A skin colour survey in three adjacent areas in Mazandaran, North Iran

Mehrai, Haideh

A SKIN COLOUR SURVEY IN THREE ADJACENT AREAS IN MAZANDARAN, NORTH IRAN

A DISSERTATION SUBMITTED FOR THE
DEGREE OF MASTER OF SCIENCE
IN BIOLOGICAL ANTHROPOLOGY

BY

HAIDEH MEHRAI

November 1979

University of Durham
Department of Anthropology

FOR

BABA AND AZIZ

CONTENTS

ACKNOWLEDGEMENTS

My sincere gratitude to Professor Sunderland and Malcolm Smith, and all the Faculty of the Department of Physical Anthropology, for their supervision and instruction in all matters relevant to this study. I am also greatly indebted to Dr. Ghassemian from Chalous Hospital for enabling me to obtain my samples.

ABSTRACT

The main objective of this paper was to present skin colour data from few populations residing in the coastal province of Mazandaran, N. Iran. Statistical analysis was used to examine sexual dimorphism in the melanin concentration of the epidermis. The male and female samples were each classified into different age groups, to observe for any variation in reflectance in association with pubertal hormonal changes. Finally the present data was compared with seven other neighboring populations to examine the genetic homo and heterogeneity within these populations.

COLOUR BLINDNESS

A total of 101 samples (68 males and 33 females) were tested for colour blindness, with the Set of Ishihara Plates (1964), following the technique and instruction adopted by Ishihara. Each participant was tested individually Plates (1-19) were used for the literate, and plates (20-24) for the illiterates. Six males were found to be colour blind, while no females manifested such defective trait, in accordance with the genetic laws of x-linked traits. Classification of the defectives into Protan or Deutan type, whether mild or strong, was not very clear, and three of the participants were labelled as unclassified. The most important factor to be considered was the unsufficient number of samples, to check for this polymorphic trait, therefore this survey has been left for further investigation, when sufficient samples have been examined, to obtain the real frequency of this x-linked characteristic and also for a better investigation of the type and degee of defection.

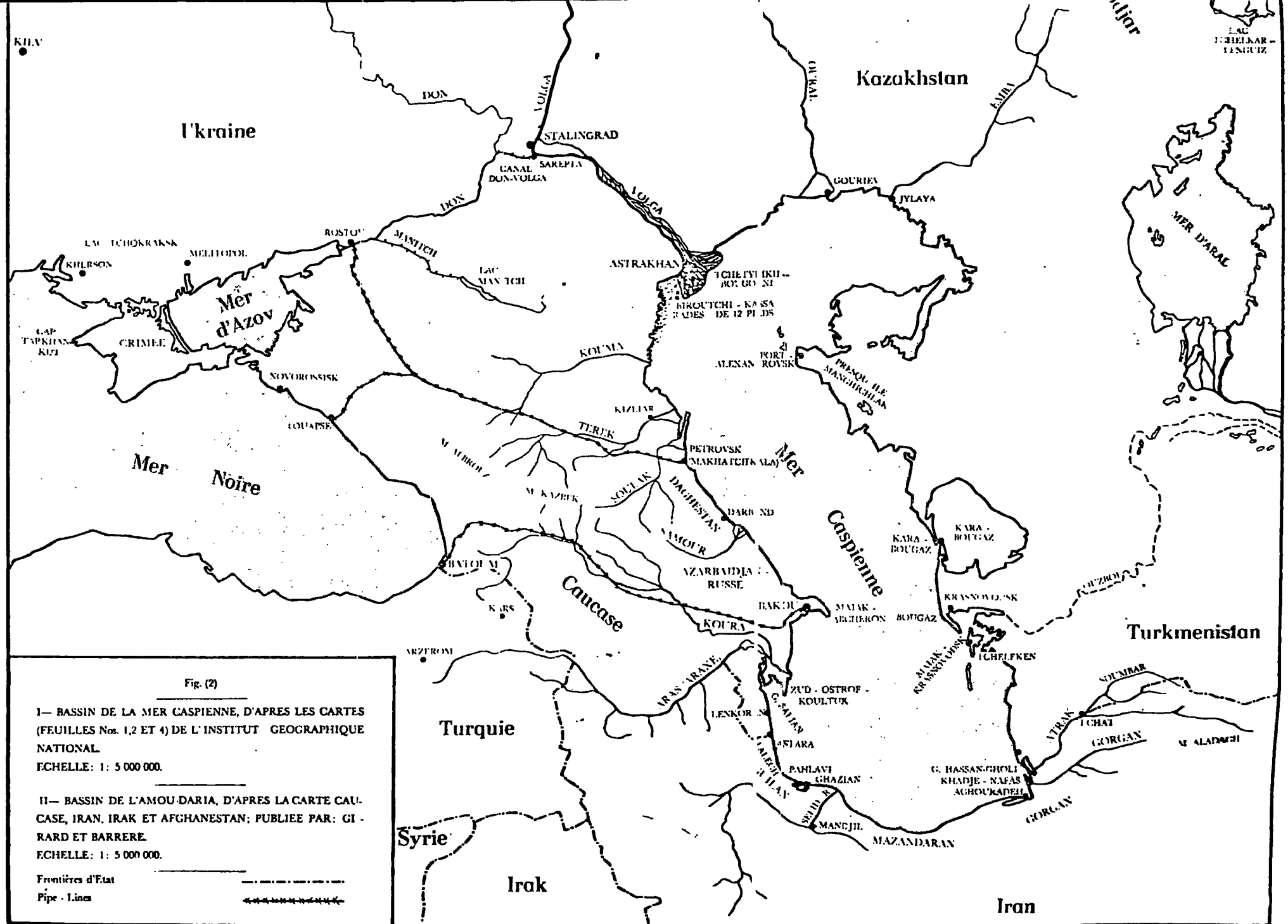


Fig. (2)

I— BASSIN DE LA MER CASPIENNE, D'APRES LES CARTES (FEUILLES Nos. 1,2 ET 4) DE L'INSTITUT GEOGRAPHIQUE NATIONAL.
ECHELLE: 1: 5 000 000.

II— BASSIN DE L'AMOU-DARIA, D'APRES LA CARTE CAUCASE, IRAN, IRAK ET AFGHANESTAN; PUBLIEE PAR: GIRARD ET BARRERE.
ECHELLE: 1: 5 000 000.

Frontières d'Etat

Pipe - Lines

THE LAND OF IRAN

A) Classical and Racial History

Iran is a variation of the word Aryan. The Aryans arrived on the Iranian plateau about 3,500 years ago and gradually gave their name to the land. Persia is also referred to the country, the word being derived from 'Pars', the name of one of the country's northern provinces, and Persian refers to their language and literature. The term Persia takes definite form, late in the history of the Oriental world, with the erruption of Aryan people into the Iranian plateau from the vast nomadic reservoir to the east and north of the Caspian Sea, early in the first millenium B.C. In modern times Iran is more commonly used, as a part of a policy exalting the wider Achaemenid or Aryan tradition.

The story of Persia before the time of Cyrus is a confused patch-work of myth and legend. Archaeological excavations during the past generations have revealed significant outlines of its cultural history. The evidence being of two kinds: pottery and inscribed writings in cuneiform script on clay tablets. The former giving a glimpse of an early civilisation, as in Perspolis, itself prior to 4,000 B.C., at first Neolithic in character, later developing into a full Bronze Age type, homogeneous in essential, reaching from the Syrian Coast to the Indus. From the latter information is gained about the political and racial background of the cultural area, with its highland belt in the north stretching from Anatolia across to the Iranian plateau, and its area of alluvial lowland and Steppe to the south, in the Syrian desert and Mesopotamia. In these early days, the highlands had not yet been occupied by the Aryan or Indo-European peoples. The people have been tentatively called Caucasian or Caspian in the absence of insufficient

reliable evidence on the ethnic origin and relation of the people. (Arberry, 1953).

Knowledge of the earliest inhabitants of Iran is very fragmentary, and recent excavations in one cave at Behistan, and in the caves of Belt and Aota near Behshahr on the Caspian coast, indicate an active flint industry, in the middle Paleolithic period as well as skeletons and skulls of the Mesolithic period. This latter material has been dated to about 10,000B.C. by carbon-14 method of analyzing pieces of charcoal from various level of digging, believing that these people were Nordic and of the same race of the Upper Paleolithic hunters of Europe. (Wilber, 1963).

Apparently in post-glacial times, the shores of the Caspian constituted an important passageway of east west movement of people, with cultural connexions between northern Afghanistan and the eastern shores of the Mediterranean. During Upper Pleistocene and Upper Paleolithic times, upper paleolithic man and his culture were very widely distributed throughout south-west Asia . This Aurignaucian man wandered extensively along the Mediterranean coastal areas, the Fertile Crescent and the shore of the Caspian (Sunderland, 1968).

Toward the end of the last glacial period, those living on the fringes of the northern Eurasian area in Iraq-Iran-Afghanistan and contiguous areas had already become Mesolithic hunters, and areas like the Caspian shores of Iran might have become important avenues for human movement and migration (Sunderland, 1968).

In the Iranian history several civilizations have risen in various parts of the country at different times, each leaving its own impression on the subsequent development of Iranian history, both cultural and

racial. The oldest known civilization of Iran is that of 'Elam', a small kingdom, which came into being around 10th century B.C., in the fertile plain, in what is now the south-western province of Khuzestan. This kingdom was overthrown by the Assyrians in the 8th century B.C., and in the 7th century, the independent kingdom of 'Media' was established. Another major Iranian group settled in the south and gave their name to the province of 'Fars' or 'Persia'. The Persians overthrew the Median kingdom under Cyrus the Great, and established their own kingdom over the entire plateau which stretched from the Indus to Egypt and from the Danube to the Indian Ocean. The Achaemian Empire lasted from 550-320 B.C., to be followed by the Parthians, ruling for 476 years, and later came the Sassanids; (Basic facts about Iran, 1973).

Later racial incursions consisted of the Greek influence with the conquest of Persia by Alexander the Great in 331 B.C., but the Greek influence was submerged under a renascence of Achaemian and purely Iranian culture. In the 7th century, the Arabs invaded most of the country, but they did not colonize the land; there seems to be little Arab blood in the modern Iranian, but they took the highly developed Persian culture, its art, architecture and literatures and dispersed it throughout the Islamic world. A number of national dynasties arose during the Arab invasions, among these were the Taharis the Saffavids and the Deylamites.

From the 9th to the 14th century, Iran suffered from incursions of various Turanian people from the east, of whom the principle were the Seljuk Turks, the Mongols and the Tartars. Their affect and invasions was devastation of lands, raging of cities and vast pyramids of

human skulls erected, and their overlordship was established in various parts of Iran, and their followers settled in Iran. Today in a belt across Northern-Iran, the Turanian element can be observed in racial types and in the Turki-speaking village and communities: Turki being linguistically unrelated to Farsi, belonging to the Ural-Altaic group which include Turkish, Finnish and the Mongol tongue of Central Asia, (Crossclose, 1947).

Other racial and cultural strains have contributed to the racial composition of modern Iran. Among the people whom the Persian and the Medes brought into subjects were races now clearly classified ethnically, such as the ancient Summerians and Elamites, whose civilization flourished in the Tigris and Euphrates valley, a thousand years before the appearance of the Aryans. Besides these were the Hittites, the Hyksos and various Semitic people of west, such as the Assyrians, the Chaldeans, the Akkadians and the Phoenicians, whose culture blended to form the Compound Asian civilization. (Crossclose, 1947).

Some various tribal or racial grouping of ancient lineages, forming an important national characteristics are the Kurds, dwelling on the boundaries of Iran, Turkey, Iraq and Soviet Armenia, ranging from the slopes of Mount Ararat in the North, southwards as far as Hamadan and Kermanshah in the range of the Zagros. Basically the Kurds are of the Aryan stock, and in appearance distinct from the typical Persian. The Lurs and the Bakhtiars dwell to the south of the Kurds, in the Zagros range, descended of ancient Aryan stock, with migratory habits. Other miscellaneous tribes are the nomadic people of Iran, the Turanians comprising the Kashgais (Turkish origin), the Turkomans and Baluchis of south-east Iran.

Basically three distinct groups, all belonging to the Aryan branch of the family of Indo-European peoples can be distinguished

in Iran: The Mediterranean, the Caucasian, and the Alpine. Also many other ethnic groups still live in Iran ranging from the Altaic Turcomans in the north-east to the darker skinned Baluchis in the South-East.

B) The Land

Iran is in the Middle East, forming the western part of Asia and the Easternmost part of the Mediterranean world. It covers most of the great Iranian plateau which lies between Mesopotamia to the west and China to the East, the steppes of Russia to the north, and the Persian Gulf and the Sea of Oman to the south. It covers an area of 628,000 sq-miles, and its longest frontier, 1,500 miles is in the north, with the Soviet Union.

Iran is bounded from the North, by the most southernly coast of the Caspian Sea. In the south, it is enclosed by the Persian Gulf and the Indian Ocean: In the North East by Russian Turkestan, Afghanistan: and in the south-east by Pakistan; from the West Iran has borders with Turkey in the north and Iraq.

Almost all of Iran lies in the north temperate zones, but the plateau as a whole offers a variety of climate. It is land of high mountains, deep valleys, great flatlands and vast arid deserts. Two major ranges divide the country in a west-easterly direction: the Alborz Range, beginning in the Caucasus, passing through Northern Iran and continuing into Afghanistan, and the second range, the Zagros, begins in Anatolia and continues right down to Baluchistan in the South-East of Iran. There are several major lakes in Iran, and the Caspian, the largest lake in the world, lying to the North, is a great inland sea. The Caspian littoral is humid and sub-tropical, while the central deserts are almost completely dry. Annual rainfall varies from an average of 40 inches in Gilan and Mazandaran (most northernly provinces)

to an average of less than two inches in the desert regions. Temperature also varies greatly: in the north-western parts it reaches 18^{O}F while in deserts and areas of the Persian Gulf it rises to 130 degrees Fahrenheit.

C) Mazandaran

The province of Mazandaran is located in the central-northern coastline plateau of Iran, and the most southernly coast of the Caspian Sea, bounded in the south, by the Alborz range, thus isolating this narrow fertile land from the southern valleys and areas of the Alborz mountains. Geographically it is located in between 36^{O}-39^{O} North and 51-31^{O} East. Temperature varies from 0^{O}-32^{O} centigrade, and very unfrequently does it fall to -10^{O}C, or rise to 40^{O}C. The humidity varies from 35% in the winter to 90% in the summer. Rainfall is up to 1000mm and occasionally increases to 1800mm in the year. Altitude is from 80-85 feet below sea level, and the winds are mostly westernly. The Caspian Sea itself is comparatively shallow and has considerable less salt content than that of oceans, and the water contains much minerals, especially iodine. The trees grow quite close to the sea. Mazandaran continues in the west to the province of Cilan, and in the east to the province of (Khorassan).

In the Islamic Period, Mazandaran was referred to as 'Teypourestan' and it constituted the central dwelling place of the 'Teypour' tribe, who are considered to have been there before the Aryan migration. Some suggestion as to the origin of the word 'Tabarestan', later derived from 'Teypourestan' comes from the Persian 'Tabar', meaning (Axe) and that the people of that land used the axe frequently for cutting the woods and getting through the forests. Another reference made to 'Tabar' is 'mountain', in the native language, that the area was quite

mountaineous (Abdolfadae).

Two important tribes, the 'Tipouris' and the 'Amards' inhabited the northern mountains or Semnan. In 171 B.C. Ashk the First (Farhad 1), pushed the Amards towards the East to Khar, East of Varamin, and the Tipouris replaced them, and consequently the whole area came to be called Teypourest and Tabarestan.

No reference to this land is made in the time of Cyrus the Great, and neither in the Avesta's geographical indices, in the Vandidad. It seems that the ignorance of this area was due to the fact that pre-Islamic kings before the Sassanids had no control over this area, because of its geographical location and characteristics, and its impassibility, providing protection from invasions from alien tribes, and if any penetration was possible, it would have been for short periods.

The Teypouris like the Amards, being a pre-Aryan race, inhabited Teypourestan, and reference to this land is made in the Greek literature as 'Tapyroi' and Tapoyroi and the Chinese have referred to it as 'Tho-pa-ssetan, or 'Tho-pa-sa-tan', in Pahlavi script as Teypourestan (Marquart, 1901).

Teypourestan and Tabarestan was later changed to Mazandaran. There is reference made in the book of Avesta in the Abay Yesht to 'Mazana' or 'Mazainya Daeva'. The inhabitants, it is suggested were tall, big shoulders and living in caves. 'Mazana-Tara', also means towards Mazana or in Mazana in Pahlavi script, classifying them as non-Iranian and non-Arab.

It seems that the fertile land of Mazandaran, has always attracted the migrants and invaders, from various areas in the north east of Iran, like Mongolia, Turkemanestan and Afghanistan.

Three tribes inhabit the province of Mazandaran:

(1) The Abdolmaleky:Turkish which have not mixed with the Mazandarinis.

(2) The Kurdotork tribe, a mixed race of Turkish kurdish and Turkish. The Kurds from Azarbaijan province in the north-west of Iran, and also the Afghans from Khorassan and Afghanistan.

(3) The Khajevandis, which are primarily kurds, coming from Kurdestan in the West of Iran, who live in the mountainous areas of the Zagros Range.

From a review of the following historical, cultural and racial history of Iran, it is plausible to consider Iran as a land in which the continuous invasions, migrations and settlements, has had its constant effect on the genetic and physical characteristics of the remaining people of Iran.

HUMAN DIVERSITY

The human species demonstrates a diversity in physiological, biochemical and anthropometric traits. These biological diversities are associated with environmental stresses and genetic components that interact to ensure the species survival. It is evident that regional differences have biological significance and the proper functioning of the physical organism towards its environment are authoritative in the genes responses. The study of genetics, immunology, paleontology, archaeology and chemical analysis have had great advantage for the study of populations, and of great use for potential biological studies in defining the different phenotypes and genotypes, as means of comparing different populations. Many inherited traits have been quantitatively measured by standard tests, and anthropometric measurements and pigmentary variations are characteristic of such categories.

Physical anthropologists research and studies are devoted to the understanding of these diversities and their biological significance. Of the biological variations in man, skin colour differences are the most observable. Early attempts to classify races were based on pigmentary differences as an index of classification, and the human species were continuously classified into different major groups. Linnaeous was one of the first to classify race based on skin colour and in 1775 Blumenbach distinguished five races of man by means of skin colour; his classifications consisted of the yellow race (Mongolian), brown race (Malaysian), red race (American), black race (Ethiopian) and the white race (Caucasian). With more systematic approach to colour measurements, and the observation of a strong clinal component, such distinct classification have been altered. It is evident that there

is no limit to the process of subdivision and subclassification, since various diversities are responses to environmental and ecological factors in addition to the genetic factors involved, and skin colour diversities are valuable regional adaptations.

Race is now defined as a biological term, and is the result of the interaction of both the genes and the environment, and it is through the mechanism of natural selection that various adaptation and modification causes racial variations. 'Race' could refer to any population or aggregate of people isolated geographically, linguistically and socio-culturally. It is also referred to a reproductive community sharing a common gene pool. Although there are few distinct breeding units in case or extreme geographical and cultural factors, usually boundaries of mating units diffuse, by migration, and hence no population is one hundred per cent pure and homogeneons and genetically uniform, and it seems logical to presume that racial differences originated by natural mechanism, gene flow and genetic drift. Skin colour and races do not necessarily correspond, since in a single race variations of all kinds, biochemical and physical exist, and the better understanding of the genes structure and function allows for observing further complexity in their influences upon one or many characters, even in one individual. Variation is the basis upon which any organism or species can allow for survival, due to the fact that nature and the immediate environment of the organism is so unpredictable that a process of adaptation is necessary to ensure reproduction and propagation. Therefore it leaves no question to the significance and value of such diversities whether in gene frequency, the different polymorphic traits and pigmentation.

Differences between populations are calculated by comparing averages through statistical procedures, and by plotting such av-

erages of different traits on a graph a pattern of geographical distribution becomes evident. Gradient of change on clines are very common than sharp boundaries, and these gradients are found in both metrical as well as discontinuous traits. Pigmentation is one variation whose geographical distribution is evident, but the technical difficulties have hindered the collection of exact data and also the complexity of the inheritance of pigmentary differences and the pigments themselves have been difficult to analyze chemically.

EVOLUTION AND DISTRIBUTION

It is generally assumed that most morphological and physiological characteristic either have or have had significant adaptive values and have contributed to survival. This assumption includes both internal and external traits and on this basis, it has seemed legitimate to assume that in man as in the majority of tessestial vertebrates, the nature of body surface, whether naked skin, pelage or plumage, represent past or current adaptive attributes. Because vascularized naked skin comes into direct contact with the environment, therefore differences in the dermal colour of naked animals including man have had value in terms of possible physiological effects. (Blume, 1961).

Gloger's theory of colouring concealment, assumes that the value of concealment for hominoids and hominids, when evolving man was weaponless and fireless in the tropics and naked for an immensely long time, promoted effectiveness in food getting with numerous incidental gains, in addition of reducing succeptibility to visually cued predators, and because of man's current distribution into various ecological settings the accumulation of social, technical and cultural advances must have enabled the possessors of a negroid albedo (coe-

fficient of reflectance) to disperse with the trait and survive in other areas, becoming emancipated from the forces of natural selection.

Blume (1961) criticises Gloger's hypothesis on stressing the advantage of black or brown pigment in reducing visibility, and regards it more as an adaptation to local environmental situation, than to a global situation.

It is suggested that the original colour of the immediate ancestors of man could have been as diverse as the skin pigment of the different anthropoid apes (Fleure 1945) (Washburn 1964). It is possible that a certain section of mankind may have arisen from light skinned, and another from dark skinned people. Theoretically there is no reason to believe that there was a single pair of genes responsible for the colour of human progenitors, and there might have been variations in the human species and primitive man. If adopting the hypothesis that the ancestors of mankind were black, (apparently, dark skin was widespread even over Europe in pre-historic days, and also for physiological reasons, that is for thermo-regulation the hominids of Pleistocene had lost their hair, and consequently had to be protected against ultra-violet radiation in areas of Africa), then the semi-albinic conditions characteristics of the Europeans and most of the inhabitants of Asia must have arisen through a mutation unfavourable to the production of black pigment and much melanin. It seems logical to presume that hominids migration to colder regions and higher latitudes, might have rendered lighter skin, by natural selection, in areas of less ultra-violet radiation. Contrariwise, assuming that the ancestors had a creamy or coloured skin, then the deep pigmentation found in Negroes, Negroids and Australoids, must

have arisen by a special mutant in direction of melanization

It seems a priori that melanin in man is of the nature of a mutation occuring in equatorial regions serving as a protection of the underlying tissues and viscera from strong sunlight, and that the inhabitants of different regions or latitudes must have gone through physiological adaptations. (Davenport, 1926). Fleuré's (1945) conclusion is that most early men of modern type in the area of hand-ax culture were rather brown in colouring and that there were specializations in two directions, towards intensification or diminution of melanin. Poiriez (1977) suggests that originally skin was darkly pigmented, and light pigmentation may be a more recent adaptation, to non-tropical habitants.

Man's early habital in the early Pleistocene was in tropical surroundings, and migrations to northern latitudes during warm interglacial or interstadial periods, exerted both physiological and behavioral adaptations, and the use of fire, clothing and tools made living in different climatic zones practical in Paleolithic period, therefore such biological acclimitization also played an important role. It may be that moving out toward lower light intensities, some populations experienced difficulty (especially the darkly pigmented), from rickets and cold damage. Dr. Post, postulated that darker skins were more succeptible to frost bite and cold, and lighter individuals might have had advantage in facing the cold and receiving enough ultra-violet radiation for its chemical synthesis of vitamin D, and therefore leaving more surviving offspring in the more temperate areas.

Skin colour differences between ethnic groups are on the average larger than what can be explained by environmental effects.

It is clear that there is a large genetic component to the trait, and skin colour varies in response to environmental conditions. Everyone including blacks tan when exposed to the sun, and the tanning reaction has survival value. Albino and those who cannot tan face serious problems, and therefore natural selection is involved in determining the world wide distribution of skin colour.

Skin pigmentation shows a regularity in its geographical distribution, and there appears to be a strong clinal component to the variation in each of the four quadrants of longtitude, apparently independent of a strong continental component. The selective advantages of a particular skin colour in a particular environment are not fully clear, but heavy pigmentation in regions of intense solar radiation certainly provides a protection against the burning and carcinogenic effect of actinic rays, and the depigmentation in Western Europe as Coon, Barn and Birdsell (1950) suggest favours the manufacture of vitamin D, in cloudy environments.

The absence of high intensity ultra-violet radiation of long duration and the relatively cold climate and low humidity might have provided a suitable environment for the development of the blond Nordic racial type. Blond or near Albinotic individuals appear in other regions of the globe as well, but in the tropics they are all at serious disadvantage, developing cancer and dying before maturity. The rate of melanogenesis adequate for the Nordic's survival in its original habitat is deleterious when exposed to a higher intensity of solar radiation, and individuals with a higher content of melanin present in the skin, or a high rate of melanogenic activity would not be subject to such damages.

There is no satisfactory evidence of pigmentary differences due to the direct sunlight while the aborigines of Central and Southern Africa are deeply pigmented, as are the natives of Ceylon, Papua and Australia, the southern Australians live entirely outside the tropics, and the Tasmans who were very dark lived at latitude of 42 to 43°, and contrariwise, the Indians of the equatorial Brazil and Ecuador seem to have never attained the dark colour of the Negroes. The heavy pigmentations of the forest region is not explicable in such terms either, unless it could be assumed that the inhabitants are of a recent migrant from other regions, and have not yet attained such environmental adaptations. In tropical zones there seems to be a difference between jungle and shaded areas, and non-shaded people; e.g. the African pygmies are lighter coloured on the whole living in shaded areas, than the surrounding Bantu. The yellow of the Northern Mongoloids in other features ideally adapted to the cold is a compromise between protection against arctic insolation and conservation of heat. The intensity of solar radiation is not necessarily high in all tropical areas, e.g. tropical rain forests, and at least in certain seasons, it may be high in the Arctic owing to reflection from the snow. Therefore, there are exceptions to the geographical rule in skin colour throughout the globe, and on the whole there is a lack of satisfactory qualitative comparison of ultra-violet radiation load in various environments. Also it must be noted that similarity in skin colour between populations need not necessarily mean a close phyletic relationship, but merely similarity in climatic environment and a parallel adaptation; e.g. the Australian aborigenes and the African negroes have no phyletic relationship, and all are heavily pigmented.

STRUCTURE AND PIGMENT

Skin is the first line of encounter with the external environment, and the integument is continuously exposed to fluctuations in temperature, solar radiation, friction and various biological and chemical agents, and it also presents a barrier towards the internal milieu, so to maintain the fluid balance. It is now possible to visualize the colour complexion of the whole individual by examining the pigment granules of the epidermal cells in the electron microscope.

Skin consists of two types of tissues: the epidermis is comprised of several layers of epithelical cells, and these layers are maintained by the underlying connective tissue, the dermis. Although the specialized products of the epidermis, keratin and melanin, play an important role in the protection of the organism, the dermis is primarily responsible for the differential and maintainance of the epidermis. The basal epidermis, (the Malphigian cell) main function is to form a fibrous protein, keratin. These basal epidermal cells are also able to form glands, the sebaceous and the sweat glands, regulating the fluid balance. The Malphigian cells also form an integumentary system.

The observed phenotypic differences between human populations in skin pigmentation, sweating and hairiness are due to functional, and not to anatomical differences. Szabo (1970), showed that the corresponding regions of Negroes and Caucasian skin contain equal number of melonocytes; thus the observable colour differences are due to differences in the activity of the melanocytes, and the frequency and distribution of sweat glands and ducts is also similar in all human populations studied. An exception to this pattern of anatomical and numerical equality has been reported by Mitchell (1968), in the number

of epidermal melanocytes in the forearm skin being significantly higher in Australian aborigines than in the Australian Caucasians. The increase in activity and number of melanocytes is due to multiple exposure of skin to ultra-violet light. Considering the thickness of the skin, there are no obvious racial differences of the stratum corneum, though it is true that chronically exposed skin shows a thicker keratin layer.

The melanocyte density does not differ significantly between corresponding areas of the epidermis in various racial types (Szabo 59, 67b). There is also inherent genetic differences acting on the pigmentary system to produce the observed differences in melanocyte numbers (Garcia et al, 1968) The environmental component also varies with different positions on the skin since not only are different parts of the body differentially exposed to solar radiation, but also it has been shown that different areas have varying capacities to tan (Edwards and Duntley, 1939). Counts on negroes and light skinned people on the number of melanocytes per unit area of skin reveal essentially the same means for a given body region, so that major population differences in skin colour do not appear to depend on variation in melanocyte number. In Negroes the granules are more numerous and larger, while in lighter skin only few brownish granules can be seen in the basal layer of the epidermis. In a negro this layer is densley black and granules are also conspicuous in the Malphigian layer and in the stratum corneum.

Melanocyte synthesize an enzyme, tyrosinase, which catalyses the oxidation of tyrosine (hydrophenylalanine, formed from the essential amino-acid, phenylalanine in the liver) into dihydroexphenylalanine or DOPA and following the oxidation process DOPA is polymerized into melanin. Tyrosinase catalyses the reaction that takes place inside the melanocyte in a specific cell organelle,

the melanosome, which shows a species - specific size, shape, and the internal structure being oval in man, its long axis is longer in racial types such as Negroids and Australian aborigines (0.8 - 1.0 um) and shorter in Mongoloids (0.5um); Caucasoid have melanosome that vary in length. The diameter of the orgenelle is about 0.25-0.5 um. Except for the differences in size of the melanosome, Homo Sapiens have a remarkably uniform melanosome structure. Melanosome produced by the melanocytes, enters the Malphigian cells by a uniform phenomenon of cell to cell propagation. The Melanosomes are incorporated into the keratinocytes, and are either kept in complexes or are dispersed individually. The keratinocytes control the dispersion or the melanosome after their transfer. (Szabo, 1975).

The skin as a series of different layers,each reflect a portion of the impinging light after absorbing a certain amount at a certain wavelength, which are succeptible to absorption by the pigments which lie in the layer. From experiments it can be affirmed that light striking the body penetrates the entire skin, including the subcutaneous fat.

Five pigments and an additional optical effect designated as scattering are factors in skin colour. These pigments are melanin, melanoid (a derivative of melanin), Oxyhemoglobin, reduced homoglobin and carotene. The turbidity of the deeper layers of the epidermis furnishes the added effect of scattering, influencing the colour.

Granules of melanin are seen in microscopic sections of skin located in the basal layer of the epidermis. It is formed by specialized dendritic cells, the melanocytes, which originate in the neural crest, near the embryonic nervous system, where they retain their neural morphology, as shown by their dendritic processes which are firmly inserted between the Malphigian cells. The melanocytes make

granules of pigment about 0.5um (um= 1/1000 mm) in diameter, and pass them into epidermal cells by way of their processes. Some melanin may also be found in the dermis where it is massed in the melanophone (Szabo 1975). It is confirmed that Melanin has a pronounced absorption at the violet end of the spectrum, but very little absorption at the red end. On histological observation, the variation in the amount of melanin in the epidermis, is responsible for differences in racial colorization. In light skinned people, with little melanin, the colour depends chiefly on the blood and varies according to the amount in the vessels and the state of oxygenation of the haemoglobin. In dark skin, the contribution of the blood supply to colour is masked to a greater or lesser extent by melanin.

In regard to melanin's amount and distribution, the normal deposition of melanin is governed by two seperate mechanisms and the resulting pigmentation is of two types: the primary or native pigmentation, where its deposition is controlled by constitutional and racial factors, is responsible for differences between brunettes and blond whites and the darkness of the negro, and also for regional characteristics, exemplified in the melanization of the eyelids, nipple and the scrotum. The second type of deposition is characterized as acquired, here the melanin forms in response to exposure to light and then dissappears after the stimulus is removed, and the formation depends upon the ease with which light could penetrate the epidermis, and also on the inherent ability of the individual to react to the light stimulus; so that in dark races, the primary melanin layer is so heavy that it needs strong exposure to cause stimuli

for reaction. Secondary pigmentation is minimal in very blond whites in whom light penetrates with ease, but the body's ability to react is minimal, while the brunette in whom again light penetrates easily, the reaction is sufficient to form secondary pigmentation. This reaction is called 'tanning' , due to an increase in melanin. Melanization also occurs in the spotty form known as freckle. Women's skin is generally poorer in melanin than in men, and melanin is the most characteristic pigment of the skin.

The disintegration of melanin particles gives rise to a different pigment in the epidermis called 'melanoid'. Its absorption slope resembles melanin, but with its maximum shifted from the ultraviolet to the visible violet. Due to its absorption characteristic it tends to make the skin a yellow of higher purity. The amount of melanoid depends upon the amount formed and stored: the formation being related to the concentration of melanin in the particular locality and the storage related to the thickness of the epidermis. Since melanoid is found in cells derived from melanin-bearing cells and resembles melanin spectrophotometrically, it is regarded as a degradation product of melanin (Szabo 1975).

Another factor contributing to skin colour is blood's most important pigment, haemoglobin, present as a mixture of oxy - and reduced haemoglobin. Each form shows characteristic absorption bands and transmission peaks. Melanin because of the absorption across the spectrum depresses the entire curve and tends to blunt the bands of oxy-haemoglobin. Both forms absorb light strongly in the 400 to 500 mu range. Haemoglobin is found in the vessels of the dermis and subcutaneons tissue. Although differences in vascular supply alter the haemoglobin's contribution in different individuals, in

different skin area of the same individual, and in the same anatomical position under different physiological conditions, there appears to be no significant differences between races in this component and under conditions of constant temperature and activity, the vascular supply to such areas as the medial aspect of the unexposed upper arm is very constant (Harrison, 1957). The presence of oxy-haemoglobin bands in certain regions are indication of a rich arterial supply and a fast rate of blood flow contrariwise the presence of reduced haemoglobin bands in other regions indicate a preponderantly venous vascular bed in the skin and a sluggish blood flow.

Carotene is found in the stratum corneum of the epidermis, as well as in the fat of the dermis and subcutaneous tissue. It is found to be responsible for an absorption band in the blue region of the skin spectrum at 482 mu. It occurs especially in parts of the body where this layer is relatively thick like the palms and soles, where the epidermal and cappilary blood layers are both heavy. Bodily carotene is derived from ingested food and variations in dietary habits amy account for fluctuations in the carotene content of the skin. The Japanese have a very rich diet of carotene, so that carotenemia is quite common in them, while dark skins have not shown any increase in carotene. (Szabo, 1975).

Sweat and sebum contribute very little to the colour of skin, indirectly by collecting dust or other extraneous material from the atmosphere and by deposition on the skin, which may effect a transient modification of skin colour.

Both layers of the epidermis, especially the mucosum exhibits the phenomenon of scattering; this scattering tends to raise the blue end of the reflected spectrum. Scattering consists of the rearrangement of light as it passes through a turbid medium, and contains correspondingly of shorter wavelengths. Since the whole epidermis and especially the stratum mucosum

varies considerably in thickness in different parts of the body, the degree of scattering likewise varies. Practically, regional variations of scattering are not well-appreciated by spectrophotometry, since the size induced by scattering is offset by the absorption of the melanoid, which is always larger in amount in a thick mucosum. (Szabo, 1975). The presence of keratin is also of importance in the role of scattering light, protecting the underlaying tissue and when melanin is reduced or absent, it may play the role of defence and protection.

It has been shown (Harrison and Owen 1956) that in vitro, the melanin concentration is linearly proportional to the reciprocal of the reflectance value. At short wavelength and high concentration of melanin, the relationship tends to be disturbed, but at long wavelengths, linearity is evident over a considerable range of concentration. It has further been found that the effect of scattering of light by the skin does not profoundly effect this relationship. The measurement of the reflectance of red light provides the most reliable method for detecting the melanin concentration in skin. (Harrison 1957).

Until recently melanin was considered a chemically inert pigment with the sole function of pigmentation. From studies it was demonstrated that the circulation of melanin in normal hyperpigmented man, the stable free radical property of melanin allows to form charge transfer complexes with certain pharmacological agents, e.g. phenothiazine. Melanin also influences biochemical reactions which may be of significance in the aetiopathogenesis of certain diseases and clinical matters. (Wasserman, 1968).

ENVIRONMENTAL CORRELATIONS

Of particular importance to human life is the environmental solar radiation, in the ultra-violet range, the radioactivity in the form of cosmic rays and the emission of radioactive elements in the earth's outer layer and in the air to which man has had a long geological period in which

to develop adequate adjustments. The world distribution of ultra-violet radiation is not known exactly, but a strong latitudinal effect can be assumed. Absorption by ozone which excludes nearly all wavelengths shorter than 0.285 um, explains most of the variation of ultra-violet light with season, time of the day, and latitude. Although absorption by ozone will mean that little ultra-violet light is received directly from the sun, when it is more than 45° from zenith, there is still a high proportion of erythemal radiation coming by reflection from the sky. Shorter wavelengths are scattered much more by gas molecules of the atmosphere than are the longer ones, so sky radiation is richer in ultra-violet than in the visible radiation, (Harrison et al., 1977).

Solar radiation has always constituted a ubiquitous and essential component of man's environment, acting directly on man and altering his chemical composition. The direct effect of light can be defined as chemical changes in the tissue constituents, resulting from the absorption of light energy in the tissue. The molecule that absorbs the photons may or may not be photo-chemically transformed in the process and more commonly it is not and the photic energy is dissipated as heat. Moreover light can cause chemical changes through the process of photosentization in molecules other than those actually absorbing photic energy (Cardinali and Wartman, 1975). Much of the radiation reaching the surface of the body does not penetrate to the deeper melanin containing layers. It is scattered, reflected and absorbed in the horny layers of the skin; however, some radiation reaches the deeper layers. Sheets of the stratum corneum from African and Europeans in Nigeria having similar thickness and exposed to ultra-violet radiation, resulted in the European specimen showing probounced penetration and much less in the African skin. Comparing darker Europeans with fairer ones, it was found (Thomson, 1955) that the latter absorbed more radiant energy in the dermis, while the former absorbed the greater part in the basal layer. On studies with ultra-violet therapy shows that

active rays do penetrate so deep to affect at least the superficial capillary circulation or to stimulate the nerve ending. (Roberts, 1977).

Solar radiation varies enormously according to the region and time and atmospheric condition. The effective load of solar radiation is determined by direct ultra-violet, visible and infra-red radiation, from the sun, and by the amount of energy diffused and reflected from clouds, trees etc. Other environmental variables are also correlated with skin colour. Recent studies by Roberts and Kahlon (1976) using reflectance data have shown that among a number of environmental variables there is a dominating association of pigmentation with latitude, and on a world-wide basis the relationship of mean pigmentation with environmental variable is remarkably close. Their regression equation of inner upper arm reflectance on the main environmental variables, which demonstrates the dominating influence of latitude and the combination of temperature, humidity and altitude, can be used to predict skin reflectances for populations in regions where the value of the appropriate environmental variables are known. Such association exists for both long and short wavelengths. Association with latitude predominates at all wavelengths, which accounts for a very great proportion of the total variance observed in the reflectance means observed in the human populations. Of the environmental variable associated with latitude, the amount of ultra-violet radiation received at the earth's surface varies inversely with latitude;theeffect of both at a given locality is modified by other variables.

These findings support the theory that geographical variations in the intensity of melanin is closely related to the intensity of ultra-violet although skin colour should be regarded as a complex of entities of different selective value rather than a single entity. The Sudanese region of Africa are exposed to the most intense solar radiation and have the heaviest pigmentation and the inhabitants of the hot deserts of

the New World are recent immigrants who have not yet been adjusted. The clouded western seaboards of the continent in temperate latitude have the least sunlight; in the Arctic, the open dust-free skies of summer and reflection from the snow and ice expose the individual to strong ultra-violet radiation and the Arctic people tend to be darker than temperate ones.

INHERITANCE AND GENETICS

Genes with a cumulative effect are very important in understanding the determination of characters like skin colour, which vary both in families and in populations, where discrete classes of individuals can be recognised. Skin colour is a continuous, graded and intermediate trait, and its quantitative measurement conforms more or less to the 'Caussian' curve. In such traits some kind of blending inheritance is involved. It can be shown that if a character is determined by a large number of genes acting together, it would display the continuous variation that is observed and the distribution of the variation of the measurement would be symmetrical with the intermediate pheno-types more common that the extremes pheno-types. It is apparent that as the number of geres responsible for a particular variation increases, it becomes correspondingly difficult to recognise distinct classes, and when large numbers of genes are involved, the frequency distribution would be continuous. Skin colour is controlled by polygenes whose individual effects are small, but act cumulatively in the determination of a single character, and the inheritance of such characters are polygenic and multifactorial.

Considering the polygenic character of pigmentary variation within a population, a polygenic hypothesis appears reasonable. Skin colour being a continuously varying character with no clearly defined phenotype classes, necessitates the theory that more than one gene pair must be involved, and for the genetic basis of differences between populations, studies of hybrid

populations are necessary. Reflectometric studies on matings between African and Europeans confirm the impression that clear segregation does not generally occur.

The average measurements of melanin pigmentation in the F_1 hybrids (mulattoes), between African and European parents, are close to the mid value between the parental means, indicating no dominance of the gene involved, and the same is true of back-crosses between mulattoes and the members of the parental populations. It has been claimed (Harrison et al., 1977) that skin colour differences in the progeny of matings between Australian Aborigines and Europeans can be attributed to segregation for a few genes only. There is no evidence for recessive genes with a major darkening effect on pigmentation, and if the normal range is due to a number of genes with simple additive effects, cases would be expected in which a child was somewhat darker than either parent, but the differences would be slight.

The general opinion of geneticists and anthropologists is that pigmentation is due to a number of genes that have an additive effect. Responsible genes are additive on average in their effects in hybrids, when parental populations are not true breeding and have heterogeneous origin. (Edwards and Duntley, 1939). Davenport and Danielson (1913), who made a systematic study on the West Indies coloured population, using the Bradley Colour Top, postulated from their observations on hybrid families, a two gene pair system, in which the whites were sstt and Negroes were SSTT, and the genes responsible for increased pigmentation had equal and additive effects. Barnes (1929) reanalysed Davenport and Danielson's data and concluded that although there was little evidence for a slight degree of dominance, no simple genetic model could be fitted to the data.

Opinions differ as to the most probable number of gene pairs involved. The results of the hybrids agree with the hypothesis that there might be four genes responsible in determining skin colour, and each of these four

genes may be responsible for about ½ of the skin colour differences between black and white and the final difference is the outcome of the cumulative action. (Poirier 1977).

Stern (1953) has attempted to discover the number of loci involved in pigmentation in hybrid populations (Negroes and Europeans) by comparing the observed frequency distribution of skin colour in American negroes with model distributions calculated for different numbers of gene pairs, and has calculated about three or four gene pairs involved in determining most of the differences in skin colour.

The fact that quantitatively varying characters depend upon many loci, necessarily introduces the complication that at some loci, there may be dominance, at others partial dominance, and yet at others no dominance at all. It is in terms of overall dominance effect and also that there would be linkage between the polygenes and possibly non-additiveness of effect due to locus interaction which cannot be sealed away. (Gardner, 1968).

Kalla's work (1969) supports the view that five gene pairs are most probably responsible for the inheritance and the variation of human skin colour and these five genes and their respective alleles are capable of independent assortment, and also that the genes are cumulative in nature, thereby causing an additive phenotypic effect which accounts for the respective reflectance value of 685 mu of the different phenotypes.

Harrison and Owen (1956) have found that the variation in skin colour in the whites is very much smaller than in the negroes, due to the fact that the white might have come from a very restricted locality, while the negroe sample include representatives from all over West Africa. The high variability of the total first generation hybrid sample suggests such an explanation.

Chi-square values have been calculated between expected and observed frequencies of phenotypes in different mating types from each of the three assumed hypothesis, assuming three, four or five gene pairs respectively.

From these Chi-square tests it is evident that a general agreement between the expected and the observed frequencies of the different phenotypes in respective matings have been reached only when five gene pairs are held responsible for the inheritance of skin colour (Kalla, 1969).

It has been shown that scales can be constructed for E.E.L. reflectance spechrophotometer measurements on which the genes for at least the difference between Africans and Europeans are additive and on which there is little or no interaction between the component and the marked effect that the environment may produce (Harrison and Owen, 1964). This means that skin colour can now not only be used as a measure of the affinity between populations, but can only be subjected to the formal analyses of quantitative variation and used for measuring problems in population genetics, such as the relative contribution of parental races to a hybrid population (Harrison et al, 1963).

There is a fundamental genetic basis of skin colour difference, both within and between races. There are some individual major genes which segregate in Mendelian fashion, affecting skin colour. For example, Phenylketonuria, show lighter pigmentation, being a recessive condition (Roberts, 1977). The study of melanin synthesis from phenylalanine and Tyrosine has provided a biochemical basis for genetic abnormalities such as albinism, phenylketonuria and alkaptonuria, but has not elucidated the genetics of normal skin pigmentation.

Interesting indirect supporting evidence as the number of genes involved in population differences comes from studies by Livingstone (1969, 1972). He finds that with four loci, the evolution of the range of human skin colour differences would take about 800 generations with no dominance, even with slight differences in fitness (6% maximum) and migration between populations. In his subsequent model he also took into account the effects of population size, genetic drift and allele fixation. This work shows that observed differences are not incompatible with reasonable estimates of sel-

ection in man and duration of modern human evolution.

PHYSIOLOGICAL ADAPTATIONS

Many hypotheses have been put forward as causes for pigmentary variations and distribution. Ultra-violet radiation depending in the locality has its own beneficial and disadvantageous effects. Natural sunlight acting directly on the cells of the skin of the subcutaneous tissues produces both protective and pathological responses. Of its protective responses is increase in the synthesis of malanin-pigments by epidermal melonocytes and an acceleration of cell-division leading to thickening of the ultra-violet absorbing layers, it also initiates photo-chemical and photosensitizative reactions affecting components in the extra-cellular fluid, including the circulating blood, and the photo activation of vitamin D.

One hypothesis proposed by Loomis (1967,8) as a physiological protective response to the ultra-violet radiation is the vitamin D hypothesis. Mammals require vitamin D for calcification and bone growth, and vitamin D_3 or cholecalciferol is formed and synthesized from certain steroids in the deeper layers of the skin and the subcutaneous tissues, when ultra-violet light is absorbed by its provatimin, 7 dehydrocholestrol. Recent studies by De Luca and others have shown that vitamin D components are further transformed by the liver and kidneys to the more active metabolites, acting on the intestinal mucosa to facilitate calcium absorption, and on the bone to facilitate calcium exchange.

Light skin represents an adaptation to low level of ultra-violet radiation, where decreased melanin is necessary for maximal usage of ultra-violet radiation in synthesizing vitamin D. Such skin is adaptive in northern latitudes where sunlight is minimal. Vitamin D deficiency can result in rickets and scoliosis (abnormal spinal curvature), among other defects,

which could interfere with the birth process. Children who have been chronically exposed to inadequate amount of sunlight develop rickets, a deforming disease characterized by undermineralization of the bones. The disease can be cured by irradiating the skin with ultra light and by feeding the afflicted with vitamin D daily. Lightly pigmented individuals are at an advantage in low light regions and little melanin allows increased ability to absorb sufficient light. In high latitude, the amount of ultra-violet light that penetrates to the appropriate skin layers is not sufficient to produce enough vitamin D, if the skin is too highly pigmented, this is because the ultra-violet light is absorbed by the pigment in the skin before it could promote the synthesis of the vitamin. Therefore natural selection has acted in favour of light pigmentation in high latitudes and contrariwise, darker pigmentation in the tropical and low latitude. It seems logical that such physiological metabolism are adaptive and selected for in the various environments.

In general while a vitamin D deficiency is harmful, too much of it (hypervitaminosis D) would also result in failure of bone calcification and pathological calcification, and while the dark skin reflects some of the radiation, the light skin would suffer from dermatological disease.

There are indeed exceptions to such ahypothesis. The Eskimos and the Lapps have relatively dark skin, although they live at extremely high latitudes, but they have diets very rich in natural vitamin D, and consequently have much less need to produce the vitamin with the help of the sun. (Bodmer, Cavalli and Sforza,1976).

There is implication that selection for depigmentation has been strong from recent genetic studies of overall dominance of the genes from the white parent over those from the black parent. Therefore, increase in areas of minimal sunshine where dietary vitamin D is low, and increase access of

these rays to the deeper layers would be selectively advantageous (Roberts, 77).

Another hypothesis is proposed by Fleure (1945) that when concerning the brown granules, the kidneys seem to be less efficient in hot climates and more of the work of the excretion may be done by the skin though deposition of brown granules. That excretion may also be helped by extrusion of sweat, since increase in the size and functioning of the sweat glands and expansion of the blood capillaries of the skin may be valuable in reducing surplus internal heat of the body radiation and evaporation. Dispersion of internal heat is a function needing every assistance in environments in which temperature frequently goes above the 98.6^{0}F . In the Guinea coast of Africa, brown pigment helps to reduce penetration of the heat and the people have considerable development of capillary blood vessels of skin as well as large sweat glands, both valuable cooling agencies in the moist hot climate.

Thermoregulation is also proposed as a possible physiological adaptation. Dark skin reflects considerably less light energy and absorbs more the solar energy. Almost half of the energy of the sunlight that reaches the surface of the earth lies in the visible wavelength and it is this part of the solar radiation that is absorbed in greater amounts by dark skin. (Poirier 1977). Black skin absorbs 80% or more of incident visible light while light skin only about 60% or less. About 95% of the infrared part of the radiation responsible for thermal effect is absorbed by a depth of 2mm of skin surface, and 99% of it by a depth of 3mm, thus suggesting that the differentiated response of heat load from solar energy resides in the pigmented part of the epidermis, (Hardy and Muschenheim, 1936). It becomes evident that dark skin must experience an increase heat intake for this reason. The extra load on the temperature-regulating mechanism even in strong sunlight is probably small, but it might be a significant disadvantage, when the subject is near to limits of tolerance, but it is suggested that the

heat-load problem does not seem to be the main selective force involved in the emphasis on pigmentary distribution. (Poitier 1977)

It has been suggested that the melanin of the Negro, because it brings about greater local heating of the skin, leads to a more profuse sweating and that this is of advantage in the tropics. Thomson (1951) has shown that sunburn tends to reduce sweating in white skin to a greater degree than in negro skin, and this might conceivably give the Negroes a certain advantage in this regard. Blume (1961) argues that while profuse sweating may confer a somewhat greater degree of comfort under conditions where water is rapidly evaporated, it could only increase the water loss and that this is quite disadvantageous with regard to survival. On the selective advantage of deeper pigmentation in association with thermo-regulation is its less succeptibility to sunburn damage, which could damage the sweat glands and disturb them functioning and hence heat regulation, therefore efficient sweating is a critical factor for dark skin. Dr Roberts (1977) also suggests that acclimitization to heat as a component of adaptive role of melanin against solar radiation appears reasonable and that deeper pigmentation triggers earlier activation of heat loss mechanisms, such as sweating, or perhaps the heat load is insufficient for the disadvantages to operate. Another possibility is that pigmented skin may act as a more efficient dissipator of the solar heat load by radiation (Harrison 1961).

It seems, therefore, that melanin not only bestows on deeply pigmented skin the potential selective advantage of protection against carcinogenic effect of ultra-violet rays, it also safeguards against interthermo regulative activites. The evidence for such a hypotheses is conflicting, and several studies suggest small differences of about 2 to 3%, in the emissivity coefficients of black and white skin between 5000nm and 8000nm; but even a small physical effect of this magnitude may be significant from the point of view of adaptation or survival (Roberts 1977).

Wasserman (1965) argues that the main selective factor in the evolution of darker pigmentation in the tropics is disease and not climatic factors. His argument is based on the primary need for survival for tropical people, being protection against many infectious and parasitic diseases, and that the dark skin is a by-product of successful adaptation of a more efficient reticuleondothelial system. Dr. Roberts considers this hypotheses inadequate in explaining the lighter pigmentation of the whiter skin apart from it ignoring other adaptive values of malanin.

The ultra-violet part of the spectrum in greater doses promotes injury in the form of sunburn and carcinogenesis. The carcinogenic wavelength lies between 2537 and 3341 A, A = Angstrom, (wavelengths are commonly expressed in either Angstrom units, (A U or A); milli-microns (mu); or microns (u).

4000 A.U = 400mu = 0.4u = 4 x 10 - 5cm)

while erythema (redenning) is induced increasingly rapidly at wavelength less that 3200, reaching a maximum of 2800 A. Mid-ultra violet erythermal radiation (290 - 320nm) causes sunburn to appear within several hours of exposure. The inflammatory reaction results from the release of vasocative substances from damaged epidermal cells. These substances presumably diffuse into the dermis where they damage the capillaries (dilating the small blood vessels), causing erythema, heat and swelling (Robert 1977). Chronic exposure to the sun for long duration can cause permanent changes in skin structure in the epidermis. These changes include skin atrophy, the formation of keratin plaques and the appearance of squamous cell carcinoma, in succeptible individuals; Dermal changes include the disintergration of collagen and elatis fibres. (Cardinali and Wartman, 1975).

From such damages, adaptations occur in that as the erythermal threshhold is raised, sunburn subsides and suntan develops. The protective effect which develops involves two processes, the thickening of the stratum corneum,

and melanization. The decrease in epidermal penetration to solar radiation brought about by corneal thickening is demonstrable in utiliginous and in albino skin, who do not tan, but increase their erythermal threshhold. Damage to the skin also involves the sweat glands and during the erythematic period an individual's heat regulating ability is disturbed.

In general pigmented skin is immune to such dermal and cellular damages. In many regions such as Africa, Australia and parts of the Southern U.S.A., the incidence of cancer of the skin (epithelomia) of parts of the body habitually exposed, is considerably higher in light-skinned people, than the pigmented inhabitants of the regions, providing selective values for pigmented individuals.

In the white population, cutaneous cancer (basal cell and squanomous cell cancer) pre-dominates on the face and principle exposed sites, and the incidence is greatest in regions of high intensity sunlight, and its incidence decreases with increasing latitude. Melanoma also becomes more common among white skinned people as the tropics are approached The rarity of cutaneous cancer in dark-skinned as compared to white skin is notable. The selective effect of protection against these tumours is small being relatively infrequent and occuring mainly in the later years of life after reproduction has ceased, but melonoma, also rare, is selectively more severe since it could occur in young adults; it is a pigmented tumour which in Europeans arises from pigmented spots in the epidermis and in the Negroes from relatively unpigmented regions of the body. Melonoma are rare in negroes, yet malignant melonoma next to Squanomous-cell cancer is the commonest form of malignant disease seen in the East and Central Africa (Roberts, 1977).

Ultra-violet radiation can also produce mutation in living human cells, modifying the DNA structure by radiation of wavelengths between 300 and 320 mu. Although 280mu is the optimum wavelength for producing mutations and

radiation under 290 mu is practically filtered out by the atmospheric ozone, but there are certain chemicals and natural substances which in the presence or absence of oxygen, can enable wavelengths up to 300 mu to produce mutation. (Dyer, 1969).

Therefore, it is evident that the protective role of melanin in dark coloured races, inhabiting the tropics against carcinogenics radiation is selective and of great adaptive biological value, and it does mask from a biological point of view the unadaptive heat intake ability, although the latter is yet in a state of primary investigation and it must be seriously considered that every characteristic has its own significance.

Blum (1961) in general questions the adaptive value of the melanin pigment of the human skin. He considers the relationship between the phenotype and the environment and suggest that selection depends upon the closeness of fit between the two; complete fitting should not be expected in complicated situations prevailing in nature, but a total of positive and negative values representing advantageous and disadvantageous facets of the phenotype with respect to corresponding facets of the environment. On the interaction between certain physiological responses of man and a particular facet of his environment, in this case, sunlight, the factors are quite complex, and that the particular environmental factor has many physiological effects, while other environmental factors are also acting upon the organism. From Blum's table, it is evident

Physiological effect	Negro skin	White Skin
1. Solar heat load at high environmental temperature	-	+
2. Sunburn	+	-
3. Cancer of skin	+	-
4. Prevention of rickets	$\pm$	$\pm$

that he considers both the adaptive and non-adaptive attribute of each of these factors, and questions its absolute survival value, and racial

distribution. It appears that more biological and physiological speculations is necessary to consider with absolute certainty the adaptive value of each factor involved in racial, geographical and biological variability.

PIGMENTARY VARIATION WITH SEX AND AGE

Melanin concentration in the skin is related to the amount of the enzyme tyrosinase and dopase, and these in turn are under genetic control. Melogenesis is accelerated by oestrogenic hormone, which enhances the activity of the enzyme tyrosinase (Hall, 1969), and large doses of oestrogen gives a more pronounced melanogenic effect (Snell and Bischitz. 1960). Edwards and Duntley (1939) in their study have established not only the pigments responsible for skin colour, but have also shown the influences of various steroid hormones on melanogenesis and have stimulated more recent work on the pigmentogenic properties of adrenocortical hormones. Investigation and data on the pigmentary pattern of the skin and its respond to altered hormonal status were carried out by Hall et al, 53. Their studies were based on two areas where melanin deposition is markedly responsive to sex hormone stimulation, the areola of the breast and the scrotum.

Adolescence is a period of considerable hormonal disturbance in life and creates changes in human skin pigmentation, and hormones are well known to elevate and also to suppress the melanic metabolic activity of the skin (Hamilton et Hubert, 1938; Talbot et al, 1923). It has been suggested by Kalla and Tiwari (1976) that the phenomenon of ageing may be an important factor in influencing the sex differences in human skin pigmentation. Ageing particularly during adolescence influences made of sex differences in colour.

Colour changes in childhood and adolescence among Caucasians are noted by several studies. Kahlon (1973), observed that in both sexes a darkening occurs after the first few years of life to reach a maximum at about puberty, and that after puberty a lightening of the skin occurs which appears to continue into early adult life. These effects are also more marked in females than in males. Until early adulthood the female trend is towards intensification of pigmentary pattern, thereafter the distinction of the pattern lessens, except during pregnancy where it is at the greatest extreme.

Tiwari and Kalla in their studies on two populations of Mediterranean and Tibetan origin, observed a decline in both sexes, in the melanin content of the skin when passing through adolescence, yet the decline being more pronounced in females. They also observed increase in the pigment at the age of eleven years in both sexes, which might have been due to pre-pubertal increase in the melanocyte stimulating hormones. (Marshall 1960). A similar pre-pubertal increase in the pigmentation is observed among the Quecha Indians (Conway and Baker, 1972) It is likely that after puberty there occurs a fall in the melanocyte stimulating hormones, which may account for the decrease in the melanin pigment during late adolescent period. Pre-pubertal and post-pubertal changes in both sexes are different and may be due to the degree of differential levels of melanocyte stimulating hormones, since it has been observed that the boys are lighter in colour than the girls at younger ages, and there is a reversal in that the boys become darker than the girls at advanced ages, at least up to 16 years; also that the post-pubertal decrease in the pigment is more than the pre-pubertal increase, in particularly the females, and the age curves suggest a longer duration of the pre-pubertal increase in females than in males. (Kalla 1973).

These observations suggest a dimorphism in the penultimate effects of adolescence on skin pigmentation. Age changes in human skin pigmentation have been observed by Garn et al (1956); Walsch (1964); Huzinga (1965); Omoto (1965); Tiwari and Kalla (1968, 9); Kalla (1969) and Conway and Baker (1972).

Tiwari and Kalla(1968/9) concluded from their research that some inner environmental factor must be operating to cause such effects, also behavioural factors like the degree of indoor/outdoor activities, costume and occupation, might all have their respective effects in pigmentary dimorphism. The sexual discrepancy is explained on a female hormonal basis. A study by Robins (1972) has shown that females under prolonged therapy with drugs possessing melonocyte - stimulant exhibited a proportionately greater skin melanin increase over their non-treated controls, than did the corresponding male group. Females are lighter coloured than men in general, due to the female skin containing less blood and melanin and having different vascularity;areas of strong primary melanin, like the nape of the necks, the linear nigra and the axilla show a correspondingly higher melaninratio than the equivalent structure in man; Carotene is also much greater in females (Edwards and Duntly, 1939).

TECHNIQUES OF CALLIBRATION

The older methods of comparing skin colour with printed colour standards like the 'Broca Scale', and Ridgeway's 'Colour Standards', suffer from the inconstancy of the human eye, as well as from difficulties inherent in the standards in the illunination, also the standards change during the process of repeated exposure in light, and finally from repeated printing of the scale, and the colour are not the same always. Another technique for classifying skin colour was devised by Professor Von Luschon, consisting of 36 rectangular masses of opaque glass, tinted in a graduated series to match different skin colours, but its surface

being too shiny makes the matching of the skin very difficult.

Since skin colour is a continuously varying character, especially in a hybrid population, between different pigmented people. The use of discrete standards, involving visual matching of skin colour against colour standards, introduces an unnatural discontinuity in the variation. Colour matching has been replaced by colour measurement and increased knowledge of the optical properties of the skin has broadened the theoretical implication of skin colour studies. In 1952, Weiner, realized the suitability of portable spectrophotometer which provided an accurate and objective method of measuring skin colour on a continuous scale, which largely supplanted other methods. In 1953, Edwards and Duntley used the Hardy Spectrophotometer, regarding the nature and band of absorption of the different pigments and substances in skin. The effectiveness of portable reflectometers offers a more objective quantitative study of pigmentation and has opened up the possibility of population surveys for anthropological purposes, and also for accurate work on the genetic and inheritance of pigmentary differences.

The E.E.L. (EVANS ELETROSELIUM LTD) Spectrophotometer is an instrument which measures the intensity of light in an extremely narrow band of the spectrum at a known wavelength, and it is designed to measure the reflectance of a sample in nine regions of the spectrum. The machine is designed in the form of two main units, namely a galvonometer (provided with two scales, the lower is uniformly divided in 0-100 divisions, whilst the upper is an inverse logorithmic scale marked ∞ - 100), and an applicator head which is freely movable and can be applied to the regions of the skin surface. By examing the spectral curve one may identify the pigment giving rise to colour, and evaluate their approximate quantity. This is possible since every substance has a specific absorption in some part of the spectrum. A pure white standard like Magnesium

Carbonate has absorption entirely outside the visible spectrum, while pure grays or blacks are caused by a uniform absorption within the visible spectrum.

Before connecting the reflectometer (applicator) head, the zero-setting is adjusted and for each filter the sensitivity is adjusted to give a reading of 100% against the standard. The skin reflectance is measured in the selected wavelength by reading the percentage reflectance in the linear 0-100 scale. The applicator head directs light from a 6 volt, 6-watt tungsten lamp at an angle of 45°, and focus it on the skin surface; part of the light is absorbed, while the remainder of the light which is reflected activates a photo cell, and the current generated is passed onto and measured and recorded by the galvonometer. Throughout this process the light beam emitted from the standard source (an electric bulb) passes through interchangeable filters with a known dominant wavelength and with characteristic transmission curves, before striking the skin surface. The amount of light reflected from the surface is compared with the amount reflected from a pure white standard. The EEL Spectrophotometer is equipped with nine filters of varying colours spaced throughout the visible spectrum, from the blue to the red end. These filters are referred to as Ilford Filters; they are narrow waveband filters which transmit the following dominant wavelengths: 601 - 425 nm, 602 - 455nm, 603 - 485 nm, 604 - 515 nm, 605 -545 nm, 606 - 575 nm, 607 - 605 nm, 608 - 635 nm, 609 - 685 nm.

Reflectances are inversely proportional to the melanin content at all wavelengths, however values at 635 and 685 nm are valid over a very wide range of melanin concentration (Harrison and Owen, 1956), and are little affected by the skin blood supply. None of the filters have exactly the same dominant wavelengths, and even when there is close similarity, the spectral transmission curves are quite different, (Garrard, Harrison and Owen, 1967). The mean values of reflectance at each wave-

length constitute the basic data from which indices of overall lightness and darkness can be derived. The means of the readings at nine wavelengths may be taken as an approximate measurement of overall lightness and darkness irrespective of the particular pigment or optical effects examined. (Barnicot, 1958). The amount of oxygenated blood in the skin affects the readings very little in the red region, therefore the readings at 685 mu (filter 609) is the most suitable, as a measurement due to melanin (Edwards and Duntley, 1939). In general the amount of light reflectance becomes less and less as wavelength becomes shorter and shorter, except at wavelength 605, in which for the whites, the curve rises steeply from the blue to the red end of the spectrum, and shows a pronounced trough in the green region during the absorption of light by haemoglobin. In the darker people the fall is hardly detectable and the curve is smooth and much more nearly horizontal rising less steeply towards the red end.

It has been shown from the EEL instrument that transformations are necessary such as the means of the logs of the 'blue' filter reflectance, and of antilogs of the 'red' filter reflectance are calculated. These transformations are necessary and required at 425 mu and 685 respectively, for comparing populations which differ markedly in skin colour (Harrison and Owen 1964; Weiner et al., 1964).

This instrument has been used to measure skin reflectance on different countries and populations by many anthorpologists: Weiner (1951); Lasker (1954); Barnicot (1958); Das and Mukherjee (1963); Sunderland (1967) (1973); Harrison and Owen (1964) (1967); Kalla (1969) (1973) and Cartwright (1975).

SAMPLES

During the months August and September 1979, a total of 101 boys and girls were measured for reflectance of skin colour The participants comprising 68 males and 33 females, were drawn from the inhabitants of three adjacent areas in the province of Mazandaran: Two of the areas Chalous and Nowshahr (small towns) are seperated by a distance of seven kilometers, with the third area Kourkoursar (a village) midway between them. The samples were all born in either of these regions or adjacent villages, that extends further towards the mountains (maximum distance four kilometers) and their parental origin, although not exactly clear does not go far beyond the neighboring villages and towns.

Considering the small distances existing between the many villages and towns, and also similarity in climatic conditions (the degree of humidity and rainfall) and occupation (mostly fishing and rice agriculture) constant migration and inter-marriage is expected. The only factor to be considered in the approximate vicinity of these three areas to the sea and to the mountains. The closeness to the mountains, has allowed recurrent migration (winter and summer migrations) and admixture of the coastal inhabitants with the mountaineous peoples, thus allowing for increase heterogeneity and variability within the samples.

The socio-cultural and religious regulations are important factors, when considering differences in the reflectance measurements of the two sexes. Islamic conditions prevail quite stringently, although Mazandaran was one of the last areas to be invaded by the Arabs, and this factor could be an inherent basis to the results obtained, which differentiates between the sexes activities. Males in general are more liable to outdoor activities and frequent migrations. Although females work in the rice fields like the males, but they are fully covered from head to ankle, while males use very scanty clothing are continuously exposed to solar radiation. It must also be noted that younger females are

less restricted against cultural and religious regulations, and do occasionally avoid head garments and wear sleeveless shirts, while older girls are more conscious of their social and religious duties.

Reflectance from two areas of the skin have been obtained: (1) The middle of the forehead, in between the hair line and the base of the nose, representing a region most frequently exposed to insolation, and allowing an estimate of the tanning capacity; (2) the inner surface of upper right arm, a region least or very rarely exposed. This latter region is mostly measured as representing an individual's initial pigmentation, with the characteristic of poor tanning capacity and also showing the least variation in all races, in comparison with other sites of measurement.

METHOD OF EXPERIMENT

A portable reflectance spectrophotometer (EEL), fitted with nine filters was used for this fieldwork obtained by permission from the Department of Anthropology, University of Durham.

Reflectance values were obtained for each individual throughout the whole visible spectrum, (from the blue to the red end of the Spectrum). The nine filters corresponded with the following dominant wavelengths: 601-425mu, 602-455mu, 603-485mu, 604-515mu, 605-545 mu, 606-575mu, 607-605mu, 608-635mu, and 609-685 mu. All wavelengths have been used, since the use of one wavelength in skin colour measurements would not be sufficient, since reflectance of certain wavelengths would not have the same accuracy over the total range of reflectance, because of the curved relationship between the wavelengths concerned, and calculation of the tanning capacity would not be allowed. (Ritger-Aris, 1973)

A block of magnesium carbonate ($M_g\ CO_2$), the surface of which was periodically scraped off to keep all extraneous elements off, served as a white standard reflecting 100%, against which the amount of light reflected from the skin at various spectral regions could be measured.

The performance of the instrument was periodically checked during the

course of the work, by disconnecting the applicator head from the galvonometer and checking the zeroing. For every individual measurement, the reflectance was standardized to 100% against the $M_g\ CO_2$.

The time of the investigation unfortunately, masked the real reflectance values, especially in the males, because of intense radiation prevalent in these summer months. The increase in outdoor activities, the frequent use of the sea and river for swimming and the accumulation of salt, have been considered factors allowing for fluctuations and masking of the initial pigmentation. Due to religious regulations, sites of measurements could not be cleaned, to clean off sweat and salt.

Harrison and Owen (1964) have suggested that skin reflectances at 425mu, 545mu and 685mu wavelengths are mutually more comparable if R425mu, is transformed to its logarithm, and R685mu transformed to its 'antilog'. This procedure has not been carried on for the comparitive methods adopted in this study, since it has been suggested that individual reflectances percentage are needed for such transformation, and transformation of the means would not be suitable, although Lourie (1971) suggests that the difference between the two methods are negligible.

Before proceeding to the systematic analyzation of the data available, some important considerations must be taken into account:

(a) In inter-population comparisons, average years of the samples must be considered, as has been observed that pigmentation and age are closely associated, especially during pubertal period, when physiological and hormonal changes, could cause fluctuations in the percentages reflectance values (Kalla, 1973).

(b) The Geography (Climate and latitude). The cultural and religious aspects of the populations, and the historical invasions and migrations under comparitive study must be recognized, allowing for differential degrees of indoor/outdoor activities, occupation,

type of costume, and sexual dimorphism in regards to social behaviour.

(c) Individuals and populations have varying genetic potential of tanning for each site Lee and Lasker (1959) and are also differentially exposed to solar radiation, therefore both the genetics and environmental factors must be considered.

(d) In general factors like migration, racial admixture, genetic drift and hybridization can all be a source in the observed differences when analyzing the data, specifically when the populations under comparison either belong to a similar race or inhabit somehow similar geographical and ecological areas.

The data obtained from the present study and those obtained by other researches have been analyzed in two different parts:

(1) Intra-population differences
   a. Within sex differences
   b. Between sex differences
   c. Within and between sex(es) differences in association with age.

(2) Inter-population comparisons.

INTER-POPULATION DIFFERENCES

The mean percentage values, the standard error, the standard deviation and the coefficient of relative variation, of the inner surface of the upper arm and the forehead, for each sex at nine filters (425mu to 685mu) have been calculated, and are presented in table 1. Figure 1 also demonstrates the curves obtained, when plotting the values on the graph. Figure 2 shows the observable differences in skin pigmentation, between the sexes for each site seperately.

The 't' test has been used for statistical analysis and comparison of within and between sex(es) differences at each site of measurement, and the results are presented on table 2.

It is evident by observing the data on table 1 that the female samples exhibit higher reflectances, and are lighter coloured on both sites, at all wavelengths, than are the males. On statistical analysis the differences between the males and females, for each site seperately, shows significant differences as well, throughout the spectrum with $p < .001$.

The differences between the two sites (the upper inner arm and the forehead, also show both observed and statistical differences. The effect of tanning is observable, where the arm shows higher reflectance than the forehead These differences are visible at all 9 filters as well, with $p < .001$. Such significant differences between the two sites validates the theory that if assuming the reflectance from the upper inner arm as the initial pigmentary level and those of the forehead as induced pigmentation by ultra-violet radiation, then the degree of tanning capacity of each individual or any population can be computed.

From observing Figure 1, it is seen that the differences between the two sites in each sex is different. The females show higher difference in comparison with the males. It is not very clear whether these differences can be

attributed to the differential degree of tanning, whether genetical or environmental that is if assuming that slightly darker pigmentation might tend to show a lower difference between initial and induced pigmentation, or whether it could be attributed to the socio-cultural facors, which allows the males to indulge in more outdoor activities, and exposing the upper-inner arm very frequently to insolation, and consequently minimizing the differences at the two sites. Although individuals with very similar initial pigmentation manifest various degrees of tanning (Lee and Lasker, 1959) or even in a homogeneous population, it seems more plausible to associate these degrees of differences to the overexposure of the males, in contrast to the invariably unexposure of the females at both sites.

Figure 2 also demonstrates that both sexes show less difference in the mean reflectance values on the forehead than that on the arm. This could be explained on the differential or extreme differences observed in the costume worn by the two sexes, allowing for greater differences in the arm, and also assume that females also do expose their forehead, not infrequently to allow for such differences at the two sites. The effect of tanning becomes quite clear when computing the differences between the sexes at each site. The differences at the arm is from two to three times higher than the differences between the forehead: at 425mu, the arm shows a difference of (9.87%), while the forehead mean difference is (3.77), and 685mu (9.68) and (4.6) respectively, but the mean differences do not appear to decrease at each wavelength or towards the longer wavelengths.

On observing the standard deviations, the differences in the variability cannot be clearly distinguished at each wavelength, but on observing the coefficient of relative variation (S.D x 100/$\bar{X}$) some points become clear: (The percentage coefficients are listed on table 3.

(a) A general trend of decreasing variability, towards the longer wavelengths is observed at both sites, for both sexes. This is in confirmation with other studies, in which decrease towards the red end of the spectrum has been observed in fairer pigmented skin (Barnicot, 1958; Huizinga, 1968; Harrison and Owen, 1964). It has also been suggested by the above authors, that variation is considerably greater at the blue and green region of the spectrum that at the red end of the spectrum, due to the fact that variations in the blood supply and vascular components exert their main effects at the shorter wavelengths, whose effects are masked in darker skins. The low variability at the longer wavelengths is due to the low melanin concentration in fairer skins, and accounts for more homogeniety in the melanin content of the skin.

(b) While the decrease in the variability is approximately constant throughout the spectrum on the upper inner arm, the forehead exhibits an irregular decrease, which might be caused by differential degree of exposure to ultra-violet radiation. As observable from the table the males do show higher coefficients of variability on the forehead as would be expected except at 425mu, but the females manifest this increase on the forehead at certain wavelengths only, exceptions are at 425mu, 455mu, and 545mu. Thus it could be concluded that the variability at the shorter wavelengths on the upper inner arm is higher, because of the differences in the haemoglobin concentration exerting great effects.

(c) In general, the males tend to show higher coefficient percentages than the females at both sites with very few exceptions. Such an observation might be explained either to the fact that the male

samples might be more heterogeneous in origin, or because that they are more frequently exposed to solar radiation, since tanning of the skin can increase the variability. (Lee and Lasker,. 1959). Therefore the increase observed in the males can more precisely be attributed to behavioural and cultural factors, allowing for the females to demonstrate more homogeneity.

To examine variation in melanin content of the skin with age, within each sex and between sexes, the samples have been divided and classified into three age groups, namely: pre-pubertal, pubertal and post-pubertal, Females: (8-11 years), (12-15 years),(16 and older) respectively and Males: (8-13 years), (14-19 years), (19 and older) respectively.

The mean reflectance values, of the two sites, plus their standard errors and standard deviations, on all wavelengths, for each sex, at each classified age group has been computed, and is presented on table 4.

From observations of these raw data, it is seen that females exhibit higher reflectances at all wavelengths at both sites, and at each respective age groups. It is also observed that both sexes show an increase in reflectance on the arm, from pre-pubertal via pubertal to post-pubertal period. On the forehead the trend is different. For both sexes the pre-pubertal period shows lower reflectances, and an increase in observed at pubertal period, but at the post pubertal period the females show a darkening of the pigment of the skin at all wavelengths in relation to pubertal period, and the males only exhibit an increase in reflectance at the longer wavelengths.

On statistical analysis, almost no significant differences are observed when comparing the respective age groups, of each sex on the forehead, neither are their any differences observed on the arm when comparing the pre-pubertal and pubertal period. Only significant differences are found for the females

when comparing pubertal and post-pubertal period, with few exceptions (635mu and 685mu no significant difference), and for the male when comparing the pre-pubertal and post pubertal period (with the exception of 635mu). It could be discussed that that these differences between the sexes, in association with age, are caused by the differential effects of physiological and hormonal changes, that females might be affected by hormonal chages more pronouncedly at puberty while males show a change, that is a lightening of the skin gradually, that is such changes observed only when the pre-pubertal period is compared with the post-pubertal period. Not finding any significant differences on the forehead might be explained on the basis that continuous or not infrequent exposure to solar radiation would possibly maske the effect of such hormonal metabolic changes in pigmentation, although ligher pigmentation is expected for both sexes reaching pubertal period. 't' values are presented on table 5.

Table 6 presents 't' values computed for a statistical comparison of the different age groups in association with the period of puberty, between the sexes. No significant differences are observed on both sites, at pre-pubertal period. This could be caused by a differential degree of pre-pubertal increase in pigmentation in both sexes (Marshall 1960; Tiwari and Kalla 1969; Conway and Baker, 1972, and Kahlon 1973). It is also suggested that females trend towards intensification of pigmentary pattern is more pronounced than for males, and these could consequently minimize the differences between the sexes. Also it might be interesting to point out that both sexes at younger ages, seem to have similar behavioural attributes, in regards of outdoor activities and use of very little clothing, and exposing both sites equally.

Statistical differences are observed between the sexes at both pubertal and post-pubertal period at both sites. This could be due to the very different mean reflectances observable between the sexes, allowing for such dif-

ferences as to the fact that females are more affected by the hormonal metabolism, and thus melanogenic activities would be different for each sex.

Figure 4 presents curves of reflectances for each sex at different age groups at each site. These curves show that the classified age groups in each sex exhibit more mean differences on the forehead than on the arm. They also show that the differences between the age groups on each site appear to be higher for the females than for the males. Finally it is seen that on the arm both sexes show a decrease of mean differences towards the red end of the spectrum, while on the forehead this is not clearly distinguishable.

Computing the mean differences between the sexes at each sites, at both age groups, it is observed that on the forehead, the differences are much less than on the arm: e.g. at 685mu, mean difference of the forehead at pre-pubertal period is (3.73), on the arm it is (6.21), at pubertal period it follows respectively (6.65) and (7.42) and at post pubertal period, forehead mean differences is 3.22 and the arm is (9.76). From these observations it becomes evident that an increase in mean differences between the sexes in association with increase in age, especially on the arm, is also observable, while on the forehead the trend is reversed when approaching post-pubertal period. The high mean differences at the arm between the sexes at each age group, is caused by the characteristic nature of this region being invariably unexposed especially in the females, and the increase in the mean differences in relation to increase in age might be well explained on the basis of differential effects of melanocyte stimulating hormones.

The standard deviation (the coefficient of variation) as presented on table 7, shows quite high percentages, for the females at pre-pubertal period on the arm in contrast to the other age groups. This could be caused by the

very few number of samples, whose individual reflectances are quite variable, while on the forehead the variability lessens to one half. In general lower percentage coefficients are observed towards the longer wavelengths, as would be expected, with few exceptions. The males show higher variability than the females, and it seems that the variability appears to be higher on the forehead for both sexes at all age groups, except for the one exception discussed above. The variabilities at the different age groups, as observed, may be explained on the basis of the differential degrees of hormonal changes and also that the effects of tanning, not only is different at various regions in the body, but could also be different at various age groups.

INTER-POPULATIONS COMPARISONS

The present data has been compared with some neighboring countries. Samples from Turkey, West Pakistan, Afghanistan/Iran and Iraq/Syria are residents of Lebanon, and their exact geographical origin is not known. The Chechen have originated from the Caucasus and reside in the oasis of Azaq, in Eastern Jordan. The Sikhs are from the North western part of India and the Kurds, are ethnically from Kurdestan, and reside in similar climatic and geographical conditions as the Chechen.

Racial and linguistic affinities is expected between the Turkish and the Iranian samples, especially in the province of Azarbaijan in the most northernly western part of Iran. Turkish influx is also anticipated in the northern coastal provinces of Iran, namely Gilan and Mazandaran.

Iran and West Pakistan share a vast territory in the south-eastern part of Iran in Baluchistan. This geographical area in Iran is quite different to the climatic condition of Northern Iran. The former is dry and desert like being near to the 'Kavir' of Iran, while the latter is somehow sub-tropical and humid. Although similar genetic constitution is expected between the two

populations, such environmental differences plus the geographical characteristic of South east of Iran which has very close relationship with the Persian Gulf inhabitants, would allow for variations in the selective pressures for certain characteristics, namely skin colour.

Khorassan, a province in the north-east of Iran shares a common border with Afghanistan, and has always provided easy migration and admixture, but it does not seem that such gene-pool admixture would have reached the coastal provinces in the North of Iran, because of different climatic conditions. But it must be considered that in historical times, Iran, Afghanistan and Pakistan constituted one big empire, therefore racial affinities and ethnic origin is anticipated, and linguistic affinities are still widespread.

Iraq has borders with Iran in the extreme west, and two of the Iranian provinces, Kurdistan and Kermanshah share constant influx and migration, and similar climatic conditions. The combined samples of Iraq/Syria, and the Kurds (Jewish Kurds) who are ethnically from Kurdestan, a territory spreading into Iraq, Iran and Soviet Armenia, are all expected to share similar gene pool.

Although all these countries share somehow common gene pool and admixture with different parts of Iran, but the fact that Mazandaran in the north of Iran not only has different climatic conditions, but has also been somehow geographically isolated from such influx, since it is only bordered in the North by the Caspian Sea, and has not been so much under the influence of migration of different populations. But in general similarities in both genotype and phenotype attributes is expected, when considering the Aryan race and historical movements and settlements.

Although Iran and India share no border, but it must not be neglected that, Pakistan was once a part of India, and has only recently attained independence, therefore India did have borders with Iran in the past.

Table 8 presents data, obtained from other researchers, on skin colour. The mean reflectance values, and the standard deviations are presented at three

wavelengths: 425mu, 545mu and 685mu, for two sites, the upper inner arm and the forehead.

Table 9 presents reflectance percentage values at 685mu, in decreasing order for each population. This wavelength has been chosen, since according to many anthropologists (Harrison and Owen,1964), it is at this wavelength that the amount of melanin concentration is observable, showing the least amount, eliminating any effect of vascularization and blood supply. At the shorter wavelengths, from 400 to 500 mu, the individual and racial differences in vascular components and haemoglobin concentration is visible, because it is in this region of the spectrum, where melanin is absorbed most by the blood components. Therefore reflectance values at 425mu, has also been presented, to allow for racial differences or similarities in this region of the spectrum.

Figure 5 presents histograms, allowing for further demonstration of the gradation observed in the skin colour and pigmentary variations of the populations under study.

Figure 6 shows the reflectance values of these populations against two wavelengths, 425mu and 685mu.

Table 10 presents 't' values computed for a statistical comparison of these populations at three wavelengths, covering the whole spectrum.

Table 11 presents the percentage coefficients of variability for each population allowing for an estimate of the homo and heterogeneity of each population.

From table 9 it is observed that the male population from Northern Iran, show the least reflectance values for both regions, in comparison to the other samples. The effect of tanning must be considered, in which the Iranian males spent many hours exposed to solar radiation, with very scanty clothing, allowing for both regions to become highly pigmented. Considering the fact that the past-inhabitants of these areas were fair-skinned people coming from

further north, the obtained results does not seem to be very realistic. In general due to their lower mean reflectance, they show closer affinities to the W. Pakistan and Sikh samples, at both ends of the spectrum, and at both sites. The similarities are more pronounced at the forehead. The Kurds, Chechen and the combined Afghanistan/Iran samples have intermediate mean values on the arm at 685mu, followed by the samples from Iraq/Syria and Turkey with the highest reflectance. On the forehead, which cannot be a measure of initial pigmentation of these populations, due to differential degree of exposure and outdoor activities and the genetics tanning capacity of each population, show somehow similar order to the arm.

On statistical analysis, W. Pakistan and N. Iran show significant differences on the arm at both ends of the spectrum, while on the forehead the differences are only significant at 425mu. Such differences could be explained on the basis of contrasting variabilities in the two samples: N. Iran has a coefficient of variation of 685mu on the arm of (9.58) and (11.08) on the forehead, while the W. Pakistan shows almost half the variability of (4.46) and (7.36), respectively. Also it is observed that the variability is higher on the forehead for both sexes. Considering the climatic conditions prevailing in the summer months in N. Iran, with intense solar radiation would allow for similar reflectances on the forehead

In general significant differences are observed when comparing the present data with the other populations on the upper inner arm and the forehead, except for the Sikhs, who do not show such statistical differences on the forehead.

The highest reflectance means are observed in the samples inhabiting the most accidental part of the middle East, especially those at higher latitudes like Turkey and Iraq/Syria. Although these populations, all somehow originating from the Aryan race, and inhabiting the vast area in the north

of the temperate zone, thus sharing racial origin, but the selective pressures of climatic and geographical variations, and ecological conditions does allow an explanation for such differences.

Comparing the N. Iranian females with the other populations, different relationships are observed. It seems more plausible to consider racial and genetic affinities of these populations on the basis of the reflectance values obtained for the females. The reason is because females are in general invariably protected against insolation, specifically on the arm region, due to religious and socio-cultural factors. Therefore the results obtained, might very well represent the initial pigmentation of these populations, and a more valid conclusion might be drawn in regards of similarities and dissimilarities in the dermal melanin concentration.

From the observed data it is seen that in contrast to the males, the females (N. Iran) samples attain a quite high level in the reflectance values, especially on the upper inner arm. They show nearer reflectances to the lighter pigmented populations namely Turkey and Iraq/Syria, at all three wavelengths. Similarities with the Kurds are more observable at 685mu, the Sikhs, Chechen and W. Pakistan, respectively show lower moon reflectances. The very close reflectance means at 685mu, as observed from table 9 e.g. Iraq/Syria (60.20), Kurds (60.02), N. Iran (59.68) and Turkey (59), shows only a mean difference of (1.20%), between these populations.

On the forehead, the relationship is different. The N. Iranian samples show lower reflectances, and present an intermediate level. Such differences between forehead and upper inner arm in population comparison might be caused by the differential degree of exposure, different costumes or head garments, or caused by the occupation involving outdoor activities.

On statistical analysis, no significant differences are observed on the arm pigmentation, between N. Iran, Turkey and Iraq/Syria, except at 425mu for

the latter, which could be caused by differences in the vascularization of the dermis. The Kurds and N. Iranian females show significant differences only at the blue and green region of the spectrum, but not at 685mu. These statistical computation explains similarity in the melanin content of the skin of these populations.

N. Iran and Chechen show significant differences at both ends of the spectrum, as has been observed in the raw data, on the arm. The Chechen being of a Caucasus origin, have mostly migrated to the south, towards the middle eastern countries, and different climate and environmental components might allow for such variation, in addition to the fact that admixture of the Chechen with other middle eastern populations could also be a basis for such differences, as observed from their coefficients of variability, they do show high variability.

Iran and W. Pakistan also show significant differences on the arm, which is expected when considering the different climate, and the neighboring populations of W. Pakistan, allowing for genetic admixture,thus the former being more pigmented.

The Sikhs show significant differences on the arm as well compared to the Iranian females who are much lighter. Considering the costume of the Sikh women who expose their arm almost continuously to the solar radiation ever present throughout the year, in contrast to the moslem females who have this area covered all the time gives allowance for such statistical differences.

On the forehead, the N. Iranian females show statistical differences with Turkey and Iraq/Syria samples, confirming to the raw data. This could be caused by the amount of time spent outdoor on the use of head garments

The Chechen and N. Iranian females show no differences on the forehead, which might be the effect of similar degrees of exposure to solar radiation.

No significant differences are observed at 685mu, between the Sikhs and the N. Iranian samples, and compared with W. Pakistan, the reverse is true, in where significant differences are only observed towards the longer wavelengths.

Observing figure 6, an insight into the affinities and dissimilarities of these populations, either in the melanin content or the vascular component, becomes available. Two population data from the Belge and The Bushmen are also plotted against the two wavelengths, to demonstrate the similarity in the Middle Eastern populations in contrast to the two extreme populations in regards of pigmentation.

In general all the Middle Eastern populations, do show closeness in melanin content of the skin, as well as in the blood's contribution to the skin, when compared to the other populations, inhabiting regions of different latitudes and geography and climate, and also because of differences in the genetics constitution of each population. Both genetical and environmental factors seem to account very importantly for such contrast. The similarities of reflectance percentage values of the populations under study, allow for a closer gene pool and classical and racial history in addition to the latitudinal effect of the vast area inhabited by these Middle Eastern populations.

Figure 7 shows curves obtained on all wavelengths for a broad comparison of the present data with the two populations exhibiting extreme reflectance values. Data for these two populations, the Belge and the Bushmen, is presented in Table 12.

On the upper inner arm the females show closer affinities in reflectance with the Belge females. The curves do not resemble one another, owing to the

depression at 545mu, in the Belgian curve, which is characteristic of fair skin, and it is at this wavelength where the effect of oxy and reduced haemoglobin has its highest absorption. This effect is decreased, and not observed at all when obtaining curves for darker pigmented individuals in whom the presence of increased melanin granules, masks such an effect. The increase towards the longer wavelengths is gradual for the Bushmen, while it is sharp for the Belges. The N. Iranian samples demonstrate an intermediate level, especially towards the red end of the spectrum. The Bushmen show a more sharp rise in contrast to the Belges and the Iranians On the forehead, the N. Iranians show much lower reflectance means, due to the radiation present in N. Iran, which could be absent in Bruxelles.

The males show closer reflectance mean to the darker pigmented population, the Bushmen, and the curve obtained also resembles that of the Bushmen. It does not seem to be intermediate, and it is surprisingly very close to the Bushmen and far from the Belges. This could be the result of overexposure. On the forehead the differences in the mean reflectance values between the N. Iranian and the Bushmen sample decreases especially at the shorter wavelengths. It might be possible to suggest that the samples from N. Iran might have high tanning capacity, so much as to allow closeness to a population which has different genetics constitution and inhabits a different geographical and climatic and latitudinal condition.

One important factor causing variations in both initial and induced pigmentation, when comparing populations who are expected to have closer and similar pigmentary level, is the tanning capacity. Primarily the genetics potential of tanning, and secondly the differential degree of exposure to ultraviolet radiation may account for such variations whcih provokes more speculation in the results obtained. That the relative effect of sun tanning and exposure is not the same at all levels of initial pigmentation has been suggested.

(Barnicot, 1958; Weiner et al, 1964; Harrison and Salzano, 1960; Kalla, (1971).

Kalla (1969) suggests that because of the high variability in the maximum melanin excitation percentage (M.E.P) among individuals even at similar pigmentary levels, the differences between most of the populations or groups are found to be non-significant, but differences are anticipated in induced pigmentation in response to ultra-violet irradiation, chiefly due to the individual or population variation in the thickness of the corneum affecting the penetration of the different ultra-violet wavelengths to a different extent.

The effect of solar radiation varies with the area of habitation, and the intensity of exposure to ultra-violet is modified by the function of occupation, costume and differential activities, and the genetical ability of an individual or a population to sustain the tan.

Skin tanning tends to increase with increase in initial pigmentation up to a certain level and a further increase in the initial melanin concentration of the skin causes a slight but gradual lowering of tanning (Kalla, 1971). Skin tanning is related to the easiness of light to penetrate the skin and the inherent ability of the individual or group to be stimulated to melanin production.

These considerations allows for such differences in the coefficient of variation between populations. These diversities introduce a source of concomittant variation in the reflectance value, especially at the upper inner arm, causing an enhancement of the variance and hence the standard deviation. It has been suggested that tanning of the skin increases the variability, (Jansen, 1953, Lee and Lasker 1959; Omoto 1968; Kalla, 1968).

The high variability observed in the N. Iranian samples is quite expected in view of the fact that the region under study has had great racial

admixtures in historical times. Racial mixture has been greatest in parts of Persia which have had the historical zones of passage for invading armies and tribes, namely areas like Azarbaijan, Khorassan and Baluchistan. Mazandaran because of its geographical location and its characteristic impassability has been a relatively homogeneous area, but invasions by tribes such as the Kurds, Turks and Arabs have caused racial mixture, especially that Iran is limited by water from two directions, and an east and west passage way has only been possible. The high variability might also be caused by the effect of sun-tanning, but since the females who are rarely exposed to radiation do also show high variability, it might be argued for a genetic heterogeneity.

In general the high variability observed in these populations decrease towards the longer wavelengths, therefore allowing for more genetic homogeneity in the melanin content of the skin. At 685mu, on the upper inner arm, in the males the Kurds show the highest (10.71), N. Iran (9.58) and Western Pakistan the least (4.46); on the forehead the Chechen (11.12) have the highest, N. Iran (11.08), and Turkey the least (7.26). For the females on the arm and the forehead, the Chechen show the highest variability (19.24) and (14.46) respectively; N. Iran (7.44) and (11.30) and Turkey the least (3.63) and (7.47).

CONCLUSION

Statistical analysis of the N. Iranian data obtained for skin colour, revealed significant differences between the males and females, which might have been the effect of overexposure of the males to solar radiation. Further analysis for investigating whether pigmentation and age showed any close association demonstrated that significant differences were observed at pubertal period for the females and the post-pubertal peridod for the males due to differential effects of hormonal changes. Only at pre-pubertal period, the sexes showed no significant differences between them.

Comparing the present data with some neighboring and Middle Eastern countries, in general close affinities in pigmentation was observed. The N. Iranian males showed the least reflectance and the highest pigmentation on both sites, while the females showed quite high reflectance, resembling the pigmentation of Turkey and Iraq/Syria. The relationship of these populations varied according to the wavelength at which it was measured. On statistical analysis significant differences were observed between the males from N. Iran and all other populations except for W. Pakistan and the Sikhs, at the forehead. The females in contrast, showed closeness in skin colour with Turkey, Iraq/Syria on the arm while on the forehead it demonstrated differences with these two countries plus the Kurds. The countries that reflected lower values, having darker pigmentation show quite differences on both sites like the Sikhs and the samples from W. Pakistan. The Chechen only showed significant difference on the upper inner arm.

Closeness in skin pigmentation is anticipated in between these populations, who inhabit the vast territory in the noth temperate zone, and who are also expected to show closer genetic homogeneity when compared to European or African populations, but variations within these populations has also been anticipated when regarding the phenotypes of these populations. To arrive on a theoretical estimate of the number of factors involved in the determin-

ation of the phenotypes, many factors must be considered.

The latitudinal effect of solar radiation, ecological variations and socio-cultural and religious factors dominating the behaviour, occupation and differential degree of outdoor activities, and costume of each sex in the population are some factors allowing for fluctuations in the percentage reflectance. Racial admixture of each population, according to its geographical zone, and neighboring countries, and historical and racial admixture due to invasions and settlements, might have all introduced an element of heterogeneity within the populations. Some other important factors allowing for such variations could be hybridization, genetic drift, gene flow. All these factors would have their own selective pressures to account for such variations.

APPENDIX

SOME CONSIDERATIONS WHEN OPERATING THE SPECTROPHOTOMETER

Two (E.E.L.) spectrophotometers were used to examine variation in the reflectance readings. Five coloured tiles and thirteen human samples were measured with each spectrophotometer at each wavelength and slight fluctuations in the percentage reflectances were observed. The experiment was carried on by primarily examining the samples with one spectrophotometer many times on each wavelength, and the result showed varied reflectance reading at each measurement. Therefore, the final value was obtained by callibrating the average of all readings for each wavelength. The same procedure was used for the other spectrophotometer. Therefore, by experiment it was shown that not only different spectrophotometers showed slight differences in the values, but also that the same was observed within a spectrophotometer. This experiment resulted in questioning the extent of validity of callibrations obtained by experimenters when using the spectrophotometer, and whether it was necessary to measure samples many times before obtaining a final measurement.

Some inportant factors considered as the cause of these variations in the measurements are as follows:

1) The interior of the instrument sometimes tends to accumulate dust, and as a result there could be a constant reflectance internally, as opposed to the normal matt black, which should minimize this reflectance. The effect of this is to give a false '0' reading, i.e. if the instrument is placed on a black cavity, it should read zero, however, it is possible that it will read +1 or 2%. This effect can be minimized by cleaning the optics compartment and if necessary spraying it matt black.

2) Filters themselves will vary slightly in their transmission characteristics and dominant wavelengths and that the gelatin filter will alter as a function of time, which could be overcome by substituting dye in the main glass filter.

3) It is important that the image of the lamp should hit the sample aperture centrally.

4) The effect of zero offset is going to be most significant when one is monitoring low levels of reflectances, and will increase to a maximum relation effect at zero.

5) The linearity of the photocell is not usually a problem unless for some reason the circuit develops a high resistance. This sometimes happens if the contacts on the photocell becomes oxidized, and the photocell will then give a logarithmic output.

6) To verify whether the instrument is performing linearly overall, the most satisfactory way is to utilize grey callibration standards and with a correct set up instrument one could achieve conformity to within $\pm$ 1%.

7) The adjustment of the light source is of primary importance since the response of the instrument is completely altered by incorrect adjustments, and it is advisable to check the adjustment occasionally.

8) Periodical testing of the galvanometer zeroing at intervals is necessary.

9) Bulb output of the spectrophotometer could vary from machine to machine.

10) The state of the surface on which the machine is installed does affect the zeroing of the galvanometer.

11) Slight movement of the galvanometer when in an unclamped state.

12) The state of the standard, on which dust, grit and grease and other extraneous material would differentiate the standardization.

13) On holding the applicator head at odd angles, especially on an unsmooth surface (the forehead) external light is allowed to penetrate.

14) The use of varying applicator heads when using one machine, might allow fluctuations.

15) The time variation is of important consideration, e.g. the time allowed between the standardization to 100% reflectance and measuring the sample.

16) Standardizing on the $M_g CO_2$ or any other standard surface, must be done for every measurement.

17) The high degree of sensitivity of these machines to light is susceptible to slight fluctuations, with penetration of external light.

TABLE (1) Mean reflectance values, standard error and standard deviation for females and males.

FEMALES .no=33	Wavelengths in mu								
U.I.A	425	455	485	515	545	575	605	635	685
Mean	28.04	32.87	35.62	37.28	37.62	41.89	50.96	56.60	59.68
S.E	1.03	1.09	1.08	1.13	1.07	1.06	1.08	0.82	0.77
S.D	5.92	6.24	6.25	6.47	6.14	6.09	6.18	4.71	4.44
FOREHEAD									
Mean	17.77	20.42	22.89	23.22	24.65	29.01	38.92	46.27	50.01
S.E	0.63	0.62	0.75	0.75	0.67	0.78	0.99	1.06	0.98
S.D	3.62	3.54	4.33	4.31	3.87	4.48	5.67	6.07	5.65
MALES no=68									
U.I.A MEAN	18.17	21.60	24.39	26.65	27.20	31.24	39.72	46.50	50.00
S.E	0.56	0.58	0.67	0.43	0.55	0.57	0.67	0.65	0.58
S.D	4.62	4.77	5.09	3.59	4.51	4.69	5.53	5.35	4.79
FOREHEAD Mean	14.00	16.30	18.01	19.07	20.68	23.98	33.30	41.12	45.41
S.E	0.42	0.49	0.53	0.50	0.43	0.50	0.63	0.66	0.61
S.D	3.49	4.09	4.38	4.12	3.59	4.19	5.24	5.48	5.03

TABLE (2)

Wavelengths in mu	't' values								d.f
	425	455	485	515	545	575	605	635	685	
FEMALE Arm / Forehead	8.49	9.97	9.64	10.41	10.29	9.79	8.25	7.73	7.74	64
MALE Arm / Forehead	5.96	6.95	7.84	11.45	10.08	9.53	6.95	5.79	5.46	134
U.I.A Male / Female	8.41	9.16	8.98	8.78	8.68	8.78	8.87	10.1	9.66	99
FOREHEAD Male / Female	4.97	5.21	5.29	4.60	4.95	5.40	4.79	4.13	3.97	99

ALL ABOVE VALUES ARE SIGNIFICANT (P IS LESS THAN .001)

ARM = UPPER INNER ARM = U.I.A
d.f = degrees of freedom

TABLE (3)

COEFFICIENT OF RELATIVE VARIATION FOR FEMALES AND MALES

Wavelengths	U.I.A		FOREHEAD	
	MALE	FEMALE	MALE	FEMALE
425	25.43	21.11	24.90	20.37
455	22.08	18.98	25.09	17.34
485	20.87	17.55	24.32	18.90
515	13.47	17.35	21.60	18.56
545	16.58	16.32	17.36	15.70
575	15.01	14.54	17.47	15.44
605	13.92	12.13	15.74	14.60
635	11.50	8.32	13.55	13.12
685	9.58	7.44	11.08	11.30

TABLE (4)

Mean reflectance value, standard error, standard deviation and coefficient of variation for three age groups FEMALES

Wavelengths in mu		425	455	485	515	545	575	605	635	685	no
U.I.A PRE/PUBERTAL	Mean	23.12	25.25	28.37	29.75	30.5	35	44.25	51.75	55.25	4
	S.E	4.63	4.92	5.20	4.17	4.62	4.37	4.83	2.95	3.06	
	S.D	9.27	9.84	10.24	8.34	9.25	8.75	9.67	5.91	6.13	
PUBERTAL	Mean	25.6	30.2	32.4	33.5	34.2	37.6	47.4	54	57.4	5
	S.	1.01	1.74	1.69	1.43	0.92	1.50	2.38	2.59	1.91	
	S.D	2.61	3.90	3.78	3.20	2.05	3.36	5.32	5.79	4.28	
POST/PUBERTAL	Mean	29.37	34.71	37.5	39.37	39.52	43.94	52.83	57.96	60.89	24
	S.E	1.10	0.99	0.97	1.05	1.03	0.98	0.95	0.74	0.74	
	S.D	5.38	4.87	4.76	5.16	5.04	4.79	4.67	3.61	3.63	
FOREHEAD PRE/PUBERTAL	Mean	15.75	18.75	20.75	22.37	23.25	27	38	45.5	48.5	4
	S.E	1.37	3.22	2.42	2.13	2.49	1.78	1.82	2.21	1.32	
	S.D	2.75	6.45	4.85	4.27	4.99	3.56	3.65	4.43	2.65	

TABLE (4)CONTINUED:

FEMALES

Wavelengths in mu		425	455	485	515	545	575	605	635	685	no
PUBERTAL	Mean	19.9	20.6	23.9	24.2	25.8	30.3	40.7	48	52	5
	S.E	1.22	0.001	1.50	1.59	1.24	1.50	1.39	1.92	1.95	
	S.D	2.51	2.70	3.36	3.56	2.77	3.35	3.11	4.30	4.36	
POST/PUBERTAL											
	Mean	17.6	20.58	23.04	23.17	24.65	29.08	39.96	46.04	49.85	24
	S.E	0.78	0.76	0.91	0.95	0.81	0.98	1.38	1.37	1.21	
	S.D	3.80	3.72	4.47	4.64	3.95	4.82	6.78	6.70	5.91	

U.I.A

MALES

PRE/PUBERTAL											
	Mean	16.06	19.79	21.61	23.36	25.31	29.9	38.46	45.67	49.04	26
	S.E	0.60	0.76	0.79	0.79	0.73	0.80	1.08	0.01	0.90	
	S.D	3.06	3.86	4.05	4.05	3.71	4.10	5.52	4.67	4.59	
PUBERTAL	Mean	18.13	21.73	24.52	25.63	27.09	30.74	39.26	46.11	49.98	23
	S.E	0.80	0.89	0.96	1.08	0.84	0.90	1.06	1.15	0.90	
	S.D	3.86	4.29	4.61	5.18	4.01	4.32	5.10	5.52	4.31	

TABLE. (4) CONTINUED .

MALES

Wavelengths in mu		425	455	485	515	545	575	605	635	685	no
POST/PUBERTAL	Mean	21.37	23.97	27.81	28.18	29.89	33.68	42.03	48.05	51.13	19
	S.E	1.07	1.22	1.37	1.23	1.13	1.18	1.30	1.46	0.40	
	S.D	4.67	5.32	5.99	5.38	4.91	5.16	5.65	6.36	1.76	
FOREHEAD PRE/PUBERTAL	Mean	12.73	14.96	16.85	18.02	19.5	23.38	32.61	40.61	44.77	26
	S.E	0.73	0.81	0.88	0.95	0.74	0.83	1.09	1.12	0.62	
	S.D	3.76	4.12	4.48	4.16	3.79	4.25	5.55	5.72	3.17	
PUBERTAL	Mean	14.78	17.33	18.78	19.59	20.52	24.22	33.26	40.89	45.35	23
	S.E	0.74	0.83	0.94	0.88	0.79	0.82	1.04	1.13	0.99	
	S.D	3.54	3.96	4.51	4.22	3.80	3.94	4.98	5.42	4.74	
POST/PUBERTAL	Mean	14.10	16.95	18.68	19.89	20.34	24.53	34.31	42	46.63	19
	S.E	1.27	0.92	0.91	0.88	0.71	1.03	1.20	1.24	1.16	
	S.D	5.55	4.02	3.96	3.85	3.09	4.51	5.25	5.40	5.06	

TABLE (5)

Wavelengths in mu		425	455	485	515	545	575	605	635	685	d.f
					't' values						
					FEMALES						
PRE-PUBERTAL/ PUBERTAL	U.I.A	0.519	0.950	0.740	0.850	0.785	0.563	0.584	0.572	0.596	7
	FOREH	2.338*	0.537	1.104	0.687	0.915	1.418	1.177	0.852	1.485	
PUBERTAL/ POST-PUBERTAL	U.I.A	2.353*	2.247*	2.615*	3.304**	3.861**	3.536**	2.119*	1.471	1.701	27
	FOREH	1.685	0.014	0.489	0.556	0.778	0.681	0.377	0.831	0.940	
PRE-PUBERTAL/ POST-PUBERTAL	U.I.A	1.312	1.884	1.722	2.237*	1.904	1.994	1.741	2.039	1.790	26
	FOREH	1.172	0.552	0.884	0.342	0.534	1.023	0.856	0.207	0.753	
					MALES						
PRE-PUBERTAL/ PUBERTAL	U.I.A	2.062*	1.655	2.334*	1.691	1.606	0.696	0.527	0.299	0.740	47
	FOREH	1.965	2.051*	1.500	1.308	0.939	0.778	0.432	0.232	0.497	
PUBERTAL/ POST-PUBERTAL	U.I.A	2.418*	1.480	1.961	1.554	1.888	1.977	1.652	1.044	1.167	40
	FOREH	0.462	0.307	0.076	0.241	0.169	0.235	0.660	0.608	0.840	
PRE-PUBERTAL/ POST-PUBERTAL	U.I.A	4.324**	2.910**	3.905**	3.284**	3.414**	2.642*	2.114*	1.381	2.120*	43
	FOREH	0.931	1.623	1.448	1.555	0.818	0.865	1.047	0.832	1.415	

FOREH= forehead
*= significant at .05
**= significant at .01 or less

TABLE (6)

't' values

Wavelengths in mu		425	455	485	515	545	575	605	635	685	d.f
					MALE/FEMALE						
PRE-PUBERTAL											
	U.I.A	1.511	1.097	1.281	1.505	1.108	1.146	1.169	1.968	1.944	28
	FOREH	2.010	1.140	1.512	1.903	1.440	1.842	2.536*	1.969	2.548*	
PUBERTAL											
	U.I.A	5.269**	3.931**	4.052**	4.389**	5.730**	3.916**	3.123**	2.976**	3.509**	26
	FOREH	3.810**	2.235*	2.659*	2.573*	3.591**	3.558**	4.286**	3.147**	3.042*	
POST-PUBERTAL											
	U.I.A	5.214**	6.823**	5.758**	6.896**	6.313**	6.632**	6.712**	6.063**	11.57**	41
	FOREH	2.347*	3.039**	3.386**	2.533*	4.014**	3.137**	3.080**	2.189*	1.923	

*= significant at .05
**= significant at .01 or less

TABLE (7) COEFFICIENT OF VARIATION

Wavelengths in mu	PRE-PUBERTAL		PUBERTAL		POST-PUBERTAL	
U.I.A	M	F	M	F	M	F
425	19.05	40.09	21.29	10.19	21.85	18.32
455	19.5	38.97	21.29	12.91	22.19	14.03
485	18.74	36.73	18.8	11.70	21.54	12.69
515	17.34	28.03	20.21	9.55	19.09	13.11
545	14.66	30.33	14.8	5.99	16.43	12.75
575	13.71	25	14.05	8.94	15.32	10.90
605	14.35	21.85	12.99	11.22	13.44	8.84
635	10.22	11.42	11.97	10.72	13.24	6.23
685	9.36	11.09	8.62	7.50	3.44	5.96
FOREHEAD						
425	29.54	17.46	23.95	12.61	39.36	21.59
455	27.54	34.4	22.85	13.11	23.72	18.10
485	26.6	23.37	24.01	14.10	21.20	19.4
515	23.08	19.10	21.54	14.71	19.36	20.03
545	19.44	21.46	18.52	10.74	15.19	16.02
575	18.2	13.18	16.27	11.10	18.39	16.57
605	17.02	9.60	14.97	7.64	15.30	17
635	14.08	9.74	13.22	8.96	12.86	14.55
685	7.08	5.46	10.45	8.36	10.85	11.9

M= MALE
F= FEMALE

TABLE. (8)

MEAN AND STANDARD DEVIATION FOR SOME MIDDLE EASTERN POPULATIONS

POPULATION	no	Sex	Site	Wavelengths	425mu		545mu		685mu		AUTHOR
					Mean	S.D	Mean	S.D	Mean	S.D	
TURKEY	37	M	U.I.A		28.8	4.88	36.6	3.96	59.3	3.02	SUNDERLAND (1973)
			FOREH		21.4	3.36	26	3.89	55.9	4.06	
	18	F	U.I.A		30	5.26	38	3.99	59	2.14	
			FOREH		24.2	3.03	30.1	3.33	57.4	4.29	
IRAQ/SYRIA	35	M	U.I.A		27.4	4.50	34.1	4.40	57.4	3.10	SUNDERLAND (1973)
			FOREH		20.9	3.43	24.9	3.78	55	4.22	
	19	F	U.I.A		31.2	5.78	39.1	4.47	60.2	2.34	
			FOREH		24.6	4.37	30.1	4.21	57	4.47	
W.PAKISTAN	16	M	U.I.A		20.5	2.26	26.9	2.74	52	2.32	SUNDERLAND (1973)
			FOREH		15.6	1.64	19.5	1.70	46.6	3.43	
	35	F	U.I.A		21.9	4.66	28.4	4.91	51.3	4.04	
			FOREH		17.8	3.10	21.8	3.32	46.6	4.82	

TABLE (8) CONTINUED

POPULATION	no	Sex	Site	Wavelengths	425mu M	S.D	545mu M	S.D	685mu M	S.D	AUTHOR
CHECHEN	23	M	U.I.A		27.4	4.20	33.6	5.04	55	3.96	SUNDERLAND (1967)
			FOREH		17.5	3.69	22.6	3.67	52.5	5.84	
	7	F	U.I.A		21.2	4.1	29.1	5.50	51.9	5.68	
			FOREH		17.1	5.38	24.1	6.14	50.9	7.36	
AFGHAN/ IRAN	38	M	U.I.A		24.2	3.52	31.7	3.75	55.7	2.68	SUNDERLAND (1973)
			FORE		17.9	3.22	22.8	3.70	51.2	5.44	
KURDS	52	M	U.I.A		21.11	4.21	29.19	5.32	54.89	5.88	LOURIE (1971)
	39	F	U.I.A		24.19	3.53	33.73	3.52	60.02	3.10	
SIKHS	100	M	U.I.A		23.18	3.6	29.62	3.8	53.96	3.83	ROBERTS AND KAHLON(1972)
			FOREH		14.42	2.5	19.92	2.70	45.04	4.25	
	100	F	U.I.A		23.34	3.36	30.46	3.71	54.94	3.53	
			FOREH		16.43	2.77	22.57	3.09	48.11	3.76	

TABLE (9) .

MEAN REFLECTANCE VALUES OF THE MIDDLE EASTERN POPULATION IN DECREASING ORDER AT TWO WAVELENGHTS: MALES

POPULATION	WAVELENGTH 425mu	POPULATION	WAVELENGTH 685mu
U.I.A			
TURKEY	28.80	TURKEY	59.30
IRAQ/SYRIA	27.40	IRAQ/SYRIA	57.40
CHECHEN	27.40	AFGHAN/IRAN	55.70
AFGHAN/IRAN	24.20	CHECHEN	55.00
SIKHS	23.18	KURDS	54.89
KURDS	21.11	SIKHS	53.96
W.PAKISTAN	20.50	W.PAKISTAN	52.00
N.IRAN	18.17	N.IRAN	50.00
FOREHEAD			
TURKEY	21.40	TURKEY	55.90
IRAQ/SYRIA	20.90	IRAQ/SYRIA	55.00
AFGHAN/IRAN	17.90	CHECHEN	52.50
CHECHEN	17.50	AFGHAN/IRAN	51.20
W.PAKISTAN	15.60	W.PAKISTAN	46.60
SIKHS	14.42	N.IRAN	45.41
N.IRAN	14.00	SIKHS	45.04

TABLE (9) CONTINUED
MEAN REFLECTANCE VALUES OF THE MIDDLE EASTERN POPULATION IN DECREASING ORDER AT TWO WAVELENGHTS: FEMALES

POPULATION	WAVELENGTH 425mu	POPULATION	WAVELENGTH 685 mu
U.I.A			
IRAQ/SYRIA	31.20	IRAQ/SYRIA	60.20
TURKEY	30.00	KURDS	60.02
N.IRAN	28.04	N.IRAN	59.68
KURDS	24.19	TURKEY	59.00
SIKHS	23.34	SIKHS	54.94
W.PAKISTAN	21.90	CHECHEN	51.90
CHECHEN	21.20	W.PAKISTAN	51.30
FOREHEAD			
IRAQ/SYRIA	24.60	TURKEY	57.40
TURKEY	24.20	IRAQ/SYRIA	57.00
W.PAKISTAN	17.80	CHECHEN	50.90
N.IRAN	17.77	N.IRAN	50.01
CHECHEN	17.10	SIKHS	48.11
SIKHS	16.43	W.PAKISTAN	46.60

TABLE (10)

't' values

POPULATION	Sex	Site	Wavelengths in mu 425 mu	545 mu	685 mu	d.f
N.IRAN/ TURKEY	M	U.I.A	10.85**	11.06**	12.17**	103
		FOREHEAD	10.63**	6.87**	11.60**	
	F	U.I.A	1.22	0.27	0.74	49
		FOREHEAD	6.75**	5.27**	5.24**	
N.IRAN/ W.PAKISTAN	M	U.I.A	2.93**	0.34	2.44*	82
		FOREHEAD	2.71**	1.93	1.13	
	F	U.I.A	4.73**	6.81**	8.13**	66
		FOREHEAD	0.37	3.25**	2.66**	
N.IRAN/ IRAQ-SYRIA	M	U.I.A	9.76**	7.47**	9.46**	101
		FOREHEAD	9.61**	5.45**	10.21**	
	F	U.I.A	2.38*	1.44	0.31	50
		FOREHEAD	6.81**	5.65**	6.85**	
N,IRAN/ KURDS	M	U.I.A	3.63**	2.17*	4.88**	118
	F	U.I.A	3.27**	3.22**	0.37	70
N.IRAN/ AFG HAN-IRAN	M	U.I.A	7.54**	5.49**	7.86	104
		FOREHEAD	5.79**	2.86**	5.39**	

TABLE (10)CONTINUED

't' values

POPULATION	Sex	Site	Wavelengths in mu 425mu	545mu	685mu	d.f
N.IRAN/ CHECHEN	M	U.I.A	8.17**	5.40**	4.95**	89
		FOREHEAD	3.99**	2.18*	5.21**	
	F	U.I.A	3.67**	2.18**	3.41**	38
		FOREHEAD	0.31	0.23	0.30	
N.IRAN/ Sihks	M	U.I.A	7.52**	3.63**	5.69**	166
		FOREHEAD	0.85	1.48	0.50	
	F	U.I.A	4.34**	6.33**	5.58**	131
		FOREHEAD	1.95*	2.81**	1.80	

TABLE (11) COEFFICIENT OF RELATIVE VARIATION AT 685mu FOR SOME MIDDLE EASTERN POPULATIONS

MALE U.I.A

KURDS	N.IRAN	CHECHEN	SIKHS	IRAQ/SYRIA	TURKEY	AFGHAN/IRAN	W.PAKISTAN
10.71	9.58	7.20	7.10	5.40	5.09	4.81	4.46

MALE FOREHEAD

CHECHEN	N.IRAN	AFGHAN/IRAN	SIKHS	IRAQ/SYRIA	W.PAKISTAN	TURKEY
11.12	11.08	10.62	9.44	7.67	7.36	7.26

FEMALE U.I.A

CHECHEN	W.PAKISTAN	N.IRAN	SIKHS	KURDS	IRAQ/SYRIA	TURKEY
10.94	7.87	7.44	6.42	5.16	3.89	3.63

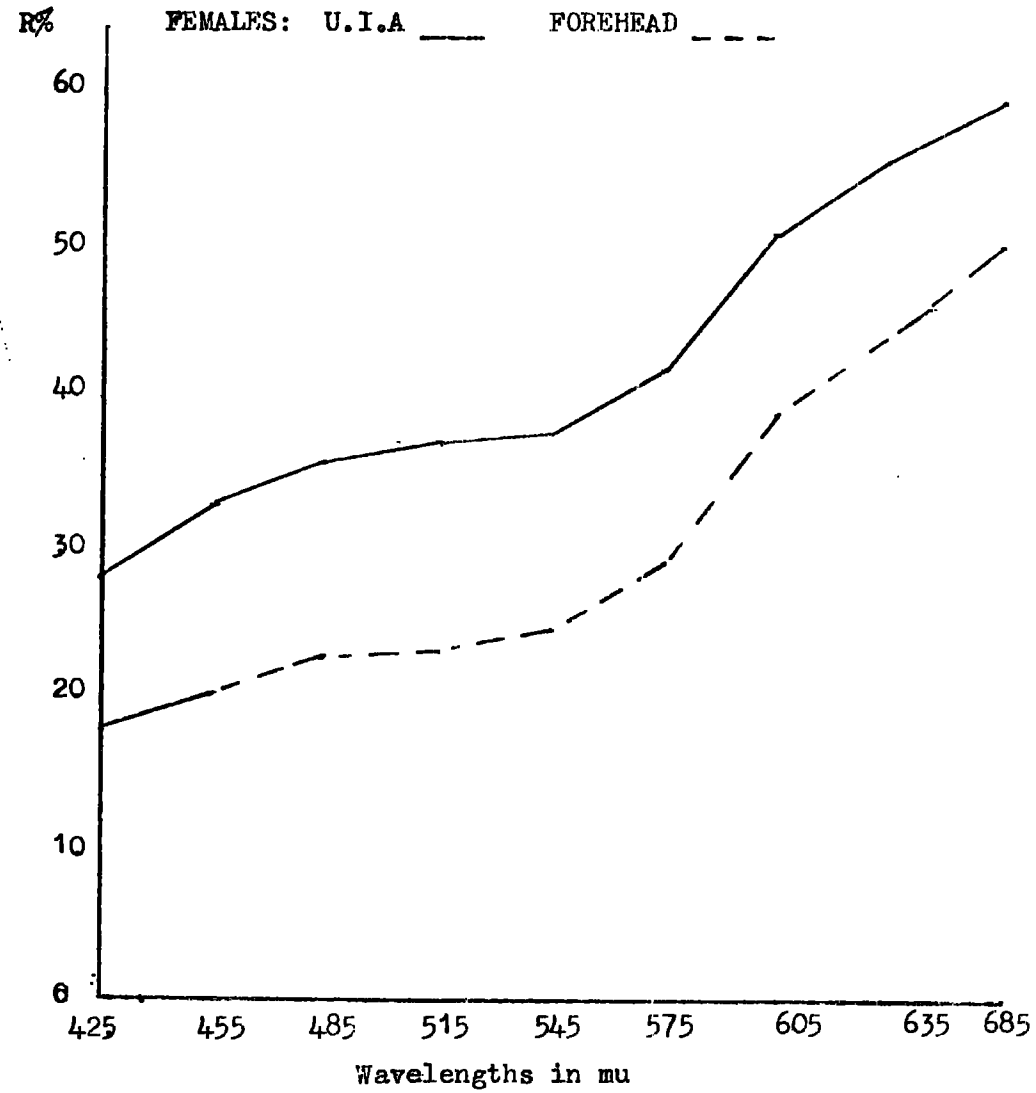
FEMALE FOREHEAD

CHECHEN	N.IRAN	W.PAKISTAN	IRAQ/SYRIA	SIKHS	TURKEY
14.46	11.30	10.34	7.84	7.81	7.47

TABLE (12)
DATA ON TWO POPULATIONS WITH EXTREME REFLECTANCE VALUES

POPULATION	no	Sex	Site	Wavelength	425	455	485	515	545	575	605	635	685	AUTHOR
BELGES	143	M	U.I.A	M	37.71	44.73	46.74	46.71	44.77	48.87	59.52	65.72	67.27	LEGUEBE (1961)
				S.D	4.83	5.01	4.76	4.30	3.96	3.84	3.75	3.15	2.90	
			FOREH	M	27.87	32.53	34.22	33.68	31.56	36.68	51.07	60.67	62.48	
				S.D	3.63	3.53	3.71	3.90	4.00	4.46	3.92	3.75	3.81	
	177	F	U.I.A	M	36.50	43.48	45.31	45.65	44.57	48.77	58.50	64.28	65.88	
				S.D	3.98	3.54	3.53	3.57	3.62	3.34	3.44	2.92	2.47	
			FOREH	M	32.44	37.26	39.05	39.13	37.27	41.86	55.50	63.50	65.66	
				S.D	3.53	3.66	3.60	4.20	3.74	3.86	3.35	3.95	3.60	
BUSHMEN	42	M	U.I.A	M	12.66	15.51	16.17	17.23	18.11	21.11	28.35	39.43	42.54	TOBIAS (1963)
				S.D	2.45	2.87	2.73	3.40	2.76	3.22	4.06	4.39	4.17	
			FOREH	M	12.00	14.33	14.45	15.35	15.62	18.11	25.25	36.35	39.31	
				S.D	2.59	2.97	2.76	3.81	3.00	3.94	5.18	6.38	6.68	
	46	F	U.I.A	M	13.17	16.63	17.35	18.17	19.03	22.53	30.24	40.83	43.62	
				S.D	2.52	2.59	3.02	3.06	3.22	3.05	4.51	4.32	3.82	
			FOREH	M	12.24	14.41	14.78	15.70	15.90	18.60	25.77	36.45	39.90	
				S.D	2.30	2.20	2.55	2.92	2.36	3.01	3.80	4.18	3.91	

FIGURE (1) MEAN PERCENTAGE CURVES FOR FEMALES AND MALES



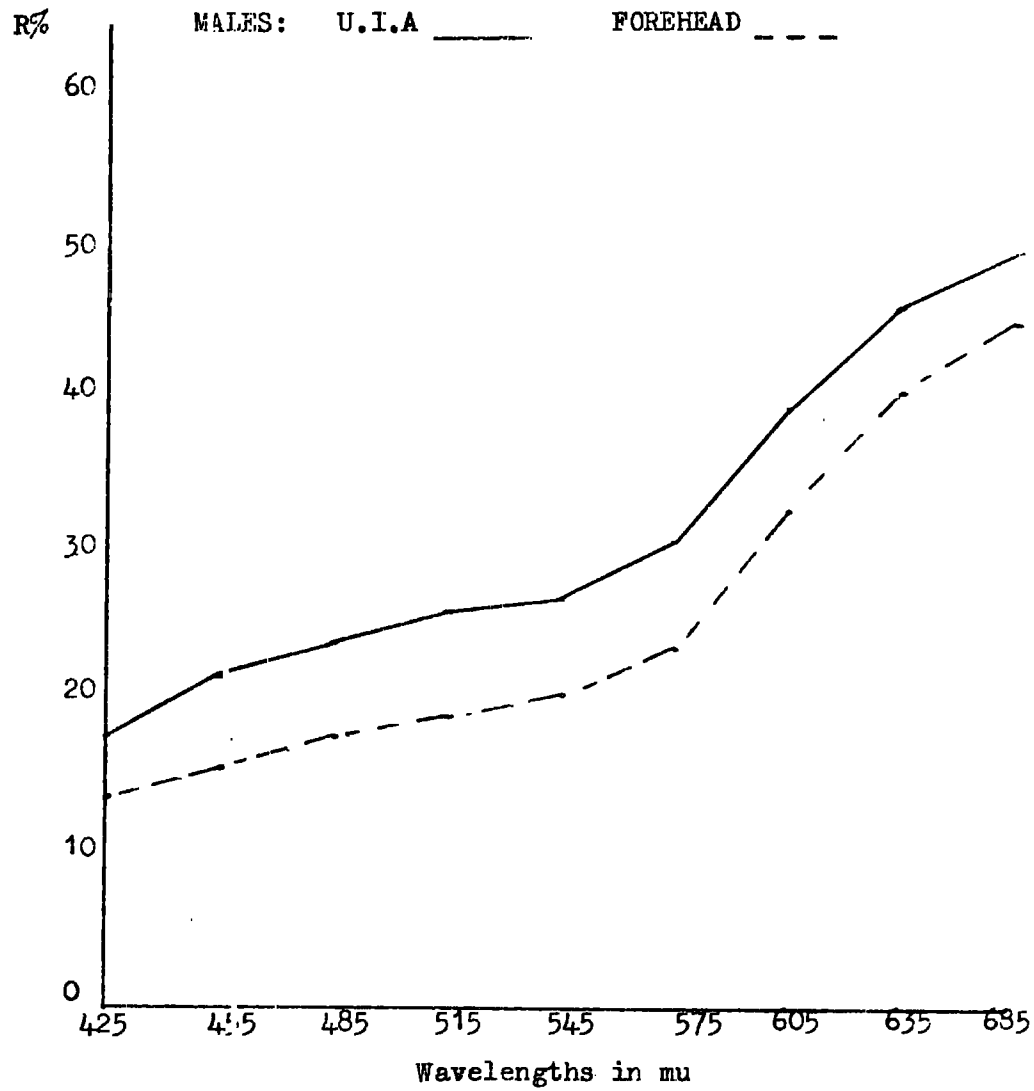
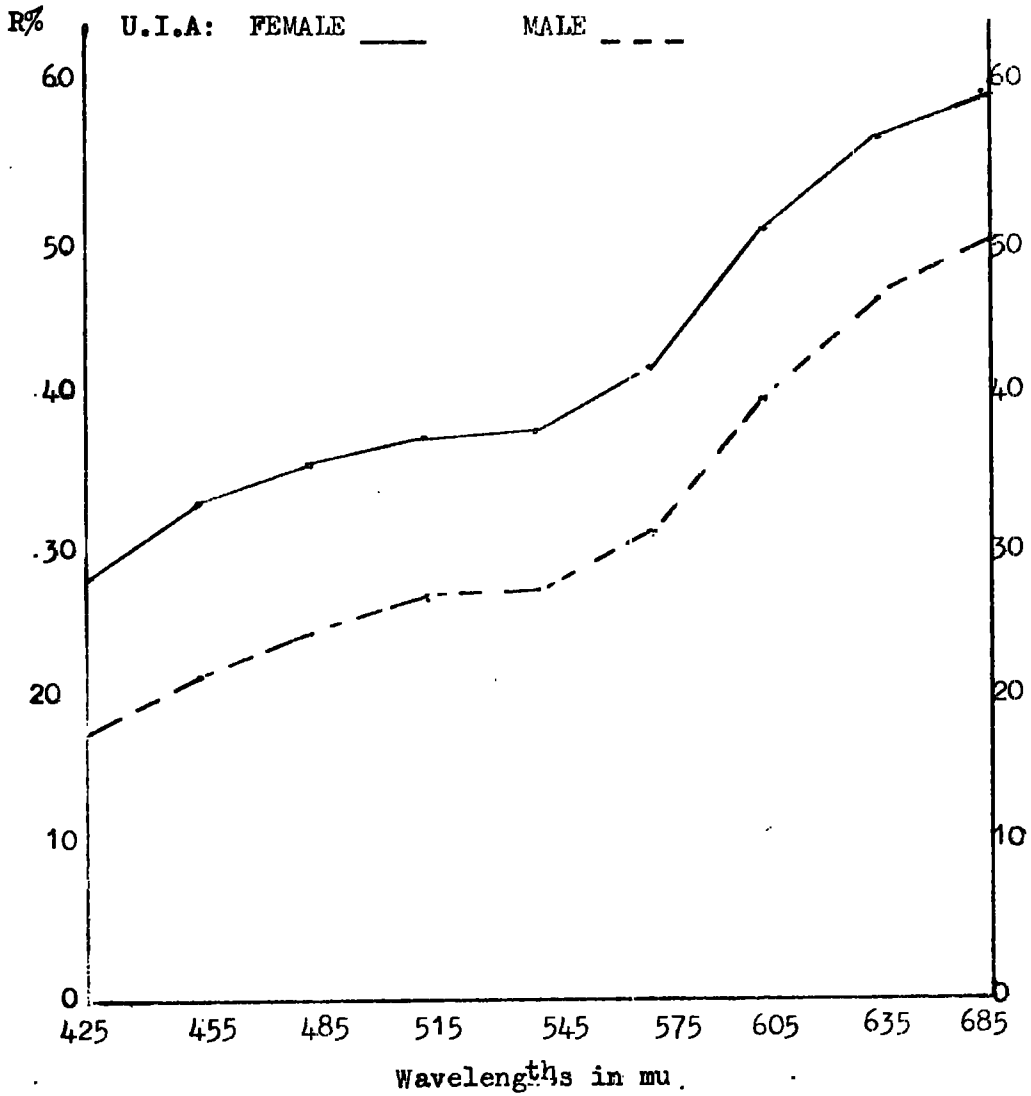


FIGURE (2) MEAN CURVES DEMONSTRATING DIFFERENCES AT EACH SITE BETWEEN THE SEXES.



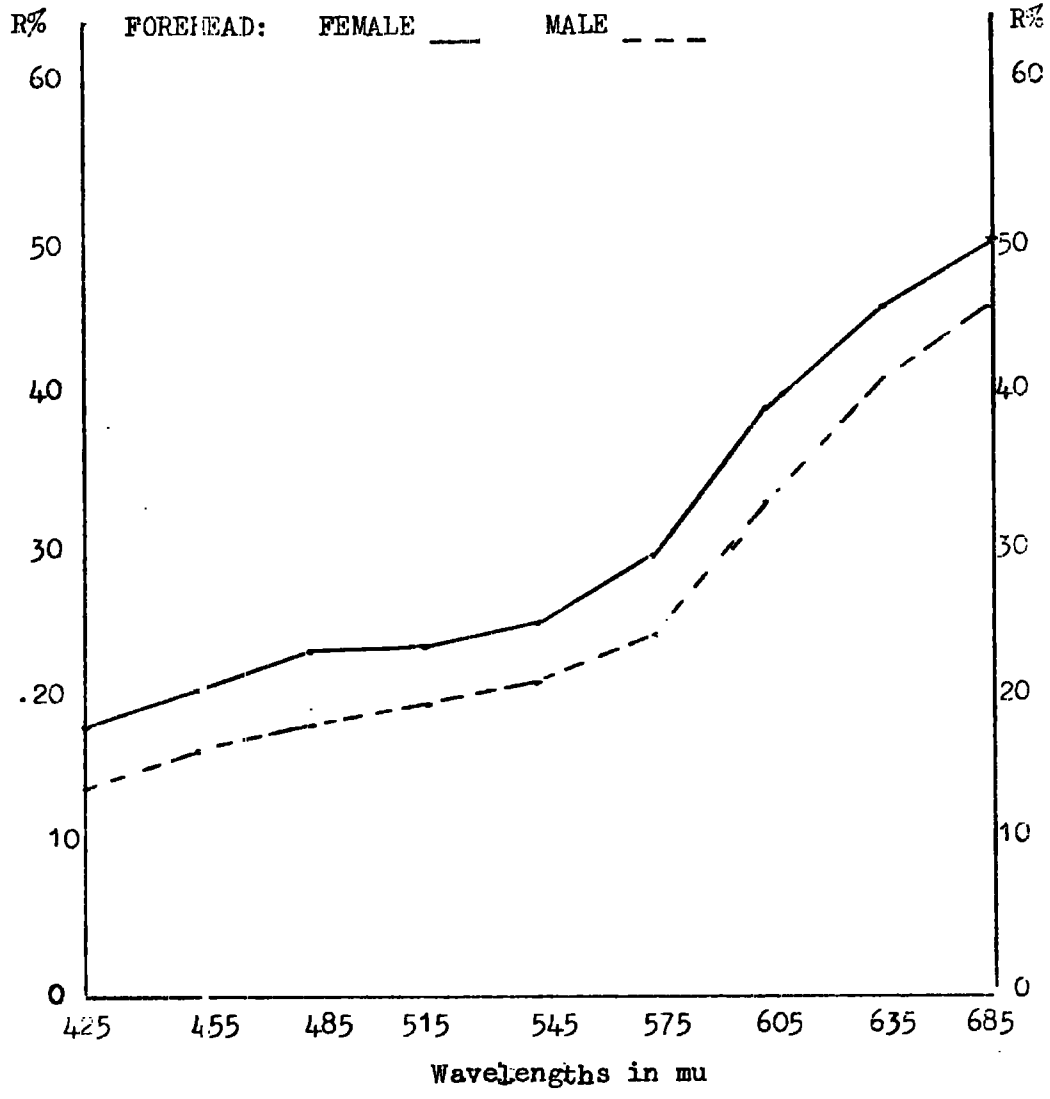


FIGURE (4)

MEAN REFLECTANCE CURVES FOR THREE AGE GROUPS FEMALES

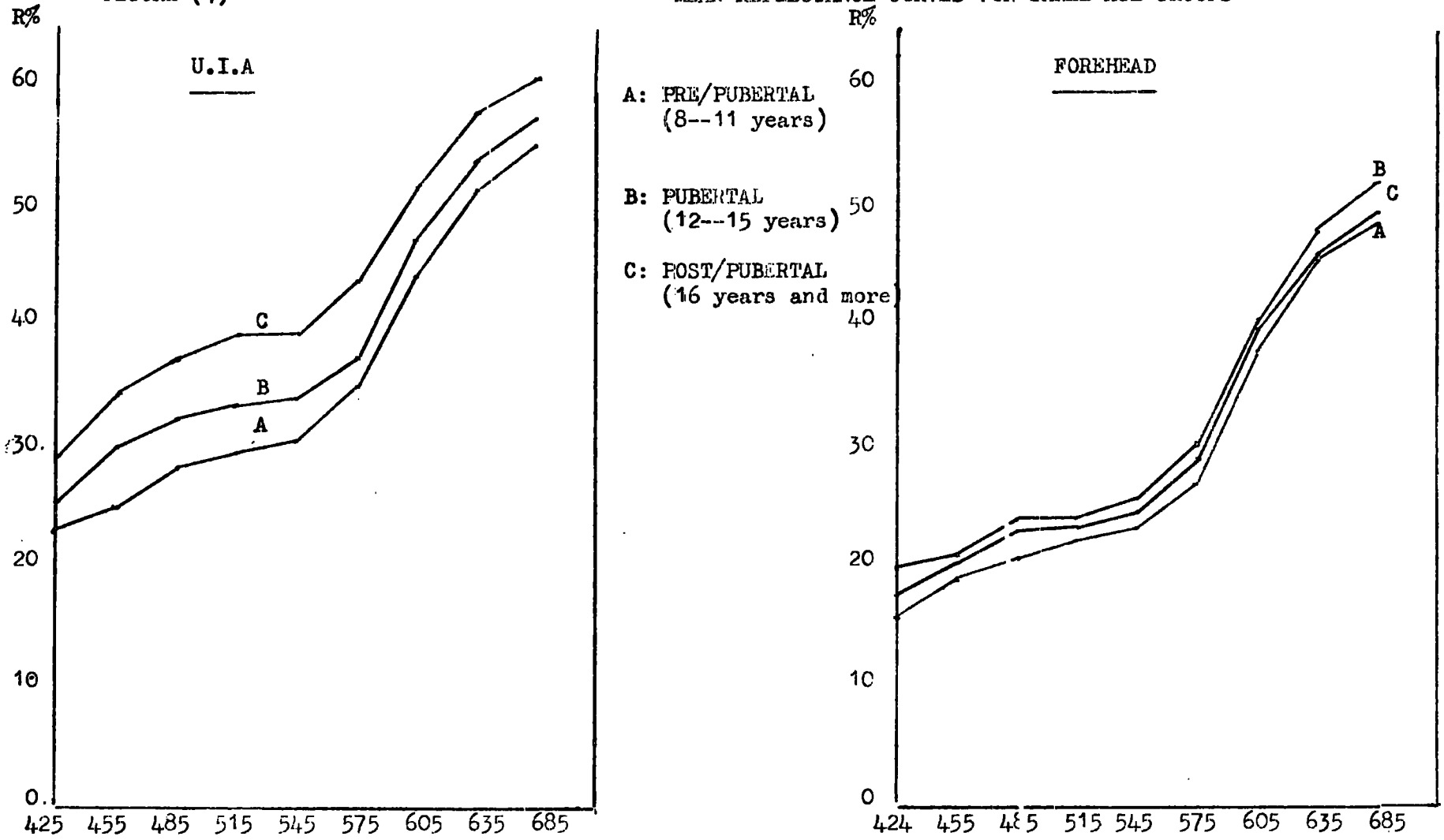
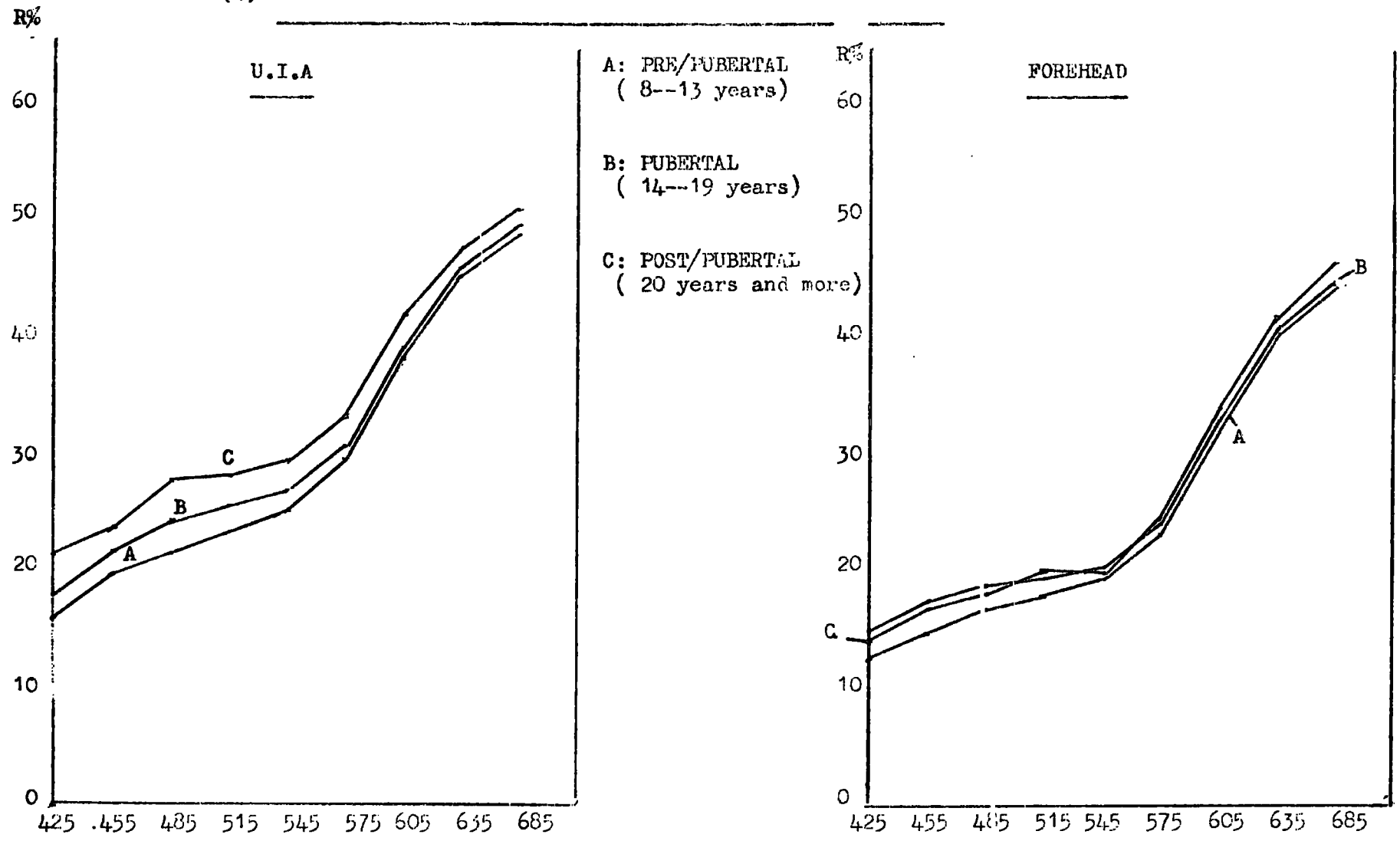
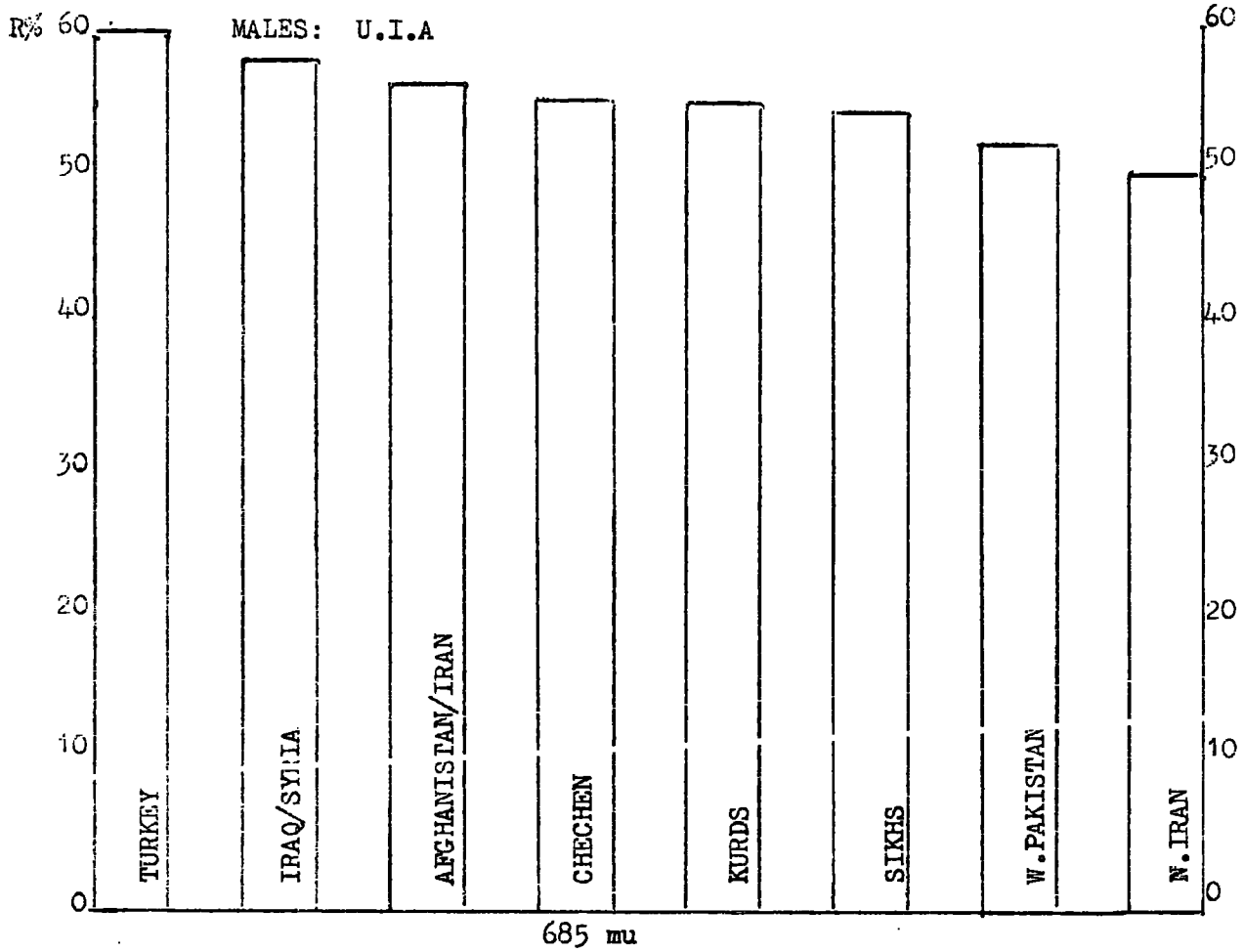
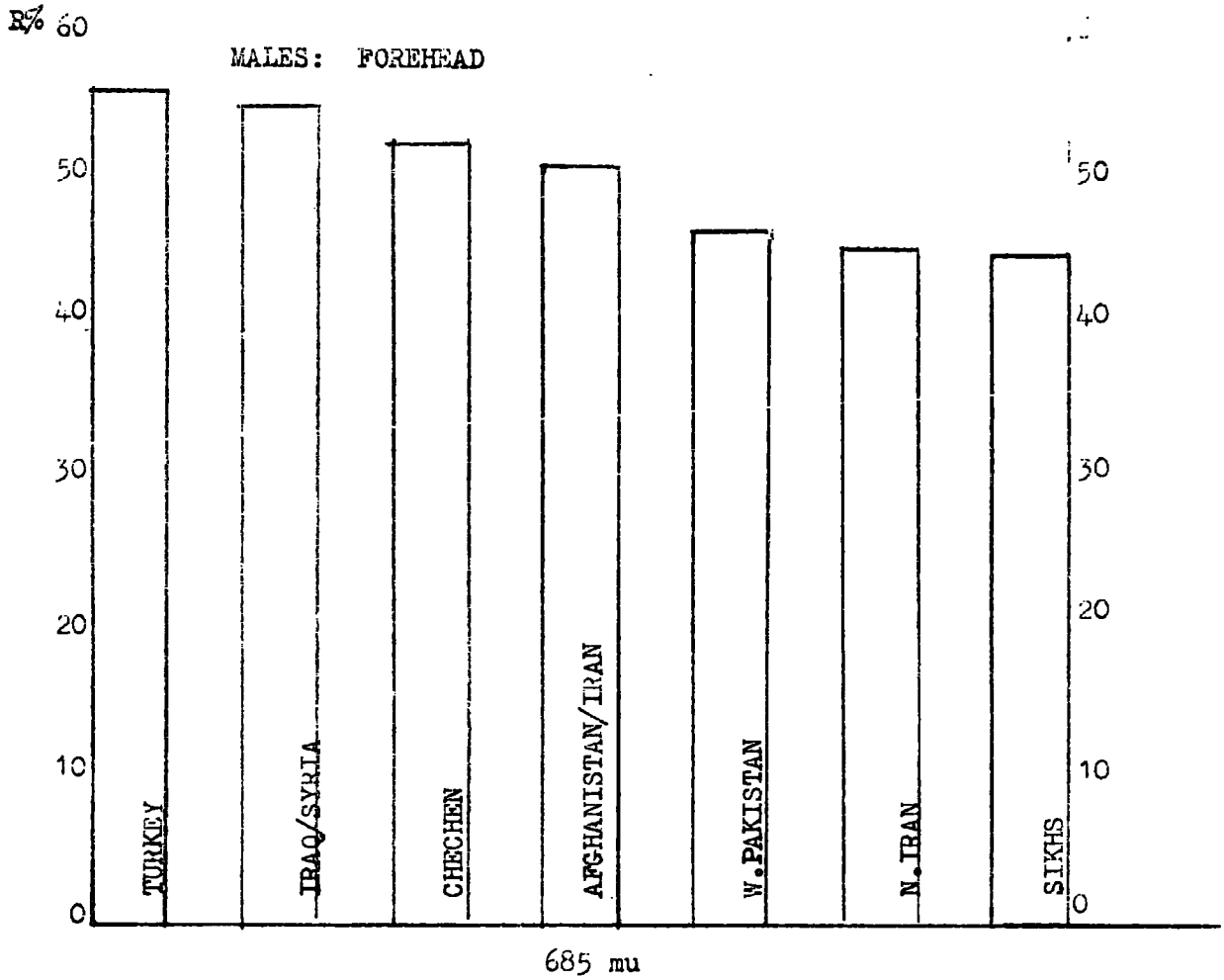


FIGURE (4) MEAN REFLECTANCE CURVES FOR THREE AGE GROUPS: MALES



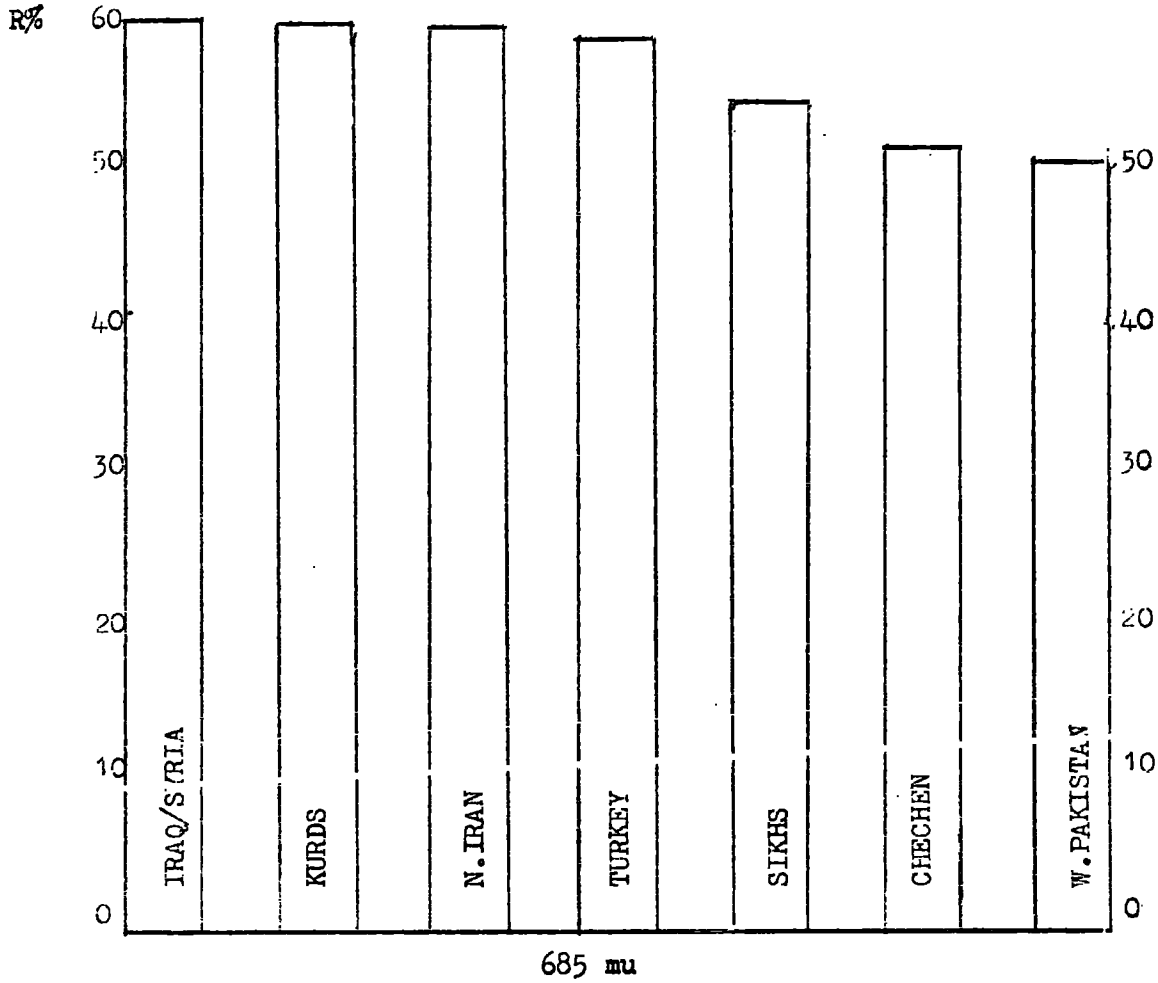
FIGURE(5) HISTOGRAMS DEMONSTRATING GRADATION IN REFLECTANCE VALUES IN THE MIDDLE EASTERN POPULATIONS



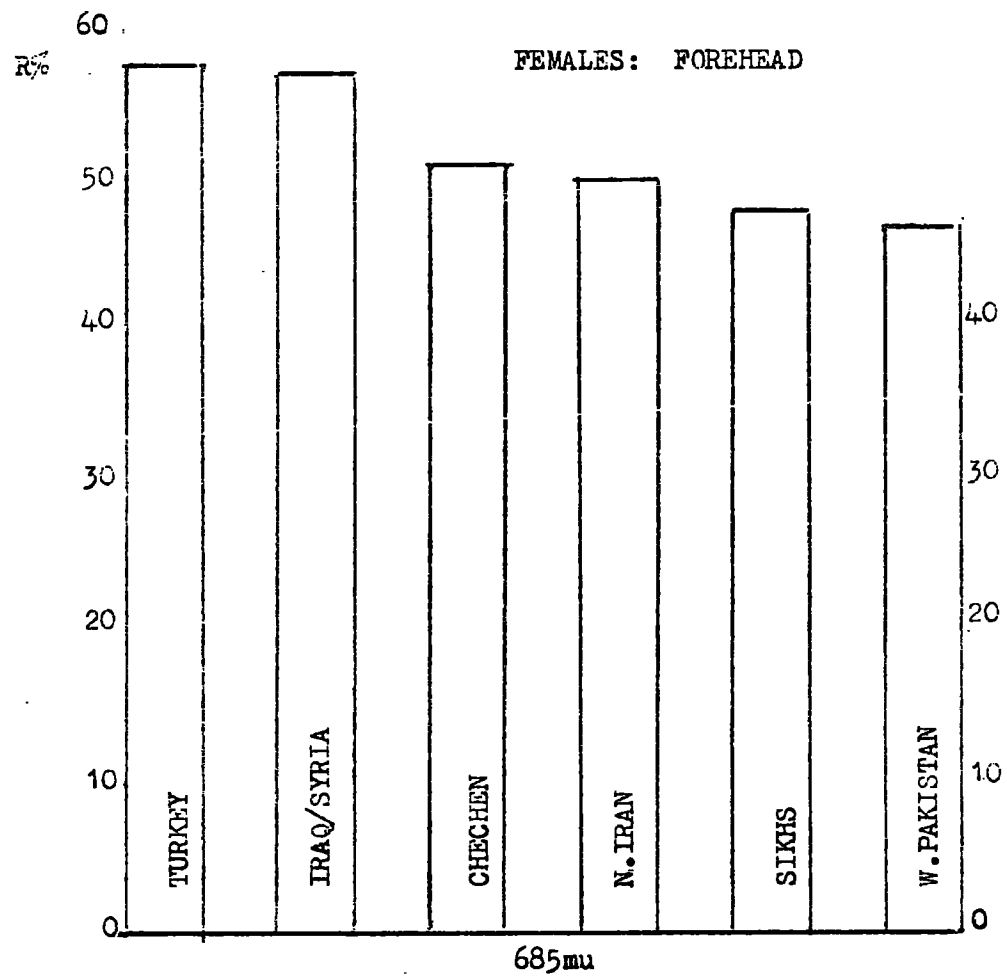


FIGURE(5) CONTINUED

FEMALES: U.I.A



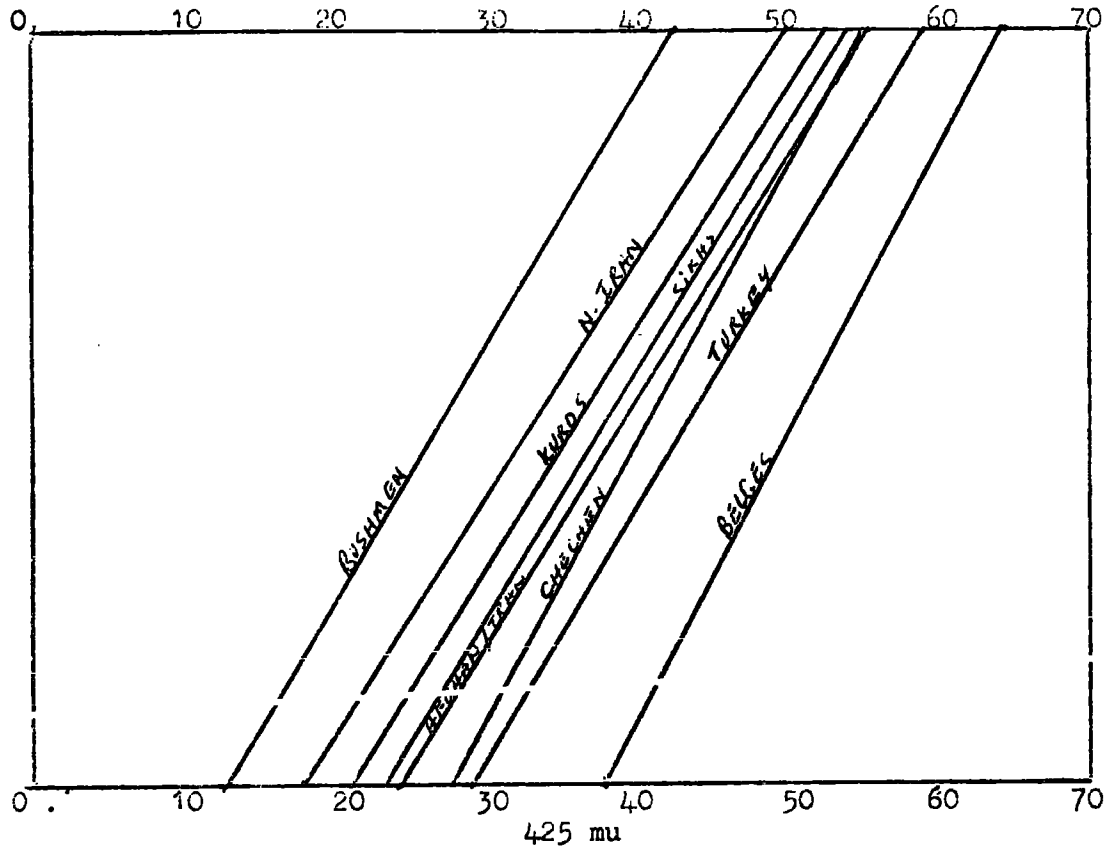
FEMALES: FOREHEAD



FIGYRE (6) MEAN REFLECTANCE VALUES PLOTTED AGAINST TWO WAVELENGTHS

MALES

U.I.A



FOREHEAD

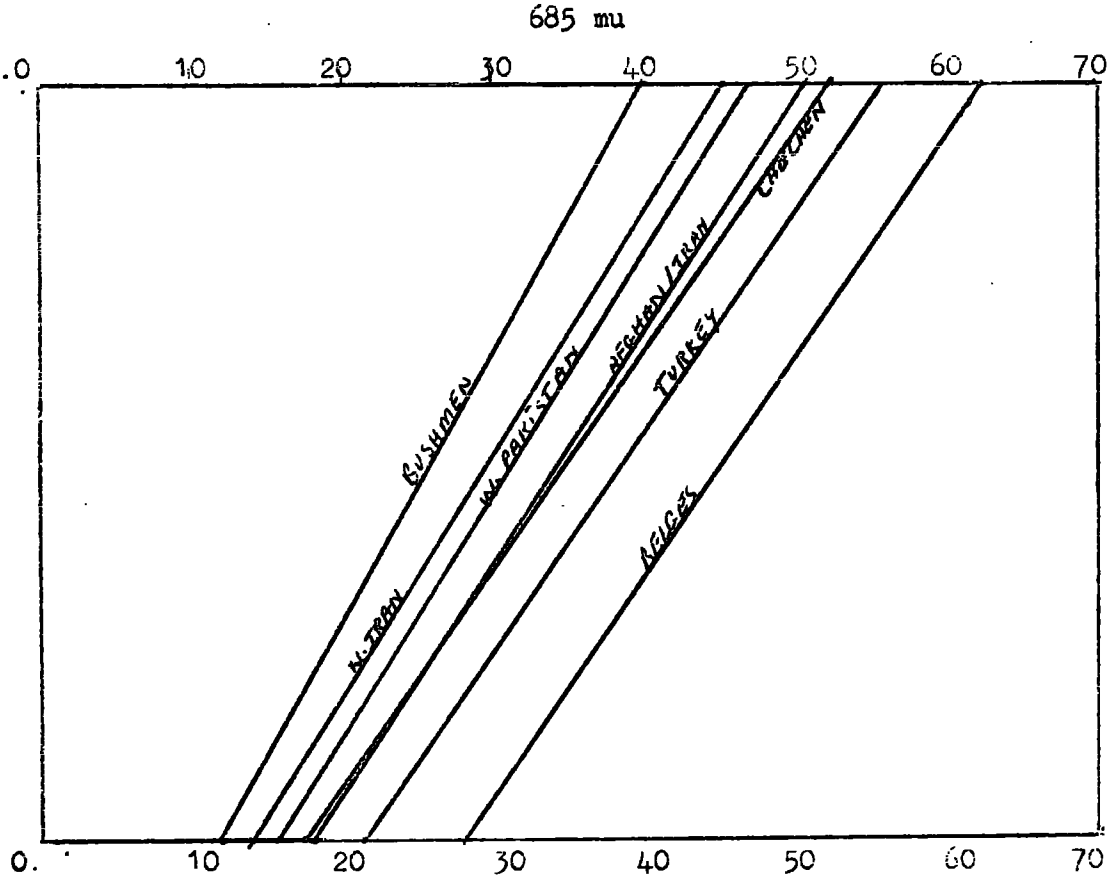
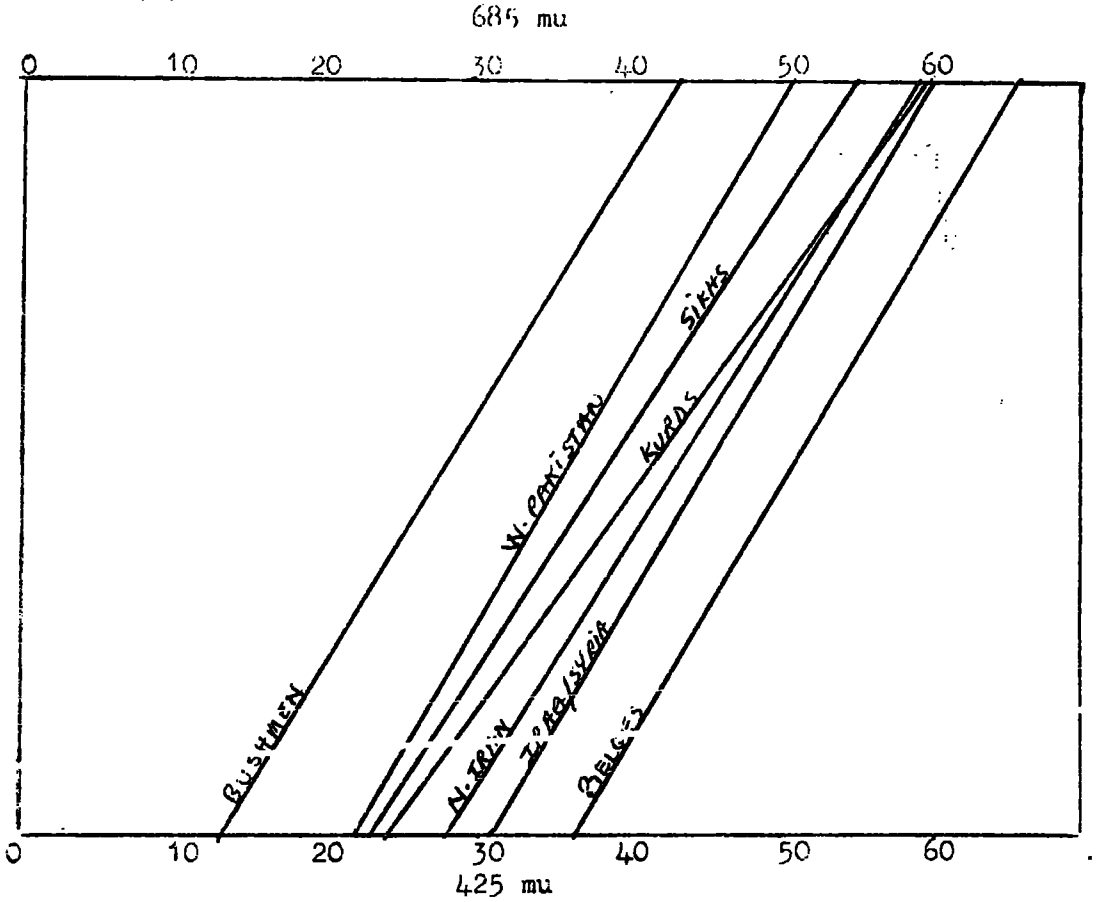


FIGURE (6) MEAN REFLECTANCE VALUES PLOTTED AGAINST TWO WAVELENGTHS

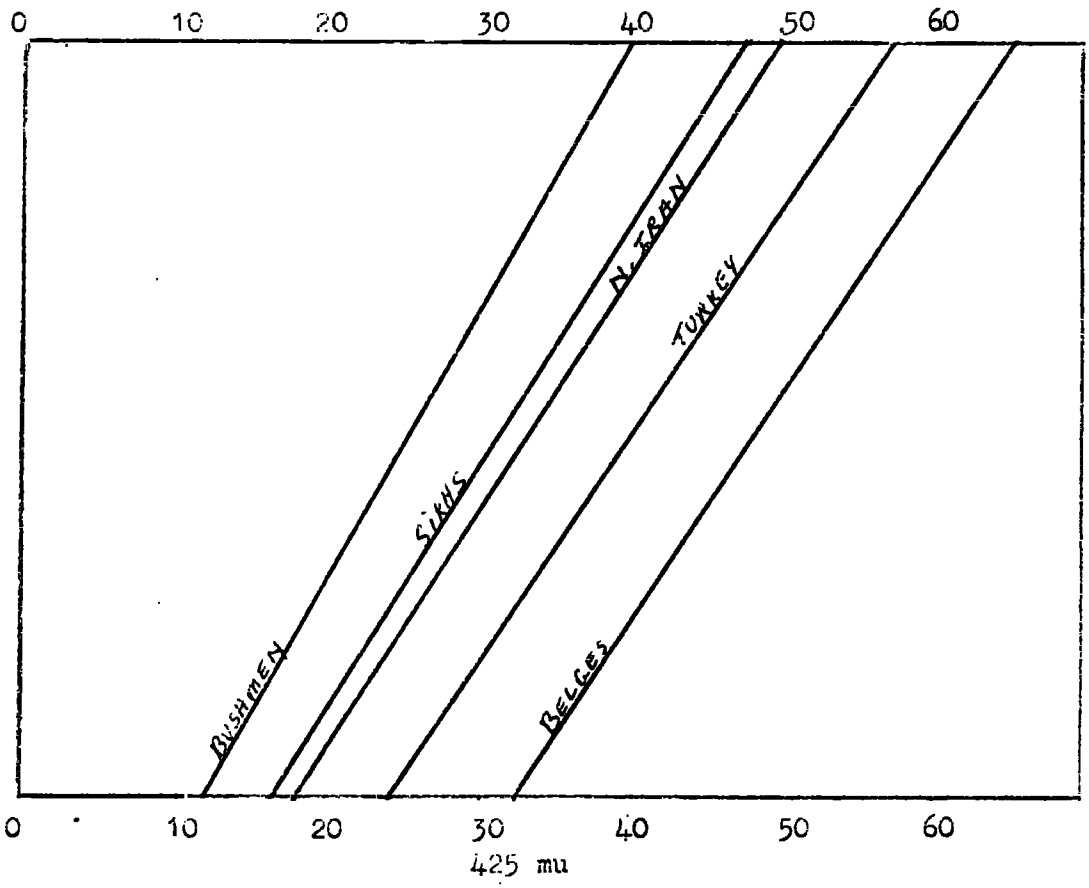
FEMALES

U.I.A



685 mu

FOREHEAD



FIGURE(7) REFLECTANCE CURVES FOR THREE POPULATIONS: MALES

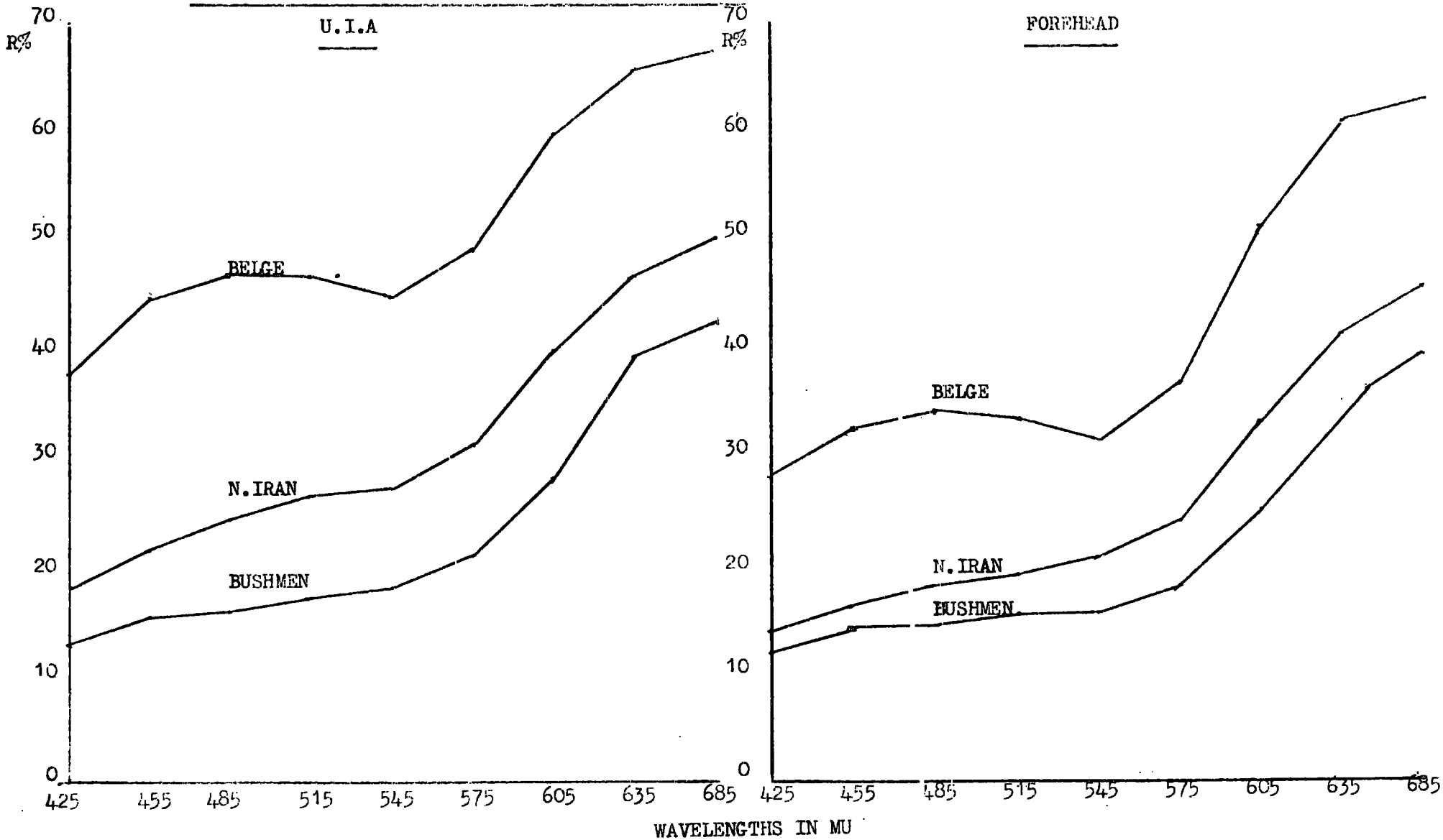
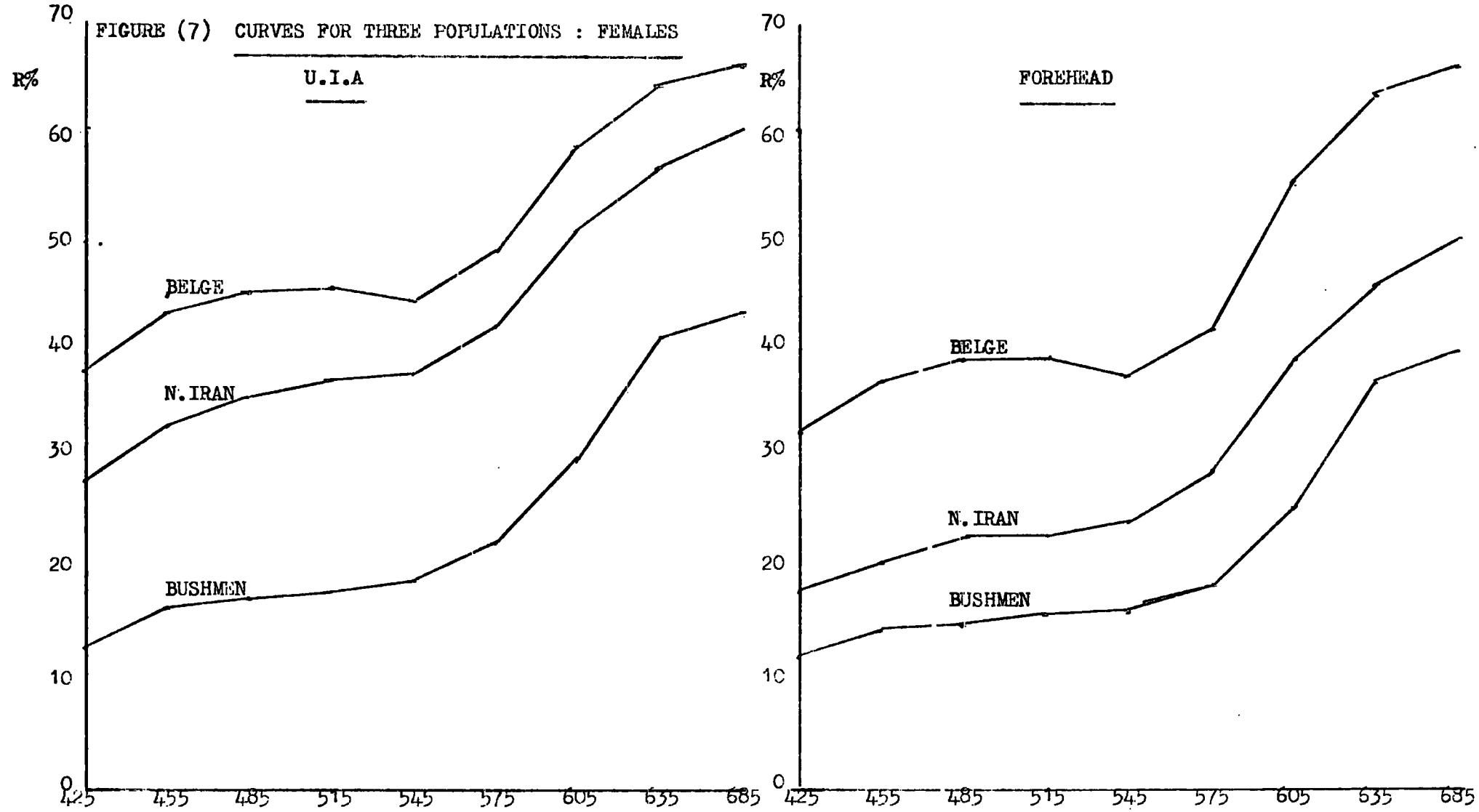


FIGURE (7) CURVES FOR THREE POPULATIONS : FEMALES



BIBLIOGRAPHY

1. ARBERRY, A.J., (1953) The Legacy of Persia, Oxford : The Clarendon Press.

2. BAKER, P. T., (1958) Racial Differences in Heat Tolerance, Am. J. of Phys. Anthropology, 16 : 287 - 306.

3. BAKER, P.T., and WEINER, J.S., (1966) The Biology of Human Adaptability, Oxford University Press.

4. BARNICOT, N.A., (1957) Human Pigmentation, Man., 57 : 114.

5. BARNICOT, N.A., (1958) Reflectometry of the Skin in Southern Nigerians and in some Mulattoes, Human Biology, 30 : 150 - 160.

6. BASIC FACTS ABOUT IRAN (1973) The Ministry of Information : Publications Department.

7. BLUM, H.F., (1961) Does the Melanin Pigment of Human Skin Have Adaptive Value? Quarterly Review of Biology, 36 : 50 - 63.

8. BODMER, W.F., and CAVALLI-SFORZA, L.L., (1976) Genetics, Evolution and Man, W. H. Freeman and Company.

9. BRIGGS, L.C., (1975) Environment and Human Adaptation in the Sahara. In : Physiological Anthropology. (Ed) Damon, A., Oxford University Press.

10. BUETTNER, K.J.K., (1968) The Effects of Natural Sunlight on Human Skin. In : The Biological Effects of Ultra-Violet Radiation. (Ed) Urbach, F., Pergammon Press, London : 237 - 250.

11. BUETTNER - YANUSCH, J., (1973) Physical Anthropology: A Perspective. John Wiley & Sons Inc.

12. CARDINALI, D.P., and WURTMAN, R.J., (1975) The Effects of Light on Man. In : Physiological Anthropology. (Ed) Damon, A., Oxford University Press.

13. CAVALLI - SPORZA, L.L., and BODMER, W.F., (1971) The Genetics of Human Populations., Freeman, W.H: San Francisco.

14. COON, C.S., (1955) Some Problems of Human Variability and Natural Selection In Climate and Culture., The Americal Naturalist., Vol. LXXXIX, No. 848: 257 - 278.

15. COON, C. S. (1966) The Living Races of Man, London : Jonathan Cape.

16. COON, C.S., CARN, S.M., and BIRDSELL, J.B., (1950) Races : A Study of Problems of Race Formation in Man., Charles Thomas Co., Springfield, III.

17. COWLES, R.B., (1959) Some Ecological Factors Bearing on the Origin and Evolution of Pigment in the Human Skin., The American Naturalist, Vol. XCIII, No. 872 : 283 - 293.

18. CROSECLOSE (1947) Introduction to Iran., Oxford University Press, N.Y.

19. CRUZ-COKE, R., (1970) Colour-Blindness : An Evolutionary Approach, Springfield : C.C. Thomas.

20. DAS, S.R., and MUKHERJEE, D.P., (1963) A Spectrophotometric Skin Survey Among Four Indian Castes and Tribes.

21. DAVENPORT, C.B., (1926) The Skin Color of the Races of Mankind. Journal of the American Museum of Natural History., Vol. 26 : 4459.

22. DUNLAP, K., and LODEN, R.D., (1942) Anomalies of Colour Vision., Science, 96 : 251 - 252.

23. EDWARD, E.A., and DUNTLEY, S.Q., (1939) An Analysis of Skin Pigment after Exposure to Sunlight., Science, 90 : 235 - 237.

24. EDWARDS, E.A., and DUNTLEY, S.Q., (1939) Pigments and Color of Living Human Skin., The American Journal of Anatomy, Vol. 65, No.1 : 1 - 32.

25. EDWARDS, E.A., FINKLEISTEIN, N.A., and DUNTLEY, S.Q., (1951), Spectrophotometry of Living Human Skin in the Ultra-Violet Range., Jrnl. of Invest. Dermatology., 16 : 311-321.

26. FERNANDEZ, J (1976) Some Minor Considerations of the Skin Colour of Several Caucasoid Populations. Personal Communication.

27. FIELD, H., (1939) Contributions to the Anthropology of Iran., Anthropological Series, Vol. 29, No 1 and 2

28. FITZPATRICK, T.R., & SZABO, G., (1959) The Melanocyte : Cytology and Cytochemistry. J. Invest. Dermat., 32 : 197 - 209

29. FLEURE, H.J., (1945) The Distribution of Types of Skin Colour., Geographical Review 35: 580 - 595.

30. FORD, E.B., (1945) Polymorphism. Biol. Rev., Vol. 20, : 73 - 78.

31. FREEMAN, F.R., and LOOMIS, W.F., (1967) Vitamin D and Skin Pigments. Science, 158 : 579

32. GARCIA, R.F., MITCHELL, R.E., BLOOM, J., and SZABO, G., (1977) Number of Epidermal Melanocytes, Hair Follicles, and Sweat Glands in Skin of Solomon Islanders .Am. J. of Phys. Anthrop. 47,3 : 427 - 434

33. GARDNER, E.J., (1968) Principle of Genetics, Wiley Eastern Private Ltd. : New Delhi.

34. CARN, S.M., SELBY, S., and CRAWFORD, M.R. (1956) Skin Reflectance Studies in Children and Adults. Am. J. Phys. Anthrop., Vol. 14 : 101 - 117.

35. GARRARD, G., HARRISON, G.A. and OWEN, J.J.T., (1967) Comparative Spectrophotometry with E.E.L. and Photovolt Instruments. Am. J. Phys. Anthrop., Vol. 27, 389 - 396.

36. GARTH, T.R., (1933) The Incidence of Colour Blindness Among Races., Science., 77 : 333 - 334.

37. HAMILTON, J.B., (1939) Significance of Sex Hormones In Tanning of the Skin of Women. Soc. Exp. Biol. Med., 40 : 502

38. HARRISON, G.A. (1957) The Measurement and Inheritance of Skin Colour in Man. The Eugenics Review., 49, 2 : 73 - 76.

39 HARRISON, G.A., and OWEN, J.J.T. (1956/7) The Application of Spectrophotometry to the Study of Skin - Colour Inheritance. Acta. Genet., 6 : 481 484.

40. HARRISON, G.A., and OWEN, J.J.T. (1964) Studies on the Inheritance of Human Skin Colour. Annals of Human Genetics., 28 : 27 - 37.

41. HARRISON, G.A., OWEN , J.J.T., DA ROCHA, F., and SALZANO, F.M. (1967) Skin Colour in Southern Brazilian Populations: Human Biology, 39: 21 - 31

42. HARRISON, G.A., WEINER, J.S., TANNER J.M., AND BARNICOT, N.A. (1977) Human Biology. Oxford University Press.

43. HULSE, F.S. (1967) Selection for Skin Colour Among the Japanese. Am. J. of Phys. Anthrop., 27 : 143 - 156.

44. ISHIHARA, S. (1964) The Series of Plates Designed as a Test for Colour-Blindness: 24 Plates. Kanehara , Shuppan: Tokyo.

45. JACQUES, J.A., KUPPENHEIM, H.T., DIMITROFF, J.M., MUKEEHAM, W., and HUSS, J. (1955) Spectral Reflectance of Human Skin In The Regions of 235 to 700mu. J. App. Physiol., 8 : 212.

46. JASEN, M.T. (1953) A Reflectance Spectrophotometric Study of Ultra-Violet Erythema and Pigmentation. J. Clin. Invest., 32 : 1053.

47. KALLA, A.K. (1969) A Study of the Age Differences in Skin Pigmentation in Males. The Journal of the Anthropological Society of Nippon., Vol. 77, No. 5/6 : 62 - 68.

48. KALLA, A.K. (1969) Changes in Skin Tanning with the Changes in Initial Pigmentation of Skin. The Journal of the Anthropological Society of Nippon., Vol. 77, No. 5, 6 (767/768).

49. KALLA, A.K. (1969) Inheritance of Skin Colour in Man. The Anthropologist, Special Volume: 159 - 168

50. KALLA, A.K. (1970) Melanin Excitation by Ultra violet Rays in Differently Pigmented Skins. The Eastern Anthropologist., Vol. XXIII, No. 1: 65-73.

51. KALLA, A.K. (1973) Ageing and Sex Differences in Human Skin Pigmentation . Z. Morph. Anthrop., 65 : 1 : 29 - 33.

52. KALLA, A.K. and TIWARI, S.C. (1970) Sex Differences in Skin Colour in Man. Acta. Geneticae Medicae et Gemallologiae., 19 : 472 - 6

53. KALMUS, H. (1965) Diagnosis and Genetics of Defective Colour Vision Pergamon Press Ltd.

54. KHERUMIAN, R., and PICKFORD, R.W. (1959) Heredité et Frequence Des Anomalies Congénitale Du Sens Chromatique. Vigot Frere, Paris.

55. LASKER, G.W. (1954) Seasonal Changes in Skin Colour.

56. LEE, M.M.G., and Lasker, G.W. (1959) The Sun Tanning Potential of Human Skin. Human Biology., 31 : 252 - 260.

57. LEGUEBE, A. (1961) Contribution A l'étude De La Pigmentation Chez L'homme. Institut Royal Des Sciences Naturelles De Belgigue., Tome XXXVII, No. 11: 1-29.

58. LEGEUBE, A. (1976) Catalogue of Spectrophotometric Data on Skin Pigmentation. Institut Royal Des Sciences Naturelles de Belgigues; Documents de Travail: No.9.

59. LEGUEBE, A. (1977) Analyze In Composantes Principales de la Couleur de la Peau,L'Anthropologie, Tome 81, No.1 : 99-114

60. LEGUEBE, A. La Pigmentation Cutanee : Caractere Adaptif ou non?

61. LERNER, A.B., and FITZPATRICK, T.B., (1950) Biochemistry of Melanin Formation. Physiol. Rev., 30 : 91 - 126.

62. LIVINGSTONE, F.B., (1969) Polygenics Model for the Evolution of Human Skin Colour Differences. Human Biology, 41, : 480 - 493.

63. LOURIE, J.A., (1973) Physical Characteristics of the Yemenites and Kurdish Jews in Israel. Phil.Trans. R. Soc., Lond. B., 266 (101-112).

64. MARASHI-MIR SEYYED, Z., (1966) The Tarikh-1-Tabarestan - O - Royan - O - Mazandaran. History of Tabarestan Royan and Mazandaran. Sharqh. Book Shop.

65. MARQUEZ, M.N.T., (1977) Chromosome and Colour Blindness. Opthalmologica., Basel 175 : 305 - 308.

66. MASON, P., (1948) Pigment Cells in Man, In : Biology of Melanoma. N.Y. Academy of Science, 4 : 15.

67. MELLART, J., (1965) Earliest Civilization of the Near East, Thames and Hudson, London.

68. MOFAKHAM-PAYAN, L., (1969) Etude Geographiques de la Mer Caspienne., la Societe Geographique de Khorassan. Imprimerie de l'Universite de Machad,Iran.

69. NEEL, J.V., and POST, R.H., (1963) Transitory 'Positive' Selection for Colour Blindness, Eugenics Quarterly, 10 : 33 - 35.

70. NEWMAN, R.W. (1975) Human Adaptation to Heat. In Physiological Anthropology.,(Ed) Daman, A. Oxford University Press.

71. PICKFORD, R.W. (1958) A Review of Some Problem of Colour Vision and Colour Blindness. The Advance of Science: J. Psychology, Vol 25: 104 - 17.

72. PICKFORD, R.W. (1959) Some Heterozygotes Manifestations of Colour Blindness. Br. J. Physiol. Optics., 16 : 83 - 95.

73. PICKFORD, R.W. (1959) The Inheritance and Frequency of Colour Blindness Surgo., 26 : 29-32.

74. PICKFORD, R.W. (1963) Natural Selection and Colour Blindness. Eugenics Review., Vol 55 : 97 - 101

75. POIRIER, F.E. (1977) In Search of Ourselves: An Introduction to Physical Anthropology. Burgess Publishing Company.

76. POST , R.H., and RAO, D.C. (1977) Genetic and Environmental Determination of Skin Colour. Amer. Jour. of Phys. Anthrop., 47, 3 : 399 - 402.

77. POST, R.H. (1962) Population Differences in Red and Green Colour Vision Deficiency : A Review and a Querry on Selection Relaxation. Eugenics Quarterly, Vol. 9, No. 1 : 131 -146.

78. POST, R.H. (1971) Relaxed Selection in Civilized Populations: Colour Blindness. Humangenetik., 13, 4 : 259 - 264.

79. RAY, A.K. (1969) Colour Blindness, Culture and Selection.
Science. Biol., Vol. 16 : 203 -8

80. RIJN-TOURNEL, J.V. (1966) Pigmentation De La Peau De Belges Et D'Africaines.
Bull. Soc. Roy. Belge. Anthrop. Prehist., 76 : 79 - 96.

81. RITGER-ARIS, C.A.E. (1973) A Reflectometric study of the Skin in Dutch Families.
Journal of Human Evolution, Vol. 2: 123- 136

82. RITGER-ARIS, C.A.E. (1973) Relationship between Skin Reflectances at Several Wavelengths in Inter and Intra population Comparisons.
Human Biology, Vol. 45, no. 4: 613-626

83. ROBERTS, D.F. (1977) Human Pigmentation: Its Geographical and Racial Distribution and Biological Significance.
J. Soc. Cosmet-Chem., 28, No. 6 : 329 - 342.

84. ROBERTS, D.F. and KAHLON D.P.S. (1976) Environmental Correlations of Skin Colour. Annals of Human Biology Vol. 3, No. 1: 11-22.

85. ROBERTS, D.F. and KAHLON, D.PS. (1977) Human Skin Pigmentation.
(In Press)

86. ROBERTS, D.F. and SUNDERLAND, E. (1973) Genetic Variation in Britain.
Taylor and Francis Ltd.

87. STARICCO, R.J. and PINKUS, H. (1957) Quantitative and Qualitative Data on the Pigment Cells of Adult Human Epidermis. J. Invest. Dermat., 28: 33-44

88. STERN, C. (1970) Model Estimates of the number of Genes pairs involved in Pigmentary Variability of the Negro-Americans. Human Heredity., 20 : 165 - 168.

89. SUNDERLAND, E. (1967) The Skin Colour of the People of Azroq. Eastern Jordan. Human Biology., Vol. 39, no. 1: 65 - 70.

90. SUNDERLAND, E. (1968) Early Man in Iran. In : Cambridge History of Iran. No. 1. The Land of Iran., (Ed) Fisher, W.B. University Press: Cambridge

91. SUNDERLAND, E. (1973) Skin Colour Studies in Some Middle Eastern populations. (Personal Communication).

92. SZABO, G. (1959) Quantitative Histological Investigation in the Melanocyte System of the Human Epidermis New York. ACHAD. Press. Inc. : 99-125

93. SZABO, G. (1975) The Skin as an Adaptive Organ; In: Physiological Anthropology. (Ed) Damon, A. Ox. Uni.Pr.

94. THODAY, J.M. (1965) Correspondence: Colour Blindness. Eugenics Review, 56, 4: 232 -233.

95. THOMSON, M.L. (1955) Relative Efficiency of Pigment and Horny Layer Thickness in Protecting the skin of Europeans and Africans against Solar Ultra-Violet Radiation. J. Physiol, 127: 236.

96. TIWARI, S.C. (1963) Studies of Crossing Between Indians and Europeans. Annals of Human Genetics., 26: 219-227.

97. TIWARI, S.C. (1964) Skin Reflectances Studies in Some Upper Caste of Bengal.Anthropologist, Vol. IX, Nos. 1 and 2 : 13 - 16

98. TIWARI, S.C. and KALLA, A.K. (1969) Dimorphism in the effect of Adolescence on Skin pigmentation. Antropologist: Special Volume: 169 - 174.

99. TIWARI, S.C. and KALLA, A.K. (1969) A Study of the Skin Colour Changes During Adolescence Among the females Acta. Med. Auxol I, 3 : 218 - 222

100. WALD, G (1960) Defective Colour Vision and its Inheritance. Proc. Natn. Acad. Sci., 55: 1347-1363.

101. WALSCH, R.J. (1963) Variation of Melanin Pigmentation of the Skin in some Asian and Pacific People. Journal. Royal.Anthrop. Inst., vol 93, 1: 126-133.

102. WASHBURN, S.L. (1964) Racial Differences in Skin Colour. American Anthropologist., 66: 1173-4

103. WASSERMAN, H.P. (1968) Quantitative Data on Skin Pigmentation in South African races. South African Medical Journal., 42: 98-101.

104. WASSERMAN, H.P. (1969) Melanin Pigmentation, and the Environment. In: Essays on Tropical Dermatology, (Ed) Simons, R.D.G.A. and Marshall, J. Excerpta Med., Amsterdam: 1-16

105. WEINER, J.S. (1951) A Spectrophotometer for Measurement of Skin Colour Man., 51: 152-153.

106. WILBER, D.N. (1963) Iran Past and Present. Princeton University Press.