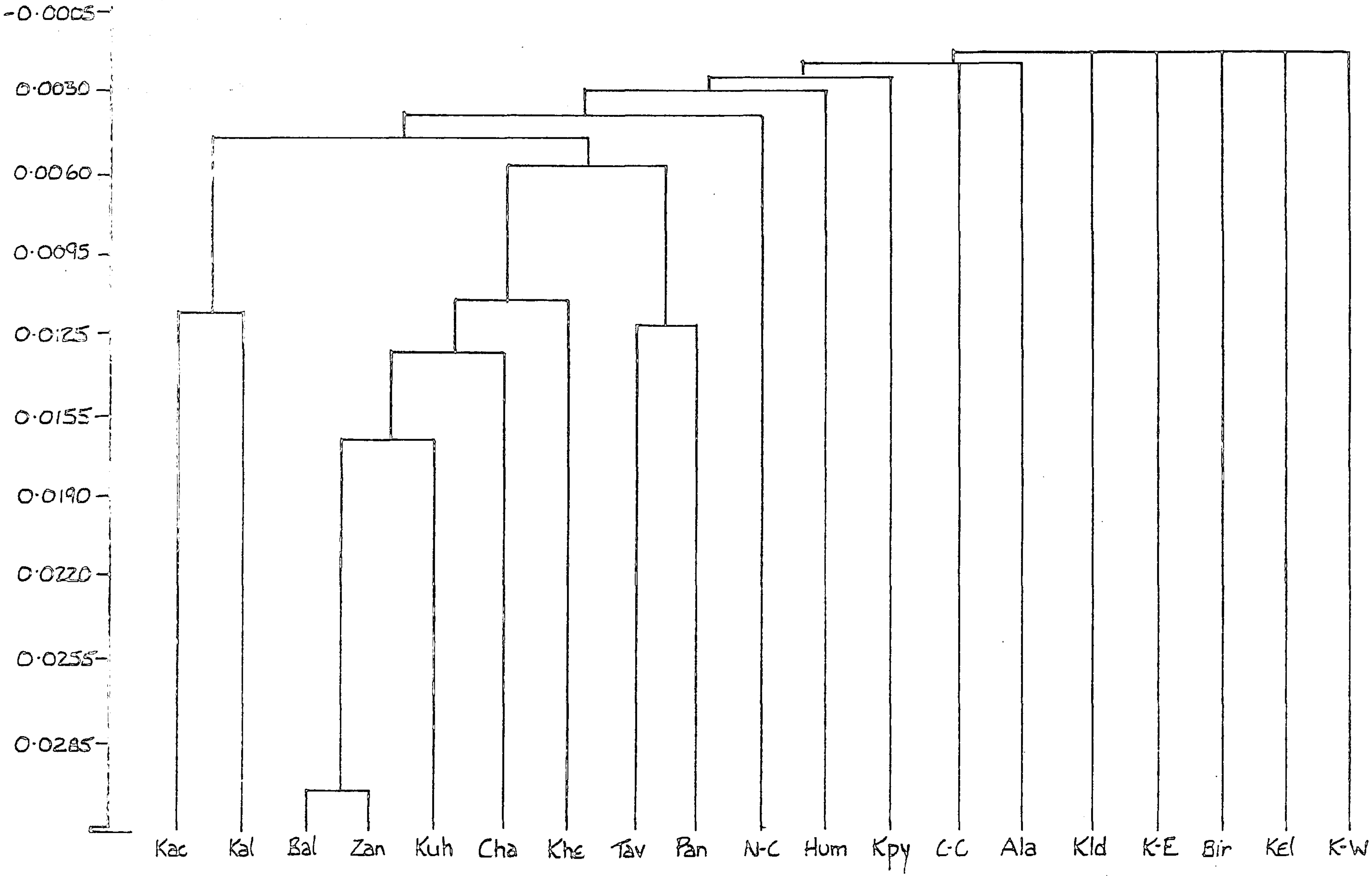
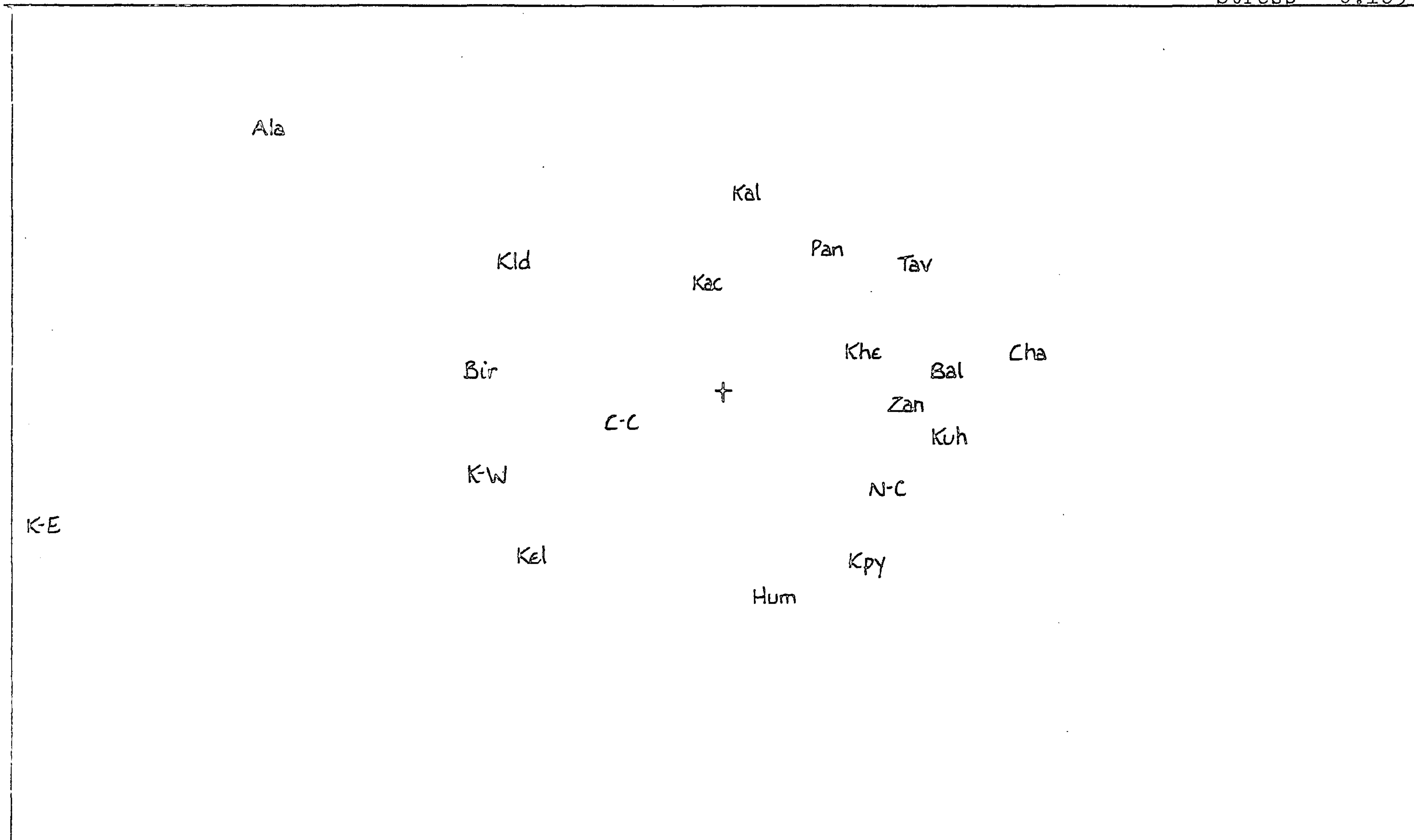


Figure 6.8b SPATIAL POSITION OF SUBDIVISIONS BY MD-SCAL BASED ON RELATEDNESS COEFFICIENTS (Ri) BY ISONYMY

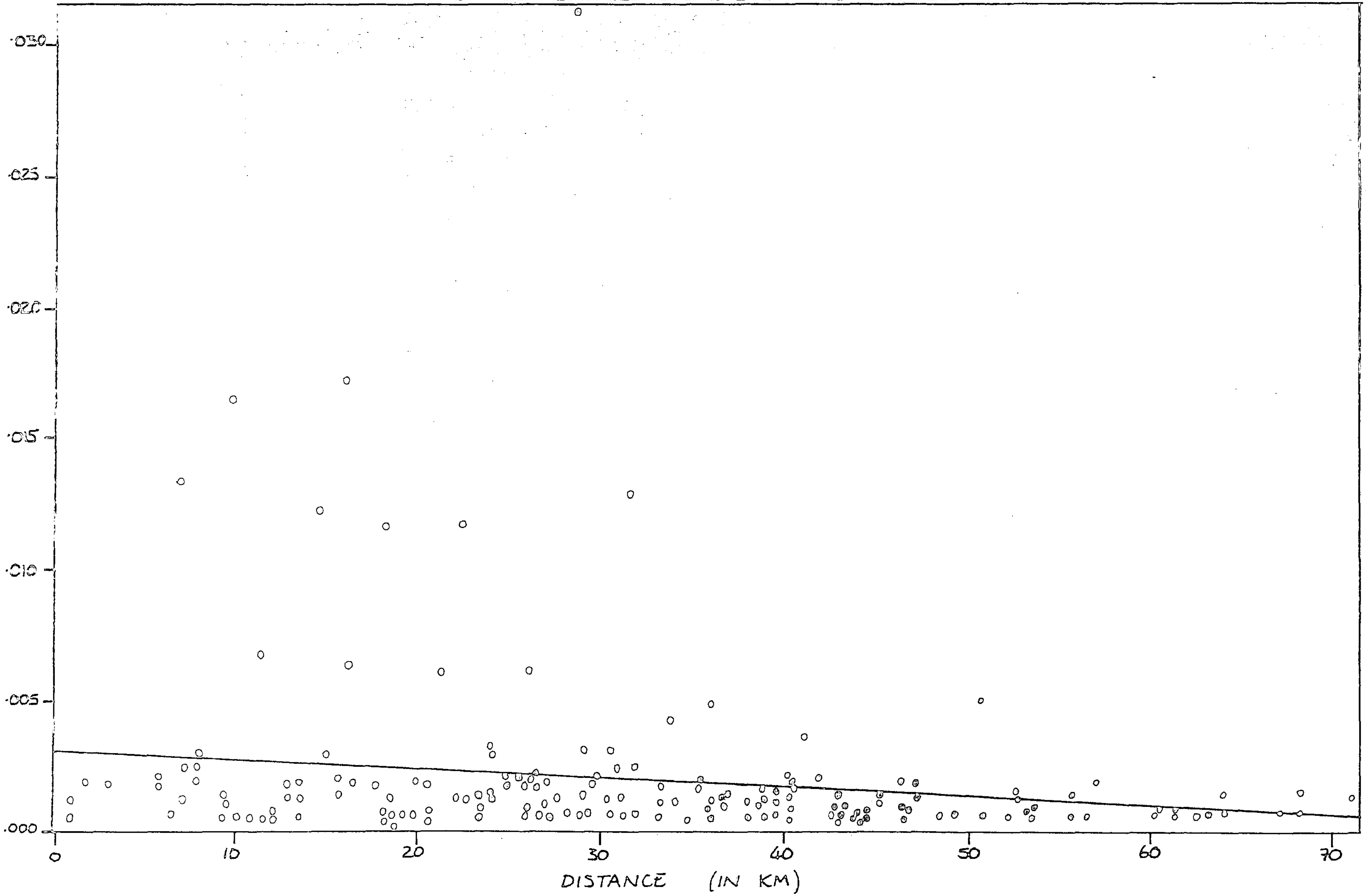
Stress = 0.165



small negative relationship: r= -.211 p=.003. The low correlation between isonymic relatedness and geographic distance is indication of other factors that are influential in either restricting or facilitating free mobility. These factors are the sporadic and heterogeneous distribution of settlements and clustering of villages, local topography and altitude, the religious and linguistic structure, the kinship network and the communication system dictating the differential distribution of surnames. Therefore, if surnames are localized but have access to free flow, and if the orientation of flow is not selective, then relatedness between the units and their convergence is bound to occur, while non-random flow of surnames caused by topographic barriers and linguistic proscriptions would result in a population composed of homogeneous demes with localized genes.

Many studies have been based on isonymy (Lasker et al, 1972, 1979; Watson, 1975; Lasker, 1977, 1978a, 1978b, 1980; Kaplan et al, 1978; Souden and Lasker, 1978; Kuchemann et al 1979; Flora and Vona, 1980; Kashyap and Tiwari, 1980; Raspe and Lasker, 1980; Lasker and Roberts, 1982; Lasker and Mascie-Taylor, 1983). In some of these analyses, it has been observed that the correlation between Ri and distance is low, though negative. Lasker (1977) claims that a low correlation is an indication to the 'Island Model' of gene distribution, where each population division demonstrates a high degree of isolation and a low coefficient of relationship with others. In general, one distinct, inflexible model is not applicable to the population under study. The 'Isolation by Distance Model' is not applicable

Figure 6.9 CORRELATION OF GEOGRAPHIC DISTANCES AND COEFFICIENTS OF RELATEDNESS (Ri) BY ISONYMY IN THE NINETEEN SUBDIVISIONS OF SHAHRESTAN NOWSHAHR



either, since distance is not the only major factor, and both topography and cultural factors must be accounted for. (it should also be noted that the methodology of measuring the straight-line distances between the units based on theoretical centres does not give a high resolution, and also ignores altitudinal effects).

One interesting factor to be recognized is the relatively high correlation that has emerged between the two different models of migration. Both the migration matrix model and the isonymy model demonstrate the primary subdivision of Shahrestan Nowshahr, in term of migration and gene flow, and the continuing genetic relatedness within the subdivisions of B.Markazi and B.Kelardasht. Furthermore, the application of the different models and techniques of analysis and their correlation substantiate the structure and pattern of migration in the Shahrestan.

The coefficient of relationship has also been examined within and between the three Bakhshes, and with the outside localities of the ostans of Mazandaran, Gilan and 'Other Ostans' (Table 6.18).

Separate matrices were produced for each sex, and for both sexes pooled. The mean local Ri for the males of the three Bakhshes was .00727, and for the females it was .00737, and they do not reveal any substantial difference in terms of surname distribution. The mean between Ri for each sex shows a higher coefficient for the males (.00040) than for the females (.00033), but including the outside localities the difference is smaller: males (.00045) and females (.00047). The correlation coefficient between the sexes shows a high correlation (r= +0.985). Such

Table 6.18

COEFFICIENTS OF RELATEDNESS (Ri) BY ISONYMY BETWEEN THE THREE BAKHSHES AND THE OUTSIDE WORLD

MALE & FEMALE	No	Bakhsh Markazi	Bakhsh Chalous	Bakhsh Kelardasht
Bakhsh Markazi	565	.00730		
Bakhsh Chalous	159	.00040	.00515	
Bakhsh Kelardasht	571	.00025	.00050	.00430
Ostan Mazandaran	144	.00120	.00050	.00030
Ostan Gilan	373	.00045	.00035	.00025
Other Ostans	232	.00040	.00050	.00040

MALE	No	Bakhsh Markazi	Bakhsh Chalous	Bakhsh Kelardasht
Bakhsh Markazi	284	.00800		
Bakhsh Chalous	75	.00045	.00900	
Bakhsh Kelardasht	295	.00020	.00055	.00480
Ostan Mazandaran	68	.00155	.00080	.00020
Ostan Gilan	187	.00040	.00025	.00020
Other Ostans	127	.00020	.00040	.00040

FEMALE	No	Bakhsh Markazi	Bakhsh Chalous	Bakhsh Kelardasht
Bakhsh Markazi	281	.00785		
Bakhsh Chalous	84	.00025	.00905	
Bakhsh Kelardasht	276	.00030	.00045	.00520
Ostan Mazandaran	76	.00100	.00025	.00040
Ostan Gilan	186	.00060	.00040	.00035
Other Ostans	105	.00055	.00055	.00055

high correlations substantiate the assumption of no significant differential migration by each sex, although it should be noted that the values in the coefficients are small and have been rounded down, and this could swamp the detection of small differences. In general, the differential migration of the sexes needs to be confirmed with more research.

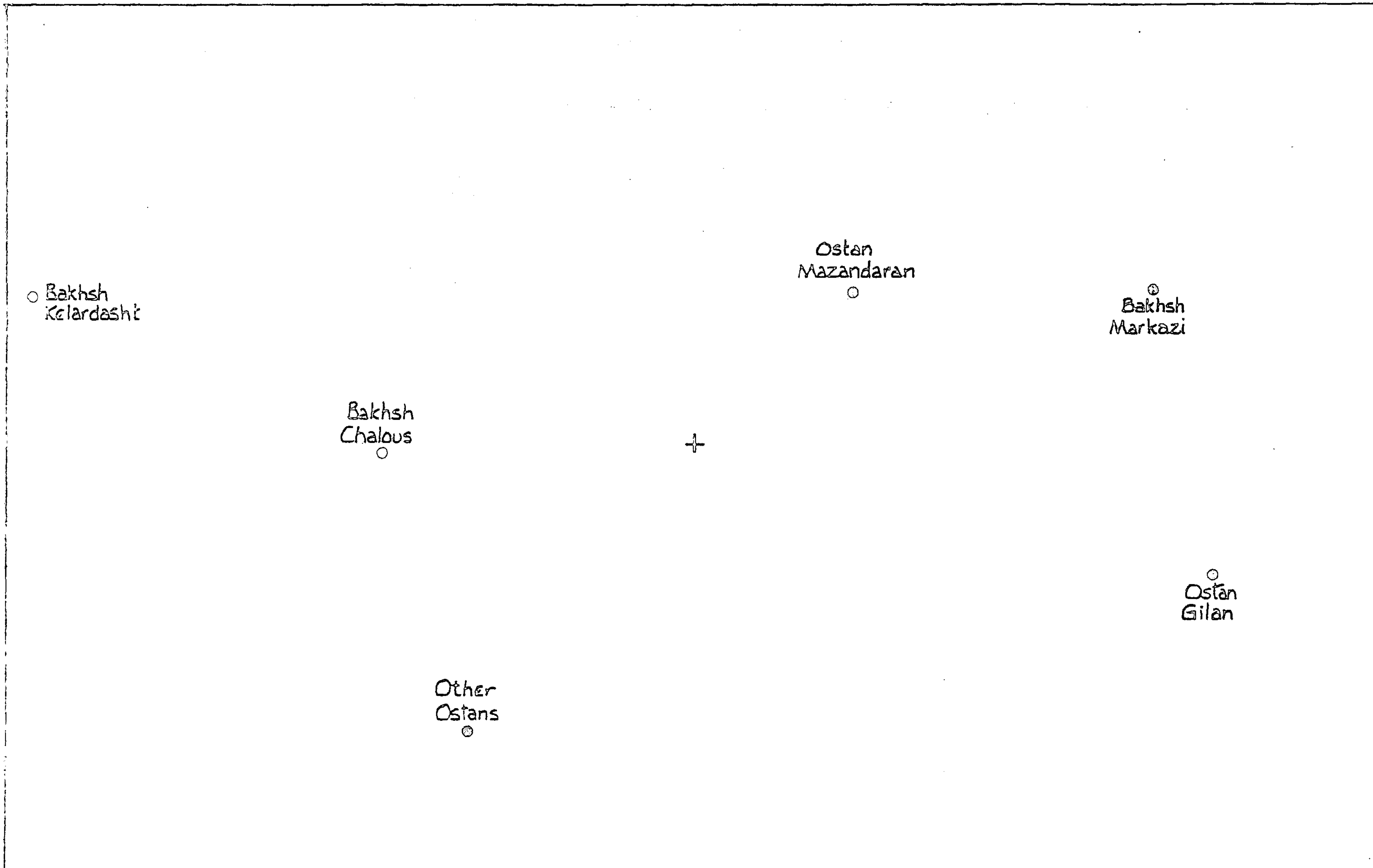
The within (local) Ri for both sexes combined shows that B.Markazi has the largest coefficient. The mean between Ri for the three Bakhshes is .00038. As expected B.Chalous and B.Kelardasht show higher relationship than all other pairs of relationships, ie B.Chalous and B.Markazi, and B.Markazi and B.Kelardasht. The latter pair of dehestans shows the least Ri. Therefore it is observed that primarily each Bakhsh shows very high within-coefficients compared with between-coefficients, and secondly a geographic element is noticed in terms of commonality of surnames.

Estimation of Ri indices with the outside localities reveals that B.Markazi and O.Mazandaran have very high coefficient (.00120), mainly due to the most eastern dehestans of Kalej and Kachrestagh. All other indices range between .00025 to .00050. B.Chalous shows high relatedness coefficients with B.Kelardasht and O.Mazandaran, and far less with O.Gilan and B.Markazi. B.Kelardasht is highly related to B.Chalous and ostan of Mazandaran and 'Other', and less with B.Markazi and O.Gilan (Fig. 6.10).

In general, it appears that it would be more instructive to ignore administrative boundaries, namely the divisions of the Bakhshes, and for the estimation of Ri to be based on

Figure 6.10 SPATIAL POSITIONS OF THE THREE BAKHSHES AND THE OUTSIDE WORLD BY MD-SCAL BASED ON RELATEDNESS COEFFICIENTS (Ri) BY ISONYMY

Stress = 0.0659



actual distances between the localities. These results indicate that not only are geo-topographic factors influential in terms of surname flow, but they also reflect the historic links between the different regions, as observed between B.Chalous and Kelardasht, and between B.Markazi and O.Mazandaran.

The analysis and results of the isonymy method reveal that it is more instructive to examine surname migration in villages rather than in dehestans or bakhshes, in order to obtain a better estimate of Ri between population units, since analysis on larger units ignores many factors conducive to restriction of gene flow, and consequently the identification of Mendelian populations. Conclusively, both types of surname analysis have indicated some degree of surname localization, although variable according to the region.

6.3 INBREEDING AND CONSANGUINITY

6.3.1 Marital isonymy and inbreeding

Mating patterns in human populations are the result of the interaction of various biological, demographical, socio-cultural and geographic factors. Random mating in evolutionary terms will lead to reduced heterozygosity and variance between populations, while non-random and selective mating result in genetic localization and homogeneity within a population. In no population is mating completely random, but the departures from randomness may be small enough to be negligible (Spulher, 1972). The causes for non-randomness are fragmentation of the populatation into smaller subdivisions

(Cavalli-Sforza, 1957), and factors such as sedentary subsistence patterns of economy, linguistic and ethnic factors, consanguinity and preferential marriages, and small population size and density that result in small breeding population sizes. These factors, in addition to matrimonial radii and family size, are influential in maintaining the differential distribution of inbreeding levels.

Inbreeding refers to the mating of two individuals who share one or more common ancestor. In large populations, inbreeding is the result of non-random mating, and consanguineous marriages reflect preferential matings since the probability of selecting a relative at random is very small. In small populations, the chance probability of selecting a relative as mate is quite high and randomly mating pairs may all be closely related by descent, therefore inbreeding is caused by the non-random aspect of mating behaviour. The two components of inbreeding have been thoroughly studied (Allen, 1965; Crow and Mange, 1965; Schull, 1972; Kirkland and Jantz, 1977).

The consequences of inbreeding as examined in experimental studies reveal increased homozygosity, fixation of genes and reduction of mean phenotypic value between the members of the population, and increased differences in genetic composition with neighboring populations.

Wright (1922) estimated the coefficient of inbreeding by measuring the deviation of genotype frequencies in an inbred population from that expected under panmixia; the frequency of genotypes from two autosomal alleles under three patterns of mating are:

Panmixia	F=0	P=1
Intermediate	F>0	P<1
Complete	F=1	P=0

where 'F' denotes inbreeding and 'P' is the panmictic index, ie the probability that two genes are not identical by descent. Departure from panmixia is expressed in terms of the average inbreeding coefficient of an individual in relation to the total population, and on averaging the coefficient of all individuals a mean inbreeding coefficient of the population can be obtained.

The mean inbreeding coefficients for known human populations are low, and the maximum value commonly observed in isolated populations is around 0.006 (Tripp-Reimer, 1980). In populations isolated by geographic or cultural factors, or those in the rural areas where demes are composed of small members, endogamy is high and cousin marriages are prescribed, and exhibit high inbreeding coefficients and biological relatedness (Spulher and Kluckon, 1953; Bonne, 1963; Cavalli-Sforza, 1963; Lasker and Kaplan, 1964; Crow and Mange, 1965; Roberts, 1965, 1967; Kashyap, 1980).

Inbreeding levels are estimated directly from pedigrees and genealogies, and indirectly from isonymy. Since there are four kinds of first cousin marriages, but only one has the same paternal name (ie father's brother, which is 1/4 of all cousin marriages), then the contribution of isonymy to inbreeding can be estimated as four times the inbreeding coefficient of the offspring of first cousins. Lasker (1977) speculated that the frequency of same surnames between pairs of spouses, ie marital isonymy 'Im', can be used to estimate the inbreeding coefficient, since the coefficient of relationship by isonymy between parents is equal to twice the inbreeding coefficients of the offspring.

In a randomly mating population if P_i is the proportion of males in the population with a particular surname, and q_i is the famale proportion with the corresponding surname, then isonymous marriages will occur with a frequency of $p_i q_i$, and the contribution these make to the overall inbreeding coefficient of the population is $\sum p_i q_i / 4$, which is equal to the random contribution to inbreeding. This is equal to Wright's (F_{st}) , defined as the probability of identical homozygosity due to the chance unions of relatives under conditions of random mating in finite populations (Roberts and Rawling, 1974). Crow and Mange (1965) showed how (F_r), the random component of inbreeding may be used to calculate both (F_n), the non-random component and (F), the total coefficient of inbreeding:

$$F_r = (\sum pq)/4$$
$$F_n = (P-\sum pq)/4(1-\sum pq)$$
$$F = (F_n-(1-F_r)F_r)$$

where P is the proportion of isonymous marriages.

The assumptions necessary for applying this method to available data are as follows: a) Isonymy implies common ancestry. b) Neither sex is disproportionately represented among migrants. c) Consanguineous relations occur through both male and female ancestors in random proportions. d) Population is monogamous. e) No fertility differentials between consanguineous and non-consanguineous marriages (Roberts, 1980). f) The maximum inbreeding coefficient is (.25) since the method does not apply to marriage of sibs.

Most of these assumptions in the various studies based on isonymy are usually not fully met, and deviating factors such as polyphyletism, surname duplication, patrilocality, biases in marriage preferences and breakdown in surname transmission through illegitimacy, adoption and change of surnames tend to overestimate the inbreeding estimates. Ellis and Starmer (1978), found lack of agreement between the inbreeding coefficients based on pedigree analysis and isonymy. In estimations of inbreeding from isonymy, factors like differential family size (Cavalli-Sforza, 1973), differences in age in terms of reproduction (Cavalli-Sforza and Bodmer, 1974), restrictions in mating by propinquity and cultural and traditional elements (Schull, 1972) and in general the demographic structure (Dyke et al, 1983), must be accountedfor and incorporated in the model.

In general marital isonymy is not equivalent to inbreeding and has limited utility in studies of inbreeding in terms of defining departures of mating patterns from panmixia. However, studies on inbreeding, estimated from marital isonymy, have proved useful in yielding information on marital migration, and in distinguishing the two components (random and non-random) of inbreeding (Yasuda and Furusho, 1970, 1971; Rawling, 1973; Friedl and Ellis, 1974; Roberts and Rawling, 1974; Sud et al, 1975; Ellis and Starmer, 1978; De Vore, 1980; Floris and Vona, 1980; Kashyap, 1980; Roberts, 1980).

The application of the present data to the marital isonymy model has been avoided in consideration of one of the main assumptions of the model, which is uniform consanguinity through both the paternal and maternal lines. This factor will be discussed in the next section.

6.3.2 Consanguinity in Iran

The three dominant traits of nuptiality in Iranian society are generality, precocity and consanguinity. These are interrelated and control conjugal conditions. Generality is more pronounced in the females, and the proportion of female celibates (11.6%) is smaller than the male counterpart (27.5%) (Le Population de l'Iran, 1974). In terms of precocity and early marriage, young girls are engaged from birth and married at puberty, therefore age at marriage is low. Consanguinity and preferential marriages are very characteristic of Iranian family life; the reasons are religious, tradition, the kinship structure, socio-economic and geographic factors.

In general these traits are more dominant in the rural area where contact and influence from outside has been less, and adherence to traditional beliefs and customs has not changed. As demonstrated in Chapter Three, both generality (proportions married) and early marriage are more pronounced in the rural areas, and statistical studies carried out in Iran have revealed that the extent of consanguinity is invariably higher in the rural areas (Le Population de l'Iran, 1974; Nehaptian and Khazaneh, 1976).

Tables 6.19 - 6.22 present some figures on the extent of related and consanguineous marriages in Iran (rural and city),

Table 6.19 PERCENTAGE OF CONSANGUINEOUS MARRIAGES IN IRAN

Area	Percent
Four rural districts	32.8
Villages in the North	31.5
Tehran suburbs	29.2
Tehran city	25.1

Table 6.20 DIFFERENT TYPES OF REGIONAL ENDOGAMY IN IRAN

	Four rural Districts	A village in the North	Suburbs of Tehran
In the same village			
Males	82.9%	80.1%	-
Females	66.4	56.4	4.0
In the same district			
Males	13.6	5.1	-
Females	29.0	20.0	-

Source: Population de L'Iran (1974)

and the distribution of the different types of related marriages. From these studies it is observed that the proportion of related marriages is more frequent in the rural areas, and according to Nehaptian and Khazaneh (1976), more than 35% of all marriages in the rural areas are related, while in the urban areas this figure is less than thirty percent. The reasons for the differential rates are varied and interrelated. The sedentary subsistence economy of the rural inhabitants, in addition to their geographic isolation, have been influential factors in limiting the choice of mates, and thus restricting marriages to within the same natal and residential locality or to neighboring villages. This is further substantiated by comparison of the place of residence of spouses before marriage in different regions (Table 6.20).

In Iran parallel cousin marriages, ie the the marriage of the descendants of two brothers or two sisters, is more frequent than cross-cousin marriages, ie the children of a brother marrying those of a sister. In general, in both the rural and urban areas, cousin marriages (particularly union with the daughter or son of a paternal uncle) are more frequent and highly prescribed. From the tables presented, it is observed that the proportion of marriages contracted in the paternal family line is more pronounced in the rural areas, than in the cities. Primarily according to tradition it is usually the females who move to the husbands' localities on marriage, and therefore become resident in other villages. In such conditions, the children will have more contact with the paternal relatives, and this is further enforced by two

Table 6.21

DISTRIBUTION OF DIFFERENT TYPES OF CONSANGUINEOUS MARRIAGES

Type of relation	Tehran	Torbat (rural)
Daughter with paternal uncle	25.9	32.5
Daughter with paternal aunt	10.9	19.3
Daughter with paternal relative	9.4	18.7
Total	46.2	61.5
Daughter of maternal uncle	21.0	12.5
Daughter of maternal aunt	20.1	18.2
Daughter of maternal relative	12.7	7.8
Total	53.8	38.5
Grand Total	100.0	100.0

Source: Population de L'Iran (1974)

Table 6.22

DISTRIBUTION OF MARRIAGE RELATIONS OF WIVES WITH HUSBANDS

Type of relation	City	Rural
Son of paternal uncle	7.54	10.9
Son of paternal aunt	4.01	4.14
Son of maternal uncle	2.42	3.38
Son of maternal aunt	4.14	3.71
Other relatives	11.47	13.36
Unrelated	70.42	64.51
Total	100.00	100.00

Source: Nehaptian and Khazaneh (1976)

other factors: geographic isolation and restriction of movement, and secondly the patriarchal system of family life, ie the father's decision on the offspring's marriage. This latter factor is further enforced by the fact that the children marry at an early age and are invariably dependent on the parents for subsistence and financial assistance. These factors compel and necessitate the union of related individuals and further circumscribe the type of relations.

In the urban areas the dissimilarity between matrilateral and patrilateral marriages is smaller, due to increased population density, contact, accessibility, education and departure from traditions. Table 6.23 presents some figures on the association between population size and the frequency of related marriages. It is observed that primarily in large cities which have been more influenced by migration from the rural areas, traditional customs also prevail at higher frequencies. Studies on migration have revealed that rural people usually migrate to smaller towns but are later attracted to more urban centres, therefore the proportion of related unions are found to be higher in the latter areas (Nehaptian and Khazaneh, 1976). In the rural areas, there is no significant difference between the first three types of localities, but in the very small settlements where number of households are few the proportion of related marriages exceeds forty five percent.

Without doubt, modernization and industrialization, in addition to more efficient transport systems, have altered both the demographic structure and composition of the population,

Table 6.23

PERCENTAGE DISTRIBUTION OF RELATED MARRIAGES BY POPULATION SIZE

REGIONS	TYPES OF MARRIAGES		
URBAN	Unrelated	Related	Daughter/Son of paternal uncle
1,000,000 +	71.65	38.35	5.33
200,000 - 1,000,000	60.75	39.25	10.55
100,000 - 200,000	75.36	24.64	3.49
25,000 - 100,000	74.29	25.71	5.37
5,000 - 25,000	60.11	39.89	11.90
RURAL			
1,500 +	62.62	37.38	10.54
500 - 1,499	67.49	32.51	9.06
200 - 499	65.39	34.61	10.52
200 or less	54.80	45.20	16.07

Source: Nehaptian and Khazaneh (1976)

in addition to the behavioural attributes of the population in terms of subsistence patterns and kinship structure. More contact between the rural and urban areas have been conducive to more mobility, higher exogamy and consequently diminishing consanguinity. It is necessary to emphasize that the rural areas have not been affected by these factors in a uniform way. Factors such as the extent of geographic isolation, topography, altitude, vicinity to urban areas and ethnic and linguistic proscriptions on marriage must be borne in mind. Even within rural society, Ajami (1976) found social stratification with which he also associated differential demographic structure.

No indices of consanguinity per-se are available for the shahrestans, dehestans or villages in Iran, but it is speculated to a large extent that due to the factors mentioned above, and also the results obtained from the migration analysis which indicated low range of movement and small population sizes, inbreeding coefficients must be quite high, although inbreeding would vary according to the nature of the rural area.

It would be extremely useful to investigate inbreeding coefficients in villages or clusters of villages situated in the more isolated regions , ie in the highlands, where some of the descendants of the ancestral inhabitants of Mazandaran reside, in addition to the non-indigenous Kurds and Laks, who belong to the sunni sect of Islam and are ethnically alien to the Caspian territory and constitute separate founder populations.

6.4 SUMMARY

The interesting aspect of the various methods of analysis in this chapter has been the concordance in the results obtained. In general, both models of migration, whether based on parental mobility or surname flow, have revealed some points on the population structure of Sh. Nowshahr. The pattern of clustering of the dehestans, and the bi-division of the total area almost invariably on either side of the Chalous River, reflects the historical structure of settlements and migration. Unfortunately documents pertaining to the historical demography of the Caspian area are extremely few and fragmentary, and thus it is impossible to verify the results obtained. However, within each division smaller clusters exist which reflect both the geographic and the ethnic/linguistic aspects of population movement. An example of the latter is the recurrent relationship observed between the dehestans of Baladeh-Kojour and Zanouss-restagh in both surname and dialect analyses.

Conclusively, the analysis on migration pattern within Shahrestan Nowshahr, ie between its subdivisions, has revealed a population that is not totally panmictic, but composed of homogeneous units of villages or clusters of villages structured by geographic and cultural aspects of the environment.

CHAPTER SEVEN

GENETIC STUDIES IN THE CASPIAN PROVINCES

7.1 BLOOD GROUP, SERUM PROTEIN AND RED CELL ENZYME POLYMORPHISM IN THE CASPIAN LITTORAL

The estimation of gene frequencies, genotypes, phenotypes and their distribution, trends and equilibrium provides more direct information on the origin of the genes in the populations, in addition to assessing the extent of their localization and isolation and deviation from panmixia.

Direct genetic survey and analysis of gene frequencies was impossible in this study, but abundant genetic information exists on the various regions of Iran, within which some pertain to the Caspian Littoral.

Bajatzadeh and Walter (1968, 1969a), observed in their study on the distribution of blood-group frequencies in Iran regional differences in the distribution of phenotypes and genes (Table 7.1). They divided Iran into six broad geographical regions: Tehran, North, Northwest, West, Central and South, and East. For the ABO and Rh systems they found good agreement between the expected and observed phenotypic frequencies, but noticed some regional differences. They also observed extensive homozygosity in P, Kell and Duffy^{a} phenotypes. The differences in the MN system between expected and observed proportions in the Northwest and specifically in the North of Iran, was attributed to restrained panmixia caused by particular

Table 7.1 Regional distribution of blood-groups, serum proteins and red cell enzymes in Iran.

		Tehran	North	Northwest	West	Central & South	East
ABO	Sample	115	73	76	110	113	78
	A_1	22.9%	16.1%	12.2%	17.5%	18.4%	26.1%
	A_2	3.4	5.9	1.9	4.6	5.5	7.6
	B	13.7	12.3	19.7	11.9	15.2	13.5
	O	60.0	65.7	66.2	66.0	60.9	52.8
MNS	Sample	113	58	66	107	109	67
	MS	15.4%	10.6%	16.3%	20.6%	20.2%	16.6%
	Ms	44.4	51.5	49.6	44.7	42.6	47.6
	NS	9.9	7.5	2.0	8.4	8.8	5.3
	Ns	30.3	30.4	32.1	26.3	28.4	30.5
Rh	Sample	113	63	68	107	109	70
	cde	32.7%	34.6%	25.3%	37.4%	35.4%	36.5%
	Cde	7.7	8.2	5.8	3.4	2.4	1.9
	cdE	2.2	3.7	0.0	2.3	0.0	0.0
	CDe	36.9	36.5	44.9	41.8	45.7	47.3
	CDE	2.7	1.3	1.5	1.0	3.3	2.9
	cDE	7.2	4.2	12.7	6.5	4.3	4.0
Hp	Sample	400	179	250	313	245	179
	Hp^1	32.4%	31.0%	27.6%	28.2%	26.3%	24.9%
	Hp^2	67.6	69.0	72.4	71.8	73.7	75.1
Gc	Sample	385	177	245	308	238	178
	Gc^1	62.1%	65.2%	64.6%	67.8%	65.7%	66.8%
	Gc^2	37.9	34.8	35.4	32.2	34.3	33.2
Gm	Sample	374	169	233	300	231	173
	Gm^1	18.5%	25.4%	20.9%	22.1%	19.5%	18.4%
	$Gm^{1,2}$	5.6	7.1	7.6	8.2	7.6	8.1
	$Gm^{1,5}$	7.6	0.0	0.0	0.0	0.0	0.0
	Gm^5	68.3	67.5	71.5	69.7	72.9	73.5

		Tehran		North		Northwest		West		Central & South		East	
P	P+	71	63.4%	35	60.0%	46	71.0%	73	68.9%	73	68.9%	46	70.0%
	P-	41	36.6	23	40.0	19	29.0	33	31.1	33	31.1	20	30.0
	Total	112	100.0%	58	100.0%	65	100.0%	106	100.0%	106	100.0%	66	100.0%
	p^P	0.395		0.368		0.461		0.442		0.442		0.452	
K	K+	10	9.1%	4	6.9%	7	10.9%	2	1.9%	9	8.5%	1	1.5%
	K-	100	90.9	54	93.1	57	87.1	101	98.1	97	91.5	65	98.5
	Total	110	100.0%	58	100.0%	64	100.0%	103	100.0%	106	100.0%	66	100.0%
	p^K	0.047		0.035		0.056		0.010		0.043		0.008	
Fy(a)	Fy(a)+	60	65.2%	44	78.6%	46	78.0%	68	71.6%	59	62.1%	41	66.1%
	Fy(a)-	32	34.8	12	21.4	13	22.0	27	28.4	36	37.9	21	33.9
	Total	92	100.0%	56	100.0%	59	100.0%	95	100.0%	95	100.0%	62	100.0%
	Fy^a	0.410		0.538		0.531		0.467		0.384		0.418	
Inv	Inv(1)	98	27.7%	48	28.7%	56	24.7%	64	22.4%	44	19.7%	45	26.8%
	Inv(-1)	256	72.3	119	71.3	171	75.3	222	77.6	179	80.3	123	73.2
	Total	354	100.0%	167	100.0%	227	100.0%	286	100.0%	223	100.0%	168	100.0%

Source: M. Bajatzadeh and H. Walter (1969)

Table 7.2

SANGHVI-DISTANCES

	Tehran	North	North West	West	Central & South	East
Tehran	-	.66	.84	.68	.68	.79
North		-	.76	.57	.75	.79
Northwest			-	.73	.77	.87
West				-	.48	.54
Central & South					-	.45
East						-

Source: M. Bajatzadeh and H. Walter (1969) geographical and sociological conditions. The frequency of haptoglobin phenotypes and genes showed variation in their distribution, with higher Hp^2 gene frequencies in the eastern part of Iran. In addition, deviations from Hardy-Weinberg proportions were also observed in Tehran, North, Northwest and West, with surpluses of homozygous Hp^{1-1} and Hp^{2-2}. The Gc phenotypes and genes were not found to be heterogeneous regionally, but North and East Iran showed differences between the observed and expected proportions. No differences for the Gm gene in the six regions were observed.

In order to distinguish any marked regional or ethnic genetic differences within the country, they applied Sanghvi's Distance test, which showed some regional dissimilarities in the gene distribution, specifically for the Kurds in the Northwest who showed the largest genetic distance from the rest of the population (Table 7.2). In general, they assessed no significant genetic heterogeneity among the six divisions, and Kirk et al (1977) attributed this to their sampling technique, in which each of their regions constituted large areas consisting of various ethnic groups, and therefore the detection of regional heterogeneity was inhibited.

A more extensive serological study on the Caspian Littoral was carried out by Kirk et al (1977) as part of an epidemiological survey of esophageous cancer (Table 7.3 - 7.5). They divided the Caspian Littoral into six regions, extending from the west to the eastern shores, by combining some of the administrative districts (Shahrestans). Their results indicated that the Caspian area was not homogeneous geographically and

Table 7.3 Phenotypes and gene frequencies for blood-groups, serum proteins and red cell enzymes in the 6 Caspian regions

SYSTEM	AREA 1		AREA 2		AREA 3	
ABO						
A_1	57	36.5%	16	37.2%	18	33.9%
A_2	6	3.9	3	7.0	0	0.0
B	37	23.7	13	30.2	7	13.2
A_1B	10	6.4	2	4.7	2	3.8
A_2B	2	1.3	0	0.0	1	1.9
O	44	28.2	9	20.9	25	47.2
Total	156	100.0%	43	100.0%	53	100.0%
A_1	24.7%		24.3%		21.1%	
A_2	3.6		5.0		1.2	
B	17.3		19.9		9.9	
O	54.4		50.8		67.8	
	100.0%		100.0%		100.0%	
Rh						
Rh+	134	93.7%	37	86.1%	51	96.2%
Rh-	9	6.3	6	13.9	2	3.8
Total	143	100.0%	43	100.0%	53	100.0%
Rh	74.9%		62.6%		80.6%	
rh	25.1		37.4		19.4	
	100.0%		100.0%		100.0%	
Se						
Sec.	83	54.3%	25	52.1%	22	50.0%
Non-sec.	70	45.7	23	47.9	22	50.0
Total	153	100.0%	48	100.0%	44	100.0%
Se	32.4%		30.8%		29.3%	
se	67.6		69.2		70.7	
	100.0%		100.0%		100.0%	
Hp						
1-1	5	3.3%	0	0.0%	2	3.8%
2-1	56	36.6	11	28.9	17	32.7
2-2	91	59.5	27	71.1	33	63.5
"O"	1	0.6	0	0.0	0	0.0
Total	153	100.0%	38	100.0%	52	100.0%
Hp^1	21.7%		14.5%		20.2%	
Hp^2	78.3		85.5		79.8	
	100.0%		100.0%		100.0%	
6PGD						
A	139	89.7%	47	92.2%	51	96.2%
AC	16*	10.3	4	7.8	2	3.8
Total	155	100.0%	51	100.0%	53	100.0%
PGD^A	94.8%		96.1%		98.1%	
PGD^C	5.2		3.9		1.9	
	100.0%		100.0%		100.0%	

Table 7.3 (continued)

SYSTEM	AREA 1		AREA 2		AREA 3	
AK						
1-1	140	90.3%	38	86.4%	51	96.2%
2-1	15	9.7	6	13.6	2	3.8
2-2	0	0.0	0	0.0	0	0.0
Total	155	100.0%	44	100.0%	53	100.0%
AK^1	95.2%		93.2%		98.1%	
AK^2	4.8		6.8		1.9	
	100.0%		100.0%		100.0%	
AcPh						
A	24	15.5%	8	18.2%	7	13.2%
AB	65	41.9	24	54.5	26	49.1
B	59	38.1	11	25.0	20	37.7
AC	2	1.3	0	0.0	0	0.0
BC	5	3.2	1	2.3	0	0.0
Total	155	100.0%	51	100.0%	53	100.0%
p^a	37.1%		45.5%		37.7%	
p^b	60.6		53.4		62.3	
p^c	2.3		1.1		0.0	
	100.0%		100.0%		100.0%	
G6PD						
Males B+	81	98.8%	18	85.7%	23	82.1%
B-	1	1.2	3	14.3	5	17.9
Total	82	100.0%	21	100.0%	28	100.0%
Males Gd+	98.8%		85.7%		82.1%	
Gd-	1.2		14.3		17.9	
	100.0%		100.0%		100.0%	
Females B+	71	97.2%	22	95.7%	24	96.0%
B int.	1	1.4	1	4.3	0	0.0
B-	1	1.4	0	0.0	1	4.0
Total	73	100.0%	23	100.0%	25	100.0%
Females Gd+	97.9%		97.8%		96.0%	
Gd-	2.1		2.2		4.0	
	100.0%		100.0%		100.0%	
ADA						
1-1	125	80.7%	38	86.4%	37	69.8%
2-1	27	17.4	6	13.6	16	30.2
2-2	3	1.9	0	0.0	0	0.0
Total	155	100.0%	44	100.0%	53	100.0%
ADA^1	89.4%		93.2%		84.9%	
ADA^2	10.6		6.8		15.1	
	100.0%		100.0%		100.0%	
PGM_1						
1-1	49	31.6%	20	45.5%	18	33.9%
2-1	88	56.8	22	50.0	25	47.2
2-2	18	11.6	2	4.5	9	17.0
6-1	0	0.0	0	0.0	1	1.9
Total	155	100.0%	44	100.0%	53	100.0%
PGM_1^1	60.0%		70.5%		58.5%	
PGM_1^2	40.0		29.5		40.6	
PGM_1^6	0.0		0.0		0.9	
	100.0%		100.0%		100.0%	

Table 7.3 (continued.)

SYSTEM	AREA 1		AREA 2		AREA 3	
GPT						
1-1	47	30.3%	9	20.5%	19	35.8%
2-1	73	47.1	26	59.1	26	49.1
2-2	35	22.6	9	20.4	8	15.1
Total	155	100.0%	44	100.0%	53	100.0%
GPT^1	53.9%		50.0%		60.4%	
GPT^2	46.1		50.0		39.6	
	100.0%		100.0%		100.0%	

SYSTEM	AREA 4		AREA 5		AREA 6	
ABO						
A_1	18	25.7%	16	18.4%	18	36.7%
A_2	3	4.3	2	2.3	0	0.0
B	19	27.2	15	17.2	10	20.4
A_1 B	4	5.7	4	4.6	0	0.0
A_2 B	0	0.0	1	1.2	1	2.0
O	26	37.1	49	56.3	20	40.8
Total	70	100.0%	87	100.0%	49	100.0%
A_1	17.4%		12.2%		20.8%	
A_2	2.7		1.9		1.3	
B	18.2		12.2		12.1	
O	61.9		73.7		65.7	
	100.0%		100.0%		100.0%	
Rh						
Rh+	63	90.0%	66	76.7%	44	89.8%
Rh-	7	10.0	20	23.3	5	10.2
Total	70	100.0%	86	100.0%	49	100.0%
Rh	68.4%		51.8%		68.1%	
rh	31.6		48.2		31.9	
	100.0%		100.0%		100.0%	
Se						
Sec.	50	64.1%	45	51.1%	35	68.6%
Non-sec.	28	35.9	43	48.9	16	31.4
Total	78	100.0%	88	100.0%	51	100.0%
Se	40.1%		30.1%		44.0%	
se	59.9		69.9		56.0	
	100.0%		100.0%		100.0%	
Hp						
1-1	1	1.6%	3	3.6%	1	1.7%
2-1	24	39.3	30	35.7	28	46.7
2-2	36	59.0	48	57.1	31	51.6
"O"	0	0.0	3	3.6	0	0.0
Total	61	100.0%	84	100.0%	60	100.0%
Hp^1	21.3%		22.2%		25.0%	
Hp^2	78.7		77.8		75.0	
	100.0%		100.0%		100.0%	

Table 7.3 (continued.)

SYSTEM	AREA 4		AREA 5		AREA 6	
6PGD						
A	60	93.7%	84	97.7%	61	100.0%
AC	4	6.3	2	2.3	0	0.0
Total	64	100.0%	86	100.0%	61	100.0%
PGD^A	96.9%		98.8%		100.0%	
PGD^c	3.1		1.2		0.0	
	100.0%		100.0%		100.0%	
AK						
1-1	58	90.6%	70	81.4%	55	90.2%
2-1	5	7.8	16	18.6	6	9.8
2-2	1	1.6	0	0.0	0	0.0
Total	64	100.0%	86	100.0%	61	100.0%
AK^1	94.5%		90.7%		95.1%	
AK^2	5.5		9.3		4.9	
	100.0%		100.0%		100.0%	
AcPh						
A	3	4.7%	8	9.3%	5	8.2%
AB	31	48.4	44	51.1	23	37.7
B	30	46.9	30	34.9	32	52.5
AC	0	0.0	1	1.2	0	0.0
BC	0	0.0	3	3.5	1	1.6
Total	64	100.0%	86	100.0%	61	100.0%
p^a	28.9%		35.5%		27.1%	
p^b	71.1		62.2		72.1	
p^c	0.0		2.3		0.8	
	100.0%		100.0%		100.0%	
G6PD						
Males B+	28	87.5%	36	83.7%	29	93.5%
B-	4	12.5	7	16.3	2	6.5
Total	32	100.0%	43	100.0%	31	100.0%
Males Gd+	87.5%		83.7%		93.5%	
Gd-	12.5		16.3		6.5	
	100.0%		100.0%		100.0%	
Females B+	28	90.3%	40	93.0%	29	96.7%
B int.	2	6.5	2	4.7	1	3.3
B-	1	3.2	1	2.3	0	0.0
Total	31	100.0%	43	100.0%	30	100.0%
Females Gd+	93.5%		95.3%		98.3%	
Gd-	6.5		4.7		1.7	
	100.0%		100.0%		100.0%	
ADA						
1-1	43	67.2%	67	77.9%	51	83.6%
2-1	19	29.7	16	18.6	10	16.4
2-2	2	3.1	3	3.5	0	0.0
Total	64	100.0%	86	100.0%	61	100.0%
ADA^1	82.0%		87.2%		91.8%	
ADA^2	18.0		12.8		8.2	
	100.0%		100.0%		100.0%	

Table 7.3 (continued.)

SYSTEM	AREA 4		AREA 5		AREA 6	
PGM						
1-1	36	56.2%	34	39.5%	27	44.3%
2-1	22	34.4	40	46.5	24	39.3
2-2	6	9.4	11	12.8	10	16.4
6-1	0	0.0	1	1.2	0	0.0
Total	64	100.0%	86	100.0%	61	100.0%
PGM^{1}_{1}	73.4%		63.4%		63.9%	
PGM^{2}_{1}	26.6		36.0		36.1	
PGM^{6}_{1}	0.0		0.6		0.0	
	100.0%		100.0%		100.0%	
GPT						
1-1	23	35.9%	31	36.1%	28	45.9%
2-1	32	50.0	37	43.0	19	31.2
2-2	9	14.1	18	20.9	14	22.9
Total	64	100.0%	86	100.0%	61	100.0%
GPT^{1}	60.9%		57.6%		61.5%	
GPT^{2}	39.1		42.4		38.5	
	100.0%		100.0%		100.0%	

* Includes one AR

+ Includes one R allele

' Includes one 8-1

" Includes one 8 allele

Area 1: Gonbad

Area 2: northern Gorgan

Area 3: southern Gorgan, Behshahr, Sari

Area 4: Babol, Shahi, Amol

Area 5: Shahsavar, Rudsar, Rudbar, Rasht, Langarud, Bandar-Pahlavi

Area 6: Tavalesh, Astara

Source: R.L. Kirk et al. (1977)

Table 7.4

SYSTEMS IN WHICH POLYMORPHIC VARIATION WAS NOT OBSERVED

System	Number tested
Transferrin	447
Albumin	448
Caeruloplasmin	448
Protease inhibitor	412
Haemoglobin	463
Diaphorase	463
Malate dehydrogenase	463
Phosphoglucomutase (locus 2)	463
Superoxide dismutase	463
Lactate dehydrogenase	463
Isocitrate dehydrogenase	463
Peptidase A	463
Paptidase B	463
Peptidase C	463
Peptidase D	463
Phosphohexose isomerase	463
Phosphoglycerate kinase	463

Source: R.L. Kirk et al. (1977)

Table 7.5

"RARE" VARIANTS IN THE CASPIAN LITTORAL DETECTED ELECTROPHORETICALLY

System	Variant phenotypes and locality ( )
Hb	1 AD (1); 1 DD (5)
Diaphorase*	2 2-1 (5)
MDH	1 5-1 (5)
PGM_2^9	4 9-1 (1)
Superoxide dismutase	4 2-1 (1)
LDH	1 Calcutta-1 (2)
Peptidase A*	3 2-1 (1); 1 2-2 (1)
Peptidase B*	1 2-1 (1); 1 3-1 (4); 1 2-1 (6); 1 3-1 (6)
Peptidase C*	1 3-1 (6)
Peptidase D*	2 3-1 (4); 1 3-1 (5)
PHI	3 3-1 (1); 1 3-1 (3); 3 3-1 (5)
Caeruloplasmin	1 BC_{nh} (1); 1 AB (1); 2 BC_{nh} (5); 1 AB (5); 1 BC (5)
Protease inhibitor	1 MS (6); 1 MS (4); 1 FM (4)

* Designations based on comparison with published descriptions only.

Source: R.L. Kirk et al. (1977)

ethnically, and was genetically heterogeneous.

The ABO blood-group frequencies corresponded closely to the Bajatzadeh and Walter (1969a) region of North of Iran, and was also within the ranges of phenotypes and gene frequencies generally found for Iranians. They noticed marked variation between the six regions for the Rh negative gene, with a mean value of eleven percent.

Of the serum proteins, only the Haptoglobin gene was found to be polymorphic: the Hp^2 allele showed a relatively high frequency, and only four individuals showed the HpO gene, of which three occurred in the Persian-speaking region (South and East of Gilan and West of Mazandaran), and this was attributed to the prevalence of tropical diseases which are more frequent and common in this section.

For the red-cell enzymes, six were found to be polymorphic and showed regional variation, and the hemoglobins and other systems were either monomorphic or revealed the presence of sporadic variants. The 6PGD (6-Phosphogluconate-dehydrogenase) system showed an apparent cline for the PGD^c allele declining from 5.2% in the East to 0.0% in the West. G6PD (glucose-6-phosphogluconate dehydrogenase) deficiency in their study ranged from 1.2% to 17.9% for males, and 1.7% to 6.4% for females, with a marked difference in frequencies between low values in the most eastern and western regions and high values in between; these high values were attributed to the past incidence of malaria. Their results on G6PD deficiency also corresponded to earlier work by Beaconsfield and Rainsbury (1968) and Miyashita et al (1975), in support of the theory that G6PD deficient individuals are protected against malaria infection. Their analysis for the hemoglobinopathies showed one heterozygote for HbD and one homozygous for HbDD.

Using Morton et al's (1971) genetic distance analysis (Table 7.6), they observed that the six regions were genetically distinct,with no correlation between geographic location and genetic distance, and attributed the heterozygosity to ethnic origin and dispersion.

They further analyzed the data according to linguistic affiliations to assess genetic relationship (Table 7.7): the Turkish dialect being spoken in East Azarbaijan and north of Gilan; Persian dialects (Mazandarani and Gilaki) in Gilan and Mazandaran; Turkoman in east Mazandaran, Gorgan and northern Khorassan. It is not indicated whether any significant heterogeneity in language and dialect affiliations exist, but in general they argue for regional variation in ethnicity and language in the Caspian area.

Ohkura et al (1984) carried out an extensive serological study on the two predominant population of the Caspian, the Mazandarani and the Gilani as part of their survey on the distribution of the 'Acatalasemia' gene. This gene is mainly distributed in Asian populations and has Mongoloid origin. Their choice of the area was mainly due to the fact that the Caspian region has been greatly influenced by historical immigrations from Central Asia, with a preponderance of Mongoloid types in the north-east of the Caspian, Mazandaran, Gorgan and parts of Khorassan, and with Caucasoid influence mainly in the north-west of the Caspian.

Table 7.6

MORTON'S θ VALUES FOR GENETIC DISTANCES BETWEEN SIX AREAS IN THE CASPIAN LITTORAL

Area	Area 2	Area 3	Area 4	Area 5	Area 6
1	0.007	0.008	0.007	0.012	0.006
2		0.010	0.007	0.007	0.010
3			0.007	0.013	0.008
4				0.008	0.003
5					0.009
6					

Source: R.L. Kirk et al. (1977)

Table 7.7

PERCENTAGE GENE FREQUENCIES FOR BLOOD, SERUM PROTEIN AND RED CELL ENZYME SYSTEMS FOR THREE LINGUISTIC GROUPS IN THE CASPIAN LITTORAL

System		Turkoman	Turkic	Persian
Blood groups				
ABO	A_1	24.9	23.8	16.8
	A_2	4.0	0.0	1.7
	B	17.6	11.1	13.6
	O	53.5	65.1	67.9
Rh	Rh	75.0	61.6	63.2
	rh	25.0	38.4	36.8
Se	Se	32.6	42.3	33.3
	se	67.4	57.7	66.7
Serum proteins				
Hp	Hp^1	21.7	20.7	21.1
	Hp^2	78.3	79.3	78.9
Red cell enzymes				
6GPD	PGD^A	94.9	99.2	97.6
	PGD^C	4.8	0.8	2.4
	PGD^B	0.3	0.0	0.0
AK	AK^1	95.2	96.9	93.5
	AK^2	4.8	3.1	6.5
AcPh	p^b	60.6	65.6	63.9
	p^a	37.1	34.4	35.0
	p^c	2.3	0.0	1.1
G6PD Male	Gd+	98.8	94.4	83.6
	Gd-	1.2	5.6	16.4
G6PD Female	Gd+	97.9	100.0	95.2
	Gd-	2.1	0.0	4.8
ADA	ADA^1	89.4	92.2	85.6
	ADA^2	10.3	7.8	14.4
	ADA^8	0.3	0.0	0.0
PGM	PGM^1_1	60.0	70.3	66.0
	PGM^2_1	40.0	29.7	33.8
	PGM^6_1	0.0	0.0	0.2
GPT	GPT^1	53.9	57.8	58.5
	GPT^2	46.1	42.2	41.5

Source: R.L. Kirk et al. (1977)

In their study (Table 7.8) they observed no significant differences in the frequency of the 'acatalasemia' gene in Mazandaran and Gilan, but the frequencies were high in both populations, indicating influence by the successive gene flow from Asia and Central Asian populations. They postulate that these two populations served as a borderline between Mongolian and European infiltration.

In the blood-groups, they noticed significant differences between the two populations in phenotypic frequencies of Rh, Duffy and Kell: for the Rh system, the Mazandarani showed a higher frequency of CDe, cDe and lower frequencies for C^wDe and CDE, and also for Fy^a and K. Both populations showed low frquencies of the A gene 0.17 and B gene 0.16, and high frequencies of the O gene 0.68, M gene 0.66 and S gene 0.38. The frequency of P_1 was 0.42 on average, and for the Lu^a gene it was .005 in Gilan, which was within the range of those in Asians. The Di^a gene, which is considered essentially a Mongolian character, was present in one individual among 154 Mazandaranis and not found in Gilanis.

For the G6PD system, all specimens showed the B phenotype, and eleven cases of G6PD deficient individuals were found (males 8.6% and females 2.7%). The frequency of the gene was found to be similar to those of Moslems in Iran found by Bowman and Walter (1961b), Bowman and Ronaghy (1967) and Kirk et al (1977). The frequency of PGM (phospho-glucomutase) was found to be between the Mongoloid population and those of South and South-east Europe. The P^c (acid phosphatase) gene was observed, but at a low frequency, indicating the influence of

Table 7.8 Phenotypes and gene frequencies for blood, serum protein and red cell enzyme groups in Mazandaranian and Guilanians in Iran.

SYSTEM	MAZANDARANIANS		GUILANIANS		TOTAL	
CATALASE						
Screened, n	1043		993		2036	
Hypocatalesemics, n	7		5		12	
Hypocatalesemics, %	0.671		0.503		0.589	
Gene Frequency	0.0034		0.0025		0.0029	
ABO						
O	196	44.2%	133	46.5%	329	45.1%
A_1	87	19.6	62	21.7	149	20.4
A_2	27	6.1	15	5.2	42	5.1
B	114	25.7	63	22.0	177	24.3
A_1B	12	2.7	7	2.5	19	2.6
A_2B	7	1.6	6	2.1	13	1.8
Total	443	100.0%	286	100.0%	729	100.0%
O	0.677		0.699		0.677	
A_1	0.120		0.130		0.124	
A_2	0.039		0.037		0.042	
B	0.164		0.143		0.156	
MNSs						
MSS	40	11.0%	13	8.1%	53	10.1%
MSs	70	19.3	28	17.5	98	18.8
Mss	50	13.8	27	16.9	77	14.8
MNSS	20	5.5	11	6.9	31	5.9
MNSs	69	19.1	39	24.4	108	20.7
MNss	74	20.4	26	16.2	100	19.2
NSS	2	0.6	0	0.0	2	0.4
NSs	16	4.4	6	3.7	22	4.2
Nss	21	5.8	10	6.3	31	5.9
Total	362	100.0%	160	100.0%	522	100.0%
MS	0.303		0.283		0.298	
Ms	0.364		0.380		0.368	
NS	0.082		0.095		0.085	
Ns	0.251		0.242		0.249	
Rh						
ccdee	29	7.1%	20	10.2%	49	8.1%
ccDee	9	2.2	2	1.0	11	1.8
ccDEE	9	2.2	7	3.6	16	2.6
ccDEe	46	11.3	27	13.7	73	12.1
Ccdee	8	2.0	4	2.0	12	2.0
CcDee	135	33.1	43	21.8	178	29.4
CcDEe	72	17.6	40	20.3	112	18.5
CCDee	97	23.8	42	21.3	139	23.0
CCdee	0	0.0	0	0.0	0	0.0
CcDEE	0	0.0	1	0.5	1	0.2
CCDEe	1	0.2	3	1.5	4	0.7
C^wcDee	0	0.0	5	2.5	5	0.8
C^wcDEe	0	0.0	0	0.0	0	0.0
C^wCDee	2	0.5	3	1.5	5	0.8
C^wCDEe	0	0.0	0	0.0	0	0.0
Total	408	100.0%	197	100.0%	605	100.0%
cde	0.284		0.304		0.292	
Cde	0.033		0.031		0.032	
cDe	0.041		0.015		0.031	
CDe	0.471		0.412		0.453	
C^wDe	0.002		0.020		0.008	
cDE	0.003		0.016		0.019	

Table 7.8 (continued)

SYSTEM	MAZANDARANIANS		GUILANIANS		TOTAL	
P						
P_1	303	68.6%	217	63.1%	520	66.2%
P_2	139	31.4	127	36.9	266	33.8
Total	442	100.0%	344	100.0%	786	100.0%
P_1	0.439		0.392		0.418	
DUFFY						
Fy(a+)	204	66.5%	178	77.4%	382	71.1%
Fy(a-)	103	33.5	52	22.6	155	28.9
Total	307	100.0%	230	100.0%	537	100.0%
Fy^a	0.421		0.525		0.463	
KELL						
K+k-	0	0.0%	1	0.6%	1	0.2%
K+k+	9	3.2	17	9.6	26	5.7
K-k+	273	96.8	159	89.8	432	94.1
Total	282	100.0%	177	100.0%	459	100.0%
K	0.016		0.051		0.029	
DIEGO						
Di(a+b-)	0	0.0%	0	0.0%	0	0.0%
Di(a+b+)	1	0.6	0	0.0	1	0.3
Di(a-b+)	153	99.3	207	100.0	360	99.7
Total	154	100.0%	207	100.0%	361	100.0%
Di^a	0.003		0.000		0.001	
KIDD						
Jk(b+)	67	78.8%	106	71.1%	173	73.9%
Jk(b-)	18	21.2	43	28.9	61	26.1
Total	85	100.0%	149	100.0%	234	100.0%
Jk^b	0.540		0.463		0.490	
LUTHERAN						
Lu(a+)	not tested		2	0.9%		
Lu(a-)			222	99.1		
Total			224	100.0%		
Lu^a			0.005			
G6PD						
Obs.males	39		42		81	
Obs.females	53		57		110	
?	8		1		9	
Total	100		100		200	
m.Gd-	5	12.8%	2	4.8%	7	8.6%
f.Gd-	0	0.0	3	5.3	3	2.7
? Gd-	0		1		1	
Total	5	5.0%	6	6.0%	11	5.5%

SYSTEM	MAZANDARANIAN		GUILANIAN		TOTAL	
PGM$_1$						
1-1	67	59.8%	60	59.4%	127	59.6%
2-1	30	26.8	28	27.7	58	27.2
2-2	15	13.4	13	12.9	28	13.2
Total	112	100.0%	101	100.0%	213	100.0%
PGM^1	0.732		0.733		0.732	
PGM^2	0.268		0.267		0.268	
AcP$_1$						
AA	15	17.8%	8	14.8%	23	16.7%
BA	28	33.3	11	20.4	39	28.3
BB	36	42.9	34	63.0	70	50.7
CA	0	0.0	0	0.0	0	0.0
CB	5	6.0	1	1.8	6	4.3
CC	0	0.0	0	0.0	0	0.0
Total	84	100.0%	54	100.0%	138	100.0%
p^a	0.345		0.250		0.308	
p^b	0.625		0.741		0.670	
p^c	0.030		0.001		0.022	
Hp						
1-1	44	8.7%	37	7.3%	81	8.0%
2-1	201	39.6	212	41.7	413	40.6
2-2	263	51.7	259	51.0	522	51.4
Total	508	100.0%	508	100.0%	1016	100.0%
Hp^1	0.284		0.281		0.283	
Hp^2	0.716		0.719		0.717	
Tf						
BC	0	0.0%	0	0.0%	0	0.0%
CC	518	99.6	504	98.6	1022	99.1
CD	2	0.4	6	1.2	8	0.8
DD	0	0.0	1	0.2	1	0.1
Total	520	100.0%	511	100.0%	1031	100.0%
Tf^C	0.9981		0.9922		0.9951	
Tf^D	0.0019		0.0078		0.0049	
Gc						
1-1	not tested		101	56.7%		
2-1			69	38.8		
2-2			8	4.5		
Total			178	100.0%		
Gc^1			0.761			
Gc^2			0.239			

Source: K. Ohkura et al. (1984)

Caucasoids in Iran; P^c is high among Caucasians, but the relatively high frequency of the P^b allele suggested Mongoloid influence.

For the serum proteins, the Hp^2 (Haptoglobin) was closer to Mongoloids (0.65 - 0.73) than to the Caucasoids (0.58 - 0.62). The Tf (Transferrin), Tf^c was estimated as 0.995, Tf^b was not found and Tf^d was 0.0049, which is found to be relatively high since Asian populations have a relatively higher Tf^d gene frequency than the European, thus an indication of Caucasoid influence. The Gc (Group specific component) was found to be similar to the Caucasian.

In general, they observe that the gene frequencies of acatalasemia, MNSs, P, Lu, Hp and Tf are similar to the Mongoloid population, while the genes for A_1A_2BO, Rh, Fy, K, Jk, Gc are close to the Caucasian population. AcP_1 and PGM_1 wre found to be between the two, and for the Diego, G6PD and Ny^a systems they did not have any conclusive information. The authors emphasise the influence of both Mongoloid and Caucasian populations, but argue for greater influence by the former.

In general the serological and genetic surveys of the Caspian Littoral indicate regional variation in gene frequencies, and these are attributed to micro-evolutionary processes such as natural selection and genetic drift, historic immigration to the area, and the ethnic/linguistic diversities of the various populations.

The information is extremely informative and instructive for further research, specifically in factors such as the distribution of language/dialect, past migrations and origins and destinations of genes, but there are also other factors which necessarily need to be accounted for and emphasized, by identifying the section of the population which was typed and examined for blood-group and other polymorphisms, in terms of urban and rural areas; the extent of geographic and cultural (ethnic and linguistic) isolation of the populations in the more remote geographic regions of the Caspian, ie on the mountains and valleys of the Alborz ranges; the distinction between the autochtonous population and the numerous resettled groups from Azarbaijan and Kurdistan; the differential demographic structure in terms of population size and density, fertility and mortality differentials, mating patterns and the extent and range of local genetic migration.

Overlooking large areas in terms of genetic structure necessary obliterates the effects and consequences of genetic drift and deviation of gene frequencies from that expected under random mating and panmixia, and of local selection. Although genetic studies constitute direct methods of assessing the gene structure of populations, demographic and migrational attributes are also of importance for understanding the basis for the observed polymorphisms.

The observed proportions of heterozygotes and homozygotes for specific genes can either be explained by the effects of natural selection, and if selection is not geographically differential, then by the complex interaction of geo-topographical, cultural and demographic structure. Thus it would be more instructive and informative to study the genetic structure of the Caspian Littoral at smaller territorial levels where the actual Mendelian population can be delineated, and this would only be possible if a demographic survey is also undertaken which will account for the numerous factors that interact to produce the gene complex within a population and their relationship with other populations. This is in effect studying the genetic effect of dividing populations into subgroups.

7.2 BLOOD-GROUP POLYMORPHISMS, NATURAL SELECTION AND GENETIC DRIFT

Most anthropological traits are not distributed homogeneneously and show gradients in geographic distribution, related to specific environmental parameters like climate, topography, biotope, subsistence pattern, food supply, infectious diseases and social and kinship structure. The causes for the observed polymorphisms in genetic characters and serological markers and their differential regional distribution are due to evolutionary factors like migration, natural selection and genetic drift.

The function of the blood-groups are mostly attributable to immunological factors. Blood-groups reflect the differences in the antigenic-structure of human organism. The antigen-antibody system of an organism is its chief defense against foreign pathogens, and differences in this system may also lead to differential response to some diseases. Chemically and serologically the blood-group specific structure of protozoa, bacteria and various other pathogens, helminths and microorganisms are close to but not identical with those of human blood group, and thus host-antigen polymorphism has been an effective defense mechanism where a large variety of antigens are advantageous in host populations in contrast to monomorphic state (Livingstone, 1971; Mourant, 1973).

The constant exposure of populations to a disease with a high mortality rate renders selection in favour of the genetic characters in the host which increase resistance and fitness. In such situations, the favoured allele will approach fixation in the population and is maintained at a high frequency, but also kept short of complete fixation by recurrent mutation and by the influence of other selective factors which favour other gene combinations (Athreya and Coriell, 1967). Thus there is a complex interplay among several loci as the result of varied ecological and behavioural characteristics of the environment, leading to the current distribution of the various polymorphisms.

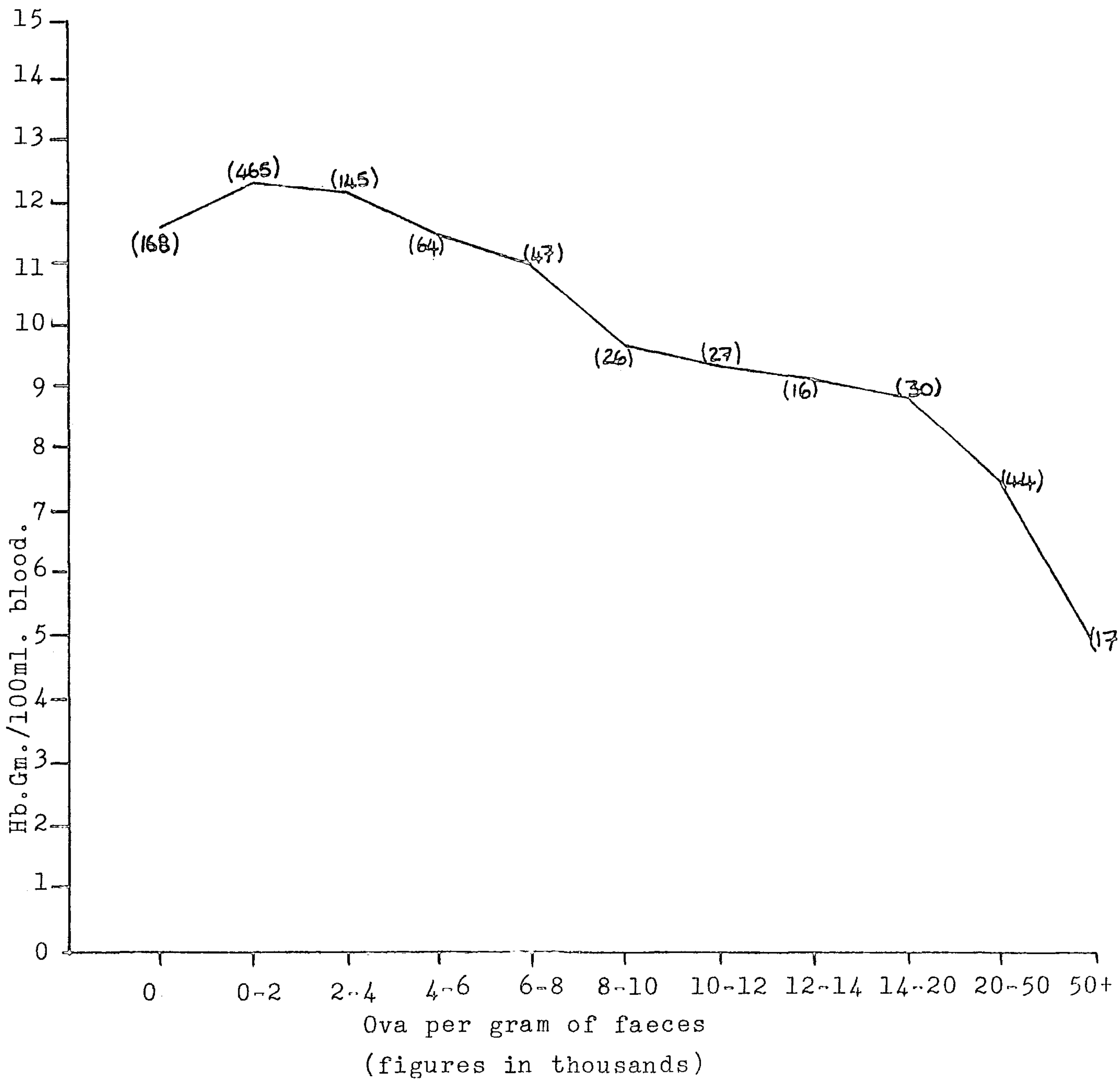
The interaction between different genes at a population level are illustrative of the important role that natural selection plays in the maintenance of the genetic load of human populations, since selection acts differentially on populations with different genetic constitutions and different ethnic and cultural backgrounds. Other than ecological and genetic (biological) factors responsible for the observed polymorphisms, other environmental factors like demographic structure, kinship pattern and consanguinity can counteract selective agents for the accumulation of certain genes.

Anemia is the most frequent disease of the Caspian Littoral, and it is primarily caused by helminthic diseases (hookworm) and iron deficiency (Amini et al, 1967). The pathlogical situation in the Caspian area is the combined result of helminthic endemicity, microbial infection, abundance of enteric worms, dietary deficiency and imbalance, precocity and consecutive pregnancies, social and tradional attributes and genetic disorders such as G6PD deficiency, abnormal hemoglobins and the incidence of favism. Sheba (1952) noticed the relationship between hookworm and anemia in Mazandarani patients, and Kajhan (1953) observed 196 cases of hookworm from a survey of 335 people, and 39 of the cases were reported as anemic (cited by Amini et al, 1967).

Amini et al (1967) observed that 46.6% of the total rural coastal population were anemic, and of these 98% showed a tendency to 'hypochromic microcytic' (iron deficiency) anemia, while the incidence in the mountain villages was only 5.5%. In their survey they observed that 75.7% of the population had hookworm, and the incidence was much higher (90 - 100%) in those aged ten years and above. Nuyken (1954) and Pouya et al (1958) were the first to observe thalassemia in patients in the east of the Caspian, inhabited by Turkomans and in the north of Iran, and reported both heterozygous and homozygous forms for the mutant hemoglobin genes; nine cases of homozygous thalassemia (0.7%) were observed by them, all of which were below ten years of age. Emami and Wadsworth (1965) attributed anemia in the west of Mazandaran to iron-deficiency.

Amini et al (1967) found a distinct relation between the severity of hookworm infection and low hemoglobin levels in all ages except for the (1-4) years age groups (Fig. 7.1). They

Figure 7.1
Relationship between hemoglobin values and severity of hookworm infection (the number of cases in each group indicated in parantheses) in the Caspian Area.



Source: Amini et al (1967)

estimated the mean hemoglobin level in the mountain people as 14.2 grams, while it was only 10.8 grams for the coastal people, and they attributed these indices to the differences in the dietary habits in the two habitats. The coastal people consume plenty of rice, which inhibits iron absorption, while the mountain people, whose diet consist of dairy products and pulses rich in iron, have a more balanced diet. The total serum protein in both populations were found to be between normal limits and was not considered as an aetiology for the iron-deficiency disease. They also observed 29.1% of G6PD deficiency, and they attributed the incidence of hemolysis in these individuals to the consumption of fava beans. A higher percentage of G6PD deficiency was found in the mountain people, in addition to a higher frequency of the Rh negative gene (30.0%), and also it showed differences in the frequencies of the ABO system from the founder population. These characteristics of the mountain people were attributed to their geographic isolation, low population sizes and the effects of inbreeding (Fig. 7.2 - 7.3).

Numerous population surveys have reported data on the high frequencies of certain mutant genes associated with spcific diseases or susceptibility to environmental factors. One of the most thoroughly studied is the association of the red blood cell defects to the past incidence of malaria (Plasmodium falciparum). Both the distributional and biochemical evidence support the theory of the higher than usual frequencies of erythrocytic defects as the result of malaria endemicity.

Glucose-6-phosphate-dehydrogenase is the first enzyme of

Figure 7.2

Percentage of G.6.P.D. Deficiency among male inhabitants of coastal and mountainous regions of the Caspian area (1966).

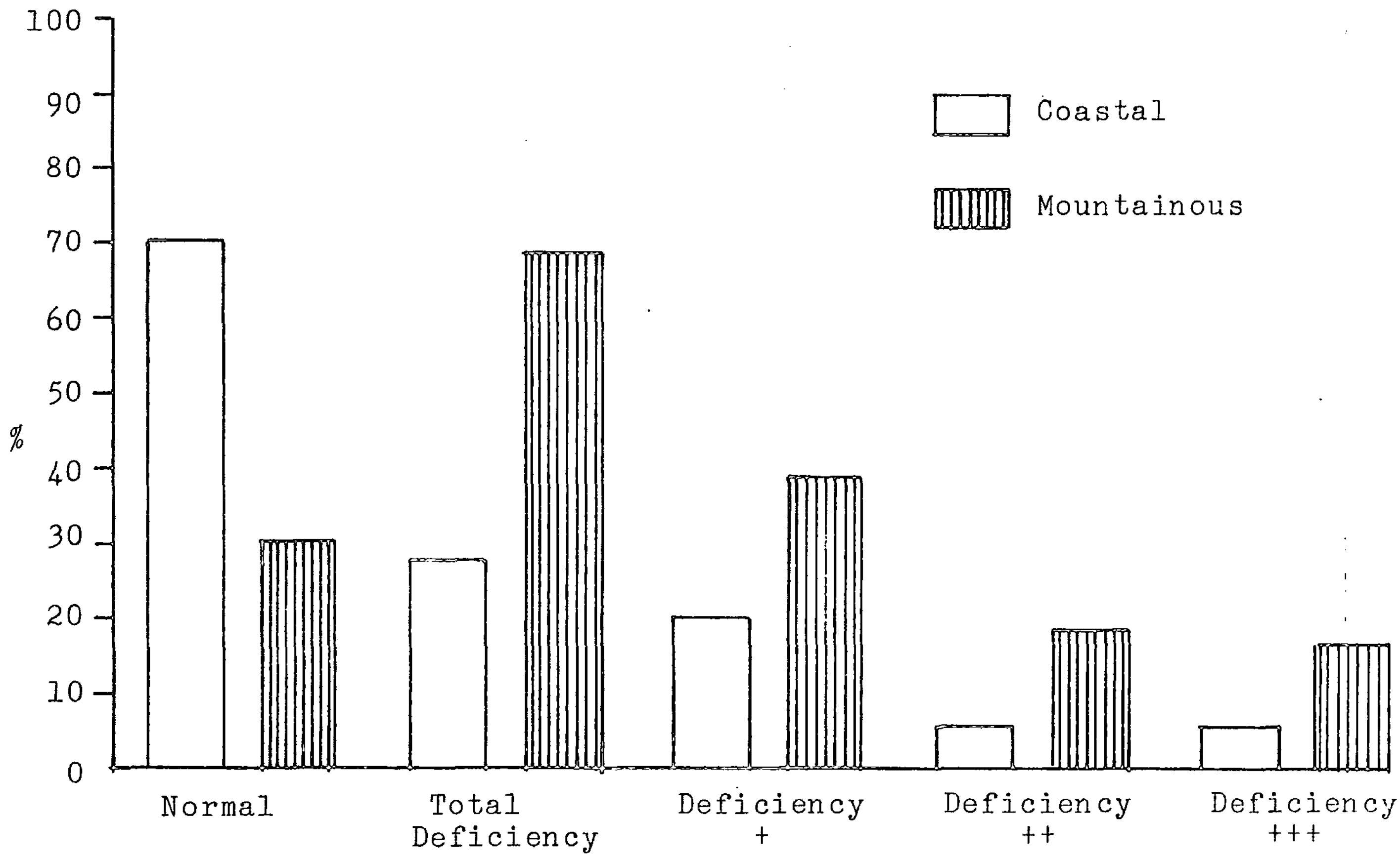
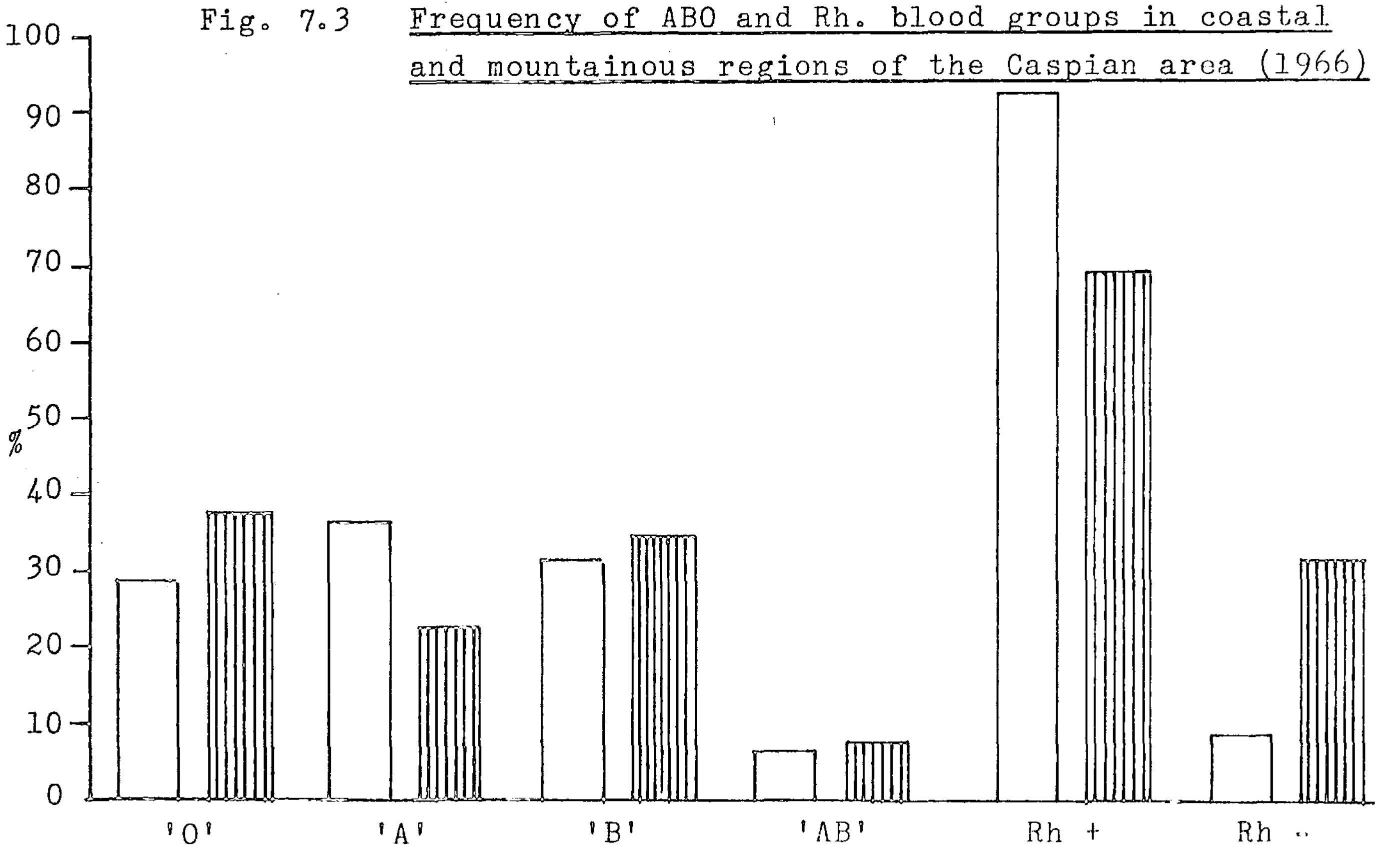


Fig. 7.3 Frequency of ABO and Rh. blood groups in coastal and mountainous regions of the Caspian area (1966)



Source: Amini et al. (1967)

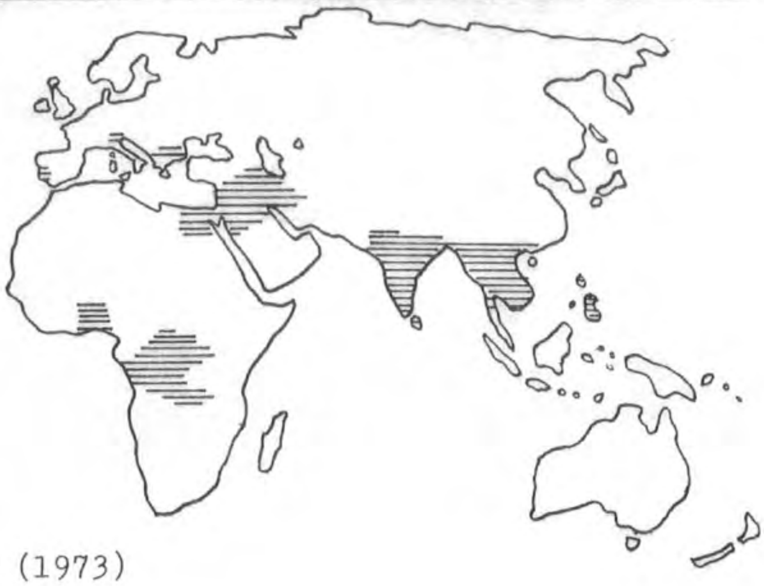
the Pentose-Phosphate-Pathway of glucose metabolism. The gene for G6PD is located on the X-chromosome, and has variable expressivity in the females due to genetic mosaicism. The two variant forms of the gene are Gd^{A} (African) and Gd^{B} (Caucasian and Asiatic), and they are distinguished on the basis of electrophoretic mobility. The two mutant forms of these genes Gd^{A-} and Gd^{B-} are characterized by low levels of enzymatic activity, although they are normal metabolizers (Beutler, 1972). G6PD deficiency is mainly caused by specific base-pair mutations, and renders the individuals susceptible to infection, red blood cell senescence and membrane deformity and consequently to hemolysis (Szeinberg, 1958).

G6PD deficiency is one of the most frequent abnormalities in sub-tropical areas, and it is widely distributed in Tropical Africa, the Mediterranean region (Sardinia, Turkey, Greece), S.W. Asia (Iran, Iraq), the Near East, Egypt, N. India and S.E. Asia (Fig. 7.4a). The highest incidence is observed in the Kurdish Jews of Iraq, at around 60-70% (Mourant, 1978). The limited geographic and ethnic distribution is explained by ethnic origin, geographic locality, altitude, consanguinity and isolation, resulting in either a balanced polymorphism or genetic drift from the founder population.

G6PD deficient individuals show severe hemolysis after ingestion of fava beans, or when given anti-malaria drugs such as Primaquine. This is due to their defective ability to respond under oxidant stress, and when challenged by exogenous oxidizing agents their already reduced GSH (Glutathione) level is further reduced to GSSG (Glutathione dissulphide), which increases the oxidant sensitivity of the cells and renders

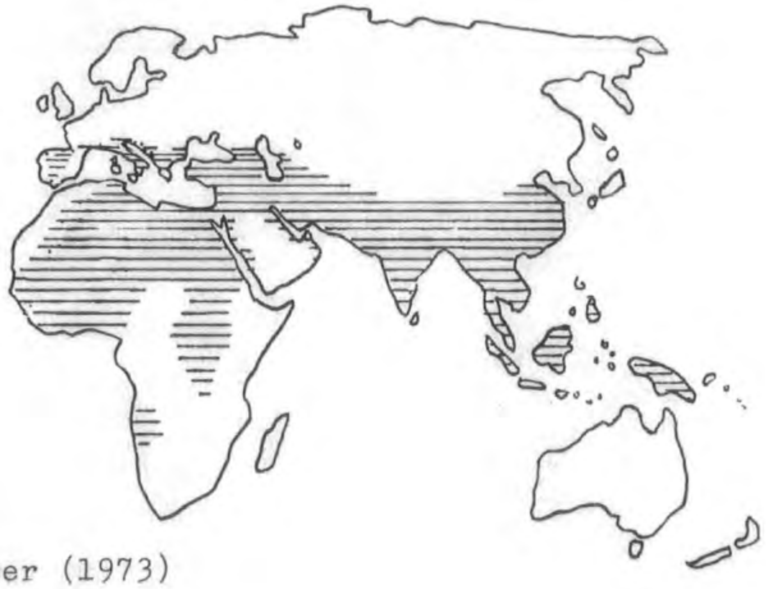
Fig. 7.4 THE WORLD DISTRIBUTION OF G.6.P.D DEFICIENCY, THALASSEMIA GENE AND P. FALCIPARUM MALARIA.

a) G.6.P.D. Deficiency



Source: Lasker (1973)

b) Thalassemia



Source: Lasker (1973)

c) P. falciparum

Source: Birdsell (1972)

them susceptible to hemolysis (Kosower and Kosower, 1970, 1974).

Glutathione stability of erythrocytes has been examined in Iranian populations, and according to Walker and Bowman (1959) Moslem males and females show 9.8% and 6.0% sensitivity respectively, and the total incidence for the Iranian population is estimated as 8.5%. The frequency of G6PD deficiency has been reported to be quite high in the Moslem population of Iran (Walker and Bowman, 1959; Bowman and Walker, 1961b; Bowman and Ronaghy, 1967). Bowman and Walker (1961b) speculate that the gene was introduced to Iran at the time of the Moslem invasion, since it is observed that the frequency for the Zoroastrians, who are closer to the original Iranian population, is 0.0%, while for the Moslems it is 8.0%. The low value for the Zoroastrians, now a small ethnic population (Seyedna, 1982), may be the result of small population size which can consequently lead to genetic drift, resulting in the loss of the G6PD deficient gene. Bowman and Ronaghy (1967) observed that the incidence of G6PD deficiency in malaria-free areas was only 1.0% among Parsis and 2.5% among Moslems, while in the malarious areas the incidence was 25.0% for the Moslems. Miyashita et al (1975) reported 5.5% G6PD deficiency in the two populations of Mazandaran and Gilan. Lehemann et al (1973) found relatively low values among Kurdish males (3.0 - 6.5%). Kirk et al (1977) also reported the deficiency in the Caspian Littoral (Tables 7.9a & b, and Fig. 7.5).

It was first suggested by Motulski (1960) and Allison (1963) that the distribution of this defective gene parallels that of falsiparum malaria and that its maintenance at high

Table 7.9a

G6PD DEFICIENCY IN VARIOUS IRANIAN COMMUNITIES

Locality	Community & religion	G6PD Deficiency	Source	
Fars (Shiraz)	Moslems	6.6	Bowman & Walker	(1959)
Fars (Shiraz)	Moslems	10.0	Bowman & Ronaghy	(1967)
Fars (Shiraz)	Moslems	9.1	Beaconsfield, Mahoubi et al.	(1966)
Fars (Kazerun)	Mamasani	15.0	Bowman & Walker	(1960)
Fars (Kazerun)	-	8.4	Beaconsfield, Mahoubi et al.	(1966)
Esfahan (Julfa)	Armenians	0.6	Bowman & Walker	(1966)
Esfahan	Armenians	7.1	Beaconsfield, Mahoubi et al.	(1966)
Jask and Chahabar	-	7.0	Beaconsfield, Mahoubi et al.	(1966)
Jask & Chahabar	-	6.5	Hedayat et al.	(1969)
Yazd	Moslems	3.5	Beaconsfield, Mahoubi et al.	(1966)
Yazd	Zoroastrians	3.6	Beaconsfield, Mahoubi et al.	(1966)
Tehran (Varamin)	-	8.2	Hamedi	(1966)
Tehran	-	6.8	Beaconsfield, Mahoubi et al.	(1966)
Tehran	-	9.9	Hedayat et al.	(1969)
Tehran	Jews	15.2	Hedayat et al.	(1969)
Tehran	Armenians	13.3	Hedayat et al.	(1969)
Caspian Area (Mazandaran & Guilan)	-	13.8	Hamedi	(1966)
Caspian Area (Mountainous)	Shiite Moslem Mazandarani	2.1	Amini, Montezami	(1966)
Caspian Area (Central)	Shiite Moslem Guilaki	15.9	Amini	(1968)
Caspian Area (West)	Shiite Moslem Guilaki	10.2	Amini	(1968)
Caspian Area (West)	Shafeite Moslem Talesh	7.3	Amini	(1968)
Caspian Area (East)	Shiite Moslems	4.9	Amini	(1968)
	Sunni Turkoman	4.9	Amini	(1968)
Caspian Area (East)	Shiite Moslem Mazandarani	8.3	Amini	(1968)
Kermanshah	Kurds, Jews	28.5	Mahoubi, Hedayat	(1960)
Kermanshah	Kurds, Moslems	18.5	Mahoubi, Hedayat	(1966)
Meshed	Moslems	7.9	Mahoubi, Hedayat	(1966)

Source: School of Public Health and Institute of Public Health Research (1970).

Table 7.9(b) Frequency of G6PD deficiency in Iranian populations

Population	No Tested	Normal	Deficient	Gd-	Author
Zoroastrians(Yazd)	146	146	0	0.0	Bowman & Walker(1961)
Armenian(Esfehan)	158	157	1	0.63	"
Zoroastrians(Yazd)				1.00	Beaconsfield et al(1967)
Gonbad	82	81	1	1.20	Kirk et al(1977)
Yazd				2.50	Beaconsfield et al(1967)
Kurds(Sanandaj)	106	103	3	2.83	Lehmann et al(1973)
Kurds(Baneh,Marivan)	77	72	5	6.49	"
Tavalesh,Astara	31	29	2	6.50	Kirk et al(1977)
Chalbah Jask	142	132	10	7.04	Hedayat et al(1969)
Mashad				7.50	Beaconsfield et al(1967)
Kazeroun				7.50	"
Moslems(Fars)	984	906	78	7.93	Bowman & Walker(1961)
Esfahan				9.00	Beaconsfield et al(1967)
Shiraz				9.00	"
Moslems(Shiraz)	221	201	20	9.05	Bowman & Ronaghy(1967)
Moslems(Teheran)	557	502	55	9.87	Hedayat et al(1969)
Jews(Esfehan, Teheran,Shiraz)	370	330	40	10.81	Szeinberg(1963)
Ghashghai	133	118	15	11.28	Bowman & Walker(1961)
Jews	139			12.00	Simhai (1974)
Jews(Teheran)	108	95	13	12.04	Hedayat et al(1969)
Babol,Amol,Shahi	32	28	4	12.50	Kirk et al(1977)
Basseri (Fars)	83	72	11	13.25	Bowman & Walker(1961)

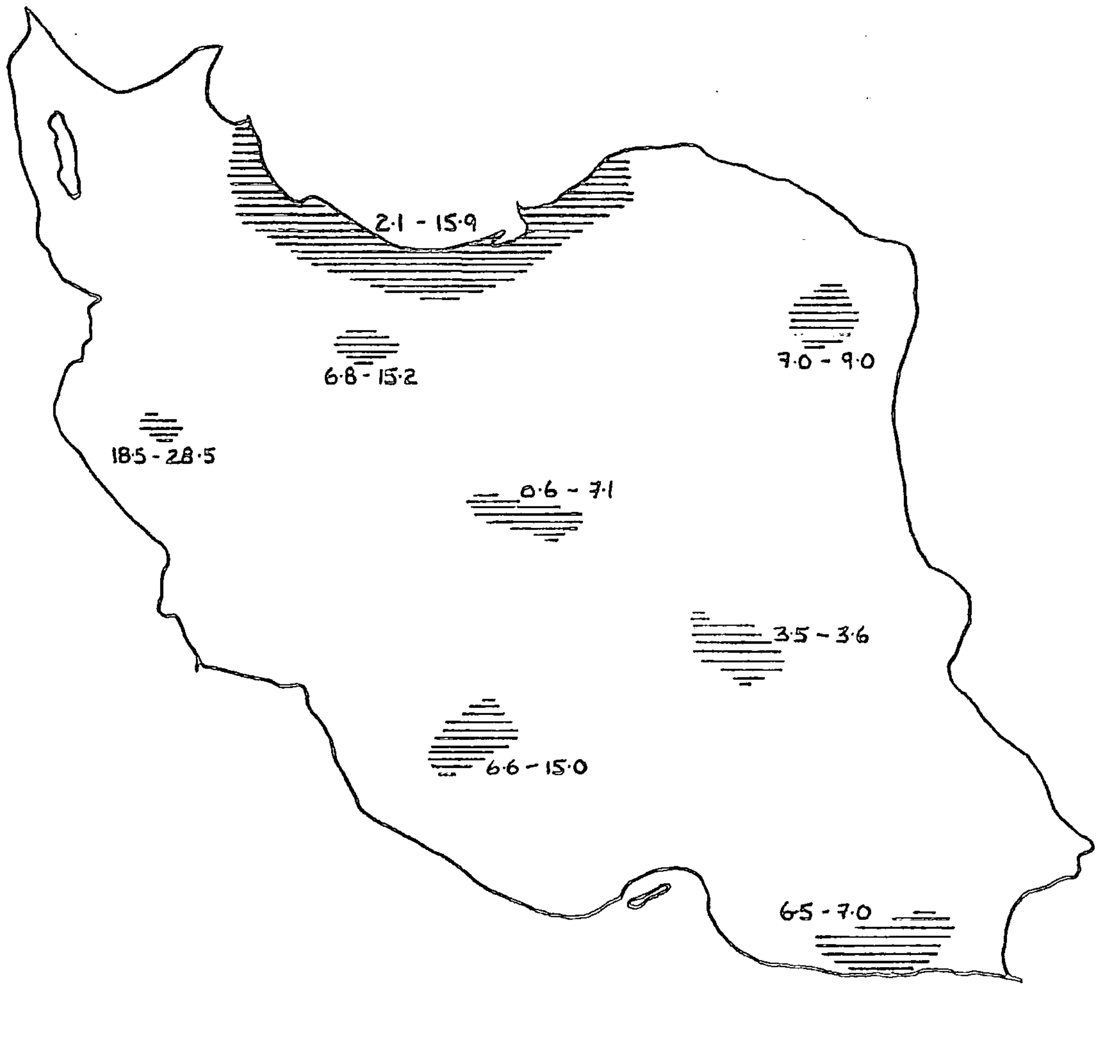
Table 7.9(b) (continued)

Population	No Tested	Normal	Deficient	Gd-	Author
Jews(Esfehan)				14.00	Beaconsfield et al(1967)
North Gorgan	21	18	3	14.30	Kirk et al(1977)
Armenians(Teheran)	102	87	15	14.71	Hedayat et al(1969)
Jews	557	473	84	15.08	Sheba et al(1961)
Shahsavar, Langarud, Lahijan, Rudbar, Rudsar, Rasht, Fuman, B.Pahlavi	43	36	7	16.30	Kirk et al(1977)
South Gorgan	28	23	5	17.90	"
Kermanshah				19.00	Beaconsfield et al(1967)
Mamassani(Fars)	91	73	18	19.78	Bowman & Walker(1961)
Kurds(Kermanshah)				25.00	Beaconsfield et al(1967)
Caspian Littoral				25.00	"
Jews(Kermanshah)				29.00	"
Kurdish Jews	63	40	23	36.51	Tills et al(1977)
Kurdish Jews	57	35	22	38.60	Godber et al(1973)
Kurdish Jews(Sanandaj, Kermanshah)	45	25	20	44 44	Szeinberg(1963)
Kurdish Jews	196	82	114	58.16	Sheba et al(1961)

SOURCE: Amirshahi,(1984)

Figure 7.5

DISTRIBUTION OF G6PD DEFICIENCY IN VARIOUS LOCALITIES OF IRAN



Source: School of Public Health
Institute of Public Health Research
University of Tehran (1970)

frequencies, although with regional differences, is due to the protection it confers against malaria. This is based on the observation that increased GSSG in G6PD deficient red blood cells inhibits ptotein synthesis by the intravascular parasite (Kosower and Kosower, 1970, 1974), in addition to premature lysis of the infected cells due to oxidant stress (Etkin and Eaton, 1975; Eaton et al, 1976). These factors result in the disruption of the synchrony of infection, the lowering of the rate of proliferation and increases immunity build up of the host. Both the distributional and biochemical evidence give support to the theory, and population surveys in Sardinia, the Isle of Rhodes, Greece and the Caspian Littoral have yielded good evidence of the correlation (Hackett, 1949; Siniscalo et al, 1961, 1966; Kattamis et al, 1969; Luzatto et al, 1969; Livingstone, 1971; Belsey, 1973; Carcassi, 1974).

Favism is one kind of hemolytic anemia. It is an ancient disease resulting from the ingestion of fava beans (vicia fava) or inhalation of the pollen.(Lin and Ling, 1962). Fava beans were one of the first plants intensively gathered by the Indo-European populations. The principal region of origin for this early cultigen has been regarded as S W Asia, although the Mediterranean region has also been cited, with further migration to Europe (Carcassi, 1974).

Favism induces intravascular hemolysis due to its toxic factor, and has an oxidizing component inhibiting enzyme activity. Their distinct agglutinating action on blood is induced by a substance that acts as an anti-malarial drug, and this substance has been suggested to be 'vicine', which is the active principle inducing acute hemolytic anemia (Lin and Ling, 1962).

The incidence of favism depends on many factors, either individually or combined: the presence of the fave beans in the local diet, the state of the bean, the presence of other substances in the diet neutralizing the effects of the toxic, like glucose, differential metabolization of the toxic, immunological factors, the susceptibility of individuals genetically, and finally the distribution of the G6PD deficiency (Donoso et al, 1969; Belsey, 1973; Schall, 1978). Both fava beans and anti-malarial drugs have the ability to reduce the glutathione level in the red blood cell and increase the level of GSSG in G6PD deficient cells (Sirivastava and Beutler, 1968; Harris, 1970), and it has been proposed that this biochemical alteration in the structure of the red blood cell confers protection against malaria infection. Positive association has been found between peak fava season, peak fava consumption and the peak breeding season of the anopheline mosquito (Hackett, 1949; Belsey, 1973; Carcassi, 1974).

Since about 1949 it has been known that favism exists in Iran, and it has been traditionally linked with the intake of fava beans. The bean is widely cultivated in Khuzestan, Gilan and Mazandaran, but the incidence of favism is more frequent in the Caspian Littoral, and even more common in the lowland villages of the Caspian than the highland villages of the Alborz (Donoso et al, 1969).

Table 7.10 shows the incidence of favism between 1958 and 1965 in Mazandaran and Gilan, showing an increase in the number

Table 7.10 Incidence of Favism between 1958-1965 in the Caspian Littoral of Iran

YEAR	1958	1959	1960	1961	1962	1963	1964	1965
CASES	43	57	190	201	176	117	267	1123

Source: Lapeysonie and Keyhan,1965.

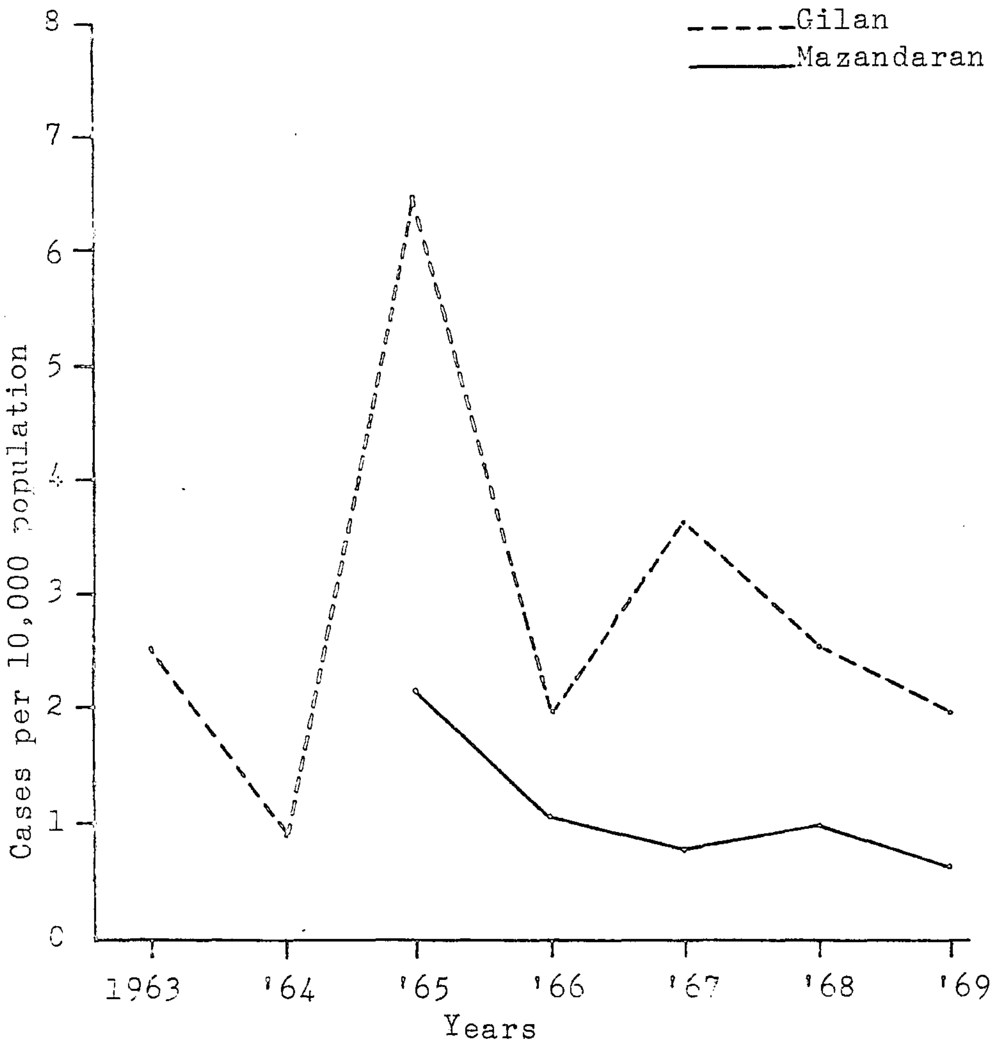
Table 7.11 Incidence of Thalassemia in Iran

Population	No	Thalassemia	%
Persians	121	43	35.0
Turkomans	71	29	41.0
Baluchis	8	3	37.0
Total	200	75	37.5

Source: Nuyken.G, 1954.

Figure 7.6

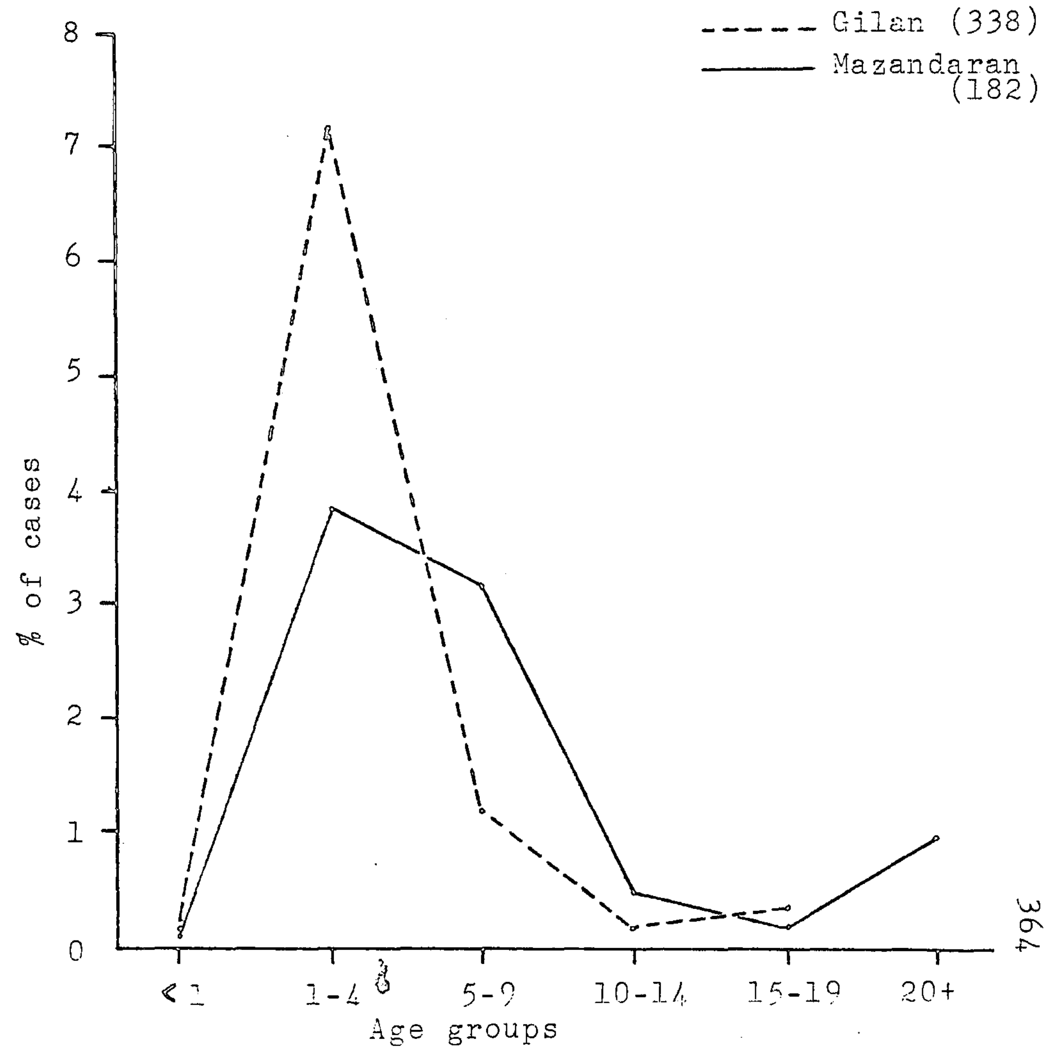
INCIDENCE OF FAVISM IN GILAN & MAZANDARAN, IRAN, 1963-9



Source: A. Belsey (1973)

Figure 7.7

AGE DISTRIBUTION OF CASES OF FAVISM IN GILAN & MAZANDARAN, 1968



of cases; it is speculated that the increase could be due to the introduction of new varieties of vicia fava, but most probably it is due to the more efficient technique of detecting the disease. The incidence of favism in 1965 was 6.39 and 2.23 per 10,000 population in Mazandaran and Gilan respectively (Lapeysonie and Keyhan, 1966). Belsey (1973) reported figures of 1.85 and 0.65 respectively for 1969 (Fig. 7.6).

Favism is generally a paedriatic disease and higher percentages of cases are found in the (1-4) years age group in both Mazandaran and Gilan (Fig. 7.7). However within the paedriatic age range there is also variation in the age distribution, reflecting the varying risk of exposure to the bean in different environments and cultures, which may enhance or alternatively inhibit the expression the disease. The male/female ratio also varies in favism, and male children are more predisposed: in Mazandaran the sex ratio was 2.7:1 (Belsey, 1973); this is explained on the variable expression of G6PD deficiency in the heterozygous female. Lapeysonie and Kayhan (1966) reported mortality from favism in Mazandaran at 1.8%, and in Gilan at 1.2% in 1965. They also observed that the rate of mortality varies in the various age groups: 4.7% for chidren less than two years old, 1.11% for the two to four years age group, and 0% among children aged five to sixteen years.

Hemoglobins are red cell proteins that carry oxygen throughout the body. The great majority of people have the normal adult hemoglobin (HgA). The hemoglobin type changes during the change from foetal to adult life, and at all stages of development. There are several structurally distinct types present in the red cells. The inherited disorders of the hemoglobins are caused either by structural changes in the amino-acid sequence of one of the molecules or a defect in th rate of synthesis (Weatherall, 1972).

Many structural hemoglobin variants have been described and identified by electrpphoretic techniques. HgS has often been reported in its association with endemic malaria, showing a high frequency in Tropical Africa, but numerous other foci of distribution in the Mediterranean area, S.W Asia and India have been reported. Lehmann (1954) suggested that the original mutation arose in S.W Asia, in a population of Veddoid type, where the gene was selectively favoured by the incidence of malaria, and from there it spread to Africa and India.

Other hemoglobin variants with milder effects, such as HgC (confined to W.Africa), HgE (S.E Asia) and HgD (N.W India) have higher frequencies compared with numerous other abnormal ones (Weatherall and Clegg, 1972). The thalassemias are characterized by a defect in the rate of synthesis and are divided into two main groups: the α and β types. Heterozygotes for β thalassemia suffer from mild anemia while the homozygous rarely survive childhood.

The thalassemia gene is mainly present in the Mediterranean area, the Middle East and southern Asia, and it is also reported sporadically in many other populations (Fig. 7.4b). Various foci of origin for the gene have been proposed: Oriental (Persian), Mongoloid, Armenian and N.Mediterranean, in addition to spontaneous mutation (Chernoff, 1959). In general, it is difficult to assess an origin, due to large scale movements of populations in historic time and admixture.

The correlation between the sickling phenomenon and resistance to malaria has been demonstrated in population surveys in Africa and Asia (Allison, 1954; Mourant, 1978). The suggestion of the adaptive value of heterozygotes in contrast to non-thalassemics was first mentioned by Haldane (1949), and was further supported by Carcassi et al (1957). It has also been reported that the incidence of thalassemia is higher in coastal areas and lowland regions. Motulsky (1960) suggested that G6PD deficiency and thalassemia have attained their world-wide distribution by protecting their carriers against malaria. It was also suggested that populations with a past history of exposure to malaria show high incidence of these traits (Chernoff, 1951; Siniscalo et al, 1961). The rates of accumulation of thalassemia is slower in populations with a high frequency of G6PD deficiency, since the latter is already providing sufficient protection against malaria mortality (Siniscalo et al, 1960) and there is also milder selection against G6PD deficiency. Carcassi (1974) suggested that the presence of thalassemia in G6PD deficient cells had the advantage of increasing enzyme levels and consequently decreasing the frequency of clinical episodes of favism, making them less liable to acute hemolysis and infections. Thalassemics also have lower ATP levels, which are conducive to the disruption of glycolis, and there is also the possibility that the increased elevation of hemoglobin A_2 in thalassemia might provide resistance, since the plasmodium prefers lower concentration of HgA_2 (Arends, 1967).

Beta-thalassemia is well documented in Iran (Nuyken, 1954; Pouya et al, 1958).. Table 7.11 presents figures on the incidence of thalassemia in Iran. The incidence of other abnormal hemoglobins such as hemoglobin Coventry, Hamadan, Daneshgah Tehran, Arya and other rare variants with high incidences have also been reported among Iranian populations (Hynes and Lehman, 1965; Rahbar et al 1967, 1973, 1975; Rahbar, 1973; Nozari et al, 1978). In general, the genetic interaction of the red blood cell polymorphisms increases the fitness of individuals between birth and reproduction against malaria and favism.

Malaria has affected man since earliest times and has been endemic mainly in sub-tropical and tropical areas (Fig. 7.4c). Since the anopheline mosquito cannot breed at altitudes above 9,000 feet, it is more common in coastal and lowland areas. Malaria is caused by a single cell protozoa parasite transferred to man via the female anopheline and is mainly intracellular, depending on the red blood cell component for survival and propagation. The four kinds of Plasmodium are: falciparum, the most lethal; P. vivax, adapted to temperate climates; P. malarie, which is more localized and P. oval which is rare. In areas where malaria has been endemic, there has been consequent alterations in the demographic, serological and genetic structure of the population.

Studies on malaria in Iran started around 1921, and areas such as Mazandaran and Gilan were categorized as homogeneous and hyperendemic in malaria (Tabibzadeh, 1970). Other areas of endemicity are the southern slopes of the Zagros mountains and the littorals of the Persian Gulf and the Sea of Oman. Of the three types of parasites P. vivax dominates the greater part of the country, while P. falciparum is seen in the southern coastal areas and P. malarie is reported to have a very low ratio of propagation. The Malaria Eradication Program started in 1957 in Mazandaran, Gilan and Azarbaijan, and by 1970 malaria was completely eradicated in the north of the country, although it is still prevalent in the south (Tabibzadeh, 1970).

Other blood group systems and serum protein and enzyme polymorphisms have also been associated with malaria, other diseases and various aspects of the environments. Vogel et al, (1960) and Vogel (1965,1970), suggested that the present day distribution of the ABO blood groups in human populations can be explained largely through selection exerted by the epidemics of plague and smallpox. This is explained on the basis of certain bacteria, protozoa and helminths having antigens related to blood group substances and therefore organisms might be resisted differentially by the subjects possessing different blood-groups, either because of naturally occuring antibodies, or inability to produce antibodies to the antigens resembling those of the host.

It is speculated that the malaria parasite contains A-like substances, and thus in areas where malaria was endemic, the frequency of B and O would be expected to be higher. The frequency of the Rh negative gene varies greatly between populations as the result of the endemicity of various tropical diseases. Since populations in the tropics are more subject to high loads of infection, different constitutions in terms of antibody formation would be subject to selection. Gorman

(1964) found a negative relation between the Rh negative gene and malaria. Differences in the y-globulin levels due to differential antigenic load have been associated with various diseases (Athreya and Corriel, 1967; Livingstone, 1971; Mourant, 1973).

Harrison et al (1976) found an association between malaria parasitism and the red cell acid phosphatase heterozygotes. Bottini et al (1971) associated acid phosphatase variants with G6PD deficiency and favism, and Ananthrakrishna and Walter (1972) with temperature and altitude. Palamarino et al (1975) found a negative correlation between the frequency of the ADA^2 gene of the adenosine deaminase system and that of G6PD deficiency, suggesting a complex process involved in resistance to malaria. Both Haptoglobin and Transferrin serum proteins variants have been postulated to owe their origin to the selective action of infectious diseases and the incidence of anemia (Mourant, 1973). The close linkage on the X-chromosome between the G6PD deficiency gene and colour-blindness, and their positive correlation with the past incidence of malaria, is interpreted as an example of the selection of a neutral gene through the close linkage with a highly adaptive one (Adam, 1961; Mourant, 1978). Vitamin E deficiency has also been associated with G6PD deficiency and favism, moderating the course of malaria since it protects membranes against oxidative agents; this deficiency results in intravascular hemolysis.

Kmet and Mahboubi (1972) carried out a genetic survey in the Caspian area on the incidence of esophagus cancer. The disease is found to be common in most parts of Iran, but mainly

Table 7.12

Age-standardized incidence rates of esophageal cancer (per 100,000) in the Caspian littoral of Iran.

District	MALES		FEMALES	
MAZANDERAN	No	Rate	No	Rate
Northern Gonbad	83	108.8	106	174.1
Northern Gorgan	44	94.5	36	79.2
Southern Gonbad	61	81.1	45	68.5
Southern Gorgan	51	61.0	18	26.7
Behshahr	11	17.9	12	18.1
Sari	20	17.3	18	16.9
Shahi	30	28.8	29	27.3
Babol	33	25.0	9	5.7
Amol	36	41.6	28	27.4
Nur	6	22.4	4	19.2
Nowshahr	12	18.5	3	7.3
Shahsavar	14	20.2	6	8.0
GILAN				
Rudsar	11	26.7	3	12.4
Langarud	4	23.9	1	5.1
Lahijan	11	17.9	6	7.3
Rasht	17	20.3	4	2.7
Bandar-Pahlavi	3	19.6	4	20.3
Sowma-Eshara	2	8.6	1	3.8
Fowman	3	7.9	0	0.0
Rudbar	0	0.0	0	0.0
Tavalesh	6	19.7	2	5.4
Astara	2	21.0	1	14.7

Source: Kmet. J and Mahboubi. E (1972)

Figure 7.8

DISTRIBUTION OF ESOPHAGUS CANCER IN ASIA

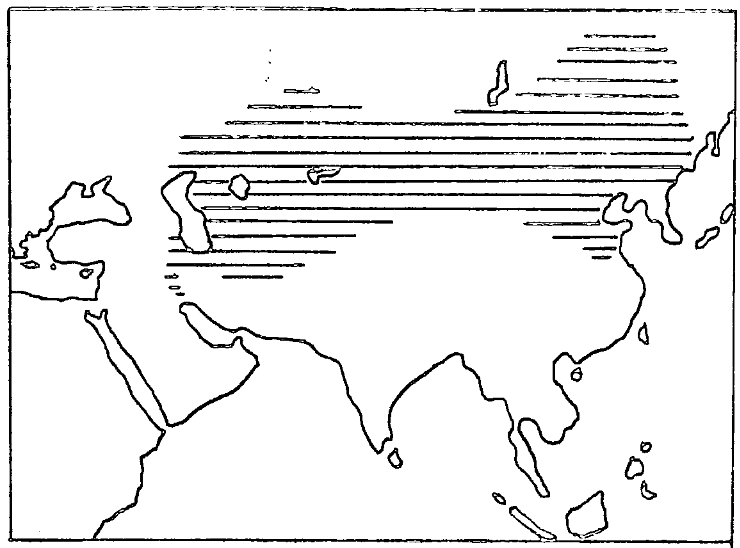
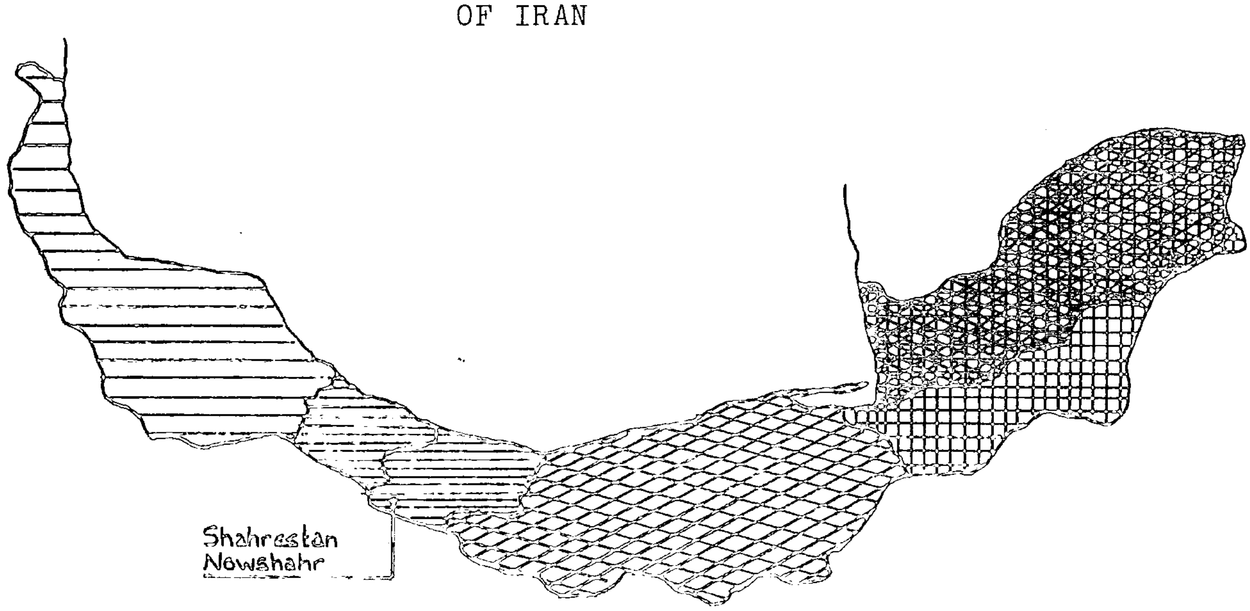


Figure 7.9

DISTRIBUTION OF ESOPHAGUS CANCER IN THE CASPIAN LITTORAL OF IRAN



- Low
- Relatively low
- Moderately high
- High
- Very high

Source: J. Kmet & E. Mahoubi (1972)

in Khorassan, Azarbaijan and the plains of Gorgan. Iran represents part of a vast area of high incidence extending from the Middle East via Iran, Afghanistan, South Central Asia, parts of Siberia to north-west China (Fig. 7.8 - 7.9). The frequency of the cancer was found to be very high in East Mazandaran and relatively lower towards the western shore of the Caspian and a clinal gradient is observable. The authors associate the frequency of the disease with the climatic divisions of the area, and the diversity in the ecology in terms of soil, vegetation and agriculture. A very high incidence, among the highest recorded in the world, was recorded in the northeastern region of the Caspian Littoral (males: 108.8 and females:174.1 per 100,000 population). A lower incidence was observed in the southeastern and central parts of the Caspian area, which have more rainfall and non-saline soils, and a steady decline is observed towards the west, reaching the lowest indices (males: 17.2 and females: 5.5) in the Caspian rain belt. It is possible that the high incidence observed in the northeast, with a gradual decrease towards the west, are the results of various factors such as different dietary habits in association with differential biotopes, and differential genetic constitution in terms of predisposition to various diseases; other influential factors would be the past migration patterns to and from the area, and the ethnic and linguistic composition of the population. In summary, the results are the consequences of local selective pressures and possibly stochastic factors.

7.3 SUMMARY

The present distribution of genetic polymorphisms in various populations has been shown to be a composite function of selection intensities, migration patterns and random processes. Selection as a systematic force acts on both the genetic constitution and the cultural attributes of the populations. The association between various blood-group polymorphisms and environmental factors (biotope and diseases), ecological attributes (topography, climate, soil and vegetation), cultural factors (subsistence patterns, dietary status and kinship structure) and demographic structure(population size and density, birth and death rates, mating patterns and the extent of migration within and between populations) is indicative of selection acting through a combination of factors to increase the biological (Darwinian) fitness of the population.

Gene frequency variations between different populations are the overall result of a multitude of factors, such as local selective pressures, differential interaction between the abnormal alleles and diseases, geographic, cultural and linguistic isolation, consanguinity, demographic imbalance, matrimonial and parental migration range, extent of admixture and the level of economic development. These factors are conducive to genetic differentiation between populations and consequently on man's genetic evolution.

Serological investigation in Iran (Amirshahi, 1983) has revealed no significant heterogeneity of blood-group polymorphisms between the various ethnic and linguistic tribes of

Iran, based on the fact that there is no proscription on panmixia and admixture in terms of marriages of different groups. In contrast, other researchers (Miyashita et al, 1975; Kirk et al, 1977; Ohkura et al, 1984) have demonstrated regional genetic heterogeneity in the Caspian Littoral. This is mainly the result of investigations in regions where geographical attributes are of the utmost importance in terms of population admixture and the possibility of genetic drift. The effect of subdivision of populations into regions on the basis of geographic and ethnic/linguistic factors can lead to genetic micro-differentiation as a result of non-random patterns of mobility and local selection factors.

In general, genetic and serological data are needed to substantiate the results from the demographic and migrational analyses of Shahrestan Nowshahr, which indicate partial isolation of the sub-divided regions.

CONCLUSION

The main object and concern of population geneticists is to elucidate and predict the genetic composition of succeeding generations. This entails examining the consequences of evolutionary forces such as selection, gene flow, mutation and drift, which determine the genetic composition of the population and the mating pattern which determines the ways in which the genes are combined. Although no genetic data were available in the present study, some insight into the role that these forces may have played has been obtained from the demographic and migrational analyses of Shahrestan Nowshahr.

Many theories of population genetics are based on the assumption that populations are panmictic; however, many studies have also shown that populations exhibit some form of subdivision. This study has attempted to define the various isolating mechanisms such as geographical features, demographic structure, linguistic affiliations and the kinship network, in order to elucidate those factors responsible for population subdivision and the changes in its genetic structure.

Population genetics theory is based on the breeding population as the unit of evolution; therefore population size is the first prerequisite for defining and delineating the local Mendelian population within which lies most of the genetic material that will be transmitted to the next generation. It is also at this level of population that micro-evolutionary processes such as gene flow, selection and drift operate.

Demographic data provide estimate of the relative size of the population dependent on parameters such as sex, age and family structure, and the influence of the processes of fertility, mortality and migration upon them. The analysis of the past demography of Shahrestan Nowshahr reveals changing patterns in its structure and composition during the last thirty years. Rapid increases are observed in the total population size between the three censuses, but with a heterogeneous pattern in the urban and rural areas. The variation in population growth has been attributed to differences in conjugal conditions, fertility rates and migration patterns. Internal migration from the rural to urban areas has been the main demographic characteristic of the population; this in turn has had a strong influence on many of the demographic parameters of both areas affecting and changing the family structure in terms of sex and age, proportion married, age at marriage, extended and nuclear family, fertility and mortality, the kinship structure and ethnic composition.

The rural area shows a higher fertility, younger age structure, a higher proportion of extended families and increase in family size due to lower maternal and infant mortality. It is also characterized by high emigration to the urban areas, and this is predominant among males who are in the reproductive age group. Ethnically it is highly homogeneous due to its geographic isolation.

In the urban areas, the population is characterized by a higher sex ratio, and an older age structure as the result of persistent immigration. The family structure reveals lower fertility and mortality, determined mainly through a decrease in the proportion of marriages, an increase in age at marriage, and a larger proportion of nuclear type families. Due to the intense migration to the urban areas, the birthplace composition of the population is heterogeneous.

Variations in the demographic composition of both the urban and rural areas have been the result of many factors: Socio-economic changes, urbanization, industrialization, development in the agricultural sectors, the expansion of towns and villages, military service, the increase in literacy and a more efficient communication network. These factors in turn have altered the structure of the population in both urban and rural areas by causing changes in the population density, decrease in land dependency, rural depopulation, opportunities to travel and a decrease in kinship and family ties. These have ultimately affected the family structure, which bears directly upon the reproductive potential of the population and the genetic structure.

Both natural selection and genetic drift are evolutionary processes that operate through the differential demographic variables. These differences can affect the size of the population, resulting in differential contribution of some genotypes to the gene pool of the offspring generation. Therefore the grater the variance in the demographic parameters that condition the processes of fertility, survival, mortality and migration, the greater the rate of change in gene frequency. Changes in allele frequencies due to selective pressures will only occur if the variability of fertility and mortality, ie fitness, are heritable and genotype specific. Demographic data give no information concerning this relationship, but with detailed demographic information, the relative opportunities for selection can be considered (Crow, 1958). Genetic drift operates mainly through non-random factors, and variance in family size which is the ultimate measure of breeding size, in addition to the kinship structure in terms of inbreeding and consanguinity can affect the genetic structure.

The analysis of languages and dialects indicate that Mazandarni and Gilaki are the two predominant Persian dislects spoken in Shahrestan Nowshahr. They are further subdivided into regional patois. Kurdish, spoken by the Kurds and the Laks is the third most popularly spoken language. It is confined to well-defined territories, mainly in the Dehestans of Balade-Kojour and Zanouss-restagh, and in the Bakhsh of Kelardasht. Farsi is mainly spoken in the more urban areas of Nowshahr and Chalous cities, which contain a more heterogeneous population. Torki is also spoken, but at a lower frequency. The results are a reflection of the intensity and orientation of migrations, which is mainly from the contiguous Shahrestans of Mazandaran, Gilan and Markazi. They also reflect the pattern of past migrations and the routes of communication. There is also evidence of both the localization and the clinal distribution of languages and dialects, whereby Mazandarani is more frequently spoken in the eastern regions, Gilaki in the west and Kurdish in isolated sections.

Assortative mating in terms of dialects has also been observed, indicating a high degree of linguistic correspondence between the spouses. This shows the extent to which languages serve as barriers to mate selection and reproduction, and consequently to genetic movement. It is evident that language can have profound effects on population structure, and contribute to the non-random component of mating, thus affecting the breeding size of the population and inhibit admixture and gene flow between various linguistic groups.

The analysis of migration patterns in Shahrestan Nowshahr reveals some interesting and consistent results in terms of overall migration, matrimonial mobility and parent-offspring movement. Analysis of the movement pattern of individual spouses from their birthplace to marriage place to final residence, revealed extreme orientation towards the place of origin, with the range of movement confined to short distances. Males showed more correspondence between their birthplace and marriage-place, as is customary in sedentary societies where residence is mainly patrilocal. Differential emigration in terms of sex was also observed, whereby males were more often the emigrants in addition to travelling to further distances. A final component to observe was that immigration from outside the Shahrestan to the individual Bakhshes was not uniform, ie while B.Markazi and B.Chalous were the greatest recipients of migrants, B.Kelardasht saw less inflow of genes.

Gene flow through marital mobility also revealed orientation towards the place of birth, ie a strong tendency for marriages to occur in the birthplace of the spouses. The distribution of matrimonial distance was highly leptokurtic, indicating intense interbreeding confined to small localities and neighboring areas, thereby limiting mate selection to a narrow geographic range. The high degree of localization of marriages and the limited spatial continuity of gene flow, reflects the importance of geographic elements in restricting free mobility in addition to the demographic structure in terms of the sedentary lifestyle, strong attachment to land, early marriages and the kinship pattern which are conducive to endogamy and most importantly consanguinity.

Spatial exogamy and marital distances indicate a temporal increase between the two generations, reflecting the secular change in the demographic and socio-cultural structure of the population. It is difficult to assess at this stage, which regions are contributing to the increase in the range of gene flow, but it can be speculated that the more urban areas which are migration routes and closer to larger towns have undergone changes in the pattern of mobility through more contact with the non-indigeneous populations.

Gene flow into the Shahrestan, ie systematic pressure, appears to have had a small effect on the gene pool, and constitutes a small portion of the recipient gene pool. Long range migration is also confined to the border areas, resulting in further reduction in the extent of admixture.

The orientation of marital movement into the Shahrestan parallels both the past and present pattern of movement. The axes of movement lie mainly between the northwest and northeast, ie across the Caspian Littoral. The origin of the exogamous partners are mainly from the Provinces of Mazandaran and Gilan comprising almost eighty percent of the total new genes entering the area; the remainder are mostly from the Central (Markazi) province. It is evident that migration is very much determined by topographical features, and follows the roadway network. The asymmetry and non-randomness of gene flow is yet another indication of restricted gene flow, which is conducive to a further reduction in the size of the gene pool.

The parent-offspring movement analysis has quantified the potential for actual genetic movement; it has also demonstrated the extent to which the gene pool of the offspring generation reflects those of their parents. Temporal genetic continuity is the main characteristic of the population, ie a large proportion of the indigenous population of Shahrestan Nowshahr, contributes to the gene pool of the next generation. This is an indication of the localization and concentration of the gene pool.

Sex differences are also observed in parental mobility, whereby there is less concordance between the birthplaces of the female parents and those of their offspring in both generations. This, again, can be attributed to the economic, demographic and social structures, resulting in patrilocal residence. There is also evidence of little post-marital mobility, as is evident from the high correspondence between the birth localities of the sibs.

Temporally, a decrease in parent-offspring birthplace correspondence is observed. The birthplace distance distribution reveals a wider dispersion of the gene pool and an increase in the size of the neighborhood, resulting in a more heterogeneous genetic composition, in conjunction with modernization and more feasible communication.

In summary, the results indicate that marital mobility, and mate selection, and consequently gene flow, are very much determined by geographic propinquity and proximity, and that space and distance are influential determinants of admixture. The effects of the observed pattern of genetic migration is the sub-division of the parent population into a hierarchically structured population, composed of partially isolated and homogeneous units of settlement which are not genetically open to complete admixture and panmixia. One can also extrapolate on the genealogical relationship within these subdivisions, and its subsequent effect on the breeding size of the population. In general the observed pattern of genetic migration elucidates the chances and possibilities for stochastic factors, ie reduction in genetic variance due to drift and local selective pressures and consequently genetic differentiation. The temporal increase in migration rate and the spatial distribution of gene flow has the overall result of reducing the effect of genetic drift and, due to more admixture, the area can be regarded as a component of a much more diffuse system.

The extent to which migration and genetic exchange between the subdivisions have enhanced gene flow and admixture, or conversely genetic differentiation, has been assessed by applying two migration models: the matrix and the isonymy models. The results have elucidated the mean kinship coefficients within and among the sub-populations, further substantiating the matrimonial and parental pattern of migration. The results indicate a relatively immobile population with small gene dispersion. In both generations, the within kinship coefficients are larger than the between-values, indicating a tendency for the units to remain distinct and partially isolated; in general local kinship is high.

In both generations, the father-offspring estimates show consistently closer kinship within and among regions than those of the mother-offspring, thus indicating that female migration is contributing more often to the transference and displacement of genes.

Variation is observed in the kinship indices amongst the nineteen subdivisions, whereas the more urban and central regions show lower within-kinship values, and are more mobile.

Comparing the two generations, the more recent generation shows lower local kinship and increase in relatedness among the regions, compatible with the increased mobility of recent years, indicating more spatial homogeneity and a shorter time needed to achieve genetic equilibrium.

There is also evidence of a hierarchical pattern of clustering, where each main cluster is composed of smaller clusters, further signifying the non-random component of movement. This pattern of clustering is mainly influenced by the irregular distribution of settlements. Genetic differentiation is further revealed by the orientation of movement from outside the study area to the individual subdivisions and the three main clusters (ie Western, Central and Eastern); the effect of genes moving into the regions is heterogeneous, and therefore the extent to which admixture can reduce genetic variance and diversity between the subdivisions and increase assimilation is varied, contributing to increased variation.

The surname analysis indicates persistence of certain family names in specific localities. The frequencies of surnames vary according to locality, the extent of geographic isolation and ethnic and linguistic affiliations. A small clinal component is visible between the subdivisions, but since the pattern and distribution of the villages are irregular, there will evidently be limitations and barriers to the free flow and random distribution of surnames. The high coefficients of surname concordance within each area points to some degree of localization, specifically in the more rural and isolated areas, reflecting the level of migration to each of the regions. A pattern of clustering of populations is also observed, indicating the influence of geographic elements on the distribution of surnames. It is evident that surnames can be studied as genetic markers and their evolution examined in terms of the effects of migration, mutation, drift and natural selection upon them, and these in turn used to define the dynamics of the population.

The extent of surname localization also provides indirect estimates of the degree of inbreeding within and intermarriage between families and populations, giving estimates of the extent of biological kinship. The present demographic structure and migration patterns of Shahrestan Nowshahr indicate small population size, geographic isolation, low admixture and a strong kinship system based on cognative marriages. These characteristics imply high rates of endogamy with the subsequent probability of greater consanguinity.

Inbreeding is strongly correlated with the human ecosystems. Localities with the highest cousin marriages are found in the more isolated mountainous regions, but the extent varies according to distance away from urban centres, in addition to family size, age at marriage, differential migration of the sexes and the extent of admixture. Inbreeding and consanguinity are very characteristic of Iranian rural villages, thereby causing limitations to gene flow and influencing the distribution of genotypes, and the manisfestation of recessive genes occuring in homozygotes; this is conducive to both selective pressures and genetic drift.

The genetic and serological data related to the Caspian provinces reveal the extent to which the physical barriers imposed by the Caspian Lake in the north and the Alborz mountain ranges in the south, have limited gene flow throughout most of its history along an east and west axis. Differences in genetic composition are therefore to be expected between these provinces and the rest of Iran. The Caspian Littoral itself is heterogeneous in terms of topography, pattern of settlements, ethnicity and ecology. Various studies have revealed a heterogeneous distribution of serological polymorphisms. The causes for the observed differences are attributed either to local selective pressures acting on the differential fitness of the population in terms of susceptibility to diseases and other environmental pressures, or attributed to stochastic factors such as genetic drift, where populations have deviated in gene frequency from the founder population due to isolation and small population size.

Although no genetic data specific to Shahrestan Nowshahr were collected, it can be speculated that the two evolutionary processes of drift and selection have been operative in the population mainly due to its varied ecology, differential demographic structure and geographic features, and, most importantly, the hierarchical sub-division of the area, resulting in differences in genetic structure.

In summary, the restriction of random gene flow, as inferred from the geographic, demographic and cultural parameters of the population structure has been assessed. These limitations have resulted in the segmentation of the main population, the small size of the gene pool and partial isolation of the sub-divisions, thus contributing to deviation from panmixia and the maintenance of genetic differentiation.

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