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A STUDY OF SOME GENETICALLY DETERMINED FEATURES IN SWEDISH, SPANISH AND NORTH ENGLISH POPULATIONS.

Juan J. Fernández

Malmö, 1984

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ABSTRACT

A survey has been conducted with the assistance of the reflectophotometric techniques within the populations of three different countries - Sweden, Spain and England - in order to study the pigmentary differences between and within them, and to what extent they obey to environmental instead of genetic diversity.

In order to illustrate the differences between accurately determining the colour of a skin and looking at its adaptive role, a detailed exposition of the physics of colour has been undertaken in the introductory chapter.

In recognition of the the effects of human behaviour and the physical milieu in moulding the phenotypical manifestations of the genetical structure of a population, extensive information was gathered about the ethnic origins of people and about their leisure and working habits. That information - together with other about non-cutaneous pigmentation, stature, blood groups and their reflectance readings - was codified and transformed into variables, in order to study their associations (if any) with each other

That task has been undertaken in chapters III to VII, where the combined effect of the behavioural variables was in certain cases found capable of explaining as much as 35 % of the internal variability. Some significant differences were also found to parallel climatic factors such as insolation and precipitation. In chapter VII a number of significant associations were found between pigmentation, blood groups and stature - and were attempted to be put in relation with certain racial strains.

Chapter VIII constitutes an enquiry into the subject of mating preferences and its potential effect on the genetic structure of the populations under study. The author´s samples have, in the last chapter, been compared to other Caucasoid populations, arriving to the conclusion that a non-negligible part of the differences is probably due to plain instrumental error.

To my wife and kids,
to her parents and
to my parents --
for their moral and
economic support.

ACKNOWLEDGEMENTS

This work required cooperation from a great number of people. First are the subjects of the experiment themselves: students, colleagues, friends and relatives. Without them, no work would have been possible. To them all I am very grateful. I am also deeply indebted to a number of teachers and oficials from different departments and institutions, who patiently allowed my work to interfere with their dayly schedules. They were mainly language teachers at Studiefrämjandet, Medborgarskolan, PLT and Demarets Språkskolan; biology teachers at Sankt Petri skola, Borgarskolan and Latinskolan; and both sorts at Söderslättskolan (Trelleborg). At this respect, directly or through their contacts, four persons were responsible for most of the sampling. In alphabetical order they are:

Carmen Demaret	Demarets språkskolan
Antoni Ivarra	Studiefränjandet and Söderslättskolan.
Mike O´Connors	Studiefrämjandet
Björn Peterssen	Sankt Petri skolan

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A significant part of the Swedish sample was gathered at Bladinskola, Malmö, whose teachers and rector are to be thanked for their cooperative spirit.

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CONTENTS

General remarks.

In order to avoid unnecessary worrying about the correct transcription of toponimic designations into English and, above all, to bypass the usual clumsiness of transcriptions into foreign languages, names of places will be used in their original form in this work. An exception will be made in the case of the names of countries. Some of these forms can, however, result unfamiliar to the English reader, for which reason these presenting the maximal difficulties will be listed below in their vernacular and English versions. Figure VII.1-2 (page 286) shows Hoyos' division of Spain in anthropodemographic regions (1952), and maps of the three lands subdivided by provinces are included in page 252.

Sweden

Norrland (lit., "Northern Land"): includes all provinces north of Dalarna and Uppland.

Skåne (=Scania): the southernmost province of Sweden.

Dalarna (=Dalecarlia): the northernmost province of central Sweden.

Götaland (ancient Gothia of Jordanes; the homeland of the Gauts or Goths - later Götar). Includes all provinces south of Dalsland, Västergötland and Östergötland (incl.).

Svealand (the Swiorice of the Beowulf saga; ancient homeland of the Suehans of Jordanes or the Suiones of Tacitus - later Svear). Includes all provinces between Norrland and Götaland.

Spain

Castilla la Nueva (lit., New Castile): includes Madrid, Toledo, Ciudad Real, Cuenca and Guadalajara.

Castilla la Vieja (lit., Old Castile): includes administratively Santander, Burgos, Logrono, Soria, Segovia and Avila - but geographically and anthropologically, Santander belongs to the northern seaboard.

Cantabria: Santander and Asturia, mainly. In Hoyos' division (1952) it extends as well along the eastern highlands of Galicia.

The Basque Country: here meant to comprise Vascongadas (Vizcaya, Guipúzcoa and Alava) and Navarra.

Vasconia: according to Hoyos, the anthropological heart of the Basque country. It includes Guipúzcoa, Vizcaya, the northern part of Alava and the highlands of Navarra. However, unless otherwise is specified, both terms will be used as interchangeable.

La Mancha: the land of Don Quijote. It comprises the lowlands in the southeastern corner of New Castile and part of Albacete.

La Rioja: another natural region, centered around the city of Logrono in the province of the same name.

Levante: part of the eastern seaboard. It corresponds to the provinces of Castellón, Valencia, Alicante and Murcia.

Castilla (Castile): both Castiles together.

An important distinction must be made between three different acceptations of the term **'Cantabrian'.** The Cantabrian coast is the seaboard facing the Cantabrian Sea - the whole northern coast. The aforementioned anthropo-demographic region, Cantabria, without administrative counterpart, is best illustrated in figure VII .1-2. By the name of Cantabri (Cantabrians), the most powerful among the ancient inhabitants of the province of Santander were known to the Romans.

The term Cromagnoid will come across in a couple of chapters. Since it has been used in somewhat different ways by a number of investigators, a clarifying remark has been considered necessary. The word is used here to designate all those Upper Palaeolithic forms in most characters ressembling the so-called "Old Man of Cromagnon" clearly more than any other form. As most common traits may be named the possession of big and robust crania displaying cranio-facial disharmony (short and broad faces allied to long, narrow skulls) and facial disharmony (short, upper face combined with long subnasal face), together with vertical, non-curved foreheads and well marked browridges; the nasal bones are prominent and the nasal opening is normally of medium size; low and broad, rectangular orbits; rather flat skull vaults, flaring zygomata and broad, squarish jaws, with absolutely great bizygomatic and bigonic diameters; massive skeletons, with broad shoulders and powerful muscular impressions - often allied to tall stature. This description excludes the Combe-Capelle and 'Negroid' Grimaldi forms and some of the central European Upper Palaeolithic finds.

Tables designated in the text by a capital letter and a number are to be found in the appendix headed by the corresponding letter; the rest are incorporated within the text (at the end of a section when they are too many).

For the sake of simplicity, the violet-blue region (up to approximately 500 nm), the green-yellow region (500 to 590 nm) and the orange-red region (590 nm and beyond) will be referred to in the text as the blue, green and red regions respectively.

CHAPTER I

I.1. The Physics and measurement of colour.

Visible light (VL) constitutes only a minute portion of the electromagnetic spectrum capable of impressing the part of the nervous system which is linked to vision and which, for the average human eye, extends between wavelengths of roughly 380 and 770 nm. Although we do need not here be concerned with the rest of the spectrum, the whole of it has been reproduced in figure I.1-1 for purposes of comparison.

Physically, light is nothing more than magnetic and electric effects travelling in a common direction. Energy is stored in its magnetic and electric fields. Before proceeding any further, three important facts, of relevance for purposes of colorimetry, must be introduced whilst the pertinent physical notions will be indicated in more detail elsewhere.

1) Since energy is associated with each wave, the relative amounts of it attached to the wavelengths in a ray of light define the spectral structure of this light, its energy distribution which is a function of the wavelength λ, $P = f(\lambda)$.
2) Not all wavelengths are equally efficient in producing light. Figure I.1-2 shows in the function of wavelength (abscissas) the luminous flux (ordinates) produced by one watt of monochromatic radiation. This curve, usually presented in percentual form, V_λ, defines the relative contributions which each wavelength makes in an equal-energy spectrum to the total light flux.
3) The structure of a light beam can then be defined by giving any of two spectra: either the radiant energy distribution, monochromatic radiant flux, or its luminous distribution, monochromatic luminous flux. The second curve is simply the product of the radiant flux curve by $k_m . V_\lambda$ -where k_m restores to V_λ its absolute dimension, since it

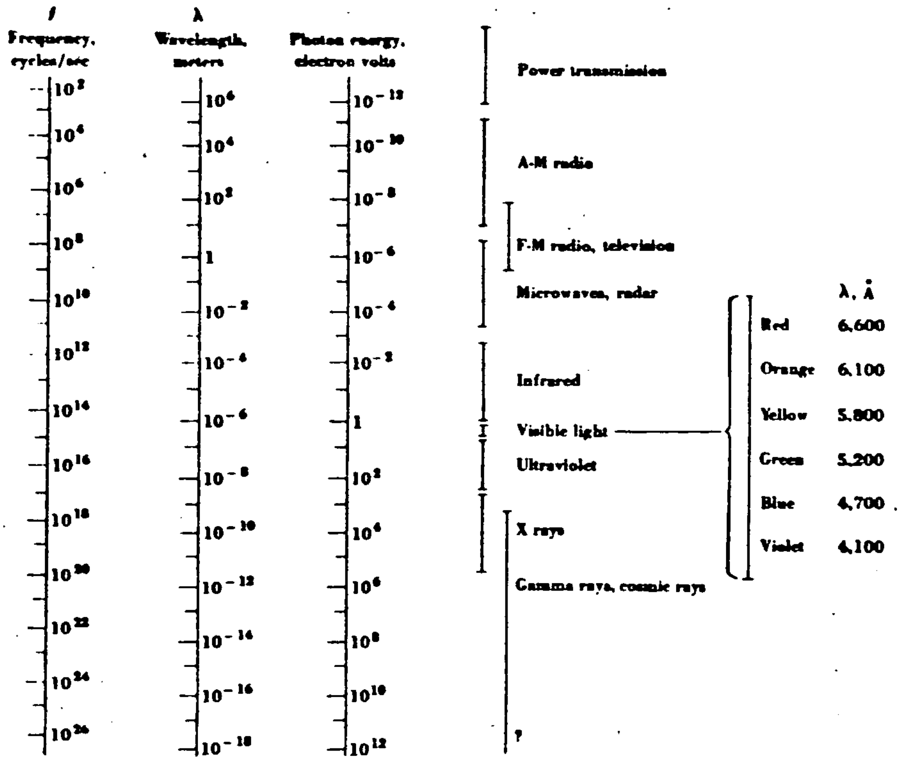

Fig. I.1-1. The electromagnetic spectrum. All scales are logarithmic. (After Young, 1968).

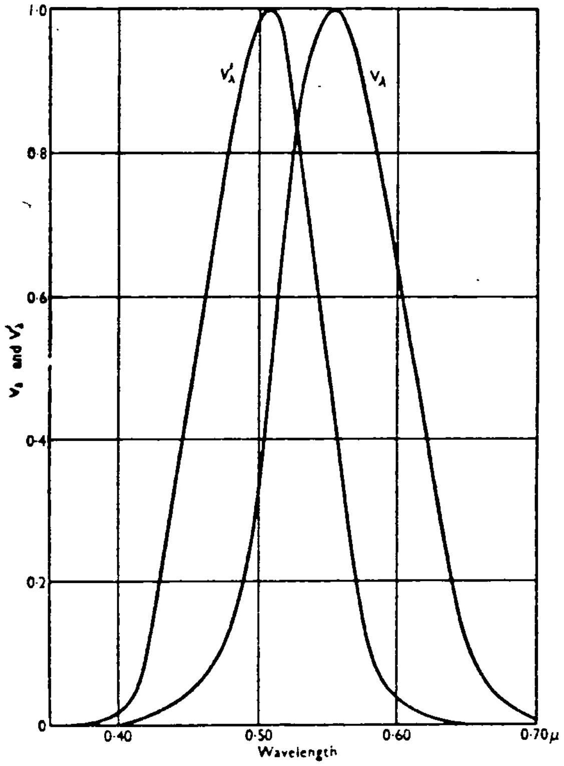

Fig. I.1-2. Relative luminosity curves for the standard observer: scotopic (V'_λ), under subdued lighting, and photopic (V_λ), under good lighting conditions. V'_λ corresponds to rod vision, as measured in the extra-foveal area of the retina; V_λ corresponds to cone vision, as measured at high intensities at the fovea. (After Wright, 1964).

corresponds to the luminous efficiency of the monochromatic radiation for which V_λ is at a maximum (which occurs at $\lambda = 0.555\ \mu$, the wavelength at which cones -in the fovea- have their maximum sensitivity).

The light which reaches a body is white during daytime and it is ideally (1) a well balanced composition of all wavelengths of visible light coming from the sun, a so-called equal energy stimulus. When that light impinges on a body's surface every individual wavelength is reflected or transmitted according to some distinctive reflection or transmission factor which is not constant all throughout the spectrum, but which depends on the magnitude of λ. The result of this selective reflection/transmission is loss of balance, the light leaving the surface (2) is no longer white. Its colour is the result of the integration into a whole of all wavelengths of VL departing the surface. In other words, a body absorbs most of those wavelengths which are the least represented in its colour. What we see then is the complement of what has been absorbed.

Once established that each colour can be represented by a particular energy distribution curve, the idea comes naturally that it should be possible to decompose all existing colours into the same set of standard stimuli (primaries), in such a way that

(1) In practice, however, experiments on colour mixture reveal that the sensation of whiteness is neither exclusively nor normally associated with such a unique combination, as examination of the energy distributions of three typical sources of white light can attest (fig. I.1-3).

(2) Not all light reflected by a body actually comes from its surface. A small part of the light refracted into it can, due to further refraction inside, be redirected backward and ultimately escape through broadly the same area as it just travelled across.

any colour 'C' could be defined by reference to the

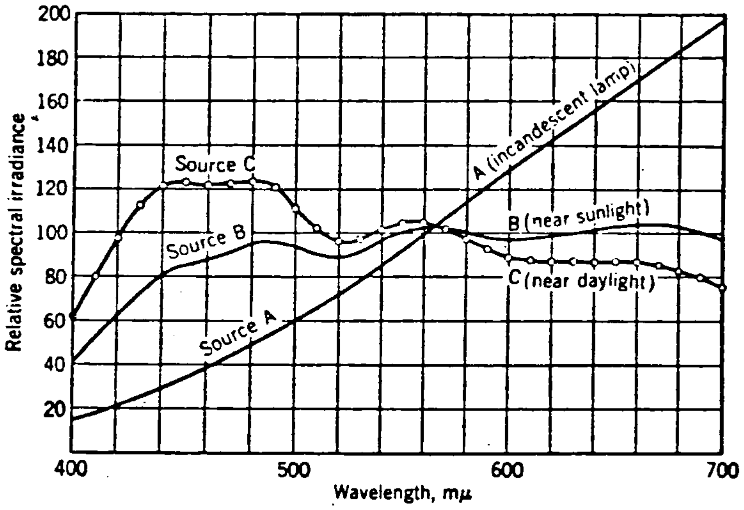

Fig. I.1-3. Relative spectral irradiances from standard sources A, B, and C. Source A is typical of the gas-filled incandescent lamp; source B, of noon sunlight: and source C, of average day light. (After Judd and Wysceski, 1952).

quantities, $q_i(\lambda)$, of each primary, $f_i(\lambda)$, required to match light (C) by adding together the standard stimuli (fig. I.1-4). Where, by using the notation $q_i(\lambda)$ and $f_i(\lambda)$, it is meant that the energy distribution curve for each primary, i, and the 'amount of stimulus' required vary - we presume so far - with both component and wavelength.

Although the number of primaries should have to be infinite, if they were to be combined additively, three conveniently chosen stimuli can - as it will be seen in time - reproduce most real colours. For convenience the standard stimuli are so elected that their luminous fluxes together add up to that of an equal-energy spectrum, and from there it is a matter of simple proportionality to prove that $q_i(\lambda)=P$. In practice the energy distributions of the three stimuli are so chosen that the chromatic sensations they convey are red, green and blue respectively. The quality of their colours is represented as 'R', 'G' and 'B'.

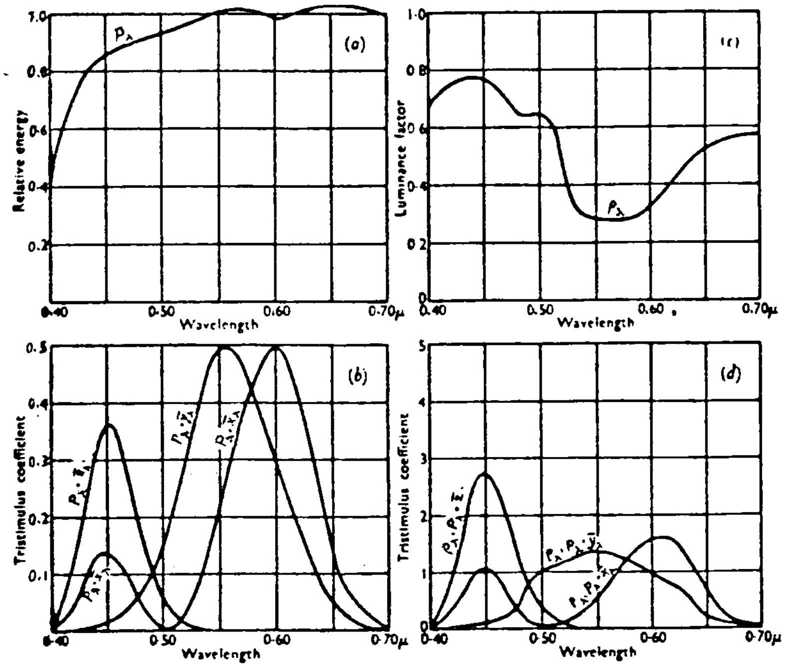

Fig. I.1-4. Graphical illustration of the derivation of the tristimulus specificacions of a coloured surface.

(a). The energy distribution of the illuminant.
(b). The product of (a) with the distribution curves of fig. I.2-13.
(c). The spectral reflection curve of the surface.
(d). The product of (b) and (c), from which the areas under the three curves will give the tristimulus values - X, Y and Z - of the surface. (After Wright, 1964).

Of paramount importance in the physics of colour is the concept of radiant flux. This is defined as the amount of energy (in watts) radiated or received by a surface in a unit of time (in seconds). Here, the radiant flux of any of the aforementioned stimuli, (C_i), between wavelengths λ and $\lambda + \Delta\lambda$ is the total amount of energy contributed by it, i.e.

$$\Delta RF_i = q_i(\lambda).f_i(\lambda).\Delta\lambda = P_\lambda .f_i(\lambda).\Delta\lambda \qquad (I.1-1)$$

and, along the whole spectrum of visible light (VL),

$$\therefore RF_i = \Sigma P_\lambda .f_i(\lambda).\Delta\lambda \qquad (I.1-2)$$

Since the luminous yield (efficiency) of a light stimulus is not independent of wavelength, in order to obtain the corresponding expression for the luminous flux, the radiant flux equation must be weighted by the aforementioned factor $k_m . V_\lambda$. The formula

$$LF_i = k_m \Sigma P_\lambda . f_i(\lambda) . V_\lambda . \Delta\lambda \qquad (I.1\text{-}3)$$

The products $P_\lambda . f_i(\lambda)$ and $P_\lambda . f_i(\lambda) . k_m V_\lambda$, for each of the components and the wavelength λ, are known as $P_{i\lambda}$ and $F_{i\lambda}$ respectively, radiant and luminous flux per unit of wavelength (measured in watts and lumens per nm respectively), also referred to as monochromatic radiant and light fluxes.

It is practical to define a new system of units (the chromatic system) by limiting the number of primaries to three and referring the light flux of each of the components (LF_R, LF_G or LF_B) to that of the corresponding primary (LF_{Ro}, LF_{Go} or LF_{Bo}), in a match where the total amount of light 'C' is made equal to one of the new units. Thus,

$$C \text{ 'C'} = \frac{LF_R}{LF_{Ro}} \text{ 'R'} + \frac{LF_G}{LF_{Go}} \text{ 'G'} + \frac{LF_B}{LF_{Bo}} \text{ 'B'} \qquad (I.1\text{-}4)$$

When colour 'C' is referred to the luminous fluxes of three other lights 'R', 'G' and 'B', I.1-4 is more commonly expressed as

$$C \text{ 'C'} \equiv R \text{ 'R'} + G \text{ 'G'} + B \text{ 'B'} \qquad (I.1\text{-}5)$$

where 'R', 'G', 'B' and 'C' have no numeral significance but represent only the quality of the lights, whilst C has the same function as R, G and B. The sign $\equiv$ indicates that the colour-matching equation above is not an algebraic equation, and it should be read that the mixture R, G and B units of stimuli (R), (G) and (B) 'corresponds to' or 'is matched by' C units of stimulus 'C'. The quantities of these three reference stimuli may be expressed in physical units of power or energy, in formal psychophysical units of luminous flux or luminance or -more often, as here- for practical reasons, in more arbitrary units -such as the so-called T-units or the amounts directly read in the scale of the instrument (Wright, 1964). I.1-5a becomes a true algebraic equation by writing

$$C = R + G + B \qquad (I.1\text{-}5b)$$

Dividing this equation both sides of I.1-5a, a so-called unit-trichromatic equation is obtained, where the amount of 'C' is measured as one trichromatic unit (or T-unit, for brevity).

$$'C' \equiv r\ 'R' + g\ 'G' + b\ 'B' \qquad (I.1\text{-}6a)$$

$$1 = r + g + b \qquad (I.1\text{-}6b)$$

and

$$\begin{aligned} r &= R/(R+G+B) \\ g &= G/(R+G+B) \\ b &= B/(R+G+B) \end{aligned} \qquad (I.1\text{-}7)$$

If the quantities R, G and B are represented as vectors $\overline{R}$, $\overline{G}$ and $\overline{B}$, arbitrarily orientated, a new, interesting, dimension is added. If a triangle (fig. I.1-5, a and b) is drawn between points R, G and B, so that the distances OR, OG and OB fulfil the relationship OR = OG = OB = 1, point C, at the intersection of vector $\overline{V}$ with the plane of the triangle (unit plane), will represent the position of colour 'C' with respect to the others - 'R', 'G' and 'B'. If the orientations of the reference vectors are kept constant, the position of any colour 'C' on the plane depends solely on the numerical values of $\overline{R}$, $\overline{G}$ and $\overline{B}$. It can be shown that if the triangle is equilateral (fig. I.1-5c), the perpendicular segments intercepted between C and each of the sides are proportional to r, g and b, the chromaticity coordinates, and they add up to a magnitud equal to the height of the triangle, h. If distances are measured in units such that h=1, the segments will exactly equal r, g and b.

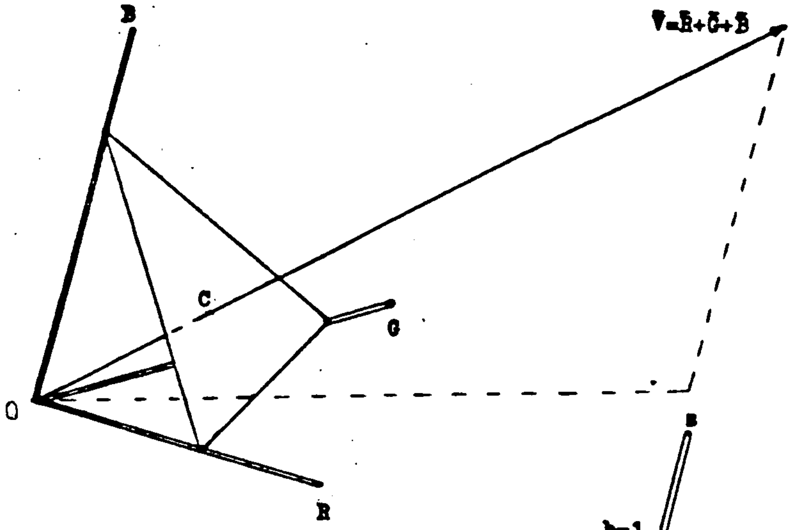

Fig. I.1-5a. Unit plane and vectors.

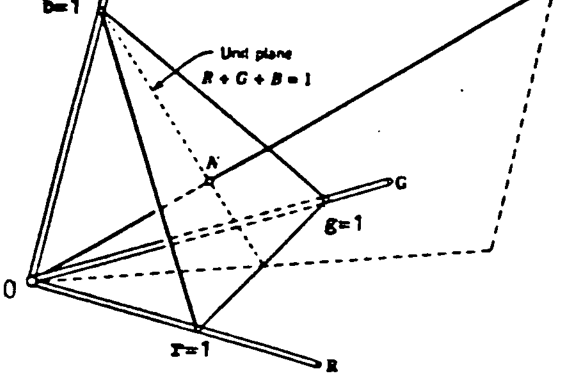

Fig. I.1-5b. Unit plane and neutral colour N.

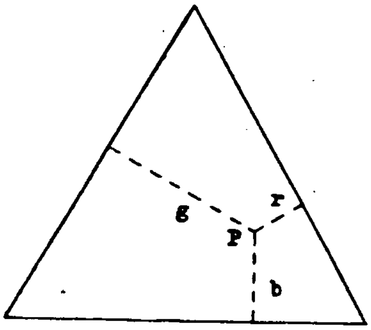

Fig. I.1-5c.
The relationship r+g+b=1 can be represented graphically by making use of a geometrical property of the equilateral triangle: independently on P's position, the sum of the perpendiculars to the sides is equal to a constant (arbitrarily regarded as one unit). In a non-equilateral triangle, only two (any pair of the chromaticity coordinates) can be represented, since - although r+g+b still equals 1 - the sum of the perpendiculars does not any longer do.

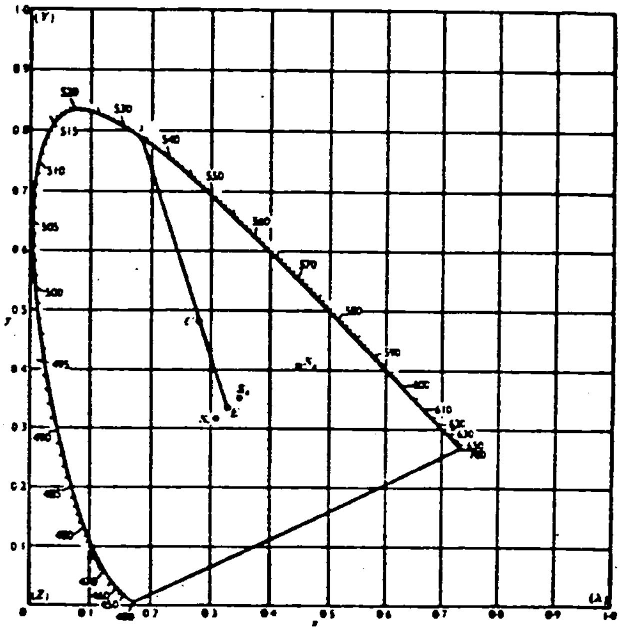

Fig. I.1-5d. The 1931 C.I.E. chromaticity cart plotted in terms of the reference stimuli (X), (Y) and (Z) with units based on an equal-energy white E. The location of the illuminants S_A, S_B and S_C is shown

Fig. I.1-5. The unit plane and the chromaticity chart. (b and c, after Judd and Wysceski, 1952; d, after Wright, 1964).

These can, thus, be regarded as some sort of coordinates, chromaticity coordinates, by means of which the position of a colour can graphically be defined. In practice it is more convenient to represent r and g, for instance, in a right-angle triangle (cartesian system), where the perpendicular segments, however, no longer add up to one. Since r+g+b still will equal one unit, the point will be sufficiently determined with two coordinates.

Since the unit lengths of the three axes, which correspond to the unit amounts of the three primaries, may be chosen in an arbitrary way, a useful choice is such that equal amounts of 'R', 'G' and 'B' result in a neutral (achromatic) colour -one in which neither green nor red, nor blue predominates, 'N'. This corresponds to our idea of what a perfect white should be, and its chromaticity coordinates (r,g,b) are (0.333,0.333,0.333) or more exactly (1/3,1/3,1/3).

Thus, all colours can be represented on the unit plane, within the frame of a right-angle triangle. In figure I.1-5d all saturated (monochromatic) colours have been plotted in a chromaticity diagram in which the primaries are unreal or imaginary, more of which will be seen below. The result is the spectrum locus. A number of features are to be noted: 1) wavelengths between 700 and 770 nm are represented by a single point and this part of the spectrum is referred to as a "long-wave and stretch", 2) there is no such exact constancy of chromaticity near the short wave extreme of the spectrum (430 to 380 nm), but there is a certain approach to it, 3) between about 540 and 770 nm the spectrum comes close to a straight line, 4) between 380 and 540 nm, the remainder of the spectrum is significantly curved.

It is easy to prove (fig. I.1-5e) that if C_1 and C_2 are the chromaticity points of two colours mixed in the proportions c_1 units of 'C_1' to c_2 units of 'C_2', the chromaticity point of the resulting colour 'C' will be situated on the line C_1C_2 at a position such that $C_1C/C_2C=c_2/c_1$. That being so, it follows that 'C' may also be matched adding to the neutral 'N' the spectrum colour 'D'. 'D''s wavelength, λ_d, is called the dominant wavelength of colour 'C', corresponding to the point where the straight line CN intersects the spectrum locus. It represents the monochromatic light which must be added to the neutral 'N' in such a way that the combined action (addition) of their luminous fluxes equals 'C''s luminous flux (1). See fig. I.1-5e.

All colours represented by points along the segment ND have the same dominant wavelength λ_d, but the ratio NC/ND accurately determines the position of colour 'C' in the diagram. This ratio denotes the proportion of spectral colour of wavelength λ_d, NC units, which should be added to the neutral white 'N' in order to produce a mixture, ND units, which matches colour 'C' and is known as purity (1). Depending on the position of C along the line ND, its value varies between zero per cent (all neutral white, no independent component 'D' at all) and hundred per cent (only spectral component 'D'). The colours situated along the spectrum locus are called monochromatic or saturated by opposition to these inside -between the spectrum curve and the line

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(1) Colours represented by points within the triangle NKL (figure I.1-5d) are called purple and have no dominant wavelength. Instead their complementary wavelengths are given, λ_c, by prolonging the line PN (P is one of the purple colours) until it intersects the spectrum locus. No purple colour can be obtained by a mixture of white and a saturated colour, for which reason all of them are called non-spectral colours.
The purity of colour 'P' is defined as NP/NE.

joining its extremes- which are called non-saturated. All, saturated and non-saturated, fill the area of the real colours. Outside is the field of imaginary (unreal) colours.

We have then arrived -from an original specification of three values: R, G and B- at two different modes of expression. The tri-chromatic mode specifies the colour quality of a stimulus by means of a "unit equation" ($r + g + b = 1$), from which the colour may be represented on a chromaticity diagram as a point (r,g). As soon as point (r,g) is plotted we are provided with the means for expressing that colour in terms of its dominant wavelength and purity, which constitute the foundation of the 'monochromatic-plus-white' mode. It is generally claimed that the main advantage of the dominant wavelength/purity specification, when contrasted with the coordinates (r,g), is its closer association with the subjectively perceived attributes of colour. A colour is not, however, completely specified by any of these two modes, as presented so far. In the case of the light reflected by a surface, for instance, the reflection factor can be halved or doubled throughout the spectrum, or the wattage of the lamp emitting the light to be matched can be diminished or increased, and in every case - although dominant wavelength and purity values would remain constant (i.e., hue and saturation) - the appearance of the colour would be different, its luminosity would be smaller or greater (dimmer or brighter). In order to complete the specification, a new concept has to be introduced: luminance, the intensity of light transmitted per unit area of surface, a physical notion directly dependent on that of luminous flux. For practical reasons a full introduction will be postponed until later.

Dominant wavelength, purity and luminance --the three characteristics of light in terms of which

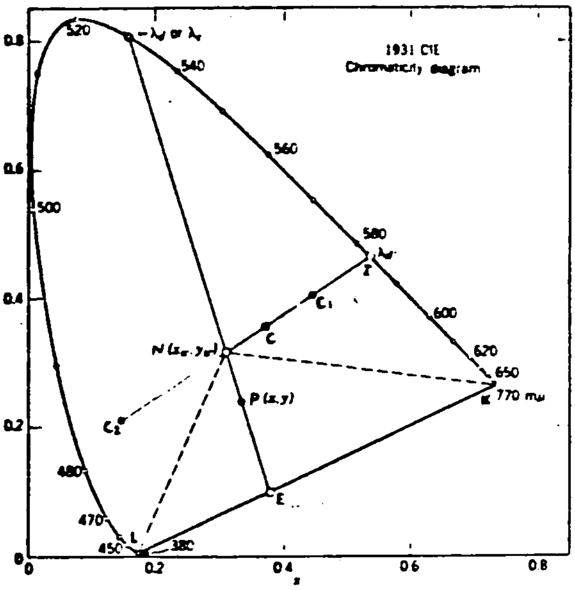
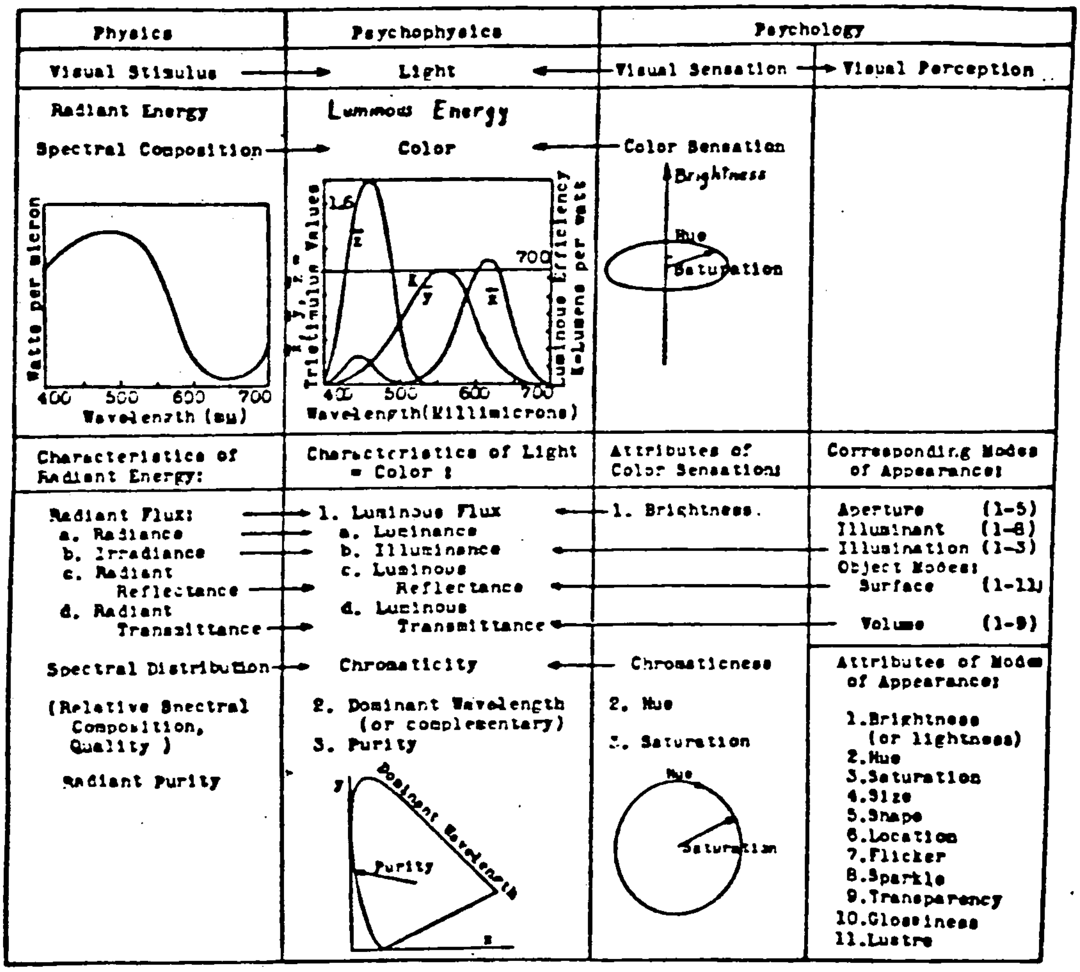


Fig. I.1-5e. Graphical determination of dominant wavelength and purity for colour C, and complementary wavelength and purity for colour P, relative to source N.



Physics	Psychophysics	Psychology	
Visual Stimulus →	Light	← Visual Sensation	→ Visual Perception
Radiant Energy	Luminous Energy		
Spectral Composition →	Color	← Color Sensation	
Characteristics of Radiant Energy:	Characteristics of Light = Color :	Attributes of Color Sensation:	Corresponding Modes of Appearance:
Radiant Flux: →	1. Luminous Flux	← 1. Brightness.	Aperture (1-5)
a. Radiance →	a. Luminance		Illuminant (1-8)
b. Irradiance →	b. Illuminance ←		Illumination (1-3)
c. Radiant Reflectance →	c. Luminous Reflectance ←		Object Modes: Surface (1-11)
d. Radiant Transmittance →	d. Luminous Transmittance ←		Volume (1-9)
Spectral Distribution →	Chromaticity	← Chromaticness	Attributes of Modes of Appearance:
(Relative Spectral Composition, Quality)	2. Dominant Wavelength (or complementary)	2. Hue	1.Brightness (or lightness) 2.Hue 3.Saturation 4.Size 5.Shape 6.Location 7.Flicker 8.Sparkle 9.Transparency 10.Glossiness 11.Lustre
Radiant Purity	3. Purity	3. Saturation	

Fig. I.1-6. Correspondence between attributes of radiant energy, light, visual sensation and perception. (After J.O.S.A., 1943).

colour may be specified - correspond in a general way to three attributes of colour sensation: hue (red, green, etc.), saturation (vivid, weak, strong, etc.) and brightness (bright, dim, etc.). The scheme in figure I.1-6 conveniently illustrates the correspondances between the terminologies in the physical, psychophysical and psychological fields.

Let us now return to the expressions in formulae I.1-2 and I.1-3. With the introduction of the summation term Σ and multiplication by $\Delta\lambda$, the functions $P_{i\lambda}$ and $F_{i\lambda}$ miss their individuality, since for each specific value of either radiant flux or luminous flux there will be an infinity of different spectral distributions of energy, P_λ , which will satisfy equations I.1-2 and I.1-3 for each of the components. All stimuli, within each of the family of P_λ curves, giving rise for each component to the same radiant and luminous fluxes are said to exhibit metameric colours. In the case of colour of physical objects, which is the main concern of colorimetry, the situation is that of the beams of light leaving their surfaces being alike in colour although different in spectral composition. When dealing with non-self-luminous objects, the spectral composition of the light reflected/transmitted, P_λ, depends on the spectral composition of the illuminant source 'I' as well as on the object's spectral reflectance or transmittance factors (which are in part a function of the illumination angle). And how any light stimulus 'C' = P_λ will be perceived by an observer depends not only on its spectral composition, but also on the observer himself and on the background lights which can temporarily modify the sensitivity of the eye to see certain colours and even become a part of P_λ itself. Two specimens or lights exhibiting metameric colours will be deemed to have the same colour under a certain illumination and judged by certain observers; under other illumination and for other observers, the two will generally appear with different colours and are said to show a metameric difference.

It follows then that any serious attempt to evolve a methodology which objectively measures colours and tells them apart, must first find a way to prevent the occurrence of spurious metameric matches. A first step goes through standardizing the conditions of illumination (illuminant, illumination angle and background) to, as it will be seen later, standardizing even the observer himself. But even so, any attempt completely to eliminate the possibility of metameric matches to appear is doomed to fail, because of the very nature of formulae I.1-2 and I.1-3. The technique of defining a colour by giving its components' radiant flux and luminous flux - or any other physical measurements derived from these two - does not give rise to any unequivocal characterization. This limitation has however never been a serious handicap in industrial colorimetry but it has in fact become its strength, since the observer will see two different stimuli as equivalent as long as he sees as identical the radiant fluxes (and luminous fluxes) of each pair of homologous components. In other words, the human eye cannot discriminate beyond the Σ level of the formulae. The aim of industrial colorimetry being the measurement of colours for the ultimate purpose of manufacturing copies, it is really of little concern whether a match is achieved by exactly reproducing a certain spectral distribution of energy or any other giving rise to the same sensation, as long as the match holds under all normal conditions of viewing. Fortunately experiments show that colour matches remain valid over a wide range of adaptation levels and conditions of contrast, at least for 2° fields (corresponding to the rod-free area of the visual field in the retina), and that only when the eye is subjected to glaring conditions of pre-adaptation does a colour-match break down.

Concerning the problems dealing with illumination conditions and standard surfaces, the 1931 C.I.E. recommends the use of standard sources - illuminants A, B or C (fig. I.1-3) - emitting light at 45° to the surface of the object under study and being collected normally, in order to avoid any eventual specular reflection. As standard surfaces to which the object's reflection factor (reflected light/total incident light) at each wavelength will be referred, $Mg\ CO_3$ has been found much more constant in whiteness than Mg O, for 'abridged' reflectophotometers, while the use of three standard coloured charts has been advised when providing the C.I.E. specifications.

The problems dealing with the standardization of the observer proved to be more difficult to tackle. Use was made of the principle underlying the existence of metameric colours, without any real (spectral) identity being strived for. A capital aspect of each matching experiment is the election of the reference stimuli. The impossibility of matching all colours by additive combination of three lights of fixed chromaticity has already been mentioned, but it is reasonable to strive for a choice that will reproduce as many colours as possible. A near maximum chromaticity gamut is attained by choosing two of the stimuli (red and blue) near the ends of the spectrum locus and the other near the middle part of it. A disadvantage is that the two primary stimuli (red and blue) selected in the vicinity of the extremes must necessarily have low luminosity. The problem is then finding the triad which will represent the optimal compromise between high luminance and wide chromaticity gamut. Once this was done, the procedure implied determining once and for all the amounts of the three stimuli required by the average eye to match a standard quantity of T-units (or one watt) of every colour throughout the spectrum. This was done by letting several groups of observers - with the aid of a visual colorimeter (fig. I.1-9) - to make matches of colour at constant wavelength intervals, $\Delta\lambda$, along the whole spectrum. Their results were averaged and adopted by the C.I.E. (Commission Internationale de l'Eclairage) as representative for the colour-matching characteristics of the standard observer (1931). A new set of variables has been defined: the so called distribution coefficients, representing the number of T-units of each component required at each wavelength to match the colour (light) of the equal-energy spectrum (fig. I.1-8). Thus, the standard observer, as specified in 1939 by the C.I.E., involved first:

1) tabulation of r, g and b, spectral chromaticity coordinates (called at that time trichromatic coefficients), from 380 nm to 780 nm at every 5 nm in terms of stimuli selected as
2) 700 nm 'R', 546.1 nm 'G' and 435.8 nm 'R' which define a system 'R,G,B' whose units have been adjusted to be equal in a match on an equal-energy white;
3) tabulation of $\bar{r}_\lambda$, $\bar{g}_\lambda$ and $\bar{b}_\lambda$, distribution coefficients or tri-stimulus values for the equal-energy spectrum, at the same wavelength intervals and for identical stimuli and units;
4) setting up the relative luminous efficiencies (then known as relative luminosities) of the T-unit of 'R', 'G' and 'B'; their values were found to be $V_{'R'}=1.00$, $V_{'G'}=4.5907$ and $V_{'B'}=0.0601$.

These tables are valid for colour matching under conditions of 2^{o} foveal vision, which corresponds to seeing with the rod-free, central area of the fovea, as measured by its angular subtense in the visual field. When considering the varying structure of the retina, from fovea to periphery and from one individual to the other, the role of eye pigment and the importance of pre-adaptation and conditions of illumination, the need for standards is readily appreciated, and it is hardly surprising to find that the colour match eventually agreed on by a group of observers does not hold as soon as the visual field is enlarged beyond the 2^o-subtense, the illumination conditions changed or the observers substituted by another group.

Thus, if in order to match the colour of an equal-energy spectrum at position λ, one T-unit of each standard stimulus $(\bar{r}_\lambda/\bar{g}_\lambda/\bar{b}_\lambda)$ is required, P_λ units of each will be necessary in order to match a colour of spectral composition P_λ $(P_\lambda.\bar{r}_\lambda/P_\lambda.\bar{g}_\lambda/P_\lambda.\bar{b}_\lambda)$. After the 1931 congress in Colorimetry it was agreed that, since the stimuli 'R', 'G' and 'B' often require negative coefficients if absolutely every real colour is to be matched, and since the meaning of a negative amount of colour could result in misunderstandings and miscalculations by some of the users of the system, an all positive reference system (X,Y,Z) -based on imaginary colours- was to be used, while the system 'R,G,B' was kept as the appropriate framework within which to define the colour-mixing characteristics of the standard observer, and as working reference stimuli (1). The formulae for X, Y and Z are similar to those for R, G and B. It is customary, however, to introduce a normalizing factor k_n in each of the three expressions with a value such that Y is clamped down to some practical figure, in the case of the standard surface, while proportions

(1) In the chromaticity diagram the new points -X, Y and Z- must determine a triangle which encloses all real colours, so that trichromatic and distribution coefficients are positive (fig. I.1-7).

X/Y/Z are left unaltered. Thus, k_n's value is: chosen as

$$k_n = \frac{100}{\Sigma\, \bar{y}_\lambda \,.\, P_\lambda \,.\, \Delta\lambda} \qquad (I.1-8)$$

In the case of object colours - a situation of special biological concern - a surface has the colour of the light reflected by it, for which reason a reflection factor ρ_λ has to be introduced in the formula. Keeping the symbol P_λ for the energy distribution of the illuminant, normally a B or C source, the light reflected by the object is $\rho_\lambda P_\lambda$ and the formulae become

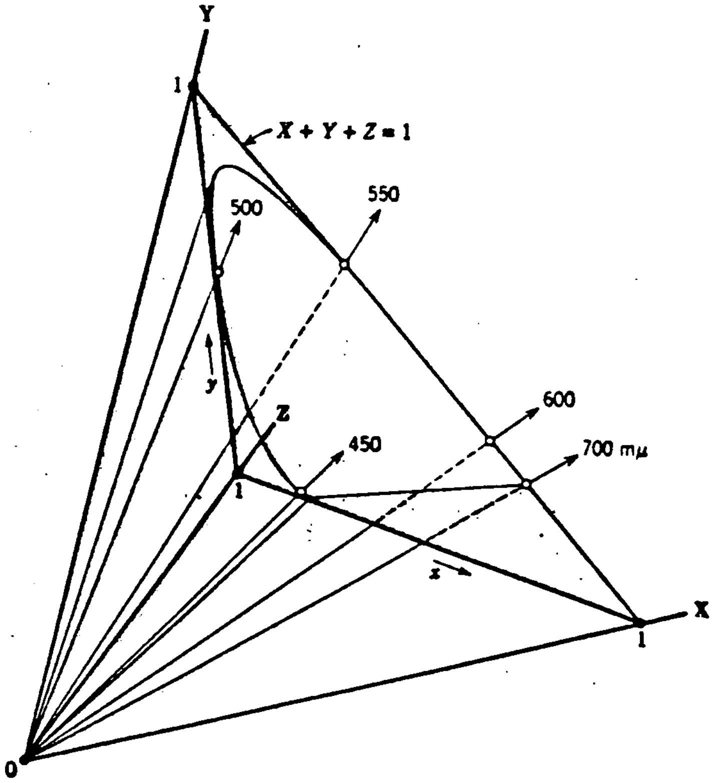


Fig. I.1-7. [XYZ]-tristimulus space in oblique projection showing location of [x,y]-chromaticity diagram (unit plane, X + Y + Z = 1). (After Judd & Wyszecki, 1963).

$$\begin{aligned} X &= k_n \Sigma\, \bar{x}_\lambda . \rho_\lambda P_\lambda . \Delta\lambda \\ Y &= k_n \Sigma\, \bar{y}_\lambda . \rho_\lambda P_\lambda . \Delta\lambda \qquad (I.1-9) \\ Z &= k_n \Sigma\, \bar{z}_\lambda . \rho_\lambda P_\lambda . \Delta\lambda \end{aligned}$$

where ρ is the reflection factor of the sample (under standard conditions of illumination and viewing) referred to that of the standard surface, which thus has a reflection factor equal to one adimensional unit.

Electromechanical devices have been designed and built which accomplish these multiplications and integrations and, in some cases, can be adapted as an attachment to a recording spectrophotometer. A modern variety has digital tristimulus integrators and digital readout devices which are used in combination with tape-punch or card-punch equipment and digital computers.

The coefficients given in the tables for the 1931 standard observer are thus not referred to stimuli 'R', 'G' and 'B' but, normally to stimuli (X), (Y) and (Z). As an additional practical normalization, $\sum \bar{y}_\lambda . P_\lambda . \Delta\lambda$ is often made equal to 100; then K_n's value is 1. Since the products $\bar{x}_\lambda . P_\lambda$, $\bar{y}_\lambda . P_\lambda$ and $\bar{z}_\lambda . P_\lambda$ are assiduous ingredients in the calculation of X, Y and Z, it has also been practicable to produce tables for them -not only for the C.I.E. standard illuminants but for other non-standard sources as well.

The election of these particular stimuli, among all non-real colours, is by no means arbitrary. Apart from determining an all-positive system, it can be shown (Wright, 1944) that - for the particular set selected - the luminous flux (and luminance) contributed by the imaginary components (X) and (Z) is null. Under those conditions, in virtue of all the mathematical accommodations performed, the luminance of an object can be made equal to its Y-tristimulus value, within a scale whose maximum value corresponds to the Y-value of the standard surface (arbitrarily chosen as Y_s=100). By doing so a scale has been created for the tristimulus values as well. The Y values are clamped up to a maximum of Y_s=100, while the respective maximum for the X and Z values are determined by the maximum Y and the proportions between the chromaticity coordinates of the illuminant source. If these are x_I, y_I and z_I, the standard surface's tristimulus values must keep the same relationship. Therefore

$$\frac{x_I}{X_s} = \frac{y_I}{Y_s} = \frac{z_I}{Z_s}$$

and since Y_s is made equal to 100,

$$X_s = \frac{x_I}{y_I}.100 \qquad Z_s = \frac{z_I}{y_I}.100$$

The problem which an anthropologist is thus going to find in practical fieldwork, if trying to determine the colour of a skin, is that of obtaining the amounts of (X), (Y) and (Z) needed to equal the sensation of colour produced by the light reflected from a surface with relative reflection factor ρ_λ when illuminated by a standard source of spectral composition P_λ under an angle of 45 degrees. The light is after reflection collected normally by one or three photocells and, if photocell-filter combinations providing at least the same overall spectral responses as the $\bar{x}_\lambda$ $\bar{y}_\lambda$ $\bar{z}_\lambda$ functions are available (fig. I.1-8), the tristimulus values can be obtained directly. If the photocell-filter combinations provide instead responses $\bar{r}_\lambda$ $\bar{g}_\lambda$ $\bar{b}_\lambda$ tristimulus values R, G and B will be obtained which can be converted to X, Y, Z values (Clulow, 1972). If not in possession of a colorimeter, the X,Y,Z tristimulus values can still be produced from a knowledge of the products in I.1-9, according to the method described above. In practice, however, many modern spectophotometers, apart from providing a full graph of the reflection curve, are also

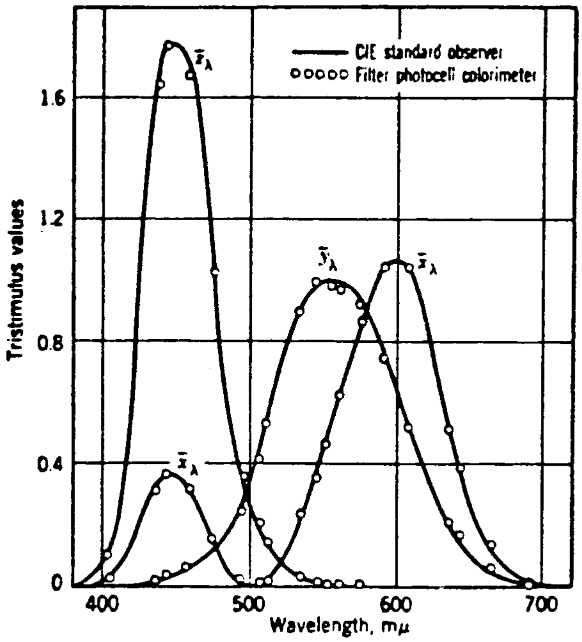


Fig. I.1-8. Example of curves showing the degree to which tristimulus filters combined with a barrier-layer cell duplicate the C.I.E. colour-matching curves $\bar{x}_\lambda$, $\bar{y}_\lambda$, $\bar{z}_\lambda$. The tristimulus filters are made up of combinations of coloured glasses arranged in series and side by side. (After Judd & Wyszecki, 1963).

attached to a tristimulus integrator which automatically computes the required values.

No presentation of the techniques for the measurement of colour through an exposition of their theoretical foundations is complete without an introduction to the various types of instruments among which they have found their application. The methods for measuring and recording colour can be classified into two main groups: matching methods and spectrophotometric methods. The first group's working principle is the matching of colours, first achieved visually by using standard coloured cards or charts and later by means of either visual or photoelectric colorimeters. The second method involves measurement of spectral wavelengths and photometric brightness (or luminance) of colours.

The first visual matching methods are basically means of classifying and comparing colours. The Ostwald system, the pioneering work on which the more modern Colour Harmony Manual (Granville & Jacobson, 1944) is based, the Munsell system (1929, 1943) and the most extensive Villalobos system (1947) are about the most representative here. Their aim is to find, among the possibilities provided by the system, one which is judged to be identical to the sample's colour, which in turn means that the system's effectiveness is a priory severely restricted by the comprehensiveness of the set of cards or charts used. In addition, all visual methods of colour matching are by their very nature subjective.

The instruments utilised for matching colours are called colorimeters and belong to either the one or the other of two different types: visual and photoelectric colorimeters. Within the last group, the human eye's role is performed by one or several photoelectric cells. Both types' operational philosophy rests on two fundamental principles:

1) most colours can be matched (with the exceptions seen before) by mixture in suitable proportions of three standard radiations, usually red, green and blue;

2) blending of any two colours can be matched by mixture of their respective matching combinations.

These two principles, in combination, especially, with two of the laws already formulated by Grassman in the 19th century (1853), provided the theoretical foundation of what was to become later the C.I.E. system of colour specification. These two laws are:

1) The human eye can only distinguish three kinds of variation related to colour: variations in dominant wavelength, purity and luminance.

2) The luminance resulting from the additive mixture of a number of lights equals the sum of the luminances produced separately by each of the lights.

In an additive (1) visual colorimeter the eye receives the light resulting from the mixture of the three primaries, whose relative proportions can be adjusted until its addition is judged to equal the colour to be measured (fig. I.1- 9). The readings can afterwards be converted to C.I.E. values. The various types of visual colorimeters differ chiefly in the means devised to achieve the additive mixture

(1) The so called substractive colorimeters, although based on the same principles, work in the opposite way. Instead of finding the amounts of red, green and blue required to match the specimen's colour, a beam of white light (assumed to possess an equal energy distribution through the spectrum) is, by stepwise absorption when passing through three filters -in for instance the sequence yellow, magenta and cyan- deprived of its blue, green and red components in that order. The density of the filters can be varied in order to control the absorption of the three primaries, until the resulting light equals the colour of the sample. The Lovibond Tintometer (made by the Tintometer Limited, Salisbury, Wiltshire, U.K.) is probably the most representative.

of the three primaries. The colorimeter contrived by Donaldson (1935) has perhaps been most widely used in industry.

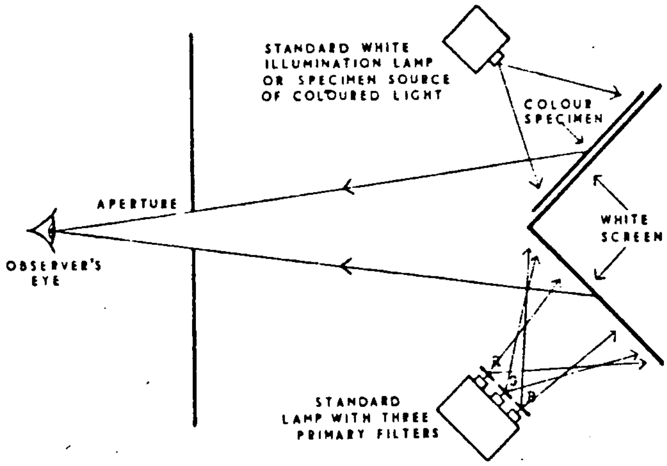


Fig. I.1-9.

The principle of trichromatic matching colorimeters. The light reflected from the upper screen is solely that of the specimen and from the lower screen only the mixture of red, green and blue light. By adjusting the amounts of red, green and blue light, for example, by varying the operative areas of the primary filters, the mixture in the lower half of the field of view can be made identical in appearance to the colour of the specimen in the upper half of the field of view.

In the photoelectric colorimeter either the reflections of the three primary lights are in succession collected by a single photoelectric cell or an originally-white beam of light is, after reflection, divided in three and each portion passed through one of the three primary filters before collection by one of three photocells. In each case, the weak electric currents generated in the photocell or photocells by the intercepted lights are amplified and measured in a galvanometer, as a direct indication of the amounts of primaries required. The measurements are made in a scale which normally supplies readings (tristimulus values) convertible or related to the C.I.E. units. It is even possible, although problematic, to design colorimeters giving direct readings in C.I.E. units. Prior to making measurements it is generally necessary to calibrate or balance the photoelectric cells against the light reflected by a good white reference surface. Typical photoelectric colorimeters are the Colormaster (made by Manufacturers Engineering and Equipment Corporation, Pennsylvania, U.S.A.) and the Color Eye (made by Instrument Development Laboratories, Massachussets, U.S.A.).

Within the second main group, spectrophotometric methods, the services of a photoelectric spectrophotometer are today utilized in order to establish how the proportion of reflected or transmitted light varies throughout the spectrum for each specimen. From this knowledge the international C.I.E. specifications can be derived in a later step. The graph obtained from these measurements provides information about the spectral composition of the light reflected or transmitted by an object when illuminated by some standard source. Such a graph can be a continuous curve (automatic recording or 'full' spectrophotometer) or an approximate spectrophotometric curve, resulting from joining together a certain number of points (between eight and sixteen) obtained in the same manner as before, ('abridged' spectrophotometers). Fig. I.1-10 , a and b, illustrates the working principles of both spectrophotometers for an opaque specimen. In both methods the light from the standard illuminant is divided in narrow wavelength bands which, after partial reflection by the specimen, are collected by the photocell where proportional amounts of electric current will be generated; these will in turn be amplified and transferred to a milliammeter or galvanometer, where they are measured as direct indication of the relative composition of light along the spectrum. Before operation the apparatus must be calibrated by adjusting to a specified quantity the light reflected by a standard white surface. The same beam of light is in each case either divided in two and each half focused on respectively the specimen and the white standard

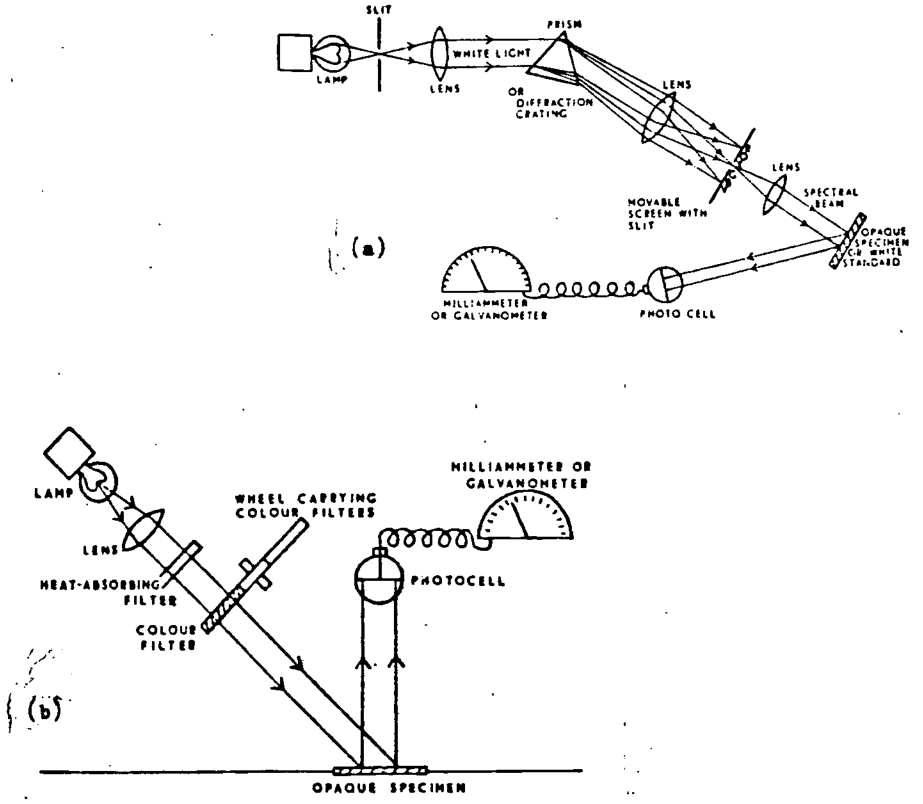


Fig. I.1-10. The principle of a full spectrophotometer, arranged primarily for measurements on opaque reflecting surfaces (a). The principle of abriged spectrophotometers for reflection (b).
(After Clulow, 1972).

('full' spectrophotometers), or focused in succession on the white standard and the specimen during the calibration process (some 'full' spectrophotometers and all 'abridged' spectrophotometers). Due to the calibrating operation, measurements on light reflected from the sample are referred to those from the white surface, which in fact provides us with the reflection factor of the specimen at the particular waveband selected. The main difference between both kinds of spectrophotometers lies in the procedure followed to produce those wavelength bands, as seen in fig. I.1-10.

Representative of the first type are the Hardy recording spectrophotometer (now manufactured by the Diano Corporation, Foxboro, Massachussets, U.S.A.) or the Leres' Trilac (made by Leres S.A. of Paris, France), the last one linked to a tristimulus integrator and thus capable of directly producing the three C.I.E. tristimulus values. Among the many 'abridged' spectrophotometers available in the market are the Pretema FS-3A Spectromat filter spectrophotometer (made by Pretema AG, Zurich, Switzerland) with 33 narrow wavebands spread at intervals of 10 nm between 390 and 710 nm. The instrument also has a built-in automatic computer for calculation of C.I.E. tristimulus values and can, in addition, be connected to another computer for storing measurements and solving colour problems.

Summary

Some aspects of the physics of colour have been introduced in some detail in order to place the C.I.E. specifications for the expression of colour in a wider theoretical context. It is generally held that, within their frame, the 'monochromatic-plus-white' mode (dominant wavelength, purity, luminance) is more closely associated to the subjectively perceived attributes of colour (hue, saturation, brightness) than the 'tri-chromatic' mode (x, y, luminance). The industrial applications - in the manufacturing of colorimeters - of the indetermination brought about by metamerism and the most important types of colorimeters and spectrophotometers have been reviewed.

I.2. The nature of melanin pigmentation.

The skin constitutes the boundary between an organism and the outside world and its main functions are in accordance with that. The skin, particularly the epidermis, protects the body against mechanimal pressure and provides a barrier against UV radiation and the organisms of disease. In addition, its impermeability provides resistance against penetration by water and restricts water loss, helping to conserve the moisture of underlying tissues(1). The lower layers of the skin, dermis and inferior epidermis,perform a sensory role by means of nervous receptors of touch, pain, heat and cold. Regulation of body temperature is carried out by cooling through increased blood flow in the vessels of the skin and by evaporation of the watery secretion of the sweat glands. Another important function is metabolic, i.e. contributing to the electrolyte balance (balance of sodium and potasium salts in the body fluids), or forming vitamin D from cholesterol when irradiated with UV light. But apart from all these functions, the skin is - in its upper layer - the seat of the substances (generally called pigments) which are the main responsible for the colour of humans, which in turn is directly related to three of the aforementioned functions - that of protection against UV radiation, the thermoregulatory and that of synthesis of vitamin D - as will be shown.

The total thickness of the skin presents wide regional variability (from less than 0.1 mm up to 3 or even 4 mm). It is generally thicker on extensor than on flexor surfaces, but is thickest on the soles of the feet and the palms of the hands, where the wear

(1) The epidermis is in general impermeable to electrolytes, but most gases and liquids pass through it easily. Especially important is the difussion of oxygen and carbon dioxide inwards and outwards respectively.

and tear is maximal. Of the two main layers which constitute the skin (fig. I.2-1), the most superficial - the epidermis - consists of a stratified epithelium which, after supression or decolouration of its brown pigment (melanin), is reported to appear as a transparent, grayish-white membrane (Duchon et al., 1968). The epidermis may be subdivided into two main groups of layers, of which the upper (consisting of three different strata) is continually being worn away by usage at the surface, while the lower one (consisting of two distinct strata) has the role of creating - by mitotic proliferation - the cells necessary for the maintenance of the upper strata. It is traversed by the ducts of sweat and sebaceous glands and by hair follicles, where these are present. In accounting for the wide range of hues and colours in the skin of the various races of man the distribution through the epidermis of the brown chromoprotein pigment known as melanin is of vital importance. It is manufactured and assembled in specialized organelles within the Golgi area of the cytoplasm in some of the dendritic cells of the lower layer of the epidermis. These cells are the melanocytes.

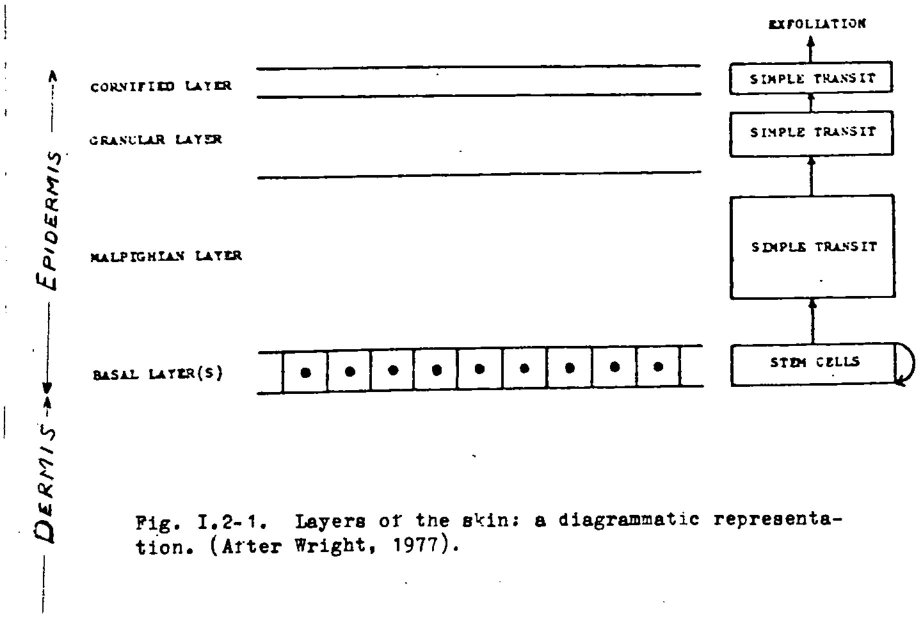
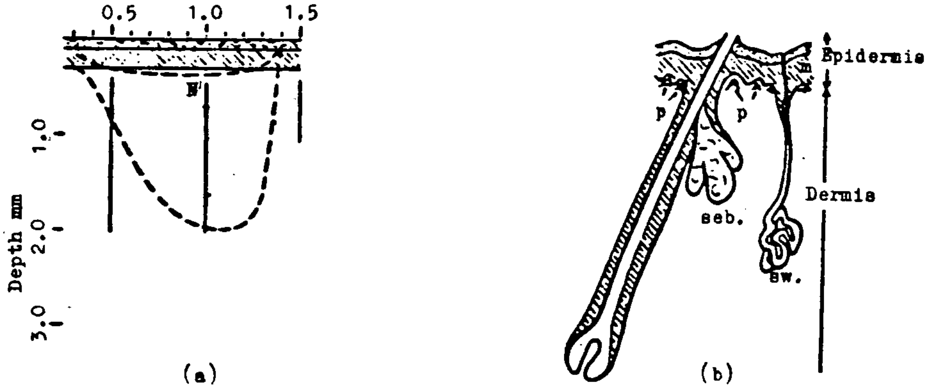


Fig. I.2-1. Layers of the skin: a diagrammatic representation. (After Wright, 1977).

The epidermis rests on a foundation of firm connective tissue - the dermis or corium - in which bundles of collagenous fibres are intermingled with a mesh of elastic tissue, which is particularly well marked at the surface of contact with the epidermis. This arrangement becomes important in anchoring the epidermis to the subjacent dermis. At the base of the dermis man has a well developed layer of fatty tissue. Superficially, among heavily pigmented races, the dermis may contain granules of melanin and is always the seat of sudoriferous and sebaceous glands, in addition to containing hair follicles, nerves and the most superficial of the blood vessels. Hair follicles and glands are in fact epidermal structures produced as downgrowths from the lower layer (stratum germinativum) of the epidermis, in the spaces between the dermal papillae. Sebaceous and sweat glands originate as appendages of hair follicles. Since part of the light of the visible (VL) region penetrates into the dermis (fig. I.2-2), blood - especially among Whites - and dermal melanin contribute also to imparting colour to the skin. The first one imparting a faint, pink colour to the skin in vivo.

On the basis of the distinctive physiological features of the integrating cells, four different strata used to be recognized in a dissection of the epidermis. From below, the first stratum is the germinal layer or stratum germinativum, mostly with two kinds of cells: dendritic and polygonally shaped. This stratum is now currently subdivided into two: a one-cell thick layer, where most of the proliferation necessary for cell replacement takes place (basal layer), and a thicker one (prickle cell layer), which derives its name from the thorn-bush like appearance conferred on it by the intercellular bridges and tonofibrils interweaved between the prickle cells. These cells are specialized in structure (and by kera-



Penetration of Light into Human Skin as a Function of Wavelength. The curves N and W indicate for Negro and White skin, respectively, *rough estimates* of depths at which radiation of the corresponding wavelengths is reduced to 5 per cent of its incident value. There are insufficient data to make more than rough estimates, and these curves should be regarded as suggestive rather than in any way exact.

Diagrammatic Representation of Skin Structures. A schematized conception in which the dimensions should not be taken as generally representative, since the skin may vary widely in its thickness. c, corneum, i.e. horny layer of epidermis. m, malpighian layer of epidermis. sw., sweat gland. seb., sebaceous gland. p, the most superficial blood vessels, arterioles, capillaries, and venules. h, hair follicle. s, hair shaft.

Fig. I.2-2. The penetration of solar radiation into human skin. (a). Penetration of light into human skin as a function of wavelength. (b). Diagrammatic representation of skin structures. (After Blum, 1961).

tinization) and they can not divide. The cells in the basal layer (stem cells) have no input from elsewhere and - together with some among those lying immediately above the basal layer (parabasal cells) - are subject to active, intermittent, regionally variable mitotic proliferation. Half of the cells generated under each mitotic cycle migrates to the surface undergoing progressive differentiation (cornification or keratinization) along the way. Wright (1977) emphasized the transit-compartment character of the up-to-the-surface following layers, whose cell material directly proceeds from the germinal layer and is continually being displaced upwards by newer, incoming cells. Among those staying in the basal layer, only a certain proportion are proliferative at any one time; the rest leave the cycle, moving into a resting phase, in which they are quiscent but still potentially fertile, and from which they can return into the cycle in times of increased cell demand. The polygonal cells continue into the Malpighian layer (the top subdivision of the stratum germinativum) where, as keratinocytes, they appear now in the company of cells provided with slender and elaborately branching processes (dendritic cells). Most of these cells are melanocytes, secretors of melanin, and around each of them a group of keratinocytes appears arranged as a pool, forming what is called an epidermal melanin unit. Every melanocyte is in contact with each of the cells in its pool through a branching process, ended by an expansion which is applied as a cap to the keratinocyte's surface (fig. I.2-3). In the cytoplasm of the melanocytes granules of a dark substance (melanin) are produced, which - after activation of the melanocyte - are transmitted along the branching processes to the cap. From there, the melanin particles (melanosomes) are either innoculated or nipped-off into the keratinocytes of the germinal layer (Magnin, 1969). It seems likely that the Malpighian cell (keratinocyte) may play an active

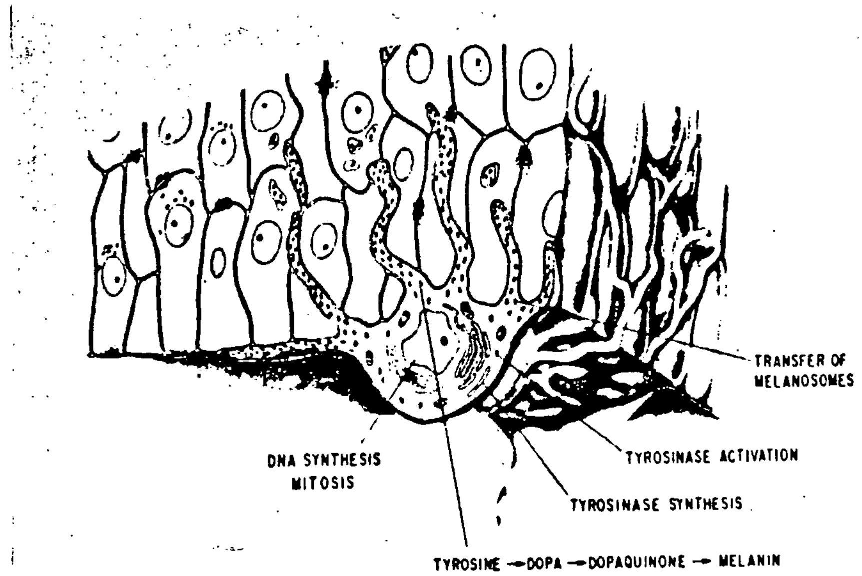


Fig. I.2-3. Biological control of melanogenesis in the epidermal melanin unit. (After Pathak, 1967).

role in controlling the synthesis of melanin granules by the melanocytes (Fitzpatrick, 1964). Once inside the keratinocyte, the melanosomes form a polar cap or perikaryon around the nucleus of the ordinary basal cells, for protection against UV radiation (as will be shown later). In black skins, however, the cytoplasm may be filled with melanin granules, and not only the cells in the stratum germinativum but also those in superior strata contain melanin granules.

The next layer, only two or three cells deep, is called the granular layer or stratum granulosum. This consists of flattened cells whose cytoplasm contains an abundance of granules of a colloid material (keratohyalin) which is believed to be the precursor of keratin - the horny material which is especially abundant in the upper stratum of the epidermis. The granular layer, together with the elastic tissue of the dermis, seems to impart pliability and resilience to the skin, so that it can - by stretching - adapt to the movements of the body.

Next comes the stratum lucidum, which has a clear, translucent appearance in stained sections. Here, cell boundaries and nuclei have lost their clear-cut outline, while the keratohyalin granules of the subjacent stratum have become transformed into larger masses of an achromatic substance.

The surface stratum, horny layer or stratum corneum, often forms the greater part of the total epidermal thickness. The nuclei are no longer evident, and from below upwards the flattened cells are gradually converted into cornified flakes. On their way to the surface, the epidermal cells carry along their melanosomes which in the stratum corneum appear not as granules but as fine, irregular, pigmented particles. They regularly freckle the horny layer of Blacks but not of Whites, except during a variable period after exposure to ionizing or UV radiation (or any other activating agent). Apart from melanin-bearing particles, the remains of decomposed heamoglobin can at times be found interspersed with the keratinized, scale-like cells. Thus, over fifty per cent of the contents of the cells in the stratum corneum is soft keratine, with more water than either in horn or hair and provided with very resistant cell-walls. Two different kinds of keratin, both strongly resistant to acids and alkalies, are included.

Some of the dendritic cells belong to the type known as Langherans cells, while others are vaguely classed as indeterminate (Magnin, 1969). Although the role and origin of these cells are not exactly understood yet(1), the third type are secretory cells derived from the neural chrest and the outer layer of the optic cup as melanoblasts, and transformed into melanocytes with the onset of melanin production in the Malpighian layer. The melanocytes migrate during neonatal life to three principal sites: 1) the epidermal-dermal junction of the skin(2) and mucous membrane, and the hair bulb, 2) the central nervous system (especially the leptomeninges) and 3) the eye (the uveal tract and the retina). All three are commonly grouped together as the melanocyte system. Different from all other cell types, the melanocyte is a specialized cell provided

(next page)

(1) The Langerhans cells have by some traditionally been thought of as worn-out melanocytes on their way to disposal at the surface. More recently (Zelickson et al., 1968), it has been suggested that they can become active melanocytes after intake of UV-radiation. To some others they are totally independant from the melanocyte lineage, and, specifically, Breathnach and Wyllie (1967) are of the opinion that they have the function of influencing somehow the surrounding keratinocytes (perhaps by loosening their intercellular attachments and even phagocyting portions of their cytoplasms).

with two or more dendritic processes (fig. I.2-3) and containing, in its pigmented phase, bunches of yellow-orange or dark brown to black cytoplasmic granules (2). The melanocyte possesses mitotic activity (Szabó, 1967), although it does not divide as often as the keratinocytes.

Those granules, the melanosomes, are located within the Golgi body. In them, eumelanins are formed by the action of a copper-containing aerobic oxidase enzyme (tyrosinase) on two aminoacids - monphenol (tyrosine) and dihydroxiphenol (DOPA) - (fig. I.2-4), and deposited in a matrix constituted by a flat lattice-like sheet of intercrossed compound fibres, rolled-up like a rug in order to give the mature granule its three-dimensional form (Fitzpatrick et al., 1967). The end product is, physically, a dark, spherical or ellipsoid organelle (0.5-1.0 µ in length, 0.2-0.3 µ in diameter) surrounded by a unit membrane, that has a regular internal pattern of dense particles deposited with a characteristic periodicity of 90 Å by 54 Å (Duchon et al., 1968).

(2) Melanocytes may also occurr in the dermis of lightly and moderately pigmented individuals as groups of cells scattered through the dermal connective tissue (Mongolian spot) or as compact cellular masses (blue nevi). They may probably be explained as migratory melanocytes arrested in their course from the neural crest.

(1) Both pigments (phaeomelanins and eumelanins) are present in human hair, but only eumelanins (dark brown to black) have until now been demonstrated in skin and eyes.

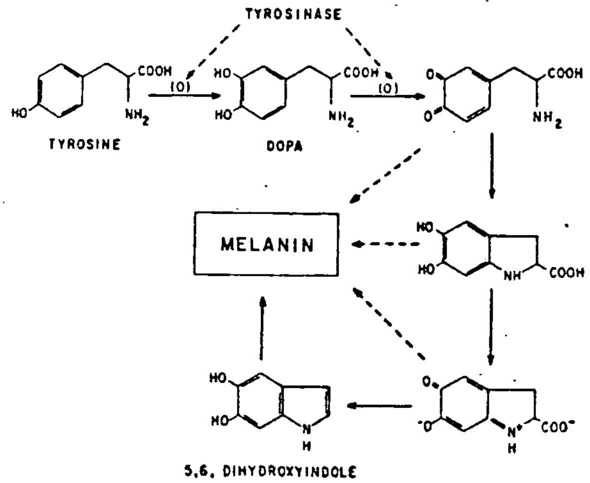


Fig. I.2-4. The tyrosine-to-melanin pathway. (After Duchon et al., 1968).

Chemically, eumelanins (or DOPA-melanins, as they are also called) are high-molecular-weight polymers of - among others - quinone and indole groups, organized in different kinds of residues (monomers) which are linked in a variety of ways. Eumelanins are insoluble in most solvents, resistant to chemical treatment and have a complicated, irregular, chemical structure; they contain metal ions - copper and zinc, firstly, but also iron, manganese, titanium, cobalt, nickle and molybdenum - and can react with others. They possess free-radical character and present paramagnetism (Duchon et al., 1968). DOPA-melanin polymers appear firmly bound to a protein (also contained,with other substances, within the melanosome), forming what is called a melanin-protein complex.

Much less is known about the chemistry and formation of phaeomelanins, the yellow-orange substance, closely related to the DOPA-melanins, which are found in human hair. They are equally formed as granules in melanocytes and - contrarily to the eumelanins - are soluble in dilute alkalies. Phaeomelanins have been found to contain iron (whence the alternative name trichosiderines) and sulphur, and this last fact-in combination with chemical and reflectrophotometric research - led Prota and Nicolaus (1967) to demonstrate that they are formed in vivo by a deviation of the eumelanin pathway. The reaction involves interaction of cysteine (a -SH containing compound) with one or several quinones produced in the oxidation of DOPA. They further concluded that the red-to-violet colours of the compound are merely produced by modification of the yellow-orange pigment during acid extraction.

The enzyme tyrosinase has a wide distribution throughout the phylogenetic scale (plant and animals) and seems to be synthesized in the ribosomes of the cytoplasm and transferred - via the endoplasmic reticulum (ER) - to the Golgi area, where, together with protein moieties, it is assembled into units surrounded by a membrane envelope (stage I melanosome). The enzyme seems to have two different activity centres, one catalyzing the reaction from tyrosine and the other for the reaction from DOPA. Copper plays an esential role in both activities. Its reaction with the sulphydril groups, -SH, present in different substances in the skin, inactivates the tyrosinase and blocks melanin formation.

A melanosome can exist in any of four different stages, of which the first three show dopa-positive reaction. The stage I melanosome has no recognizable internal structure, but this has become clearly distinctive in stage II. The stage III melanosome shows a variable degree of melanization, while a stage IV melanosome is a fully melanized granule. Tyrosinase activity ceases during this stage. (Szabó et al., 1971).

Apart from the proper epidermis-demis junction, melanin exists also in certain parts of the hair follicles and the eyes(1). In order to study its distribution, it becomes necessary briefly to review the anatomy of these areas.

The hair follicles are epidermal pits produced as downgrowths from the germinal layer. The follicle or sheath where the actual hair is embedded, consists of an outer sheath (really a continuation of the polygonal cells of the epidermis) and an inner sheath. Both expand downwards into a bulb, with polygonal and columnar cells, which slightly invaginates its free end to form a small vascular papilla (fig. I.2-5). The purveyance of nutrients from the blood vessels to the hair takes place through the papilla and along the sheath. The hair shaft itself, as well as the inner sheat, grows from the bulb by active proliferation of its cells. A hair shaft is composed of three concentric parts: a thin cuticle, an inner

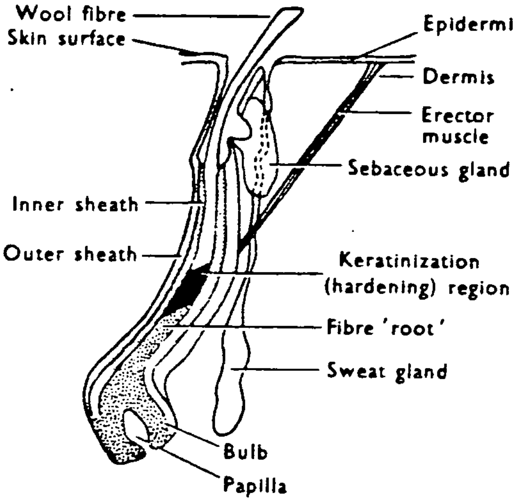


Fig. I.2-5. Vertical section of a wool follicle in the sheep. (After Ryder, 1973).

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(1) Melanosomes may be found as well in the parathyroid, thymus, ovary, spleen and adrenal medulla.

cortex and the central medulla. The cuticle is made of thin, flat, scale-like, usually unpigmented, overlaping cells. The inner cortex has rounded and longitudinally elongated pigmented cells. The central medulla, which may be absent, is filled with cells of irregular shape which may leave minute air bubbles in between. As the hair grows away from the bulb, the cells of the cortex become progressively elongated in shape. These changes are associated with the keratinization process, initiated in the cuticle, leading to the gradual hardening and final death of the cells.

Melanocytes in hair follicles are mainly localized in the outer sheath, where they have immigrated from the epidermis. The cortex, which - in most cases - makes the greater part of the hair body, consists mainly of keratinized cells with air-filled spaces in between (fusi, more numerous and bigger in thick hair). These, which are usually the only melanin-containing cells in the hair shaft, acquire their melanosomes from the upper portion of the matrix of the hair bulb by phagocyting the dentritic processes of the neighbouring melanocytes. Within the new cell, the cell-wall of the process disappears and the melanosomes disperse through the cytoplasm.

In human hair and hair follicles, melanosomes of three different kinds appear. Two of them, presumably, belong to the same lineage (eumelanins) and predominate in black and blond hair, while the third - whose different shape presumably betrays a different chemical structure (phaeomelanins) - is responsible for red hair. In black and brown hair the melanosomes are flattened and longitudinally elongated. When they are big (0.8 μ or more) and very abundant the hair appears black or dark brown, while if they are fewer in number and smaller the hair appears non-red blond. 'Blond' melanosomes are less dense than 'dark' and remind one of these in their formative stages

(Birbeck & Barnicot, 1959). Non-reddish blond hair seems merely to be the result of a diminution in both the number of melanosomes produced and the completeness of their melanization. When the melanosomes are spherical and small (0.5 μ or less) the hair takes in a red hue. The internal structure is again more discernible than in 'dark' melanosomes and the boundary of the granule is often ill-defined and irregular. An individual's hair may contain both spheric and elongated granules, the most abundant partially masking the effect produced by the others. Ash blond hair, for instance, has only 'blond' melanosomes, while golden blond hair contains both 'blond' and 'red' melanosomes and dark brown hair contains 'black' and 'red' melanosomes(1). Lack of melanization of the granules and/or absence of melanosomes from the cortical cells(2) explain albino and white hair.

Metals probably play an important role. The fact that they replace each other in small groups along the chromatic series suggests some sort of correspondence between their chemical roles in the compound and its colour(3).

The medulla also contributes to colour. In general, only thicker hairs have a medulla. The vari-

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(1) All this parallelizes very closely Gardner and Adam's conclusions (1934). (See section VII.2).

(2) Albino melanosomes exist in melanocytes of the bulb matrix, but it is uncertain whether they are passed to the cortical cells. They are more numerous but less formed than in blond hair (Birbeck & Barnicot, 1959), presumably owing to inhibition of the tyrosinase. In white hair, the melanosomes seem to have disappeared from the bulb and from the sheath, while the air bubbles appear accentuated (Le Gros Clark, 1958).

(3) White hair of any race is abundant in Ni. Among Caucasoids, golden and brown hair are rich in Ti and Mo, while in black hair these two have become scarce and partially substituted by Cu, Co and Fe. Black Negro hair is only rich in Cu and Fe (Gates, 1961).

ously sized, air-filled spaces left in between the keratinized cells actively reflect the light which reaches them. Mongoloid hair, for instance, has the biggest medulla of all and big intercellular spaces, while that of Pygmies and Negritoes either has no medulla or it is small (as in children). In senescence, atrophy of the cells in the medullary cavity, associated with loss of pigment and - eventually - with an increase in the number of medullary air-spaces, makes the hair appear white.

The human eye is roughly spherical in shape and it is bounded by three distinct layers of tissue (fig. I.2-6). The outer, fibrous layer or sclerotic coat, is extremely dense and hard. Frontally, it is continuous with the also fibrous, perfectly transparent cornea, which admits light into the interior of the eye (bending the rays so that they can be focused) Secretion from the tear glands keeps the

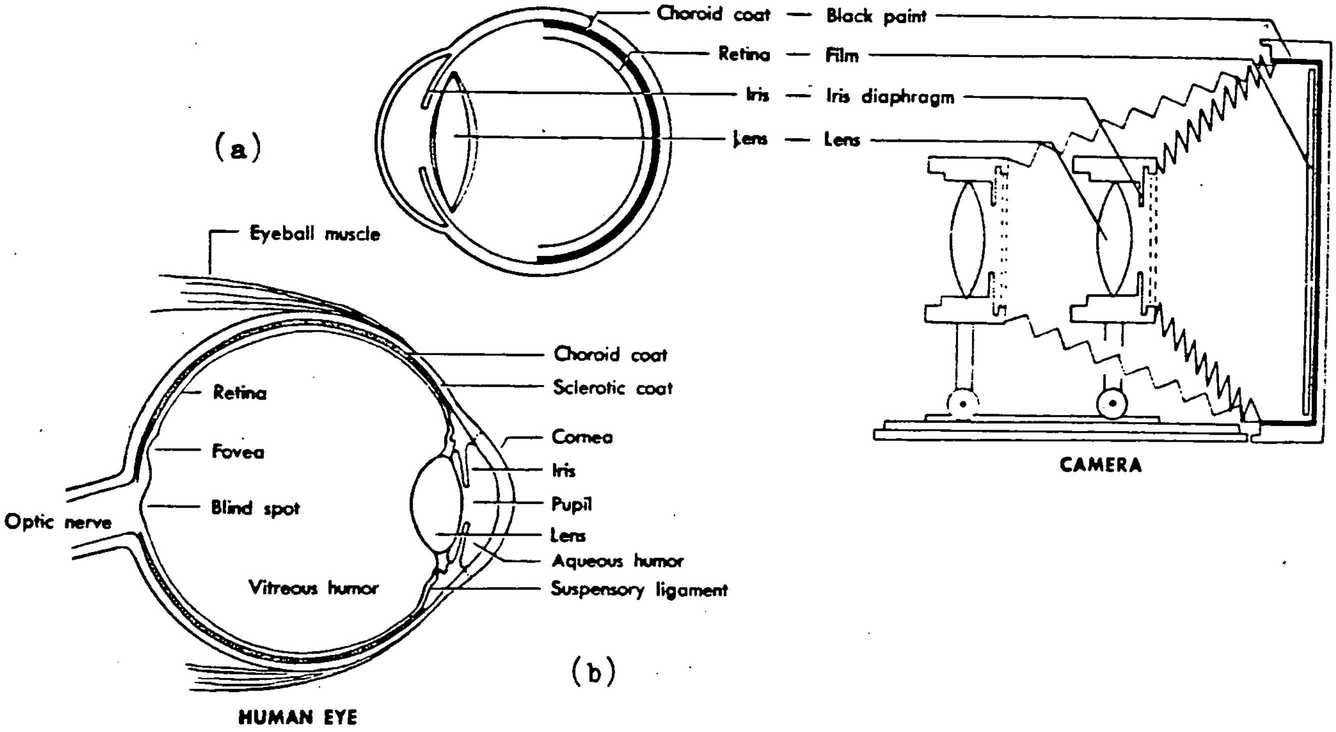


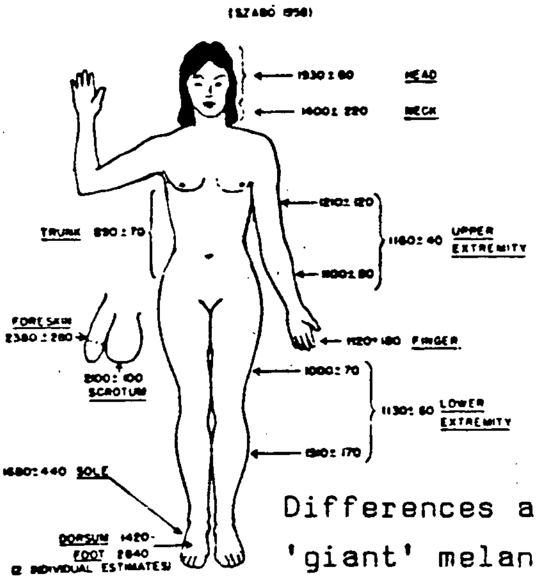
Fig. I.2-6. The human eye. (a). A comparison of a mammal eye with a camera. The eye is shown focused on a distant object (—) and on a near object (--). (b). Layers of the eye.

surface of the cornea moist and dustfree. Among Whites, the sclerotica is white (except when irritated by dust, smoke, etc), but among very pigmented individuals (as, for instance, Blacks or Australian aborigines) it may be spotted with superficial melanosomes.

The middle layer of the eye, the choroid coat, thin and pierced behind by the optic nerve, is deeply pigmented with melanin and abundantly supplied with blood vessels. It has the role of absorbing or damping the reflection of stray light rays within the eye. This function is comparable with that of the black paint within a camera. In the front of the eye, the choroid continues into the ciliary body and the iris. The iris, thin and circular-shaped, has a central opening of variable size called the pupil, which is contractile and reacts automatically to variations in the amount of incoming light, its function being similar to that of a camera's iris diaphragm. The colour of the iris, popularly known as the colour of the eye, is due to the light reflected by the pigment granules located in the melanocytes of the inner (stroma) and outer layers of the iris (in some cases between them as well). These melanocytes are 'continent' - they do not extrude their melanosomes into other cells, but retain them, instead, within themselves. The eyes, where the pigment of the inner layer is totally masked by that of the outer layer appear light brown to black (depending of the amount of pigment in the outer layer), while those without a total masking appear mixed in colour. This is due to differential transmission of light according to wavelength, with shorter wavelengths selectively scattered and reflected by melanin granules (Tyndall effect) and, consequently, adding a strong bluish tone to the reflected light. If no pigment is present in either the outer or the intermediate layers, the iris appears light blue.

The inner, delicate, nervous membrane of the eye is the retina which contains the actual light receptors, specialized cells called rods and cones. The retina is soft and semitransparent, and functions as the film in a camera. Frontally aligned with the retina is the lens - a transparent, biconvex body located behind the eye. The lens is held in position by suspensory ligaments which allow a certain degree of shape plasticity. Its function is analogous to that of the lens of a camera. In the centre of the posterior part of the retina and on the axis of the eye is the yellow spot or macula lutea, provided with a central depression - the fovea centralis - through which the dark colour of the choroid is seen. The sense of vision is most acute here. Between the lens and the cornea there is an aqueous humor and between the lens and the retina a transparent, jelly-like vitreous humor. The pigmentation of the retina follows that of the skin much more closely than the iris does. Albinos lack pigment in their retinas, and yellowish and reddish skins seem to have similar retinal tones (Coon, 1965).

The melanocytes are present in all skin regions which have been investigated, regardless of whether they are usually covered or not. There are, however, regional differences in the density of the melanocytic population - with double to triple density in the head's epidermis, especially the cheeks and the forehead (fig. I.2-7). These regional differences are symmetrically distributed throughout the body in each individual. No significant differences have been found between sexes or between races in the epidermic distribution of melanocytes (Szabó, 1959). There are, however, interracial differences in the degree of melanization of the melanosomes, their size, distribution within the keratinocytes (in complexes or individually) (Szabó, 1971). Regional and interracial differences exist as well in the intensity of dopa and tyrosine reactions, which present similar distributions and more intense reactions in exposed areas(1).



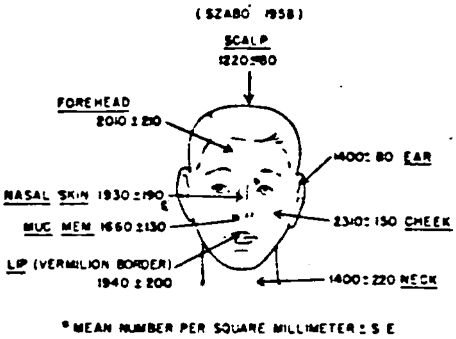


Fig. I.2-7. Regional variation in the distribution of melanocytes in the épidermis of the human body. Estimates are given per square millimeter ± S.E. mean. (After Szabó, 1959)

Differences also exist from cell to cell, with the 'giant' melanocytes (normally present in exposed regions) being strongly positive, and the small ones only weakly positive (Szabó, 1959).

Prior to irradiation with UV light, Caucasoids - on the one hand - and Mongoloids and Negroids - on the other - differ in the proportions of stage IV melanosomes and even in the total number of melanosomes in the melanocytes of their skins. Both are more abundant in Mongoloids and Negroids, which even contain more stage II and III melanosomes as well (Szabó et al., 1971). Among them melanosomes are also more abundant in the keratinocytes. Within the keratinocytes, the melanosomes of Australoids and Negroids appear individually distributed (only a very few melanosomes appear in complexes - within the keratinocytes of Negroids) and are much larger and wider than those of Caucasoids; Caucasoid mela-

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(1) Dopa reactivity is already noticeable in the foetus: it is more intense in the forehead (where the melanocytes are dendritic long before exposure to sun) than in the thigh (where they are usually rounded before exposure Tyrosine reaction is weak or absent in usually unexposed areas - although the melanocytes in the oral epithelium, penis and scrotum are positive.

nosomes are grouped in complexes of variable size and shape, like those of Mongoloids(1), but while Caucasoid melanin granules vary greatly in shape and size, those of Mongoloids are of uniform size and smaller than Negroid melanosomes.

The intensity of the dopa reaction depends on an individual's ability to suntan (the 'melanogenic potential') and on the skin's state of exposure to sunlight (Szabó et al., 1971). The melanocytes in skin biopsy sections of Caucasoids present highly variable dopa reactions: those of red-headed Caucasoids being very weak (usually in small melanocytes, with few dentrites), while dopa reactions in the melanocytes of dark Caucasoids are very strong. Mongoloid melanocytes exhibit very uniform and intense dopa reactions. In Negroids, where keratinocytes can be very strongly pigmented, they can be difficult to tell apart from melanocytes, in spite of the strong dopa reactions.

The existence of regional differences is not related to external factors, such as solar radiation, as - next to the two most pigmented areas- among the most densely populated are some unexposed regions of the body (scrotum, penis, sole of feet and nasal and oral squamous epithelium), whereas some exposed areas (such as ears and fingers) show low densities. These differences are postnatal , since they do not exist in the foetus (the total number of melanocytes increases differentially with postnatal growth of the body surface). The density of the distribution of melanocytes decreases through life - especially in old age - with the intensity of dopa reaction becoming stronger and more variable. At the same time the perykarion of the

(1) This rule is not necessarily true for parts other than the skin. Keratinocytes in Japanese hair are, for instance, reported to be very large and distributed individually (Szabó et al., 1971).

melanocytes increases in size, the dendrites become longer and hyperpigmented spots appear in great numbers with hypertrophic melanocytes(1). The absolute number of hair follicles and sweat glands become, however, finally established in foetal life. As a probable consequence of the inequalities in density of melanocyte population, the ratio of melanocytes to keratinocytes varies regionally within the same subject.

The contribution of melanocytes to skin colour is determined by their population density and by their opacity. Fitzpatrick (1964) has established a useful distinction between two partially different processes: 1) melanogenesis, formation of melanin in the melanocyte and 2) melanin pigmentation, which includes formation and distribution of pigment throughout the epidermal cells. Consequently, depending on their relationship to these processes, the factors regulating pigment cell opacity can be classified in two dissimilar groups (Lerner & Case, 1959): 1) factors operating at the enzyme (or, more generally, melanogenic) level, which influence the concentration of pigment within the cell, and 2) factors operating at the level of movement and distribution of melanosomes within the cell. A third class could be constituted including those processes functioning in unknown or dubious ways.

Into this third group belong ionizing radiation and the factors behind some of the most common sorts

(1) In addition to the appearance of hyperpigmented spots and hypertrophic melanocytes, and changes in melanocyte density, the whole structure of the basal layer changes - with epidermal ridges flattening or breaking up into short, linked ridges. Similar changes appear as well at the edge of a vitiligenous lesion and in freckles (Szabó, 1959).

of hyperpigmentation, such as those following inflammation (as in burns and several kinds of dermatitis), or responsible for such abnormal conditions as leprosy, pellagra, porphyria and scleroderma. Depigmentation following severe frostbite injury (Post et al., 1975) also belongs here. It is suggested that they represent the reaction of melanocytes to injury (either of themselves or surrounding tissue) (Lerner & Case, 1959).

To the first group belong all those factors which interfere with the normal development of the tyrosinase reaction, normally - but not exclusively - by reacting with or replacing the enzymic copper, inhibiting the tyrosinase and producing hypopigmentation. Among the factors observed to produce those effects in vivo are substances - present or not in the body - as sulfhidril and thiol compounds (e.g.: cysteine and glutathione) and hydrogene cyanide, CO and mercury containing ointments. Factors in the milieu, such as temperature (which accelerates the tyrosinase reaction), aminoacids such as phenylalanin (which inhibits tyrosinase) and cysteine (when it deviates the dopa reaction towards phaeomelanin production) are also important. Some other substances, as tolseram and chloroquin, cause depigmentation of hair but not of skin.

Sulfhydril groups in water soluble form produce strong covalent bonds with copper. Although the total amount of - SH radicals in the epidermis is constant, there are significant interindividual differences in the amount of hydrosoluble sulfhydrils (Magnin, 1969)(1). The inhibitory action of the - SH groups is counteracted by those substances which in

(1) Hypopigmented areas in vitiligo possess a greater hydrosoluble - SH content than normally pigmented areas of White skin, in spite of the equal total number of -SH.

turn inhibit them (e.g.: iodoacetamid, monobenzyl either of hydroquinone or arsenic). Similar results are obtained by melanogenic stimuli as UV radiation, and X rays, heat and inflamatory processes - by oxidation or distruction of the free sulfhydril groups which in turn allows free work of the substrate by the enzyme. Most of the sulfhydril groups are contained within the hydrosoluble tripeptid reduced glutathione (γ-glutamyl-cisteinyl-glycine), which is thirteen times more active than the next most active inhibitor (cysteine). Glutathione in the epidermis is present in amounts 100 times greater than those required for inhibition in vitro, and it is present in two alternative states: reduced and oxidized. At any given time over 90 per cent of the total is in reduced form, in spite of the continuous oxidation process. Negro reduced glutathione and glutathione reductase activity are significantly lower than those in Caucasoids, and a fall in glutathione reductase activity occurs in Caucasoids some days after exposure to UV light, simultaneously with the oxidation of reduced glutathione by means of wavelengths mainly below 320 nm (Halprin & Ohkawara, 1967). This is presumably related to the existance of four different genetically determined glutathione reductase molecules (three in Negro skin and one in Caucasoid skin).

At the melanocyte level the first effects of exposure to UV radiation are an increment of the size and density of the melanocytes, together with arborization of the branching processes (Pathak, 1967) plus a proliferation of stage II and III melanosomes and an increase in the total number of melanosomes (Szabó et al., 1971). The size of the melanocyte population may also increase, especially after multiple exposure and in previously unexposed areas (Szabó, 1967). Progression along the melanization stages might be associated with a shift in the wavelengths required for the process. Melanogenesis, detectable by reflectophotometry during the first days after irradiation, is preferentially due to the action of the waveband between 290 and 320 nm(1) (the so-called erythemal spectrum, with a maximum at 296.7 nm) (Coon, 1965). The same wavelengths stimulate the dispersion of melanin granules along the dendrites (Jung, 1975), which now appear enhanced as they are fully packed with the newly-formed melanosomes. Darkening of previously existing granules (the so-called IPD, immediate pigment darkening) must also be reckoned with (Fitzpatrick & Szabó, 1959; Blum, 1961; Pathak, 1967), since wavelengths between 300 and 700 nm (especially between 360 and 560 nm) are capable of darkening bleached reduced melanin(2). There are interracial and interregional (in the same individual) differences in the capacity of skin to react to UV radiation (Szabó, 1967). After irradiation is finished, the size of the melanocyte population reverted to its original condition, which has

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(1) Melanogenesis and migration of melanosomes appear preceded by an erythemal response ('sunburn'), whose action spectra appear to be identical to those of melanogenesis and increased pigmentation: 1) wavelengths shorter than 260 nm, 2) between 290 and 320 nm, 3) wavelengths longer than 320 nm. Wavelengths below 290 nm are filtered out by the earth's atmosphere. The optimal erythemogenic range extends between 290 and 320 nm, but melanogenesis can even be provoked by long UV radiation and visible radiation (Pathak, 1967).

(2) IPD is an ephimerous process, hardly detectable by the naked eye three hours (24 hours in the most persistent cases) after the end of irradiation. It starts immediately after exposure and, contrarily to melanogenesis, may take place without previous erythema. It is believed to be due to redistribution (in a more obvious perinuclear halo) and change of optical density of the melanosomes within the Malpighian cells, apparently without change in the melanocyte count and without melanosome transfer from any melanocytes (Pathak, 1967).

lead Szabó (1967) to suggest that the increment might just be the epidermis' emergency (acute) reaction to an unusually intensive exposure to radiation, while chronically exposed skins would not present it.

Although the aforementioned factors are responsible for some of the normal and abnormal pigmentary processes they can not account for the hyperpigmentation observed in the endocrine disorders accompanying for instance hyperthyroidism, tumours of the pituitary gland or Addison's disease, or accompanying chronic illnesses such as malnutrition and tuberculosis. In all these cases a hormone, MSH (melanin stimulating hormone), is suspected as the key for the skin's darkening. For the most part, the information concerning the impact of secretion from the endocrine glands on melanin pigmentation has been obtained from experiments with animals or from research on pathological pigmentary states. Among marine animals it has been observed that the adition of MSH provokes dispersal of melanin granules, from around the nucleus, towards the periphery. They become uniformly distributed and the melanocyte becomes opaque. On the other hand, addition of melatonin reverses the process and most of the melanocyte turns transparent. Physical factors such as pH milieu, ionic concentration and changes in temperature can also start the movement of melanosomes. Oxygen (and a change in consistency, from gel to sol) is required for the dispersal move, but not for aggregation (Lerner & Case, 1959). Many other hormonal substances are now known to produce similar effects of dispersal and aggregation on melanin granules of sea animals, batracians (table I.2-1) and mammals. Unfortunately, the results obtained from animal experiments can not always be extrapolated to man.

In humans, the adrenal glands influence (via hydrocortisone) the pituitary's activity, regulating the amounts of α- and β-MSH released by the pituitary. These two peptids (especially the most active, α) have been shown to cause darkening of the skin by increased production and dispersion of melanin granules (fig. I.2-8). The role of ACTH (also released by the pituitary, 1 % of α-MSH's activity), although not clear, is probably similar (Snell, 1967). Thus, when both adrenals are removed in man hyperpigmentation results, which can be prevented by adminstration of hydrocortisone (an inhibitor of the release of ACTH and MSH). In a similar way, the hyperpigmentation of patients with Addison's disease can be diminished by injecting cortisone or hydrocortisone. Mesantoin is another substance which, when administered orally, produces in man the same kind of effect as in frogs.

Minimum effective concentration in micrograms per 20 ml. solution required to initiate lightening of frog skin previously darkened by 50 units MSH.

Melatonin	5×10^{-6}
Noradrenaline	3
Acetylcholine	3
Triiodothyronine	60
Serotonin	150

Factors Regulating the Movement of Melanin Granules in Frog Melanocytes

Dispersing	Aggregating
α- and β-MSH	Melatonin
ACTH	Noradrenaline
Caffeine	Adrenaline
Marsilid	Acetylcholine
Apresoline	Triiodothyronine
Mesantoin	Serotonin
Progesterone	Diamox

Table I.2-1. Factors influencing the movement of melanosomes in the melanocytes of the frog. (After Lerner & Case, 1959).

The effects of other glands' secretion - melatonin (pineal), thyroxine (thyroid) and testosterone (male gonadal glands) - although observed to provoke lightening of the skin in certain animals (the two first substances) versus occasional darkening in man (the last one), have failed to give conclusive results appliable to man. Estrogene and progesterone (secreted by the female gonadal glands) also increase melanogenesis - the latter, seemingly, only when applied in small doses, the effect being the opposite in big doses. The effect here is direct and exerted only upon the skin of the genitalia and the areolar region, presumably by directly increasing the metabolic activity of the keratinocytes which, in turn, would stimulate the melanocytes. The increased pigmentation (melanogenic and vascular in origin) of nipples and areolae, genitalia, facial skin and the internal abdominal wall accompanying pregnancy is also probably due to intensified secretion of the female sex hormones (Snell, 1967).

The way in which the migration of melanosomes is initiated in the melanocytes is not exactly known. Perhaps (Lerner & Case, 1959) the hormones somehow predispose the cell membrane for the transfer of certain ions, which could then start the reactions necessary for the movement of melanosomes.

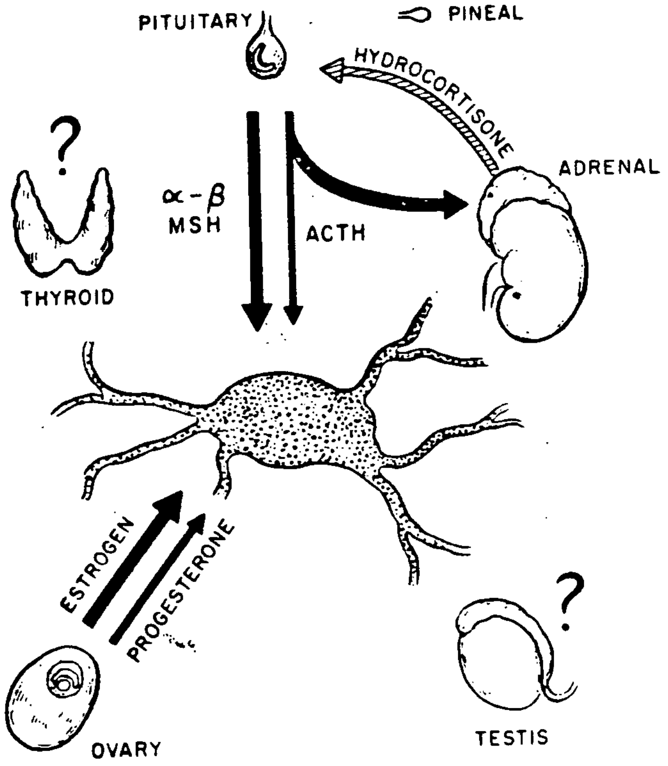

Fig. I.2-8. The effects of hormonal secretions in human melanin pigmentation. (After Snell, 1967).

Summary

In this section current knowledge about the genesis and kinetics of pigment-containing cells, as well as about their functions in the epidermis, has been reviewed, and the role of the internal and the external environment in starting, accelerating and arresting the normal processes of pigment formation and distribution throughout the epidermis has been layed out.

I.3. The reflection power of the skin and the nature of human skin colour.

Every single substance present within the structure of the skin has at each wavelength its own characteristic reflection factor with which it contributes to the total reflection figure. The granular character and discontinuity of the skin is the source of multiple reflection and refraction, with the subsequent scattering of the impinging rays of light according to wavelength. Whenever a ray of light leaves an optical medium to enter another one, a part of the energy is reflected and the rest is transmitted forward along a modified path (refraction). Along the way, the refracted light suffers absorption and, when it leaves that medium, reflection and refraction are applied again to a ray of light which has lost part of its energy along the way. A composite beam of light becomes unfolded into its components, as each of them is refracted along a different path depending on its wavelength.

The kerato-hyaline and melanin granules, the cellular and nuclear membranes of the non-keratinized cells and the surface of these in the horny layer provide plenty of optically discontinuous surfaces for scattering the light rays. The stratum corneum is an efficient absorber of light, especially at wavelengths shorter than 320 nm. Apart from keratines, the major biosynthetic product of epidermal cells and the main absorber, other components - such as histidine, urocanic acid, cholesterol, phospholipids and small peptides - also absorb radiation in the 260-290 nm waveband. In the stratum germinativum, the nucleoproteins of the nucleated cells also contribute significantly to absorption at 260 nm, while -as it will be shown- the absorption of UV, visible and even infrared by melanosomes is of profound relevance for protection of the skin.

Since all radiation below the 290 nm is practically suppressed by the atmospheric ozone (O_3) shield and by the particles and water droplets present in the atmosphere, they exert no selective influence on the shape of the refelectance spectrum of human skin. However, the skin of humans is endowed with high reflectance variability in the region between roughly 300 and 1200 nm, while beyond those borders there is practically no interindividual variation in reflectance. Below 300 nm it was found by Jacquez et al. (1955) that reflectance readings in individuals of Japanese, Negro and White ancestry varied between 6 and 8 (fig. I.3-1), of which between 10 and 20 per cent was the contribution of fluorescence of the skin (a comparatively frequent condition, especially at certain wavelengths), and the rest was mostly due to light reflected and scattered from the topmost layers of the skin (1). The fluorescent wavelengths which make some contribution to the readings lie in the range 290-400 nm. Thus, although they slightly extend into the range of visible light, their effect beyond the 300 nm border is negligible. Above 1200 nm the refectance of human skin is primarily that of a scattering component mixed with water (Jacquez et al., 1956), while the 5-6 per cent reflectance remaining beyond 1900 nm may represent Fresnel reflection at the skin's surface.

The variability in reflectance within the 300-1200 nm range depends directly on the nature and

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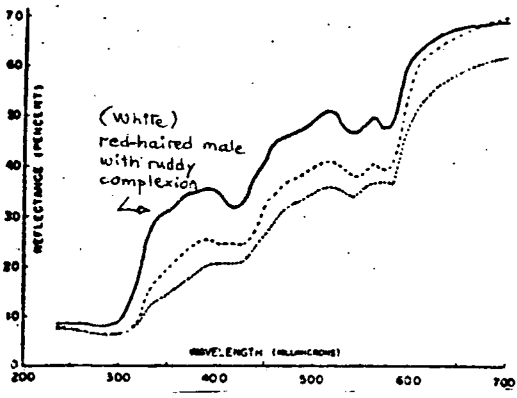
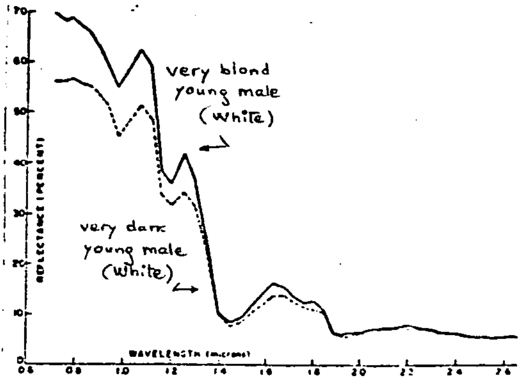
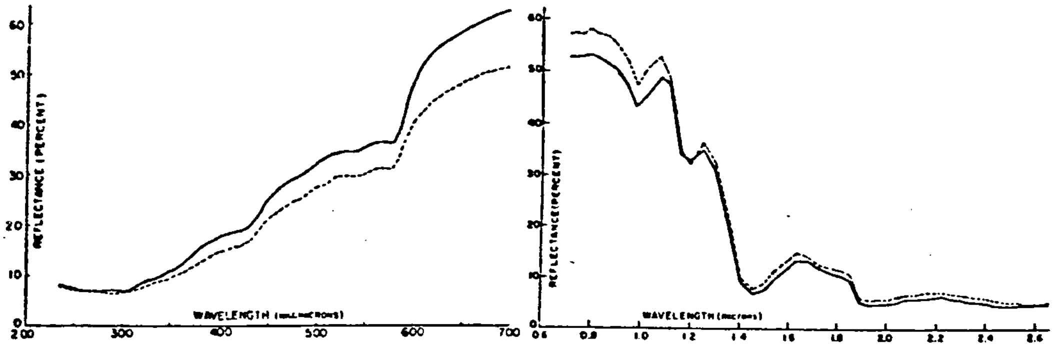
(1) It used to be thought (Jacquez & Kuppenheim, 1954) that practically all radiation between 235 and 300 nm which penetrates deeper than the very top layers is absorbed, however, Pathak (1967) has experimentally proved that between 5 and 15 per cent of the incoming wavelengths shorter than 320 nm (especially those at 240-260 and 300 nm) pass through the epidermis into the dermal papillae in 'white' unexposed epidermis.



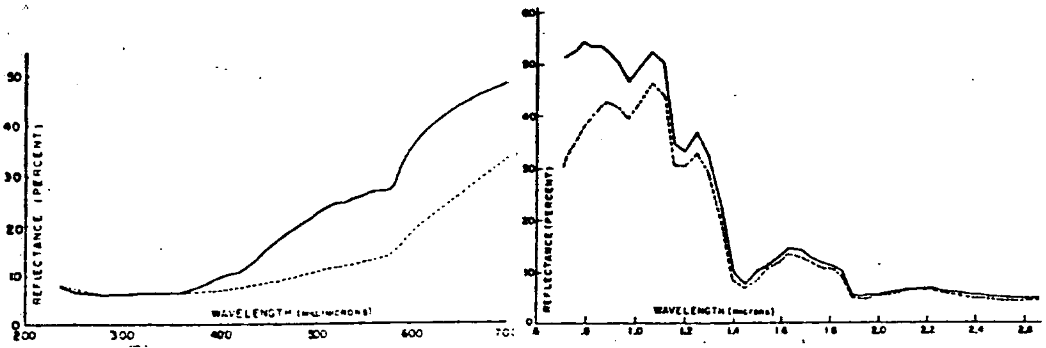
Reflectance of skin of forearm of three young white males.



Reflectance of skin of forearm of very fair complexioned (———) and very dark complexioned (- - - -) young white males.



Reflectance of skin of forearm of two young males of Japanese descent

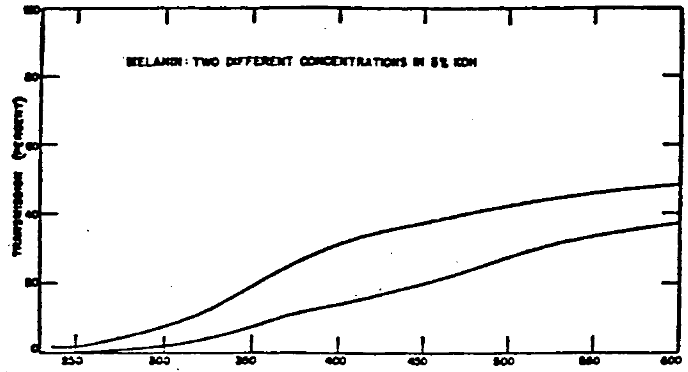


Reflectance of skin of forearm of lightly pigmented (———) and dark (- - - -) American Negroes.

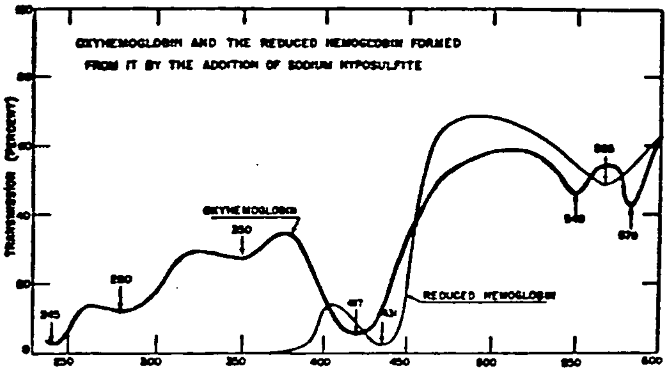
Fig. I.3-1. Reflectance of the skin of the forearm in individuals of Caucasoid, Mongoloid and Negroid origin. (After Jacquez et al., 1955; 1956).

the concentration of the substances found by the light in its path and on their distance from the surface. The two last factors vary not only inter-individually but also regionally (within the same individual) and between sexes. Melanin, for instance, is richer in the forehead, the areolae and external genital regions; it is also more abundant in the skin of men, and its concentration in the skin presents wide variability between races. Blood vessels run closer to the surface in certain parts of the body, and there are individual variations in skin blood flow and blood content (Jacquez et al., 1955). Keratin and water are also unevenly distributed. In addition, the thickness of the dermis is greater among males than among females, and there are interracial differences in the thickness of both epidermis and stratum corneum (Munro, 1967) - which, in turn, influences the total amount of keratin present in the skin. Carotene-containing subcutaneous fat is more abundant among females and it has an uneven distribution, which differs between the sexes and between races. Certain constituents of the blood plasma - such as oxy-haemoglobin, only an accidental impurity, bilirubin and carotenoids - are also detectable in varying proportions and contribute to its colour. Some components of the human diet (carotene, xantophills, luteins, etc.) can also, under conditions of sufficiently high dietary intake, become noticeable in the reflectance curve (fig. I.3-2e). The origins of all this variability are very diverse. State of health and dietary habits (environment, s.l. : habitat and culture) are important for some substances, while for others - melanin, blood flow and thickness of the stratum corneum, for instance - genetic (in combination with environment) is known to have a role.

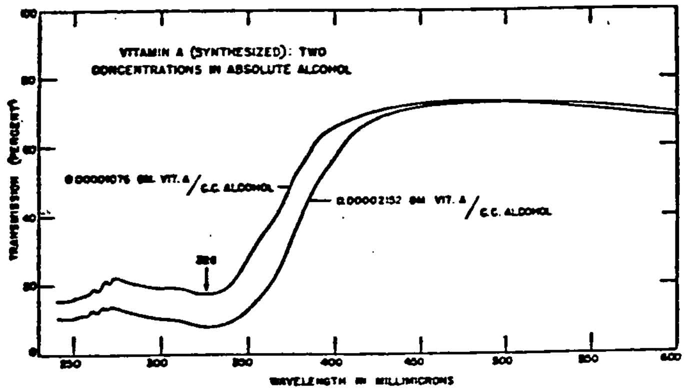
The following data on the reflectance character-



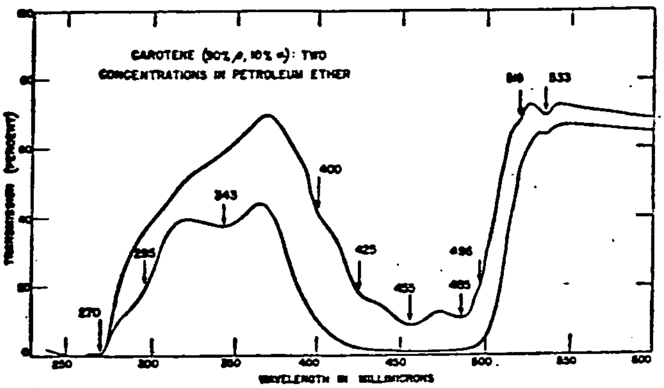
(a) The transmission of melanin in 5% KOH solution. The lower curve is of a more concentrated solution of melanin producing greater absorption and therefore less transmission than the weaker concentration. There is no demarcated band, but rather a gradually increasing absorption from the red end of the spectrum at 600 mμ into the ultraviolet.



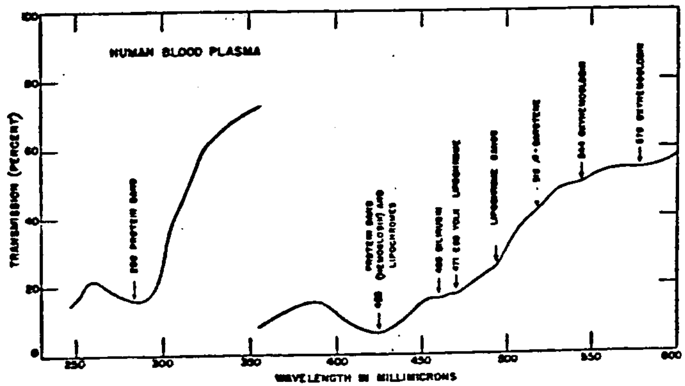
(b) The transmission of oxy- and redured hemoglobin as seen in greatly diluted hemolyzed blood. Of the oxy-hemoglobin bands, only those at 545 and 576 mμ are sharply demarcated in readings of the skin, although that at 417 may also be seen. The reading of reduced hemoglobin is abridged by virtue of the added absorption of the sodium hyposulphate. In other determinations we have observed additional absorption bands for reduced hemoglobin at 260 mμ, with a flexion point in the curve about 335 mμ (see fig. 6). In readings of the skin the band at 565 mμ may be clearly seen, that at 431 somewhat less distinctly.



(c) The transmission of vitamin A in alcohol. The characteristic absorption band is seen at 326 mμ. This is shifted 1 mμ from its usual location at 325, perhaps because of the source of this particular sample. The significance of the fine structure between 255 and 270 mμ has not been determined.



(d) The transmission of carotene in petroleum ether. The chararteristic absorption bands are indicated. Only the band at 455 mμ, which shifts to 452 in the skin, can be identified in the curves of the living subject.



(e) The transmission of diluted blood plasma. The curve on the left represents a greater dilution of the same sample as that used on the right. The absorption of various constituents is indicated.

Fig. I.3-2. Transmission curves and absorption bands of different substances normally present in human skin, as tested in vitro. (After Edwards et al., 1951).

At the dilution used for the reduced haemoglobin, the transmission falls to zero below 370 nm. This is due to strong absorption ov UV light by $Na_2S_2O_4$ itself.

istics of the most important contributors among the constituents of the skin and the subcutaneous tissue) have been extracted from Edwards et al. classical work (1951), slightly modified by the results from recent investigations.

Melanin's absorption power increases steadily from IR into UV with decreasing wavelength, without any characteristic maxima outside the infrared region (fig. I.3-2a). In the infrared it presents maximal absorption at 3000 and 6000 nm. Melanin seems to be the main contributor not only to reflection in general but even to colour, since its presence masks the absorption bands of other pigments in both the visible and the UV ranges, especially among heavily pigmented individuals (fig. I.3-3).

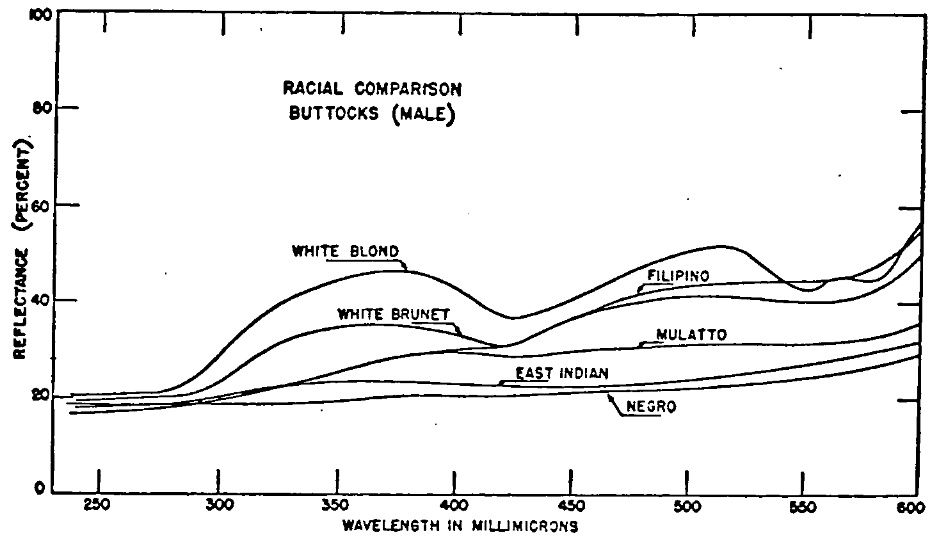


Fig. I.3-3. Melanin and the skin colour of different races. The region of the buttocks was selected as one least affected by environmental factors. In the darker subjects the larger quantity of melanin obscures the characteristics of other substances. (After Edwards et al., 1951).

The presence of a flattening of the skin reflectance curves in the vicinity of 400 nm and into the UV region has been interpreted as the effect of another pigment named melanoid by Edwards and his collaborators (1951) to emphasize its character as a melanin derivative (1). Its absorption power in the region around 400 nm seems to be much greater than that of melanin in this zone. Its initial appearance seems to depend on the formation and subsequent degeneration of considerable amounts of melanin (Edwards & Duntley, 1939), increasing for some time after the rate of production of new melanin decreases and, finally, becoming undetectable after the disappearance of most of the mother substance (fig. I.3-4).

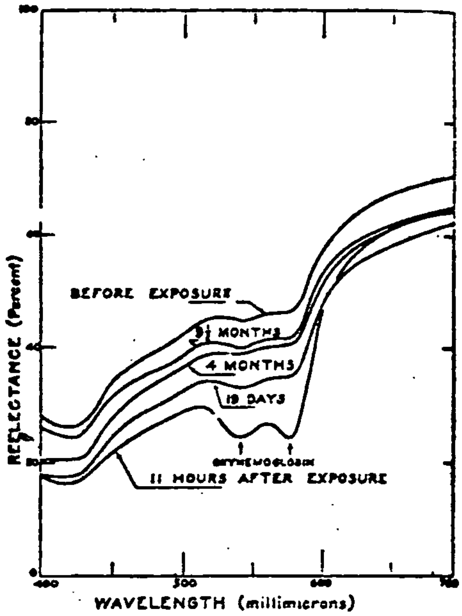


Fig. I.3-4. Spectrophotometric curves of the skin after a single exposure to sunlight. Hyperemia (oxyhemoglobin) is maximal at 11 hours, melanin at 19 days and melanoid at 4 months. Blood stagnation, as registered by reduced hemoglobin, persists from the time of the early disappearance of hyperemia for over nine months.
(After Edwards & Duntley, 1939).

For oxy-haemoglobin and reduced haemoglobin (fig. I.3-2b), Edwards et al. found several absorption bands, slightly shifted in position with respect to

(1) Buckley and Grum (1964) mean to have shown mathematically that no such pigment is present in the epidermis. Whether melanoid is really another pigment or just reduced melanin is, however, of little practical concern here.

those previously found with a Hardy spectrophotometer, at wavelengths 578 (α-absorption band), 548 (β-absorption band), 417 (γ-absorption band) (VL) and 350, 280 (UVL) for oxy-haemoglobin, and at 565, 431 (VL) and 335, 260 (UVL) for reduced haemoglobin. The proportions of both kinds of haemoglobins in human blood are not constant. They depend on the location of the blood vessels. Those lying more superficially, further away from the main blood stream and its driving motor (the left half of the heart) are richer in reduced haemoglobin (venous blood) than the others, which are richer in oxy-haemoglobin (arterial blood). UV radiation, however, provokes the dilation of the cutaneous blood vessels, and the coming of more oxygenated blood to them, displaces the equilibrium to the oxy-haemoglobinic side (a slowly receding condition named hyperemia) (Edwards & Duntley, 1939) (1).

Vitamin A was the only material, among those identified by Edwards and his collaborators, without absorption in the visible range. It presents an absorption band at 325 nm (fig. I.3-2c).

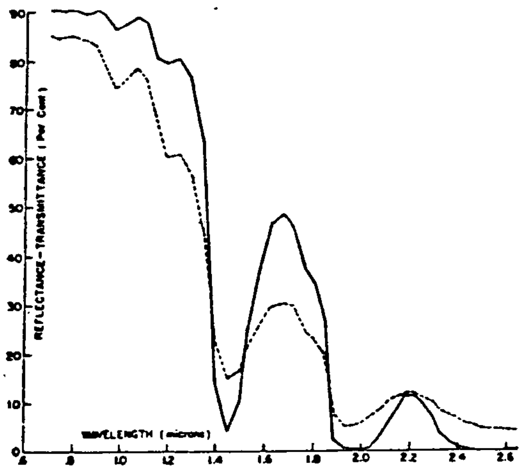
Carotene (α and β), present in subcutaneous fat, presents absorption bands at 518 and 524 nm, very weak both of them, 482, 455 and others less easily detectable (fig. I.3-2d). Heilmeyer (cited in Edwards et al., 1951) attributed to carotene an extended area of absorption between 420 and 520 nm. Occasional fluctuations in the content of carotene have not been found to be related to UV irradiation (Edwards & Duntley, 1939).

Bilirubin has its characteristic absorption bands at 460 nm (VL) and in the region below 300 nm (UVL).

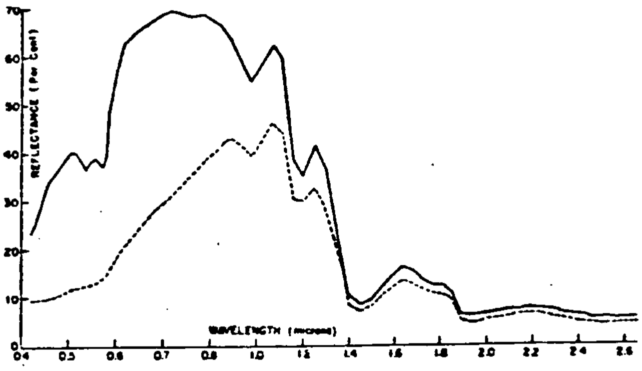
(1) At a higher dose - while further overall increase can be observed - Ramsay and Challoner (1976) observed decreased flow in the most superficial vessels, which they attributed to stasis, perhaps secondary to vascular damage.

Three absorption bands probably due to the presence of water were found within the infrared region --near 980, 845 and 760 nm. The two last minima become progressively masked with increasing pigmentation, while the first one is only slightly influenced by it (fig. I.3-5a).

Proteins of the stratum corneum, mainly keratin, have an absorption band between 260 and 290 nm (Pathak, 1967). As a whole, the horny layer absorbs UV light very efficiently, particularly that of wavelengths below 300 nm (fig. I.3-6a). Figure I.3-6 shows also, for comparison with Pathak's curves, the



(a). Transmittance curve of 1 mm distilled water in quartz cuvette (———) and reflectance curve (- - - -) of a 4.6-mm layer of a paste of 35% MgO and 65% distilled H_2O between quartz plates.



(b). Comparison of very fair complexioned white (———) and very dark American Negro (- - - -) in the visible and near infrared.

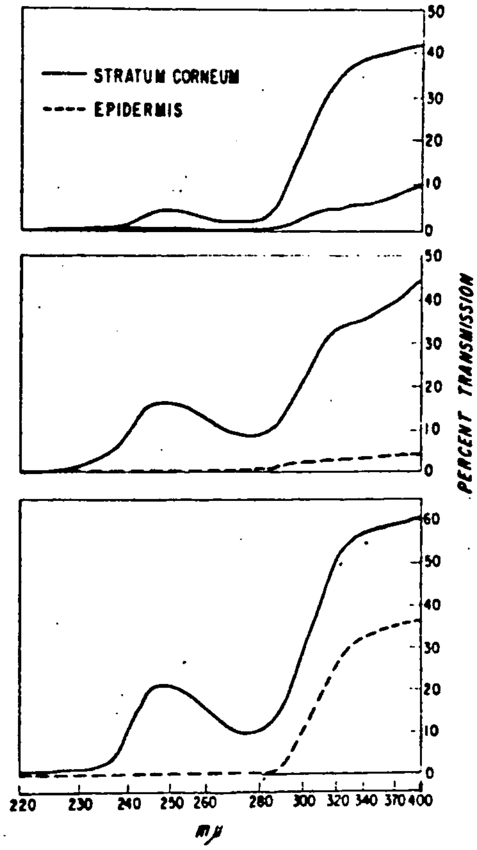
Fig. I.3-5. The absorption bands of water: (a) in solution, (b) in the skin. (After Jacques et al., 1956).

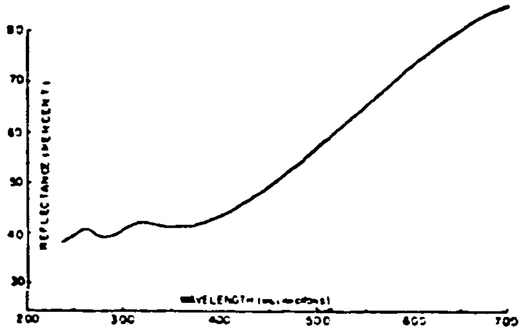
reflectance curve of a small amount of brownish coloured commercial keratin sprinkled on a block of $Mg\ CO_3$ and covered with a quartz plate.

Between 380 and 770 nm approximately the average human eye perceives the colour resulting from the optical integration of all light reflected by these substances. By large, the sensation of colour is due to the combined effect of a few substances present in the skin as either constituents of the skin structure proper or as intrusions as a result of perfusion from the cutaneous blood vessels. Their relative importance is not the same at all wavelengths, since the magnitude of the reflection factor varies with wavelength.

The most significant contributors -apart from melanin (important along the whole spectrum of VL) and haemoglobin (important at the blue and, especially, the green regions)- are melanoid (very important, although transitory in character, at the vicinity of 400 nm) and carotene (important particularly at 482 nm, perhaps underlying the whole blue-green region). The two last constituents are the least important. Although the existence of interracial variability in the thickness of the keratin-containing stratum corneum (Munro, 1967), and that diversity's concomitant function of protection against UV radiation grow increasingly harder to refute, no colourant role is normally assigned to keratin. In the 60's, however, Coon (1965) and Loomis (1967) proposed that the yellowish tint of many mongoloid skins was due to a keratin-enrichened stratum corneum, which played a protective role. Indeed, a protective role does not necessarily imply a significant colourant role, and keratin's colourant function was severely criticized later by Daniels (Daniels et al., 1972), who argued that the skins of vitiliginous or albino patients of all races are 'white' and not 'yellow'. Unfortunately, Munro's experiment did not include any Mongoloids.

Summarily, it may be said that the colour of a skin depends on the proportions in which the three main regions of the spectrum of VL are represented in its reflectance curve, as much as on the absolute values of its reflectance readings. If, for instance, the long-wavelength region (590-770 nm) appears greatly enhanced with respect to the other two the skin will have a reddish tint, while comparatively high reflectance readings in the central or the short wavelength (380-500 nm) regions will add to the skin yellowish or bluish tones respectively. In addition, absolute and relative enhancement of the green-yellow-orange zone will confer to the skin a light, brilliant, character, since this region is endowed with maximal luminous power (fig. I.1-2).





(b) . Reflectance of a small amount of commercial keratin on a block of $MgCO_3$ compared to an $MgCO_3$ standard.

(a) . . Light-transmission spectra of stratum corneum and epidermis from the scapular region of three subjects: a pigmented Negro with vitiligo (*top*), a pigmented Negro (*middle*), and a fair-skinned Caucasian (*bottom*).

Fig. I.3-6. Absorption properties of the stratum corneum, the epidermis and a sample of commercial keratin. (After Pathak, 1967, and Jacquez et al., 1956).

These facts notwithstanding, the dominant wavelength of human skin is red: Wassermann (1971), in an experiment conducted among Bantu, Cape Coloured and Southafrican Whites, has proved that the dominant wavelength for human skin colour lies between 595 and 710 nm, i.e. between orange-red and red, independent of the degree of darkness or lightness of the individual.

The nature and bands of absorption of the constituents of the skin and its relative importance in the genesis of skin colour has been indicated. In order to summarise the most important facts, they can be organized in the following manner.

1. The penetration power of the different wavelengths varies across the spectrum. This has important physiological and chromatic effects.
2. From the vicinity of 300 nm, total reflectance increases (absorption decreases) until a maximum is reached between 720 and 820 nm, among the lightest white skins, or even further away (900 nm and beyond, among heavily pigmented Negroe skins).
3. The rise in reflectance is not steady. In light skins three major oscillations -due to the absorption bands of haemoglobin- and several minor undulations are visible:
   In spite of the masking effect of the melanin, the α , β and γ absorption bands of haemoglobin (578, 548 and 417 nm, respectively) are noticeable in the reflectance curve (fig. I.3-2b). Also visible are those of vitamin A and beta carotene (at 325 and 482 nm, respectively), as well as those of water (at 760, 845 and 980, respectively).

4. Increasing concentrations of melanin can, among Blacks, lead to the practical disappearance of all these bands except for the α and β haemoglobin bands (reduced to one) and the 980 nm water band.
5. Beyond 1200 nm and below 320 nm all races present practically identical reflectance curves (fig. I.3-1). At 1200 nm and beyond the profile of the curves is dominated by the absorption bands of water. Below 320 fluorescence of the skin and absorption mainly by the proteins of the skin are the dominant factors.
6. When passing from the normal to the hyperemic condition, the α, β and γ haemoglobin absorption bands become accentuated. On the contrary, passing into the reduced condition implies convergence of the α and β bands into one at 565 nm shifting of towards longer wavelengths.
7. The dominance of melanin is complete in the red region of the spectrum. Outside that zone, although still the most important contributor to refelection between 320 and 1200 nm, its importance is by no means undisputed. Haemoglobin and carotene make their presence felt in the form of localized absorption bands, which in the case of haemoglobin only become completely masked in extremely pigmented individuals. During a prolonged period after exposure to UV radiation, melanoid also becomes transitorily important in the vicinity of 400 nm.

I.4. The meaning of pigmentary diversity.

The idea of relating skin colour diversity among humans to variation in the intensity and composition of sunlight seems natural, to laymen and anthropologists alike, when observing the effects of irradiation on the skin after a bright summer day and, particularly, since a certain rule of Gloger - formulated in related terms - exists in the field of zoology. According to this, mammals and birds inhabiting warm and humid regions are expected to be darker than races of the same species living in cooler and drier regions.

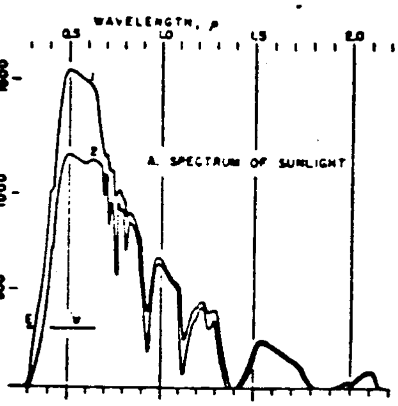
A thorough presentation of the subject would demand an exposition of 1) the way in which the structure and intensity of sunlight varies with environment, 2) the body's reaction to sunlight, 3) the extent to which colour diversity can be explained by the two first logical steps, and 4) considering alternative non-actinic mechanisms which may act in substitution of or complementary to those already proposed. For the sake of flexibility, and considering the natural limitations imposed by the character of this work, neither rigid adherence to any exposition order nor thorough presentation will be attempted here.

The extension and regions of the full spectrum of electromagnetic radiation has already been exposed elsewhere. It should be added that all radiation below 286-290 nm, excepting that produced in artificial sources, is efficiently prevented by the atmosphere from reaching the surface of the earth (fig. I.4-1). The amount and distribution of energy of the solar radiation received at the surface varies widely from place to place owing to the influence of a series of factors:

1) The solar zenith angle (depending on the latitude, time of day and season), determinating greater or lesser perpendicularity of the solar days. Greater perpendicularity implies lesser skin area directly

exposed, but also less absorption, reflection and scattering of sunlight (fig. I.4-2).

2) Altitude, linearly related to atmospheric pressure. Elevation above sea level means decreased reflection, absorption and scattering.



Spectral Distribution of Sunlight at the Surface of the Earth (after Moon, 1941). Curve 1, with sun at zenith. Curve 2, with sun at 60° (four hours) from zenith. V, spectral limits of human vision. E, spectral limits (within sunlight) for sunburn, antirachitic action and cancer induction.

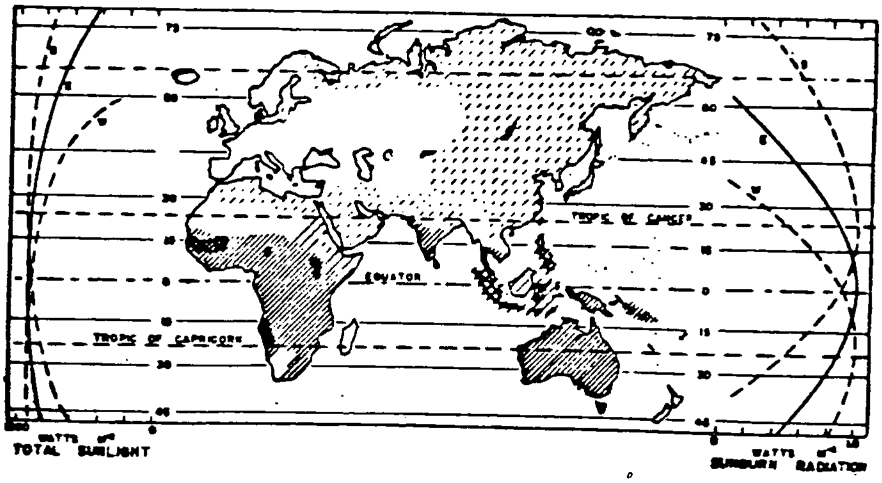


Fig. I.4-1.
(After Blum, 1961).

Map of the distribution of brown skin color (After Fleure, 1945)

On the left, distribution of total sunlight with latitude. E, at equinox; S, at summer solstice; W, at winter solstice. On the right, distribution of sunburning radiation (wavelength shorter than 0.32μ) with latitude. E, at equinox; S, at summer solstice; W, at winter solstice. The curves on the right and left are based on values from Moon (1941). Note that the curves for summer and winter solstices are distorted by the Mercator projection. These curves, based on light incident upon a surface normal to the sun's rays, neglect scattering from the sky, which may be very-important in the case of the sunburning radiation, and also neglect geometrical relationships of the human body profile with respect to the radiant environment. They are thus to be considered only as rough guides.

3) Composition and structure of the atmosphere: cloudiness, precipitation and haze, smoke, dust and fog, relative concentrations of different gases and density of the air, heat, wind and humidity. Heat, wind and humidity have an adverse effect on UV injuries by lowering the erythematic threshold of radiation. Increased figures of all others mean greater absorption, reflection and scattering. The gases are not equally effective in all regions of the spectrum and the albedo (reflectance capacity)

of clouds is very varied (1).

4) Underlaying surface reflectivity. As important as the incoming radiation is at times the radiation leaving the surface. Sunlight reflected from the soil or from a water surface can have a tanning effect and even contribute to the genesis of skin cancer (2).

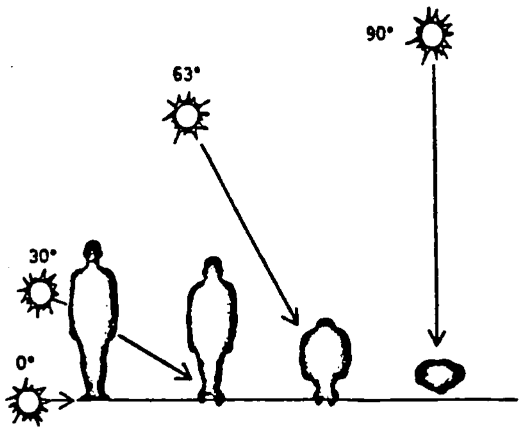


Fig. I.4-2. Surface area of direct sunlight exposure and a standing man facing the sun at different solar elevations. (After Jung, 1975).

5) Thickness of ozone layer. Ozone (O_3), the most important absorbing agent, shows important differences in thickness all around the globe, apart

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(1) UV radiation is reduced by ozone. VL is filtered by water vapour and, particularly, by oxygen. IR is filtered by carbon dioxide and water vapour.
Clouds have an average albedo of 50 per cent, but actually vary between a small percentage and 90 per cent (Drummond, 1958).

(2) Grass, although greatly dependent of its general state, shows an average albedo of 20 to 25 per cent. In general, the highest albedos are those of freshly fallen snow and the lowest are those of water surfaces. Large water surfaces can, however, possess high reflectance indices when the sun approaches the line of the horizon (Drummond, 1958).

from seasonal changes. Situated between 20 and 40 km high, the layer is thinner at the equator and thicker at the poles, a difference which is maximised by the increasing obliquity (meaning increasing length) of the path travelled by the sun rays away from the equatorial band between the tropics (1).

Exposure of human skin to sunlight has, in section I.2, been shown to provoke primary melanization (pigmentation) with erythema and immediate darkening of preformed pigment (IPD), with preference in the regions of short UV and long UV radiators respectively. The first process has a relatively late appearance and lasts for months, while the second one is extremely ephimerous and appears without delay. In practice, however, there is ample overlap in wavelength between both processes, since the first one is also initiated in pigmented (non-white) skins by radiation above the 320 nm border, while the second one is also evoked --although less efficiently-- by radiation between 300 and 320 nm.

The erythematic response (reddening of the skin), which always accompanies pigmentation (but not necessarily IPD), is associated to an enlargement of the arterioles and venules of the corium. This reflects an increase in the flow of arterial blood (2) and in the proportion of circulating oxy-haemoglobin (3) (hyperemia) (Edwards & Duntley, 1939). At the same

(1) When the sun passes above the equator, its atmospheric path to the southern parts of Scotland and Sweden is 1.5 times the corresponding path to the equator, but only 0.75 times its path to the poles (Coon, 1965).

(2) Detectable by the lowered position of the reflectance curve in the blue and green regions.

(3) Revealed by the pronounced twin absorption bands of oxy-haemoglobin.

time, there is an ascent of skin temperature closely followed by a corresponding increase in pulse rate, together with extension of the erythema beyond the irradiated area (Ramsay & Challoner, 1976). Associated to all these changes, Thomson (1951) observed diminished sweating rate, which he attributed to blockage of the sweating gland ducts (detectable by the presence of vesicular rash) and to reduced sweat secretion (brought about, it was suggested, by toxins diffused from the injured epidermis). With increasing dosis of 300 nm radiation, Ramsay and Challoner observed that a certain bluish tinge developed, in combination with marked fall of blood flow in the superficial dermis and an increase in the total dermic blood flow. This condition was tentatively explained as due to stasis in the superficial vessels (presumably secondary to vascular damage)(1). After reaching a maximum the hyperemic condition enters a long-lasting recession, which implies diminished blood flow (2) and displacement of the haemoglobinic balance towards the reduced side (3). Lagging the start of the hyperemic condition, pigmentation takes always place whenever the epidermal cells have not been severely damaged by UV radiation (4), but in

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(1) For many years it has been accepted wiyhout experimental pro f that the release of a vasoactive material and its diffusion to the dermis was responsible for the dilatation of its blood vessels (Lewis, 1927). However, Pathak's findings (Pathak, 1967) that between 5 and 15 per cent of wavelengths below 320 nm reach the dermal papillae, re-actualize again Finsen's hypothesis (1899) on direct action of UV radiation on the vessels.

(2) Revealed by increased reflectance in the region of the twin bands (the green region).

(3) Reflected in the blunting of the two twin bands.

(4) The whole sequence of events, as uncovered by the changes in the reflectance curve, is dealt with in section IV.1.

severely injured skin (sunburn) melanogenesis may be poor and pigmentation not markedly visible.

At the level of the biomolecule the events are initiated with the absorption by the electrons of the energy brought by incoming photons. When, afterwards, this energy is released again it can provoke chemical reactions at the biomolecule itself (normally in its DNA) or at adjacent sites (Jung, 1975). About 70 per cent of these DNA alterations are identifiable as cyclobutine dimers between adjacent thymines at the same DNA strand, and they interfere with the DNA's elementary functions (replication and translation). As a first consequence, epidermal replication stops and the metabolic role of the keratinocytes is disturbed (resulting in swelling of the cytoplasm and aberrant keratinization). Erythema has progressed to sunburn which, when chronically repeated, propitiates the appearance of skin cancer. Three alternative paths for disposal of the incoming energy involve, however, the participation of melanin in a protective role. These are: 1) light scattering, involving attenuation of the impinging radiation by multiple reflection and dispersion of the light rays in the melanosomes, 2) cynematic absorption of radiant energy and its subsequent dissipation as less harmful heat, and 3) generation of free radicals and oxidation by absorption of incming energy at the surface of the melanosomes. Pathak (1967) found evidence of at least two different free radicals: one in melanin, generated by short and long UV and by VL radiation, and the other in the epidermal proteins (primarily keratin), originated by short wave UV radiation.

The main function of the melanosomes seems to be that of protecting the melanocytes and the keratinocytes (around whose nuclei, especially the keratinocytes' nuclei, they are arranged), but also other dermic structures such as sweat glands and blood vessels obtain benefit from their screening action. Protection is exerted by absorbing the incoming photons, but also by acting as radical quenchers and preventing the first undesired chemical events from happening, and - if the damage occurs - by removing the harmful UV-induced dimers or by photo-reactivation and post-replicational repair, allowing the epidermis to regain its full integrity. If, however, these repair processes are overcharged, they become unable of regenerating the damaged DNA, initial erythema progresses to sunburn and, eventually, after a variable length of time, to skin cancer.

Although the connection between sunburn and UV-radiation was already known by the middle of the 19th century, it was not until the beginning of this century that Finsen (1900) demonstrated that the skin of Europeans reacted to exposure to ultraviolet rays by producing pigment, which led him to conclude that melanin protected against those rays by absorbing them superficially. It was shown later by Edwards and Duntley (1951; 1939) that five different substances are the main responsible for the colour of the skin - melanin, melanoid, carotene and the two haemoglobins - and that, in a white subject, a single exposure to sunlight is capable of provoking long-lasting hyperemia and changes in the concentrations of melanin and melanoid (ephimerous the last one), but that there were no alterations in the proportion of carotene which could be definitively related to irradiation. Several scholars (Thomson, 1951; Lee & Lasker, 1959) found that much higher dosis of radiation are required in Blacks and Mongoloids to produce erythema than among Whites (1), the order being: Blacks > Mongoloids > Whites. Thomson found also that no significant alteration in sweating rate was pro-

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duced in black skin by dosis of radiation which provoked a marked reduction in white skin.

The sequel of relatively minor physical impairments following erythema among the ill-adapted (reduced sweating rate, feber, thermical shock and collapse; or excessive prespiration -if sensitivized-rash, dihydration, cramps and collapse), although rarely leading to death, are likely to have had a selective impact on our ancestors' capacity to raise up a family by interfering with their activities as food producers and hunter-gatherers. The factor proposed as the main selective agent is, however, cancer of the skin. Piers (1948) and Schrire (1958) have explained the normal and abnormal reactions of skin after chronic exposure to intensive sunlight. While the brunette White reacts to over-exposure by tanning, the pale White fails to tan. Instead, he turns red and develops blisters. Thickening of the exposed areas of the skin (acanthosis) and development of patchy, brownish pigmentation takes place over the years, faking the tanning process, followed by roughening and dryness of the skin (keratosis). Some skins start developing ulcers, which after some time emerge as fully evolved malignant neoplasms. Schrire reports on numerous cases of rodent ulcer and epithelioma of the lip (the two most common forms of facial skin cancer) as being much more frequent among whites (especially of blond complexion) than among Cape Coloured (mainly Indian immigrants), and entirely absent among Bushmen and Bantu. Similar observations were made by Piers in Kenya and by medical researchers in Southern United States and Australia. Since according to usual medical

(1) The disparity of figures for the proportion of different levels of radiation suggest that the relationship radiation/erythema is not linear.
Lee & Lasker: Negroes/Whites = 2.2, Mongoloids/Whites = 1.3. Thomson (quoting a former work by Hauser & Vahle): Negroes (1 subject)/Whites = 10.

data (which come from societies where occidental clothing prevails), skin cancer does not seriously affect patients until generally advanced age (1), it has been concluded by some that - incidence being maximal well after the onset of the reproductive period - the significance of cancer as a selective agent is null (Blum, 1961; Leguebe, 1977). However, Schrire says, commenting the albino Bantus' low incidence of rodent ulcer: "rodent ulcer take many years to develop in Europeans, and it appears that the albino Bantu may not live long enough for this to happen, but dies at a yuothful age from epithelioma of the skin". The albino Bantu lives in his childhood and youth in his kraal, unclothed and natural, where he undergoes the initiatory phases (2). Among the albino Indians in Cuna (Mc Fadden, 1961) 100 per cent of the children had developed premalignant skin changes by the age of seven. White children living in the New Guinea highlands also develop skin cancers before puberty.

Criticism against the role of skin cancer as selective agent has implicitely assumed that the chronologic distance between the onset of the reproductive period and death or severe physical deformity have throughout thousands of years of evolution remained more or less constant, with the second conveniently

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(1) In Schrire's data only 2 per cent of the cases of rodent ulcer and 1 per cent of those with epithelioma of the lip came under medical control under the age of thirty. Among Piers' cases of cutaneous cancer (all sorts) 1.96 per cent were under thirty. All cases reported by Schrire (around 500) were of facial carcinoma, while 95.51 of those reported by Piers were affected on either the face or the head.

(2) At the respect, it must be mentioned that Thomson (1951) found the skin of the albino Negro included in his experiment to be typically European in reflectance values and in transmission of light per unit of thickness.

lagging the first. That is not necessarily true. In addition, the disfigurations which extensively affect the patients of skin cancer may, at the time of mating, have already afflicted our tropical fore-runners, deprived - as they were - of any protective occidental clothing. This factor should have severely limited their chances for reproduction, by subjecting those afflicted to some sort of negative 'sexual' selection. If, indeed, they had not died before, as the albino Bantus cited by Schrire. In the third place, the so called 'promoting' factor - decisive in the development of carcinoma (Schrire, 1958 c) - is supposed to be repeated minor trauma, which was presumably much more common among our 'primitive' ancestrors than among modern White South Africans or Kenyans. Thus, there is abundant ground for advocating for a role as selective agent for malignant carcinoma of the skin.

Not many scholars today object to the general lines of this theory, but it is by no means the only one attempting to give an explanation of the observed facts. The correctness of the preceding interpretation had at an early stage been challenged by Guillaume (1926) and Miescher (1930), who believed the real protective agent to be increased thickness of the stratum corneum, through a mechanism broadly parallel to that proposed for melanin. The anthropological world became thus divided in two antagonistic factions. In an attempt to put an end to the dispute, Thomson (1955) found that the stratum corneum of African Negroes was thicker than that of Europeans, although not significantly so, and that the transmission of UV light per unit of thickness was greater in whites. He also found that the transmission index for an albino Black, included in the African group, was comparable to the European and not to the African, as were his reflectance values. From all this, he logically concluded that melanin must be the reason for the differences between Blacks and Whites. His conclusions were accepted by Blum (1961), in a modified form, and integrated in his own theory which gave the thickness of the horny layer the main role. Thomson's inconclusive results regarding horny layer thickness (1) can be compared with Munro's (1967), who found a very high correlation (r=+0.87) between melanin concentration and thickness of the stratum corneum, even though sample sizes were small. In addition, not only corneal but also epidermal thickness is significantly smaller in Whites, with corneal thickness especially varying significantly from Whites to African Negroes, going through - in this order - New Guineans, American Negroes and Australian aborigines. Jung (1975) found that by controlled exposure to UV radiation, a maximum pigmentary stimulation, implying a 10-fold increase of the MED (minimum erythemal dose), can be induced in Caucasians, while among albinos - where pigment stimulation can not take place - the same procedure leads to thickening of the epidermal layers (acanthosis), which can provide a 4-fold protection. Both effects together can, in a normal white skin, result in a 40-fold increase of the MED.

It was soon realized that, Black absorbing more light than White, the presence of deeply pigmented skins in the tropics planted a problem since, from the point of view of thermoregulation, at high environmental temperatures skin seemed to be at disadvantage (1). The problem had, however, been partially over-estimated, as Baker (1958) found, in studying American Blacks and Whites, that Negroes

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(1) Thomson himself realized the limitations involved in his methodology for separation of the horny layer. They may have affected the results.

show higher heat tolerance than Whites under hot-wet (tropical) conditions, while the reverse is true under exposure to sunlight in hot-dry (desertic) conditions. Baker concluded that Negroes were capable of dissipating more heat than Whites without a proportionately greater sweat loss, infering that this must be possible because of higher skin temperature in Negroes (1). In addition, when Blacks were protected from the sun, their rectal temperatures under hot-dry conditions were the same and even lower than those of Whites.

Thus, a deeply pigmented skin is not needed away from the tropics, but absence of selective pressure does not account for the extremely pale skins found, for instance, in northern Europe. How did they come about? A brilliantly conceived explanation was already elaborated by Murray in 1934. The same UVB wavelengths which produce erythema and sunburn (eventually also cutaneous cancer) generate melanin and vitamin D. It is a generalized assumption that, by irradiation of the skin, 7-dehydrocholesterol (pro-vitamin D_3) --generated from cholesterol present in the skin and, to a lesser extent, in the blood--is transformed into vitamin D and a number of other subproducts.

Although as far back as 1894 Niels Finsen successfully utilized concentrated sunlight in destroying

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(2) When the surrounding temperature is so high that the normal processes of heat dissipation (by irradiation, convection and perspiration) fail to be sufficient the core temperature of the body can rise so much over the standard 98.6°F that death can in extreme cases occur.

(1) It is seldom mentioned that although more heat is absorbed by Black skin, it penetrates much deeper in the skin among Whites (fig. I.2-2), which maximizes among Blacks the efficiency of convection and irradiation.

local cutaneous infections, it was not until the disclosure of the role of the UV region of the spectrum in the cure of rickets that its nutritional role became fully evident. Even if rickets is not normally a fatal disease, osteomalacia (severe rickets) --by deforming the female pelvis-- grossly impairs or even destroys the reproductive capacity. It is old knowledge that coloured infants living in northern latitudes are more prone to rickets than white children (Abt, 1923). There is a gradual decrease in the intensity of UV radiation away from the equator, toward the poles (fig. I.4-1 and 3). Dark skin in its natural environment is thought to allow enough vitamin D synthesis to cover the needs of normal bone growth and, at the same time, to protect against the harmful effects of radiation. The situation has recently been described as: "the degree of melanization is regarded as a compromise between vitamin D requirements and requirements to protect the

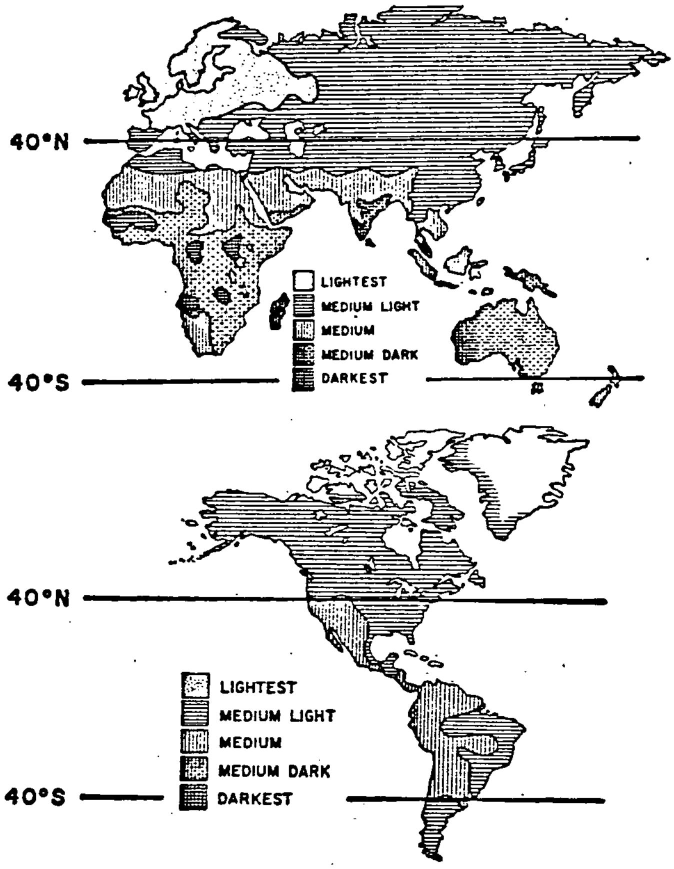

Fig. I.4-3 . Distribution of human skin colour before 1492. (After Loomis, 1967).

DNA of the basal cells from mutational damage" (Daniels et al., 1972)..

Vitamin D does not seem to be a stable substance, which might account for the fact that no cases of hyper-vitaminosis have ever been reported among Whites living in or near the tropics. However, Osler and Mc Crae (1920) -when explaining the so called functional nervous diseases, especially tropical neurasthenia (the disorder which most persistently afflicts White residents of the tropics)- comment the abnormal calcium salts and phosphates present in the urine of affected people. This evidences some degree of abnormal metabolism of calcium and phosphorus (the very same elements which vitamin D is to metabolize into normal tissue). Another disorder, presumably due to excessive photosynthesis of phosphorus and calcium, is arteriosclerosis, also affecting Whites in the tropics. In sub-tropical British India it was common say that few continuously resident white families survived the third generation. Similar pictures of decaying health come from the white communities living in the sunniest south Atlantic seaboards of the U.S., the West Indies and the Phillipines (Murray, 1934). These two hypothesis, melanin as a protective barrier and vitamin D and rickets, which actually complement each other, have for many years been the standard explanation for the variations in pigmentation. Unfortunately, the situation has to a great extent become greatly polarized between Blacks and Whites, with little theoretical and practical research done to explain other populations. Most of them fit reasonably well in between, partly due to the difficulty -even impossibility- of quantifying the environmental variables in order to determine the expected effect and contrast it against the observed one. The task is not easy since not only climate but also factors such as fashion, habits, kind of work and nutrition - just to name the basic ones - play an important role. Unfortunately little or nothing has been done in this terrain. Modern articles on skin colour show an amazing lack of ethnographic and environmental information on the populations under study. The relevance of the subject can be easily realized by quoting Edwards and Duntley (1939) who found that, after a one-hour exposure to the mid-day August sun, the skin of a normal male adult (white, judged from the reflectance readings) had not returned to its original reflectance readings nine and a half months later.

As a proof against the validity of the melanin-vitamin D hypothesis is often advocated the coexistence under closely similar climatic conditions of populations widely diverging in skin colour: particularly, the presence of the Australian aborigenes in their central desert, of the Sudanese Negroes in their savannahs, black Melanesians in certain cold and moist islands of the Pacific and of comparatively pigmented populations all around the arctic circle.

In practice, heavily pigmented populations in their Australian desert (really a semi-desert only) and Sudanese savannah are seldom exposed to extreme dry-hot conditions equivalent to these of the Yuma desert, where Baker's experiment took place. The available evidence suggests rather that the maximal pigmentation is required away from the protection of the jungle's leafy canopy, or at least in zones transitional between savannah and forest, as Turnbull's (1963) comment on the Pygmies' unability to stand the direct sunlight attests: "on one small model plantation where the Pymies were being liberated 29 died on one day from sunstroke". Pygmies are lighter (reddish-yellow) than forest Negroes, which, in turn, are lighter than the savannah

Negroes (1). The deceiving character of the crude figures for absorption and reflections appears clearly in Salthouse's experiment (in Newman, 1961) who found that two very dark Nilotes actually reflected more near infrared from the skin surface than the one White control, while two dark Bantu reflected the same as the control. All four black-skinned subjects absorbed, however, much more near infrared in the epidermis as a whole, and allowed much less to reach the dermis than the White subject. Thus, Blacks have a physiological advantage to dispose heat off their skins. In addition, they apparently possess a greater number of sweat glands (2) than Whites, and --in the case of Savannah Negroes-- a longilinear body form (high surface/volume rate) which greatly facilitates the dissipation of heat. Although Australian aborigenes have not been stud ed as extensively as African Negroes, increased reflection of infrared from the surface of the skin and short penetration of radiation must also be at work among them. Moreover, the slender, long-limbed complexion typical of desert and savannah dwellers appear also among the aborigenes, especially those of

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(2) In the west African rain forest, Bantu agriculturalists live in villages cleared in the jungle, where temperature is much higher than in the shaded heart of the forest, which is the home of their only neighbours, the Pygmies.

(1) Incomplete data from Glaser (in Newman, 1961) suggest that in the majority of bodyly regions, Bantu have more sweat glands than European Whites, while Thomson (1954) failed to confirm the earlier investigations. However, Kawahata and Sakamoto (in Newman, 1961), in a work with 5800 east Asians (Ainu, Russians, Japanese and Philipinos), found a marked regression towards more sweat glands in peoples of warmer climates, plus suggestions that the sweat gland density is a plastic response to environment.

the dry and hot north and western regions.

A different problem is brought up by the dark inhabitants of certain Pacific islands --as Tasmania, the Bougainville islands or the highlands of New Guinea-- who, in spite of inhabiting a region with a climate broadly similar to that of southwestern France and northern Spain, under frequently overcast skies, are reported to possess a deeply pigmented skin (1). Although the racial history of southwestern Oceania is very badly known, it seems that the modern inhabitants of the region derive at least a considerable part of their gene pool from people who begun the settlement of the area -from further north- at a much remoter age than previously thought: 14,000 - 23,000 BC for the New Guinean highlands (Dyer, 1974), for instance. Since The climates of these islands were harsher during late Pleistocene (2), the presence there of those populations becomes even more difficult to explain. Protection against UV radiation reflected from water surfaces and ability to trap calorific energy from long wave radiation have been proposed (Coon, 1965) as selective channels, but neither these nor other mechanisms still to exposed seem either satisfactory or applicable. The latter is, besides, difficult to conciliate with the

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(1) In a climate classified as mesothermal of the humid variety, and with abundant precipitation at all seasons (fig.I.4-4), the dark Guineans of the eastern highlands had means comparable to Harrison and Owen's west Africans (from Liverpool) (1964) and Sunderland's Sudanese of Middle Eastern extraction (1979), while the light Guineans of the same district (the Lufa "red skins") were comparable to Büchi's low caste Indians (1957/8) and to Sunderland's Middle Eastern subjects from Fezzan (Libya).

(2) For instance, extense zones of Tasmania were glaciated during the Upper Pleistocene (Coon, 1965).

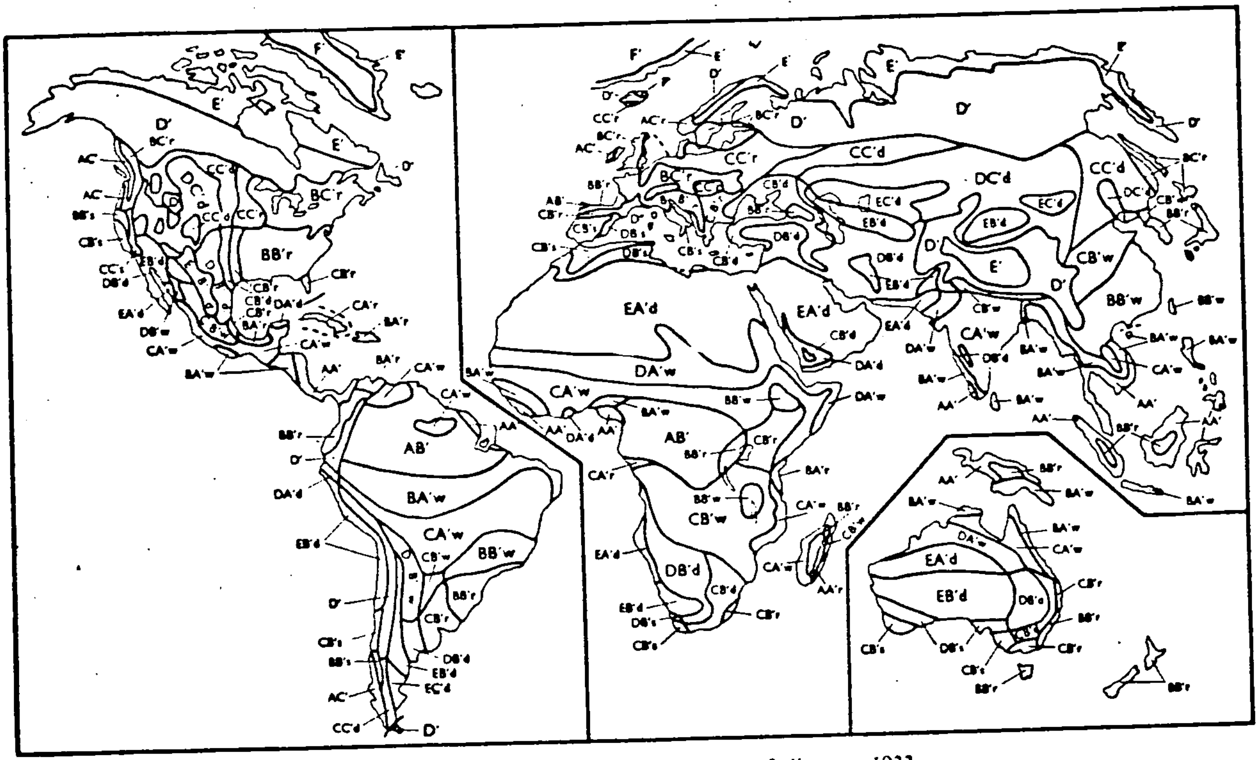


FIG. 159. Thornthwaite's classification of climates, 1933

A. WET (rain all seasons) B. HUMID, C. SUB-HUMID, D. SEMI-ARID, E. ARID

Each sub-divided where appropriate into

A'—Tropical
D'—Taiga
B'—Mesothermal
E'—Tundra
C'—Microthermal
F'—Perpetual Frost

Appended letters indicate

r = rain at all seasons
s = rain deficient in summer
w = rain deficient in winter
d = rain deficient in all seasons

Fig. I.4-4a. Thorntwaite's classification of climates. (In Briault & Hubbard, 1959).

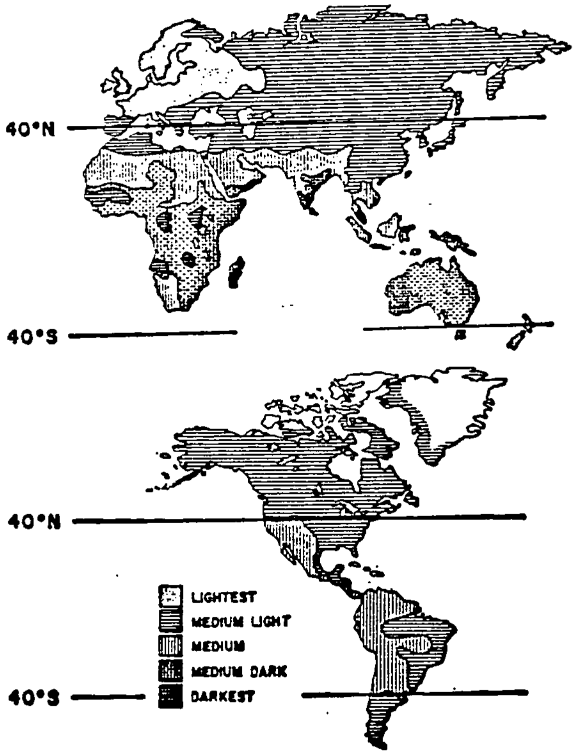


Fig. I.4-4b. The distribution of human skin colour before 1492. (After Loomis 1967).

aforementioned greater efficiency of Blacks to dissipate heat. Perhaps the answer lies with the absence of strong selection against dark pigmentation under temperate to subtropical conditions. Presumably, even among darkly-pigmented primitives, exposure of the total bodily surface to radiation under those conditions is sufficient to provide for their minimal vitamin-D requirements, thus depriving natural selection of its principal anti-pigmentary weapon, perhaps the only valid at these latitudes, and allowing the population to keep the dark pigmentation acquired in its southeast asiatic homeland. It is intriguing whether the widespread existence in Melanesia of lighter pigmented individuals (Coon, 1965; Walsh, 1971; Harvey, 1971) may have something to do with pigmentation having exceeded environmental demands.

Among the inhabitants of the far north, along the arctic circle, those of predominantly Caucasoid origin possess considerable dosis of blondism of hair and eyes (Coon, 1939, 1965), and they are dark-skinned only by comparison with their southwestern neighbours, the Scandinavians and the Finns. Towards the east, the Mongoloids - especially Eskimos - are darker. Murray himself (1934) offered a plausible explanation to this apparent enigma. The diet of Eskimos, and presumably of other arctic coastal populations as well, is rich in animal vitamin D which allows them to retain a relatively dark pigmentation in a radiation-poor environment. In addition, it may be added that the intense reverberation of sunlight in ice and snow fields can burn the skin -and, when chronic, even lead to cancer of the skin (Coon, 1965)- and, above all, damage the eyes (eventually producing blindness), and this puts a premium on pigmented eyes and skins.

The two aforementioned hypothesis together explain actually more than they leave out and the existence of a few problem populations is not enough reason to discard any of them, at least as long as we do not have a more comprehensive and thoroughful interpretation model. It must not be forgotten either that everything suggests, as it is often the case, that in reality more than one adaptive mechanism is involved: In the next lines we will see some of the others which have been proposed.

Cowles (1950, 1959) has interpreted Gloger's rule as having to do with concealment not with physiological adaptations. He points out that while a white skin easily contrasts against the colour of the background in the jungle, the bush or the savannah, a dark skin would have adaptive value while ambushing for hunt, warfare loot and women, in which primitive societies must have occasionally indulged. He specifically points out that during the long infancy of mankind, approaching an animal prey within arm's length or near enough to accurately throw the killing weapon must have been of paramount economical importance for the hunting band and, together with the advance of technology, progressively reduced the need of contending with other carnivores for the often decomposing remains of their kills, thereby diminishing the frequency of illness and death from food poisoning.

Cryptic colouration is a widely spread phenomenon among animals and there is no reason for man to be an exception, but its importance as an evolutive factor must have rapidly decreased with the introduction of clothing among most human groups. In fact, because of the relevance of the economic activity in man and since most animals preyed upon do not possess colour vision, this mechanism would have more to do with luminosity of a colour than with hue. Levels of luminance similar to those of the background being favourable to man, either as hunter or as prey.

Recently (Daniels et al., 1972 and Post et al., 1975) a new intriguing theory has been put forward. It has been observed during the two World wars, the Korean war and among troops stationed in Alaska that Negroes are apparently more susceptible to cold than Whites. More cases of frozen feet and hands, among others, were reported and statistically studied among Senegalese soldiers vs. French soldiers, Ethiopian tropps vs. White American tropps and Black vs. White American soldiers. No efforts were spared in order to avoid bias and subjectivity in making the observatio s and yet the trend is clear. Additional support comes from Stray (1943) who reported that blond recruits were clearly less affected by frostbite injuries than brunettes, within the Norwegian Army, although the difference was not statistically significant.

In vitro and in vivo experiments and a number of observations point on the same direction. Taylor (1949) was first to demonstrate that melanocytes are more prone to cold injury than the hair follicles containing them. Depigmentation among Blacks, following frostbite, has often been reported, and in all races after cryosurgery -in this case usually temporary. In the cases of severe frostbite the damage inflicted to the melanocytes is apparently so large that they are killed and repigmentation does not take place. Post et al. (1975) studying pairs of frozen skin biopsies from black and white piebald Guinea pigs, found that -whenever differential injury was shown- it was more intense in pigmented than in unpigmented skin. Other investigators report also that in vials containing clones of B16 melanoma cells, either frozen or cooled, the most pigmented melanoma cells are always less viable. This interesting theory, together with the vitamin D hypothesis,are of great help explaining the origin of the White stock of mankind, specially of its most northern branches.

The aftermath of cold injury (pain and sensory disturbances) can persist for years, and can easily impair manual dexterity. Following in order of severity, creepling of the extremities and anaerobic gangrena (tetanus, normally resulting in death) can dramatically affect the human reproductive potential of a small human community. If, as suggested by some scholars (Brace & Montagu, 1965; Brace, 1970; Hamilton, 1973), man was born in the tropics with a richly pigmented skin, wandering away from them must have progressively shifted selective pressure from an emphasis placed on protection against UV toward increased ability for trapping the UV required for vitamin D production and diminishing their susceptibility to cold, the epidermis of man becoming depigmented along the way.

Another theory of relevance when studying the origin of Caucasoid depigmented populations has been taking form during at least the last forty years. Lewis (1942) suggested that the eye of Blacks may have selective advantages under bright light conditions. More recently, Dodt et al. (1959) -studying by electroretinography the spectral sensitivity of the eye in albinos, normal Caucasoids and Negroes- found that "Negroes show a distinctly lower sensitivity than Caucasians with lighter fundi at wavelengths longer than 600 millimicrons". This led Daniels et al. (1972) to suggest that during glacial and postglacial times - in a milieu rich in snowfall, on foggy landscape and water surfaces, under prolonged twilight conditions and cloudy skies and, not least, for vision in caves by firelight and fire embers - this feature should have meant selective advantage for light eyed people. Apparently some of the genes determining skin colour affect as well eye and hair colour. Since there is a good general correlation between skin colour and pigment of the optic fundus, depigmented skins might have arised as a consequence of selective pressure favouring light eyed populations, even in the absence of any mechanism directly putting a premium on pale skins.

Concerning the colour of the eye, UV-radiation is not a factor to be counted with since the cornea completely blocks it, on the other hand intense reverberation of light from ice or snow covered open surfaces can damage the eye (eventually producing blindness). In such a tundra-like environment darker fundus would again be more at home than light ones, and that is indeed the situation today among Lapps and Northwestern Siberians in spite of the miscigenation with their more depigmented Southern neighbours.

Another interesting theory, which has lately been gaining support (Leguebe, 1977) was already proposed in the mid sixties (Wassermann, 1965). It is well known that the activity of the reticuloendothelial system (RES) is inversely related to adrenocortical activity. The cortex of the adrenal gland secretes sex hormones, gluco-corticoids (cortisone, among others) and mineralo-corticoids. Cortisone is a powerful inhibitor of RES activity. The adrenal gland is in turn controlled by adreno-cortico-tropic hormone (ACTH) secreted by the anterior lobe of the pituitary gland (hypophysis), whose middle lobe secretes also the melanocyte stimulating hormone (MSH) which regulates the production of melanin. The hormones α-MSH, β-MSH and ACTH have very similar chemical structures and it has even been suggested that α-MSH is an intermediate product in the production of ACTH. ACTH has also melanocyte stimulating properties. There are indications that a single enzyme deficiency genetically inherited, may lead to reduced adrenocortical function and increased RES activity, which might possess positive selective value in the tropics, since the RES is the principal organ of defence against bacteriological, viral and parasitological agents. Wassermann gathered all available evidence on the activity of the RES of coloured races and concluded that it is more intense among them than among Whites: more intense phagocytic functions (higher leukocyte counts) and higher concentrations of specific serum gamma globulin antibodies. Nutrition may also have an effect. Malnutrition would then increase pigmentation and RES activity in addition. Another factor to be considered since malnutrition is often endemic in the tropics.

Summary

The reasons for human pigmentary diversity have during the history of anthropology variously been identified with a number of biological variables, often of difficult quantification: concentration of melanin as a protective screen against UV radiation, and the antirachitic action of vitamen D -together in a well balanced two-fold theory; thickness of the stratum corneum and cryptic adaptive role of colour; unequal sensitivities of diversely pigmented skins to cold injury and increased sensitivity to visible IRin light vs. dark eyed people; association of the melanocyte production system to the reticulo-endothelial system (RES). The picture is indeed complicate and many-sided, the selective values of all these adaptive mechanisms being difficult to evaluate in practice. Within 'civilized' groups the importance of most of these selective pressures is expected to be in decline, but less so among primitives. At any rate, especially during the dark ages in the formation of the human subspecies - such as they are known today - more than one mechanism ought to be expected to have played a role, culture not withstanding. However, a hypothesis has at times been enhanced to the exclusion of the others, theories have been refuted because of a few new cases which do not "fit" into the picture, and culture has been alleged as the reason to extract man from subjection to environmental pressures.

Culture is itself just a dimension of man's environment, his avenue of access into habitat. Ergo, not more than general reasonable adherence to any rule or theory should in principle be expected being man's phenotype "the ultimate compromise of conflicting selection pressures"(Mayr, 1955). In other words, varying degrees of deviation from total conformity to a rule/theory are to be expected whenever greater overall fitness can be achieved by the simultaneous actions of several adaptive processes which can even be - and often are - antagonistic.

1.5. A remark on methodology.

The insufficiency of the 'abridged' spectral reflectance curves in reproducing a colour, together with the lack of unequivocal correspondence between a complete reflectance curve and the colour it reproduces, have been shown in section I.1. In addition, the evolutionary and adaptive connotations of a skin's melanin content have equally been exposed elsewhere. This newly acquired insight into the problematic of skin colour leads inevitably to realize the impossibility of - with the mathematical methodology at the disposal of the anthropologist - characterizing a skin by its colour and, simultaneously, keeping the information about melanin content as a part of that characterization.

Since it should be the purpose which primarily dictates the selection of the means, it seems right to ask here: 'What are we after when measuring the anthropological character broadly known as skin colour?', 'Are we intending an enquiry into the evolutionary meaning of human diversity in pigment concentration (and if so, which pigment/s do we mean), in skin colour or in anything else?'.

It would seem that providing an account of the reasons for the interindividual variability existing within the various factors involved in the genesis not only of pigmentation but, more fully, of differences in reflectance, absorption and transmission through the whole spectrum of radiation, should be of primary concern to physical anthropologists. Seen from this angle, the relevance of colour as an anthropological marker depends on how accurately it summarizes the complex interactions among all those factors contributing to the final product, and/or up to what extent it can be used as a valid means of classifying populations. The fact that colour does not show any unequivocal correspondence with the VL spectral reflectance curve and that the rest of the spectrum is not represented there, should be argument enough to deprive the physical entity, colour, of any chances of fulfilling such a role. This has in fact been tacitly recognized in most anthropological fieldwork, whenever 'abridged' or complete reflectance curves have been produced instead of the X, Y, Z values or its derivatives.

Some substances other than those normally considered when studying the colour of the skin (melanin and melanoid, carotene and haemoglobins) are present in the skin as structural constituents or by virtue of the constant perfussion of the cutaneous blood vessels. Thus, vitamin A and, probably (Jacquez et al., 1955), proteins of the stratum corneum, such as keratin, are normally represented by absorption bands in the UV range, while the constituents of the blood plasma (biluribin, carotenoids and, again, oxi-haemoglobin) and, under conditions of high dietary intake, even certain xantophylls (luteins of egg yolk and of maize) may be detected by several bands in the UV and the visible ranges. The constituents of the blood plasma present considerable interindividual variation in the concentration of each of these substances, while keratin may well have protective value and dietary intake is subject to individual as well as cultural variation. Although the presence of much melanin blunts the absorption bands of other pigments in the visible and the UV zones of the spectrum, the importance of these last elements should have to be evaluated before they can definitively be eliminated from the list of significant contributors to interindividual, and perhaps interracial, differences in skin colour. Similarly, the meaning of the considerable reflectance variability which exists in the infrared range, and its possible thermical connections, should have to be clarified, since it may have adaptive value.

The enormous task implied in the exploration of the rest of the spectrum becomes more practicable when pointing out that, in the part of the spectrum studied in some detail, there is practically no interindividual variation in reflectance below 300 nm or above 1200 nm (Jacquez et al., 1955; 1956). Such homogeneity beyond the borders of a widely variable region may be interpreted either as the result of some sort of adaptation to radiation from immediately outside the 300-1200 nm region - thus, a basic requirement universally satisfied and independent of environmental variation - or as deprived of any adaptive value at all. We are then left with a region, extending over part of the ultraviolet and infrared ranges plus the whole spectrum of visible light, in which wide interindividual and, above all, interpopulational variability takes place. Radiation in the UV range is mutagenic and carcinogenous (factors which restrict experimentation with humans), while the red end of the visible light spectrum and, especially, the infrared region carry considerable doses of heat.

Most theories attempting to account for the diversification of skin colour in man have placed the emphasis in melanin content and/or thickness of the stratum corneum. One of them, however, can be directly formulated in terms of colour and luminance, although its original exposition (Cowles, 1950; 1959) is another, Anyhow, it is so far melanin content which has been widely accepted as the trait, directly or indirectly, selected for (Finsen, 1900; Murray, 1934; Daniels et al., 1972; Post et al., 1975; Wassermann, 1965), while the protective role of the stratum corneum is still debated, with, lately Blum (1961), Coon (1965), Loomis (1967), Munro (1967) and Jung (1975) in favour. Thus, in recognition of the role of melanin concentration as a buffer against extreme doses (both too high and too low) of UV intake, it is primarily the concentration of melanin we are after. This figure is, according to Harrison and Owen (1956/7) "linearly related" to the reciprocal of the reflectance value (1/R) at any of the wavelengths within the red end of the spectrum. It should be pointed out, however, that, since the readings at, for instance, EEL filters 608 and 609 are rarely identical in any individual, the constant of proportionality must be a function of the wavelength.

Thus, although the importance of the absorption patterns of melanin not only at the red end but also at the blue end of the spectrum remains a well established fact, in foresight of the demands of future investigation, when more comprehensive and deeper knowledge of the significance of the distribution of skin reflectances is attained, it may be desirable not to limit measurements merely to those provided by an abridged curve within the visible range of the spectrum.

Summary

In this section the differences between the chromatic and the protective quality of the pigment of the skin have been emphasised, and knowledge has been won about the unrelatedness of some of its chromatic aspects with its protective role. A more profound insight into the possible adaptive meaning of each section of the reflectance curve has been found necessary as part of the search for a more suitable methodology.

CHAPTER II

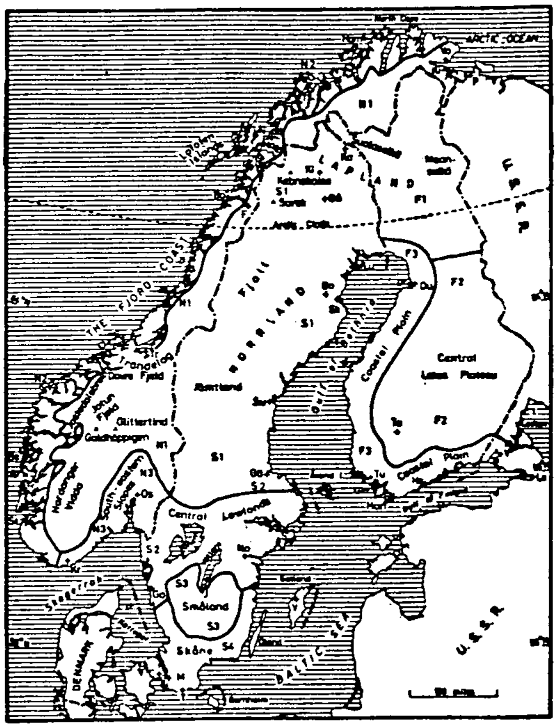
II.1. The populations: the country and the people.

Of the three geographical regions examined in this research, Iberia is by far situated at the highest altitude. Coastal plains being few in number and small in extent, the region is totally dominated by the presence of the vast tableland, generally denuded and dry, called "la Meseta" -which covers rouhgly half of the total area of Spain and almost imperceptibly slopes towards the west (fig. II.1-1b). The central Castilian nucleus, in the heart of the Meseta, has an average altitude of 2000 ft., and the whole Peninsula is traversed by no less than seven mountain ranges -five of which run either inside the Meseta or bordering it. The greatest heights are to be found outside the central tableland or bordering it along the north and the east, frequently ranging into the seven to eight thousand feet and beyond (up to around 11000 ft. in the Pyrenees and the Baetic ranges). Two triangle-shaped depressions -the Ebro Depression (average height of 1500 ft., for the most part barren and Meseta-like in character) and the Guadalquivir Depression (average height 500 ft., cultivated patches alternating with a few steppe and semi-desert areas)- complete the orographic picture.

Whereas in Spain all but the Soria-Teruel ranges, along the east border of the Meseta, run from east to west, the Scandinavian and British run in a south-north direction. The western part of the Scandinavian peninsula is constituted by a high plateau -two to five thousand feet high- from which several groups of mountains (up to around 7000 ft.) rise (fig. II.1-1a). To the west, mountains and plateau slope abruptly into the sea, giving origin to a deeply indented coastline - with partly submerged glacial troughs (fjords) and numerous offshore islands. To the north-east, through the Norrland plateau in the north - crossed by deeply cut river valleys - height decreases gradually towards the Baltic coastal plain, while further south the central Swedish and Scanian lowlands alternate with the uplands referred to as the Småland plateau. At the southern side of the Scandinavian straits, the lowlands emerge gently here and there giving origin to the Danish soil.

Highland Britain is an area of massifs and plateau country, where most of the ground stands above 1000 ft. They appear concentrated on the western parts of the island and broaden up gradually toward the north, where they basically occupy the whole country. Highland Britain includes Southwest England, Wales, the Lake District and the Pennines, the southern Uplands and the Scottish Highlands (fig. II.1-1c). Most of Ireland has the same character. The highest peaks are in western Scotland, southwestern Ireland and northwestern Wales (up to 3300 ft. and beyond), and they contribute to give the coastline its rugged character. In opposition, Lowland Britain and -to a certain extent- the central eastern region of Ireland are areas of plains, wide valleys, low plateaus and scarplands, extending towards a rather featureless coastline.

In vegetation (fig. II.1-2), reflecting the climatical and orographical diversity, Iberia is also the most varied of the three areas, although certainly not the most thickly covered. While Ireland, Britain and especially Scandinavia still conserve a fair proportion of woodland -some of it retaining its primaeval character- man has almost succeeded in totally denuding Iberia of its formerly much richer vegetal cover: only 10 per cent of Spain and 25 per cent of Portugal remains forested. Also, while in the Atlantic islands of Scandinavia -outside the mountain ranges- what is not cultivated is either grassland or forested with broad-leaved deciduous trees, or with conifers (in Scandinavia, north of the 60^{0} line), in Iberia -outside the small percentage which is cultiv-



Regional divisions of Scandinavia

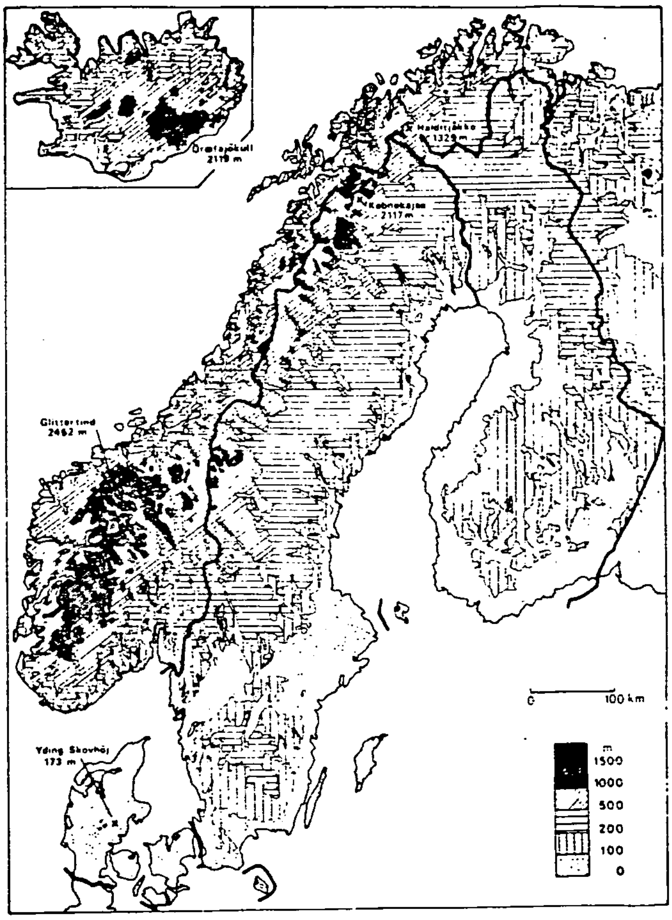
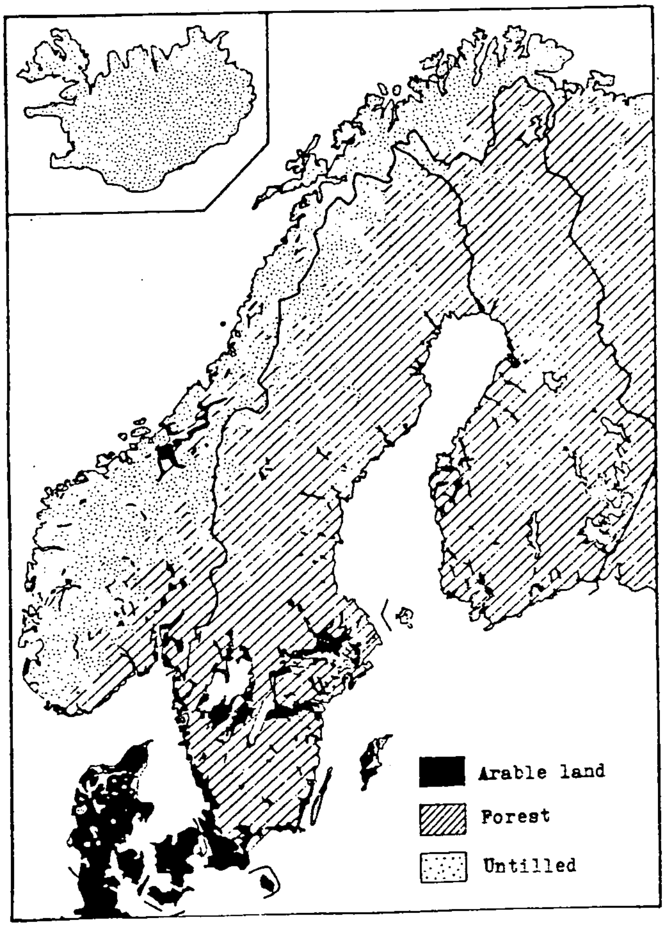


Fig. II.1-1a. Relief and natural regions in Scandinavia. (After Somme, 1968 and Monkhouse, 1966).



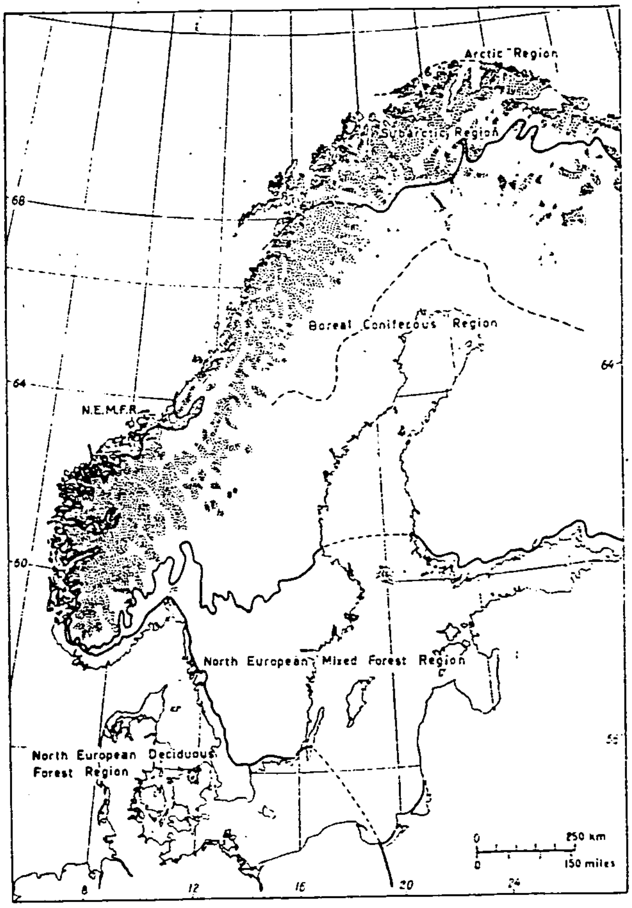
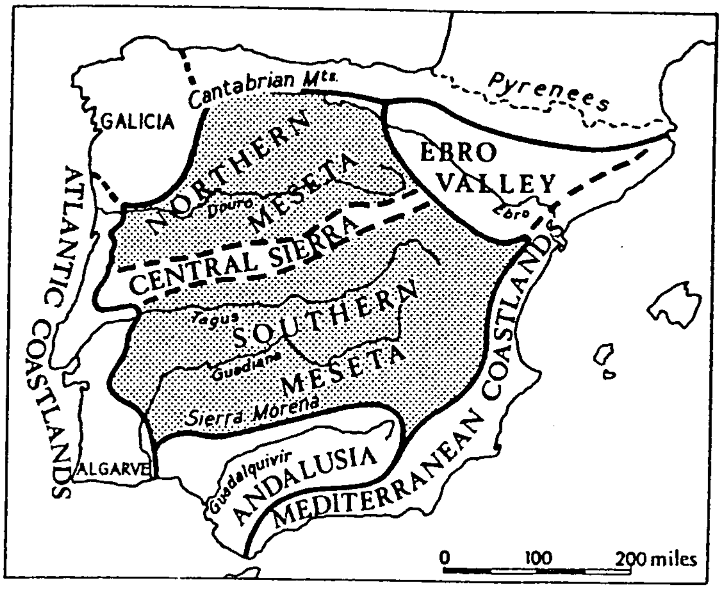


Fig. II.1-2a. Vegetation and land use in Scandinavia. (After Somme, 1968 and Alexandersson, 1972).



Natural regions of Spain and Portugal (after L. Dudley Stamp)

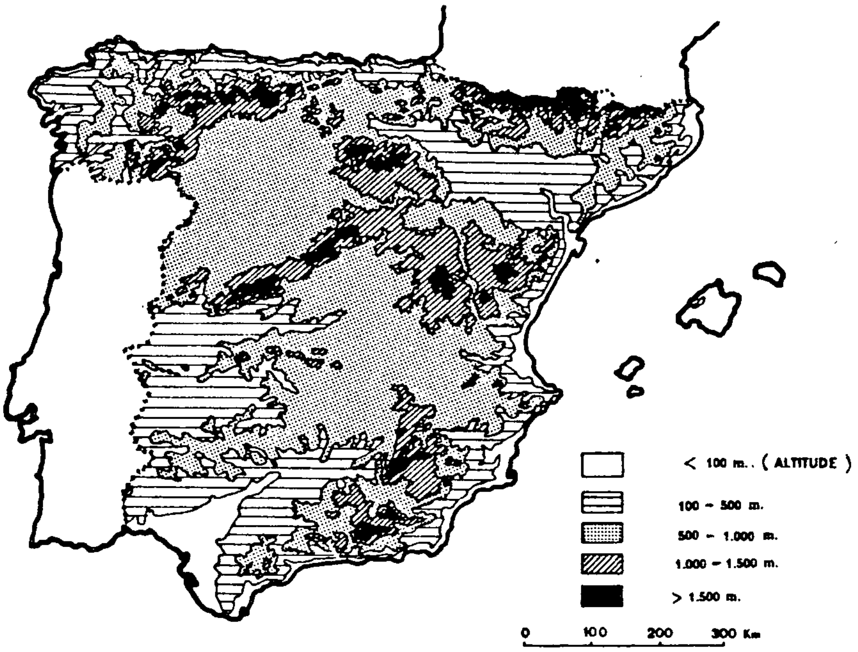
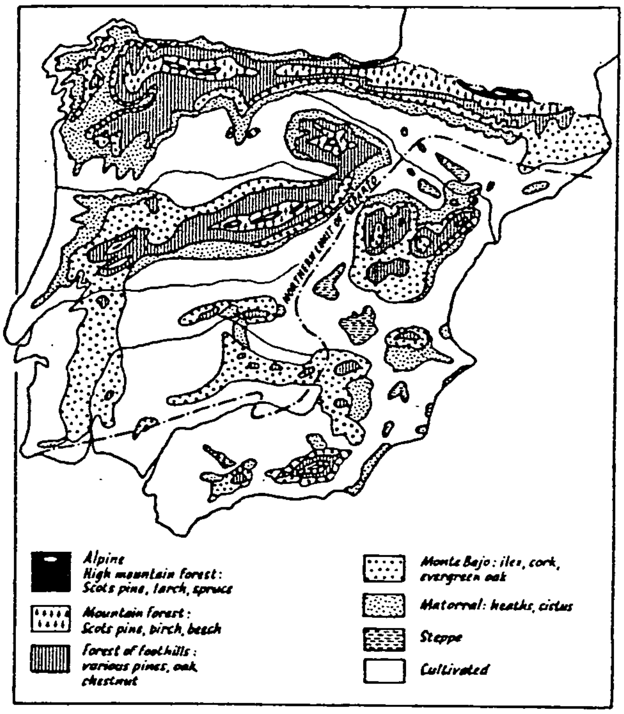
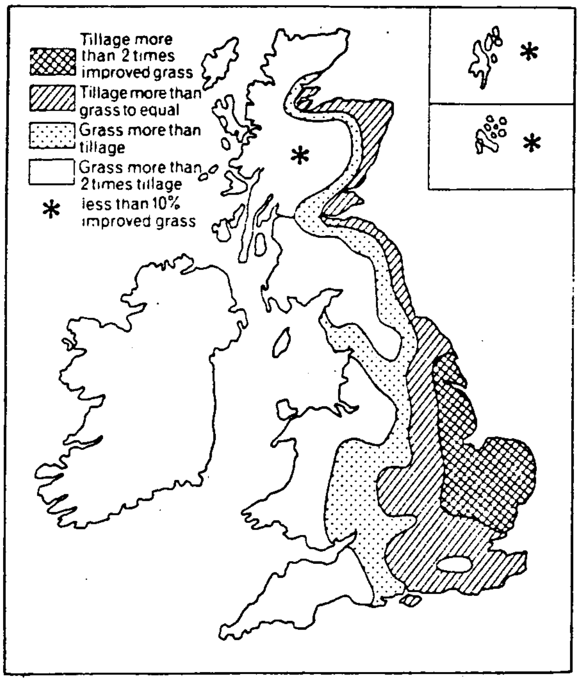


Fig. II.1-1b. Relief and natural regions of Iberia and Baleares. (After Cabo & Vigil, 1979 and Savory, 1968).



Natural Vegetation

Fig. II.1-2b. Vegetation and land use in Iberia. (After Way, 1962).



Relative extents of cropland and grassland, 1970

Fig. II.1-2c. Vegetation and land use in the British Isles (After Dury, 1978).

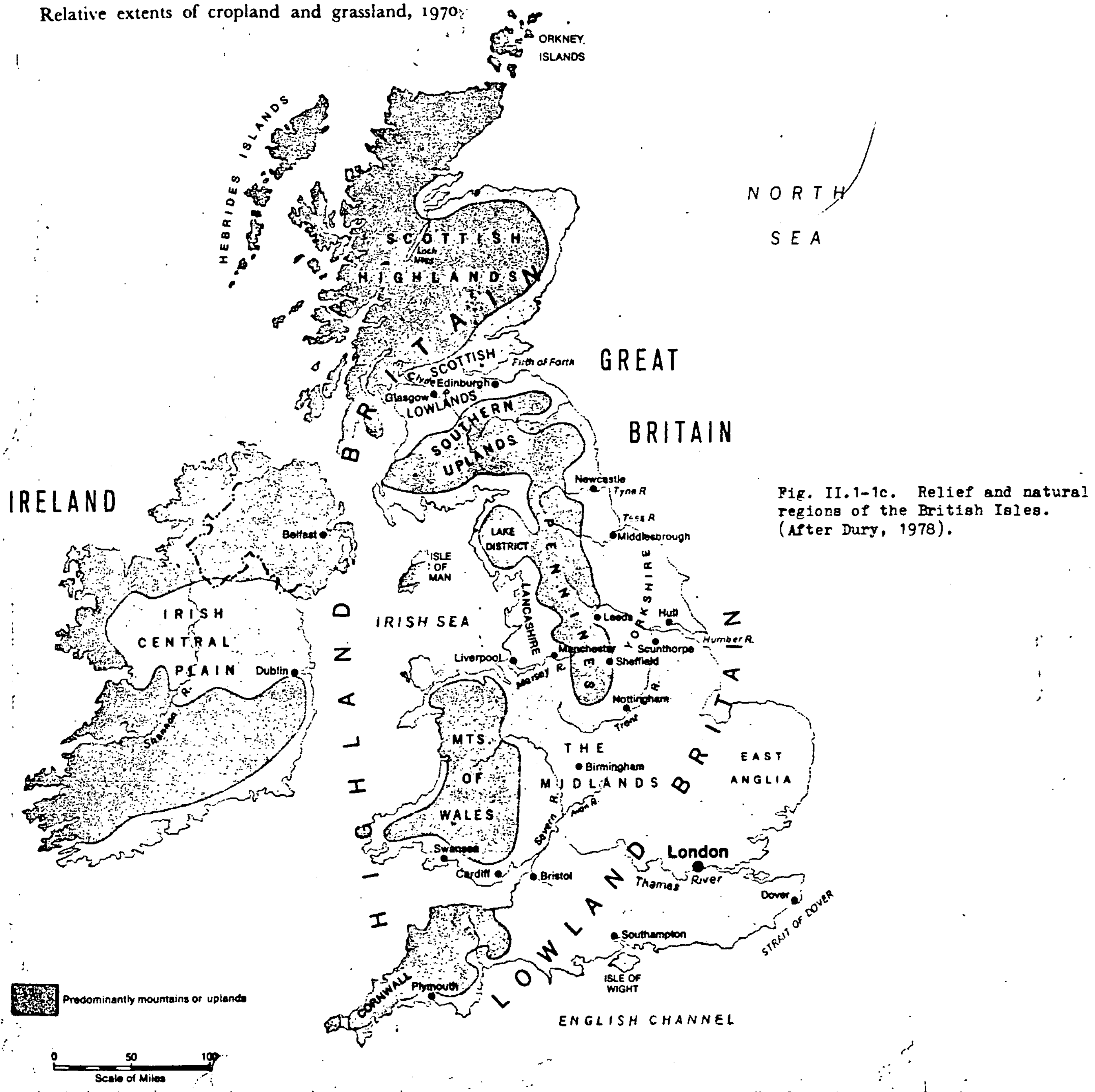
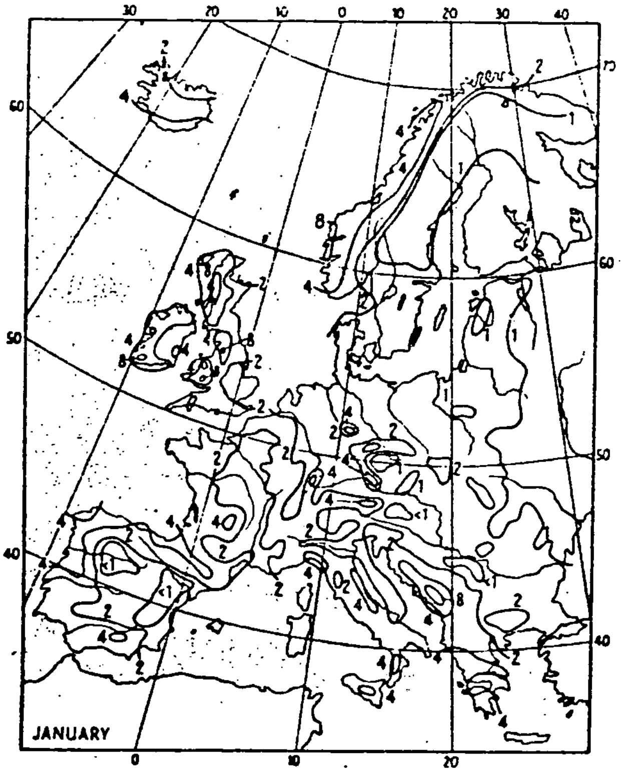


Fig. II.1-1c. Relief and natural regions of the British Isles. (After Dury, 1978).

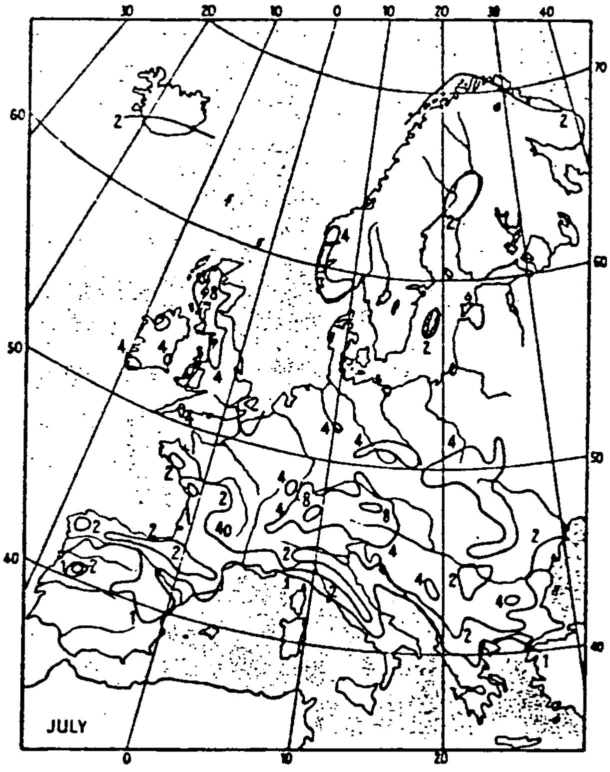
Highland and Lowland Britain. (Based in part on a map by L. Dudley Stamp.)

ated and a few reduced mountain areas of alpine vegetation- the rest is covered with deciduous mountain forest, "monte bajo" (evergreen, drought-resistant trees) and "matorral" (heath plants).

Rainfall and humidity gradually diminish in the three cases from a focus situated somewhere on the western part of each of the three areas: western Ireland, in one case, southwestern Norway, in another, and the northwestern corner of Spain, in the third case (fig. II.1-3). The southwesterly air stream of the Atlantic, which brings a constant supply of warm, moist and tropical maritime air to the northwest of Europe, exerts as well its influence in northern and western Iberia. Their effects are, however, diverse. The open insular character of the islands in the north Atlantic does not prevent the warm, moist air masses from bringing clouds and rainfalls everywhere around the Irish sea. But further north and especially further south, the Scandinavian and Iberian plateaus and their mountains more effectively screen off the inland and landmasses to the east. In Scandinavia, to the north and east and along the western coast, the region is also open to cool, most Polar maritime air from the north and, in winter, to the cold dry Polar continental air from over the Eurasian continent. Further south, winds mostly blow from the Atlantic and, in the case of Iberia, from the Mediterranean and from northern Africa as well, bringing warm air masses -dry, in the case of eastern and southern Iberia, humid, in the north Atlantic. In the Iberian Peninsula, any moisture content is rapidly either stopped over the Cantabric and north Atlantic land stretches between the coastal line and the scarped edge of the Meseta, where clouds progressively disappear into thin air- or by the highlands which cut off the great tablelands of the Meseta from both each other and from the sea.

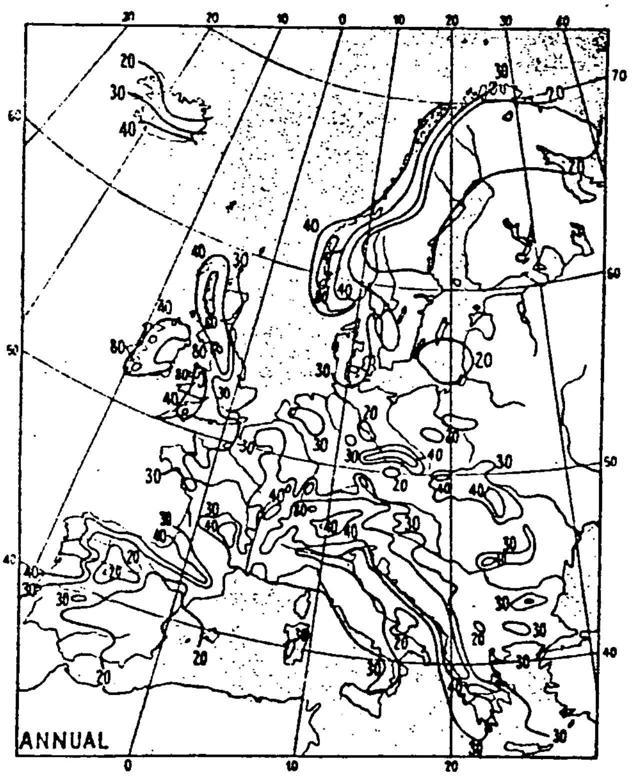


Mean monthly precipitation (in.).

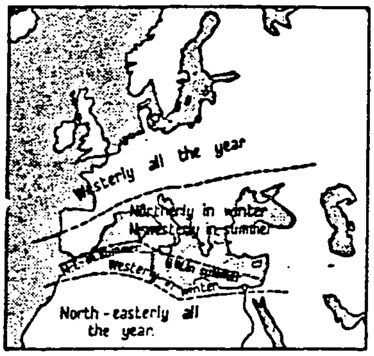


Mean monthly precipitation (in.).

800



Mean annual precipitation (in.).



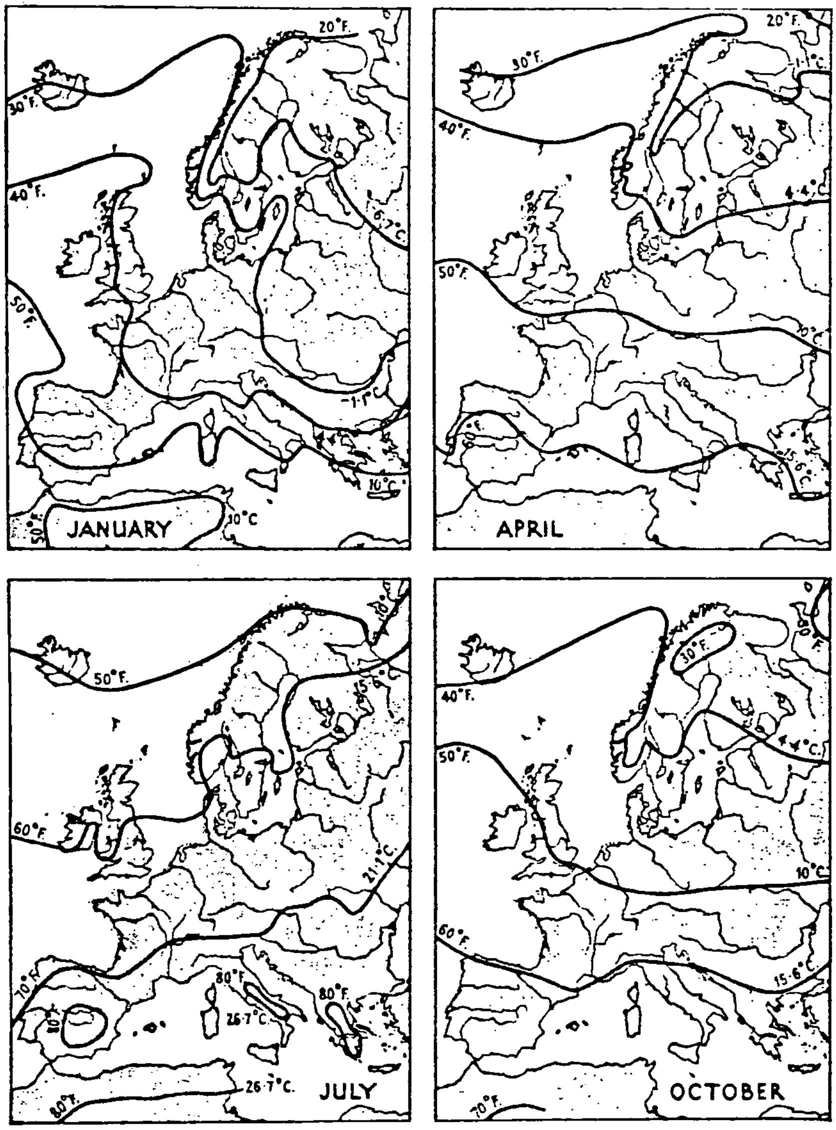
General winds over Europe and north Africa.

Fig. II.1-3. Western Europe: winds (b). (After Kendrew, 1953).

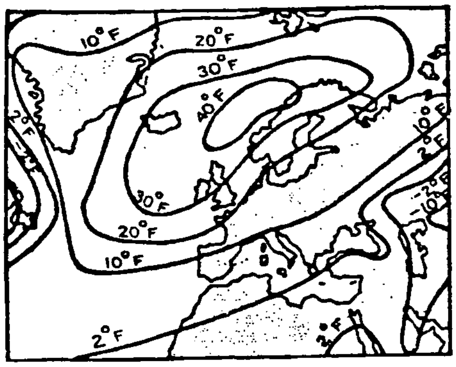
Fig. II.1-3. Western Europe: precipitation (a). (After Kendrew, 1953).

Temperature gradation (fig. II.1-4) in the inhabited areas occurs predominantly along latitude in Scandinavia and the north Atlantic islands, where the land runs from south to north, but also from the mountains toward the coast. In Iberia, although longitude (through proximity to the coast) and latitude still play a role, altitude is the main factor for most of the region. There is no longer one single thermic pattern valid year-round. The height of the plateau determines its continentality: the lowest temperatures are registered there (especially on its northern half) in the winter, and also some of the highest, during summer. Along the coast, temperature variation is small, and latitude and water content of the predominant masses are the determinant factors. The maximal summer temperatures are reached in the centre of the Ebro Depression (which almost reaches the extremes of the plateau), in the central and southern parts of the Meseta and in the Guadalquivir Depression (where the highest temperatures in Europa have been recorded).

When considering insolation (fig. II.1-5), Sweden occupies an intermediate position between the two other regions, with between 1600 and 2200 hours of sunshine a year (1400 to 2200, including Norway as well). The areas of maximum duration are in southeast Norway, along the coast of Norrland, southeast Sweden and the islands of Gotland and Öland. The areas of minimum duration include the rainy coastal areas of Tröndelag in Norway and the southwest slopes of the highlands of southern Sweden. In Britain and Ireland insolation ranges roughly between 1000 and 1800 hours of bright sunshine per year, but most of the area is under the 1600 border. It varies from a minimum in the mountainous areas of the north and northwest towards a maximum in the south and the southeast. In Iberia, excepting a northern Cantabric fringe which receives less than 2000 per year, most

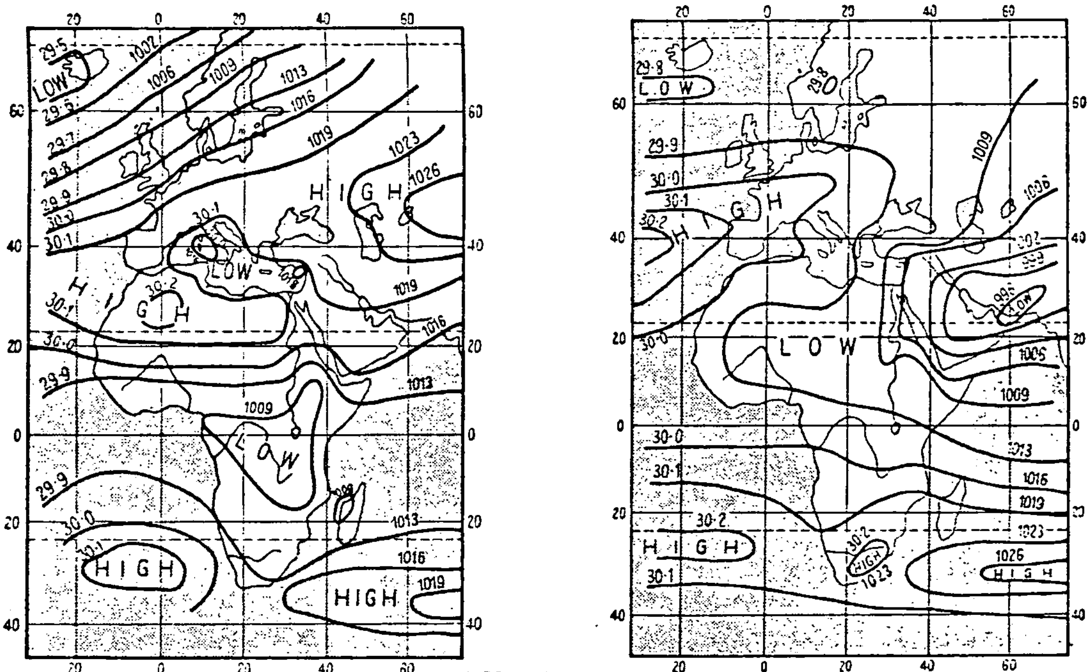


Mean isotherms.



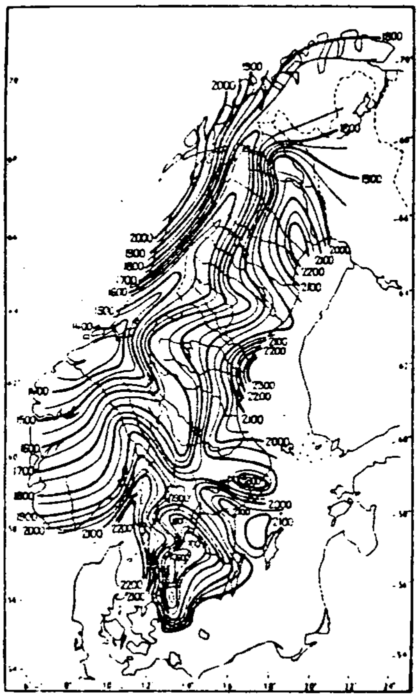
Mean anomaly of air temperature, January.

Fig. II.1-4. Western Europe: temperature (a). (After Kendrew, 1953).



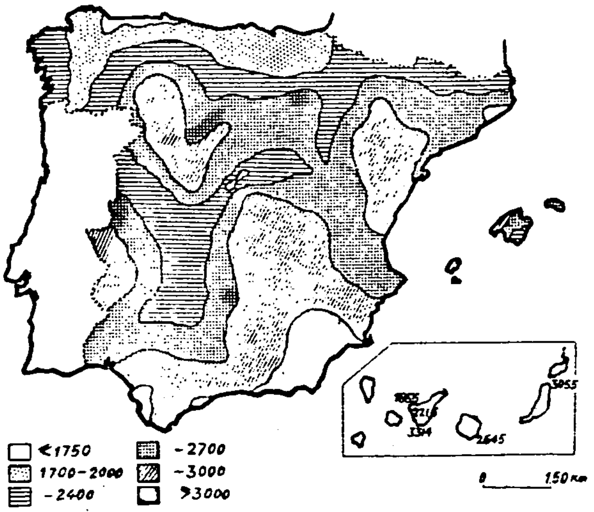
January. | Mean isobars. | July.

Fig. II.1-4. Western Europe: pressure (b). (After Kendrew, 1953).



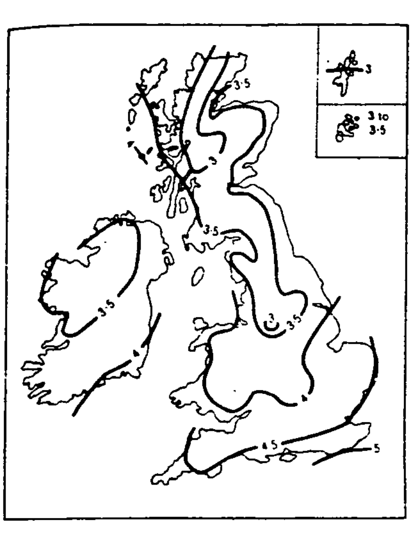
c.

(d) Annual number of hours of bright sunshine in Scandinavia. (After Ångström et al., 1974).



(d) Mean annual number of sunshine hours . (After Cabo & Vigil, 1979)

Fig. II.1-5. Western Europe: insolation. (After Kendrew, 1953).

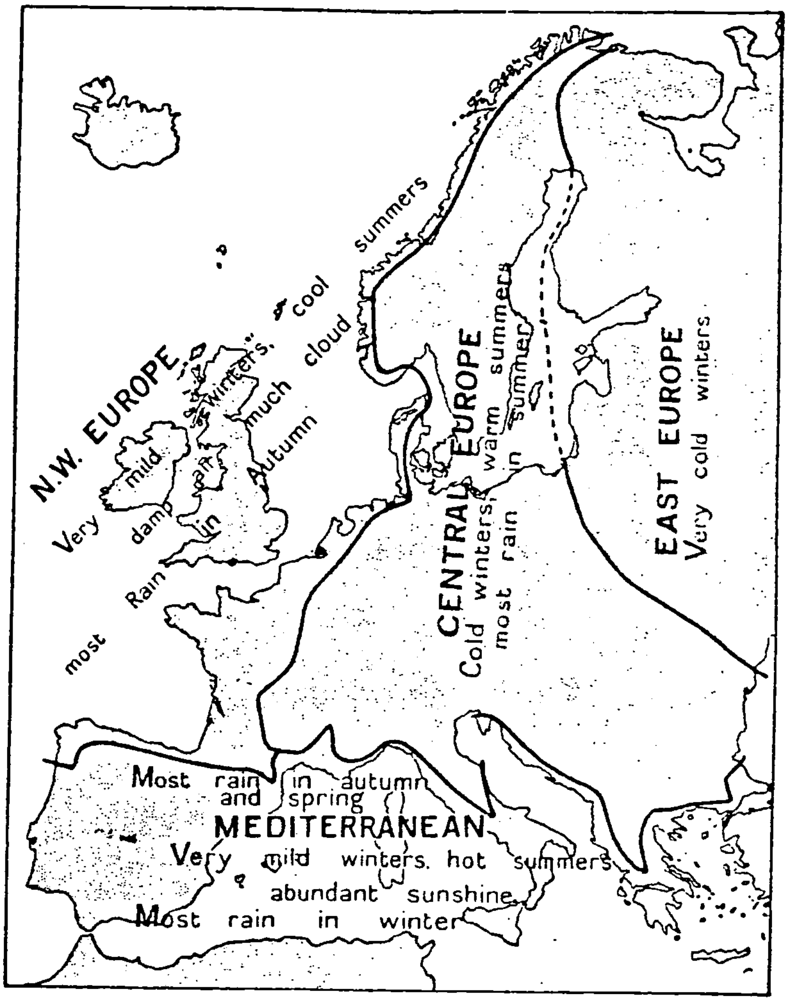


(b) Mean daily duration of bright sunshine in hours. (After Dury, 1978).

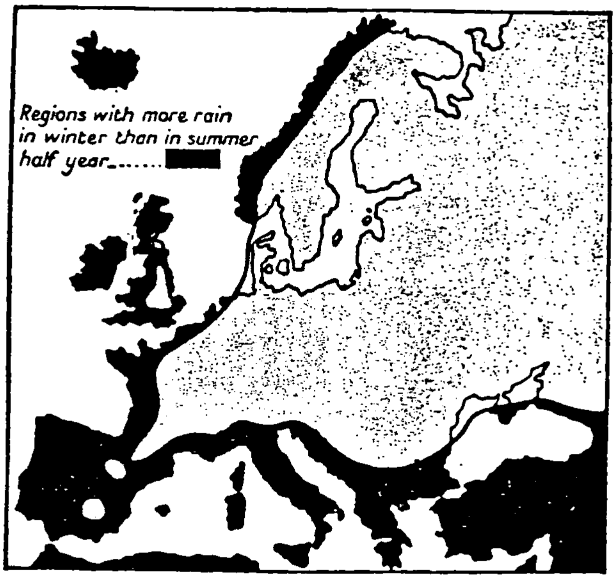
of the country enjoys more than 2000 hours of sunshine a year. The maximum (3000 and beyond) is reached in southeastern Spain and in some parts of western Andalucía, along the coast.

All aforementioned factors together determine the climate of the region under consideration (fig. II. 1-6). Thermically, the whole region can be subdivided into two types of climates: mesothermal in Iberia (yearly temperatures from 27°F to 50°F and beyond) with mild winters, and microthermal in the north with severe winters (yearly temperatures below 27°F to 50°F and beyond). Otherwise, in terms of rainfall and cloudiness, northern Spain and southern Scandinavia parallel the climatic gradation in the north Atlantic isles. A (wet: northwestern Spain, western Ireland and southern Norway -with maximum pluviosity and cloudiness) gradually merges into B (humid: the Atlanto-Cantabrian fringe south and east of the wet Iberian zone, eastern Ireland, the two western third parts of Britain and southern Sweden), which in turn transits into C (subhumid: the transitional Iberian zone, eastern Britain and the southermost tip of Sweden). All these zones enjoy all-season rain. Beyond them, the rest of Iberia belongs into the sub-humid and semi-arid categories, with rain deficiency in summer, while Scandinavia presents a tongue of tundra climate astride the mountains, gradually merging into taiga to the east and the west.

Precipitation falls almost entirely under the form of rain in Spain, and it is greatly restricted to the north and northwest and to the highest peaks everywhere. Outside that area it is predominantly of local thunderstorm character. In Britain snow becomes of certain importance, but it is in Scandinavian mountains and east of them where snow definitively mantles the role of rainfall.



Major climatic regions.



Regions with most precipitation in winter and in summer half-year.

Fig. II.1-6. Western Europe: major climatic regions. (After Kendrew, 1953).

Although only individuals which possess at least three autochthonous grandparents have as a rule been considered for analysis in the present work, this is by no means a guarantee for homogeneity - since the genetic impact of the foreign elements absorbed into the population during the past is far from being negligible. Its approximate evaluation - a task of nearly unsurmountable difficulty - is not, however, the concern of this research, for which reason only a generalized reference to the most important among those will be made here. Further information will be provided elsewhere whenever it is considered necessary.

Of the three areas, only one - Iberia - seems to have played the role of a craddle for a pre-Neolithic major section of its population. Without excluding foreign Mediterranean contributions, the modern inhabitants of Iberia appear to be the end product of a long line of local evolution, accelerated during the Mesolithic times, genetically leading the greater part of the population in a Mediterranean direction. It is still unclear to what extent environmental factors - at the expense of genetic factors - may be responsible for the appearance of internal variation within a population of predominantly unitarian origin. Yet, it is likely that the latter are the most important in accounting for the differences existing between northern Spaniards, especially Basques, and the rest of the Iberian populations. On the other hand, modern research on the subject (Ferembach, 1977) suggests that environmentally provoked (plastic) variability may be the major source of diversity between Spaniards of the Mediterranean litoral and hinterland Spaniards. Customarily, the Iberian anthropologists speak of a gracile or insular variety of Mediterranean and a robustus or Eurafrican - the first is common everywhere except in the north , while the second one is more abundant along the eastern seaboard. Leaving aside the incidence of environmental factors, the more rugged appearance of the robustus or Atlanto-Mediterranean subtype may owe much to the absorption of groups of Cromagnoid survivors, seemingly numerous in some of the Mediterranean provinces (1), by the evolving Mediterranean populations.(Fusté, 1957). The alleged intrussion of new groups with northeast African Neolithic traits into the province of Almería (Savory, 1968) - if demonstrable - would have only contributed to a further Mediterranization of Iberia.

Although Dinarico-Armenoid seaferers and Alpines have been invoked to account for the round-headedness of western Andalusians and southern Extremadurians, on the one hand, and Cantabrians on the other hand, there are no indications whatsoever of any intrussion of the adequate foreign elements in the required scale. Thus, so far they are rather to be looked upon as the result of brachycephalization in situ of the regional forms by the action of agents still unknown. On that direction points also the fact that the southwestern and middle Tagus foci of round-headedness appear already exemplified in some crania of debated Mesolithic age (Hoyos, 1947), and become more important during the Neolithic and the Bronze Age.

(1) Fusté (1957) has pointed out the survival into the Neo-Eneolithic of the east and the southeast of Upper Palaeolithic forms. They normally approach the French Crómagnon form, but even the Combe-Capelle form is represented.- this one very closely suggesting primitive Mediterranean forms.
Morant (1930/1) and Bonin (1935) have evidenced the small internal variability of a composite sample representing Upper Palaeolithic man, and this speaks against laterally deriving the Mediterranean populations from some Combe-Capelle like form. That may be so, but it may be wondered whether both author's conclusions might not have become significantly altered had the Combe-Capelle form been represented by a greater number of specimens, (some have been found later: Jelínek, 1969) - with the subsequent increase of the sample's coefficient of variation, owing to the marginal position of the form.

As a whole, with the exception of the Basques, modern Iberian populations seem to be remarkably free from the Upper Palaeolithic metric archaisms (1) which - according to some scholars (Fleure, 1923; Coon, 1939; Lundman, 1952) - may be commoner in northern Europe, perhaps owing to some adaptive character of those traits in a harsher climate (2). In contrast to Iberia, excepting the Palaeo-Mesolithic contribution, all other elements are in northern and northwestern Europe probably alien. Of the three main elements which have given the British Isles its modern character, the round-headed and strong-complexioned human type predominant among the bearers of metallurgical knowledge and Bell Beaker culture to the Islands - although culturally derived from Iberia - must have contained central European types (north German Corded and natives of Mesolithic and Danubian cultural extraction), while the Nordic element

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(1) Individuals essentially resembling the French Cromagnon type crop up sporadically among modern Basques (Fusté, 1957), and Cromagnoid traits appear occasionally among the inhabitants of the Central Sierra, according to Hoyos (1947; 1952).
The anthropology of the blood groups has not been stu studied in Iberia as thoroughly as in Britain or Scandinavia. Yet, it may be significant that, outside the Basque country, the provinces approaching Basque average r figures include all vast mountain ranges: one area extends from Soria southwards (Soria-Teruel ranges) and the other runs westwards (Central Sierra). It may be worthwhile investigating whether Cromagnoid traits and O-genotypes show any significant association.

(2) In southwest Ireland (Coon, 1939) and certain localities of Wales (Fleure, 1923), in the mountain district of southern Norway (Coon, 1939) and in certain villages of central and southern Scandinavia (Lundman, 1946 and 1967) - all rather isolated tracts - the presence of individuals metrically recapitulating Upper Palaeolithic man have been pointed out by the anthropologists. More recent serological surveys conducted within some of these districts have elicited unusually high r-figures (Casey et al., 1963; Sunderland et al., 1973; Garlick & Pantin, 1957; Casey et al., 1966; Beckman & Mårtensson, 1958).

was mainly brought by the Celtic and, especially, the German invasions. The Mediterranean component, the oldest of the three, was probably represented by the first agriculturalists - possibly of Danubian and Iberian extraction, but it is worthwhile investigating whether it may not have formerly found its way into the southern Pennines during the first half of the seventh century B.C. with the bearers of the "narrow-blade" microlithic industries of south French derivation.

By the end of the Glacial Period and until the beginning of the Boreal, western Europe emerges and evolves as the realm of three different cultural provinces, whose geographical distribution to a certain extent parallels modern racial distribution. The Ahrensburg-Maglemosean tradition along the north European plain, southern Escandinavia and southern Britain - which basically continues the Upper Palaeolithic way of life. Southwards, reaching the Mediterranean in certain areas, extends the territory of the Magdalenian-Azilian tradition, with its heart in south-central France and the Spanish Cantabrian region. South of it is the province of the Epigravettian tradition, in Mediterranean Iberia (progressively expanding into the hinterland), parts of southern France and Italy. Underlying similarities between the northern and the northwestern Europeans and among the southern European populations of our days in all probability owe much to the genetic structure of western Europe in those days. However, during the Boreal period the cultural unity of the Maglemosian province is broken in two occasions by microlithic influences arrived from the southern border of the Azilian district. The impact in Britain of the Sauvaterrian wave has already been mentioned; under the influence of the second (the Castelnovian) and without abandoning the Maglemosean tradition, the Kongemose-Ertebølle cultural complex emerges in southern Scandinavia (Kozlowski, 1976;

Mellars, 1976). In the south, Iberia perhaps converges culturally towards a Castelnovian facies, rather than being reached directly by it.

Concerning Scandinavia, its modern Nordic character seems to be mainly a Neolithic acquisition. In spite of recent Swedish objections against the foreign character of the Battle Axe or Scandinavian Corded Ware culture (Malmer, 1975), it is still widely accepted that its parental form appeared within the northeastern barbarian fringes of the ancient Mediterranean world (between the north Caspian and the north Pontic steppes) by acculturation from the advanced centres in Minor Asia and Iran - where many of its main cultural prototypes have been found (Gimbutas, 1963). Its bearers - of the rugged Mediterranean type, close to the Irano-Afghan primitive Mediterranean forms (Coon, 1939) - migrated into the Scandinavian Peninsula via Denmark or across the Baltic (around 2600 B.C.), and gradually superimposed themselves on the groups of agriculturalists (Funnel Necked Beaker or TRB culture) (1), sub-Neolithic fishers and hunters (Pitted Ware culture) (2) and hunter-gatherers of Palaeo-Mesolithic derivation. Mediterranean elements of the so-called Atlantic variety - also found in east Spain and in the "long barrows" of the British agriculturalists - have been unearthed from Megalithic interments in southern Scandinavia, and set in connection with the spread of Megalithism ultimately from France and Iberia. More likely, they may have represented the receptors of the new Megalithic influences, either a section or the mass of the TRB populations.

(1) Presumably related to the Danubian and Michelsberg cultures of central Europe - the first, at least, brought by people of eastern Mediterranean affiliation.

(2) Distributed along the coasts between the three Scandinavian countries and along the Finnish and east Baltic coasts, from where it is supposed to derive.

The skeletal similarities between Nordics and Mediterraneans (especially those belonging to the 'Atlantic' and the Middle East varieties) have been repeatedly pointed out in anthropology, and it seems a reasonable interpretation to conclude that those forms, by depigmentation in Scandinavia or prior to their arrival, and by interbreeding with the native populations gave origin to the classic type of Nordic, as known to the anthropologists.(1).

To Iberia the Nordic type was brought by the Urnfield and Celtic invasions between mainly the VIII and VI centuries B.C. and by the German invaders of chiefly the V century D.C. Its genetic influence, although considerable at first in local terms, became afterwards greatly diluted by internal displacements of populations and absorbed into the total gene pool.

In more recent periods, apart from Gypsies (2) and Jews (3), whose genetic impact has presumably been maximal in Iberia -among the three regions, there is the oriental (chiefly Muslim) influence in Iberia (4)

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(1) Upper Palaeolithic survivors are not unknown in other parts of Europe. They have been found by Jelínek (1969) in the Dnieper valley, as a whole group (Neolithic) and as single individuals within two populations of proto-Mediterranean character (Mesolithic). These two populations may candidate perfectly for the ancestorship of the Corded people.

(2) Who appeared in western Europe in the late fifteenth and early sixteenth centuries.

(3) Their presence in the countries along the Mediterranean shores antedates the Christian era, and becomes more intensive during its first years. Later on they started migrating towards the north, and by 321 A.D. there were Jewish colonies in the Rhine country.

(4) The presence of north African and Levantine colonists and traders in the Iberian coasts probably antedates the Bronze Age (Savory, 1968). In any case, it can be traced back to the period between the eigth and the end of the third centuries - when Phoenicians, Greeks and Carthagenians found their way into the country.

(roughly lasting 800 years) and - in Britain - the 200 years of Scandinavian invasions and the French Norman influence. No phenomenom of comparable importance has taken place in Sweden during historical times. Yet, Finns and Walloons (arrived during the first half of the seventeenth century) and Germans (important within Stockholm's upper class already since the Hanseatic period) have significantly contributed to the gene pool of certain districts and social sectors of the country (1). In more recent times, the coming of immigrants from eastern and central Europe and from Latin America (mostly as political refugees), but even from southern Europe and the Third World (of whom a certain proportion stays in the country), has also been felt in Sweden and Britain. In addition, some miscigenation with individuals from the former colonies - only in part of White extraction - has taken place in Spain and Britain.

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(1) However, the existence of a Finnish-like substrate in extensive parts of Sweden during prehistoric times has been repeatedly suggested on archaeological and serological grounds (Beckman, 1959).

II.2. The survey.

Most of the data on which this work is based were gathered during the 1976-7 Michaelmas and Epiphany terms and during the 1977-8 Michaelmas term, under which the author was engaged in practical fieldwork in Sweden. The British and Spanish samples were put together during the rest of the academic year 1977-8 in Durham and Madrid respectively. In addition to them, I received through the agency of my supervisor, Professor E. Sunderland, 491 cards with data on British and Danish subjects. Among these the British sample (York) was kindly put at my disposal by Mr. J. Edwards. Thus, the author's data were mainly gathered during late autumn and winter, with the exception of most of the Spanish and some of the British data, which were collected during early spring. No measurements were taken during summer. The York and the Århus samples were also put together during the non-bright part of the year.

With very few exceptions all Spaniards were sampled at the Universidad Complutense of Madrid and all British at the University of Durham, whilst among those tested in Sweden most come from schools - with a few groups contacted through either the Red Cross and the YWCA/YMCA in Malmö, or at two of Malmö's kindergartens and one of its hospitals (MAS). A few British and Spanish subjects were tested in Sweden, disconnected from any university, and all Swedes were tested in Skåne (southern Sweden) - mostly Malmö and Trelleborg. The Swedish schools visited in connection with this work, eight in Malmö and one in Trelleborg, corresponded academically to the British GCE, high school and extra-mural studies.

Apart from a few cases in each country - contacted as friends, relatives or colleagues - all contacts were held on strictly impersonal bases, and there were no reasons to suspect in the subjects any sort of intense emotional or cultural involvement with sunnier weathered countries, which could somehow have biased the sampling, with the exception of some adult students of Spanish, Portuguese, French or Italian. They were, however, too few to matter. With respect to the distribution of sexes, it may be suspected that, at least among Swedes, the more extroverted character of the females contributed to make them appear over-represented in the samples. Thus, while it seems reasonable to speak of random sampling of subjects, it cannot be held that the sampling was stratified. An a posteriori performance of stratified sampling was discarded as unrealistic, since it would have heavily reduced the size of the samples.

Although even foreigners were included in the survey in each country, their numbers were always small. For this reason they have not been considered in this work. No people of 'pure' Lapp or Gipsy ancestry (or any other kind of nomadic minority) were tested, although three or four Swedes declared to have (or suspected to have) some Lapp blood, and a pair of British revealed to have some Gipsy blood. Apart from these two ethnic groups and from the Jews, all of which have to a great extent succeeded in keeping a distinct identity, the genetic impact of all the elements absorbed during the past into the population of the three countries cannot be disdained. Investigating the concrete importance of each of those elements will not, however, be attempted here. Instead, the existing knowledge will eventually be used as a tool when interpreting the results. In each of the three countries included in this survey the different provinces were very unevenly represented (some were not represented at all). However, a different layout of the survey would have rendered it unpracticable, owing to the additional costs and expenditure of time introduced by the extensive travelling demanded.

In all 1960 individuals were tested in the three countries.1107 in Sweden, 580 in Britain and 273 in Spain. The numbers are only approximate since a few of the Spaniards and the British were surveyed in Sweden. Of these, 677 were 'pure' Swedes, 234 were 'pure' Spaniards and 79 were 'pure' British. Among the cases not collected by the author himself (457 British subjects and 34 Danish subjects) no degree of 'purity' could be established, since no information on the subjects' ancestry was available. For this reason, they have undergone a completely different treatment. Before the actual processing of the data, the Spanish, Swedish and British samples (especially York) suffered an additional reduction in size because of random eclusion of some of the cases, due to consanguinity. The principle for exclusion was always random, except when a whole family was included. Then, the parents were kept, since sample size diminished less that way. No consanguinity beyond second cousin level was detected. Tests for pigmentation and colour blindness were both performed among most of the subjects tested by the author, and saliva samples were collected from one half of the individuals in the Swedish sample and from most of those in the Spanish and British samples. The results of the saliva and colour blindness tests will be published separately in a near future. For this work only the associations between ABO blood groups and pigmentation will be utilized. In addition, a questionnaire was handed to each of the subjects involved in the tests. This was returned mostly complete in all cases with the exception of twenty seven Swedes (both sexes), who simply refused to fill it or returned it basically incomplete.

No one who has been engaged in fieldwork with humans as subjects will have failed to notice the incidence which psycho-cultural factors may have on the outcome of the work. Those influences appear under contrasting lights when, as in the present case, the same survey is conducted among people of such widely different psychological and cultural texture as the Spaniards, the British and the Swedes. Partly owing to the factors of that sort and partly due to the fact that the author was in Sweden a foreigner and unconnected to any local university, the yield there was - when considering the time and effort spent - much too low. Requests for permission to perform the test in official places were often met with either suspicion or indifference by the people in charge. In that way, three of the most promising possibilities --Malmö's Prison, LV4 (a recruit encampment near Malmö) and practically all kindergartens in Malmö-- failed to realize. All this, plus the circumstance that the survey was in its entirety conducted by the author alone, practically without any manual assistance, consequently limited the size of the samples obtained.

The data were processed by the author at the Computer Unit of the University of Durham, using one of the available standard programmes.

II.3. Techniques

Out of the three tests administered, only one of them - pigmentation - will be dealt with in this work. The two others will each be the subject of a detailed study in the near future. The results from the saliva test will, however, be used in the present work in an attempt to detect eventual correlations between different genetic traits. The collections of data was accomplished by the author of this work completely unaided, with one single exception: in Sankt Petri Skola two of the teachers - Dr. B. Petersson and Dr. B. Ahlström - took up spontaneously the task of blood testing some of the subjects, pupils attending their lectures in Biology, and even checking their colour vision on my behalf.

For purposes of exposition, the present section will be subdivided into four parts: 1) saliva, 2) pigmentation, 3) the questionnaire, and 4) variables and analysis.

1) Saliva

In order to study the secretor/non-secretor trait and the ABO blood group system, saliva samples were collected from individuals in Sweden, in England and in Spain. The tubes for collecting and storing saliva were provided in Spain and Britain by the Departments of Anthropology of Universidad Complutense de Madrid and University of Durham respectively. In Sweden they were most kindly supplied by Mr. J. Karner, in its majority, and by Mr. S. Lindberg.

The subjects were asked to spit into the tubes, without the aid of any kind of stimulant. After that, the spits were stored under deep freezing conditions for variable lengths of time (normally shorter than seven months) and then defrozen in the 'cold room' and centrifuged before the actual processing. A small group of the Swedish ones was, as an exception, kept under deep freezing conditions for a period exceeding one year and they failed to give clear results, for which reason they were eliminated. The specimens collected in Spain were first kept frozen variable lengths of time (half a week to three weeks), then thawn and centrifuged and the supernatant liquid frozen again, until the final thawing and centrifugation six months later.

2) Pigmentation

Some thirty years ago, Weiner (1951) described a portable reflectance spectrophotometer (of the 'abridged' type) and proposed its use on skin colour studies. Measurements taken with the portable spectrophotometer were found to be closely comparable to those obtained on the same living subjects by using the Hardy spectrophotometer. The apparatus recommended by Weiner was then produced by the firm EEL (Evans Electroselenium Limited) (1). Since it has been widely described in several articles, the same will not be done here. Instead, mention will be made of the fact that, since its introduction to the anthropological world, two main types of E.E.I. spectrophotometers have atleast been employed. One of them, theso called E.E.L. P.R.S. reflectophotometer, has apparently been used by Walsh only in his work on Asian and Pacific peoples (Walsh, 1963). Whether this device is really different from the other type is impossible to know froms Walsh's article, but the wavelength-filter set used (650 nm, filter glass Chance ORI) does not correspond to any of those employed by the other. The latter type is not actually a unitarian type, in spite of the generalized use of filters Ilford everywhere, since basically two dif-

(1) It is now exclusively manufactured and serviced by Diffusion Systems Ltd., 43 Rosebank Road, London W7 2EW.

ferent sets of these filters (with minor variants) have been used in the reflectance heads (Fernández, in publication). The two sets of wavelengths most commonly used are shown in table II.3-1. After the wavelength corresponding in each of them to the first filter, they will be designated here as the 425-type and the 426-type. The first seems to be, at least up to 1973, the only one exhibiting absolute constancy of filters. The apparatus most often used in this work consists of a EEL 99 Reflectance Spectrophotometer (the 'head', containing the filters and the photocell) and a EEL 200 Unigalvo (the 'readout' unit, containing the galvanometer and the power source). The wavelength set is identical to the one specified for the 425-type. Part of the data collected in Durham (the author's British sample) were taken with another spectrophotometer of the same type and with the same wavelength-filter combination. Before use, the second spectrophotometer was each time carefully calibrated on one set of arbitrarily selected surfaces, so that its readings would be nearly identical to those obtained with the first one. The spectrophotometers used in Århus and York were also EEL machines and belonged (as the two others) to the Anthropology Department of the University of Durham; but no information concerning the identity of the spectrophotometer utilized in Århus was available. The apparatus with which the York data seem to have been collected, although also a EEL, produced readings

Filters	601	602	603	604	605	606	607	608	609
Wavelengths	425	465	485	515	545	574	595	655	685
(in nm or mu)	426	470	490	520	550	580	600	660	685

Table II.3-1. EEL spectrophotometers: sets of filters most often used in human physical biology.

which - in spite of repeated attempts to calibration - were consistently higher than those obtained with the other two. The possible consequences of thse discrepancies will be dealt with in more detail in chapter IX.

Most often the skin colour of the subjects was measured in groups of five or six individuals at a time, in which case the experimenter would read the figures aloud while those tested wrote them down. While doing so, the author normally succeeded in checking that the transcription of the readings was the correct one. Even so, five utterly 'impossible' figures were later detected and eliminated from the record while 1) coding the data, and 2) checking the data. For each individual, nine measurements were taken on the middle aspect of the upper inner arm (abbreviated 'uia') and nine on the middle part of the forehead (abbreviated 'fh'). One reading for filter for place. The 'white' standard reference for calibration to zero and to a hundred was a block of magnesium carbonate, $Mg\ CO_3$, whose surface was carefully scraped off with certain regularity in order to keep it clean for calibration purpose. At the beginning of each session, after initial calibration of the 'readout' unit, the apparatus was left alone during fifteen to twenty minutes -for stabilization of the readings- and then calibrated again if necessary. For greater safety the calibration was checked every forty five minutes or so, and corrected when required.

In a couple of occasions it was found necessary to dismount the valve in the 'head' for either controlling or changing it. Adjusting again the distances from the valve to the aperture hole was done following scrupulously the instructions contained in the booklet (1) which Diffusion Systems Ltd. furnishes with the apparatus. The same adjustment was

(next page)

also done, as a preliminary precaution, before actually starting the collection of data. In addition, the spectrophotometer was in each occasion cross-checked against the means of readings formerly obtained on arbitrarily selected comparison surfaces for filters nos. 1, 5 and 9.

In a few cases, some women were only measured on the arm or the forehead, because of reasons which lay outside the control of the experimenter: two of them, feeling suspicious about the spectrophotometer, would refuse to "sacrify" anything else than their arms, while in some others clothing would prevent access to the proper part of the arm, or press it too hard -provoking the accumulation of blood. Similarly, some individuals simply disappeared without allowing for the completion of the whole series of measurements.

3) The questionnaire

The questionnaire (table II.3-2) attempts to obtain information about those behavioural patterns which form part of the environmental dimension of pigmentation, as well as about the cultural and economical factors which - because of its association with them - may be instrumental in its expression. It also pretends to locate each individual in its original geographical and ethnical background - relevant because of its genetical and environmental connotations. Most questions need no explanation, and all will, in any case, be examined in more detail at the right moment. Something may, however, be antcipated about them.

Questions number 1 and 2, left blank, correspond respectively to identification number and to the name and surname of the subject. This last piece of

(1) "Reflectance Spectrophotometer, Model 99".

1.	SELF		16. Occupation (self)			31. (self)	RELIGION AT BIRTH	
2.			17. Occupation (father)			32. (ther)		
3. Sex / Age			18. Occupation (mother)			33. (mother)		
4. Birthplace Parish	FATHER		19. Birthplace Parish	FATHER'S FATHER		34. Birthplace Parish	MOTHER'S FATHER	
5. County			20. County			35. County		
6. Shire/ State			21. Shire/ State			36. Shire/ State		
7. Land			22. Land			37. Land		
8. Ethnic group			23. Ethnic group			38. Ethnic group		
9. Nationality			24. Nationality			39. Nationality		
10. Birthplace Parish	MOTHER		25. Birthplace Parish	FATHER'S MOTHER		40. Birthplace Parish	MOTHER'S MOTHER	
11. County			26. County			41. County		
12. Shire/ State			27. Shire/ State			42. Shire/ State		
13. Land			28. Land			43. Land		
14. Ethnic group			29. Ethnic group			44. Ethnic group		
15. Nationality			30. Nationality			45. Nationality		

(self)	
46. Birthplace Parish	
47. County	
48. Shire/ State	
49. Land	
50. Ethnic group	
51. Nationality (present)	
52. ABO Blood groups	
53. Stature	
54. Eye colour	
55. Hair colour	
56.	
57. Locality of the survey	
58. Site (school, etc)	

61. Remarks	62. Arm Forehead

64. Do you generally wear some kind of a fringe or hat?	
65. Date of the last sun bath (other than = - approximately.	
Did it affect your .... upper inner arm ?	
forehead?	
66. Have you recently had any unusually intensive exposure to sunlight? when?	
where?	

67. Blood relatives (if any) at	Site	Locality	Surname	Name

		in the summer	with lamp
59. Do you often take a sunbath affecting your	upper inner arm?		
	forehead?		
60. Do you often use some sun cream ... (then)?			
Do you have any other cream or make-up ... (now)?			
on the		upper inner arm	forehead

63. What eye colour, hair colour and skin colour do you prefer in the other sex?

	dark	medium (sunburnt)	fair
eye colour			
hair colour			
skin colour			

Table II.3-2. Questionnaire and test sheet.

information was, however, optional, and it was only attempted to collect when the subject confessed to having a relative in either the place of the survey or at any other of the projected places. In connection with question no. 2 is number 67. In question no. 3, age was registered in full years. Question number 56 was reserved for the result of the colour blind test and need not concern us here, while 61 was reserved for marginal observations, like those concerning the texture of the skin of the subject (freckles, pimples, etc.)

Questions number 8, 14, 23, 29, 38, 44 and 50 (ethnic group), together with "land" and "nationality" (five times each), provided some insight into the origins of the subject, and they were especially intended for those living in countries lodging two or more different groups of people. The concept of ethnic group was not, however, easily understood. This difficulty was overcome by listing verbally the ethnic groups expectable in each situation (for instance, Scott, Welsh, Basque, Swede, Lapp, etc.), so that everybody could recognize his own case. Often the author was able to check directly with each subject or group of subjects the exactness of their answers. The probability of failures of this kind significantly affecting the outcome of the experiment is, then, practically nil, particularly since no country with a real complex ethnic structure is - as such - represented in the samples.

Questions 59, 60, 64 to 66 convey information on the behavioural aspects of pigmentation, a subject which -presumably because of its intricacy and difficult quantification- has commonly been disregarded in surveys of this sort. An enquiry was made into the subject's sunbathing habits (including the use of UV lamps), dates and degree of exposure to radiation.

Question 63 deals with the specific matter of mating preferences, according to pigmentation, of relevance in virtue of its potential incidence on selection. This question especially was often met with apprehension, even hostility, and some people blankly refused to answer it, eventually even the whole questionnaire, as a consequence.

Religion is often a useful instrument to track down the ethnic origin of people. It might, consequently, show association with pigmentation. Questions 31 to 33 have been included because of that reason. Questions 16 to 18 inform on socioeconomic status. This, like religion, may show associations with pigmentation (of the same sort as those expected from ethnic group), or may rather be instrumental in determining pigmentation. All this information about religious creed and socioeconomic status would prove to be of merely descriptive interest.

The subject of the test was expected to answer questions 52 and 53 whenever he knew the answers. Information concerning ABO blood group system was intended to be contrasted against the author's own results from saliva, in order to gain an orientative insight into the reliability of the method. Regarding questions number 54 and 55, special emphasis was put by the experimenter on either himself dictating the answers or controlling its accuracy, and the goal was normally achieved. Cases not fulfilling that requirement were listed out from the calculations. Eye colour and hair colour were determined by the naked eye. However, since the emphasis here will be placed on broad categories rather than nuances, the effect of possible inaccuracies introduced by the aforesaid procedure is expected to be negligible.

Question 62 has been reserved for the results of the reflectance test.

4) Variables and analysis.

The calculations were performed at the Computer

Unit of the University of Durham. One of the existing standard programs, SPSS (Statistical Package for the Social Sciences) - within the frame of the MTS operating system - was used.

The information contained in the questionnaire sheets was transferred to punched cards and then fed into the computer. Before the actual processing of the data, several checks were done in order to control their accurate transcription: one for each step (coding, transcription to cards) and an additional one to detect 'aberrant' values. The two first controls (some sections of the data were checked more than twice) were made by the naked eye. The last one by means of a standard program for validation of data, called Datavet. Last among all pre-processing steps was to impose on the data a subfile structure with six main subfiles - Swe, Aswe, Spa, Aspa, Gb and Agb - and a number of less important subfiles, among which York and Århus are included. Swe, Spa and Gb include people with all their four grandparents from Sweden, Spain and Britain respectively. In the last case even those with Irish grandparents were included, since this sample was already too small. 'A' stands for additional in 'Aswe', 'Aspa' and 'Agb', since all those subjects with one to three autochthonous grandparents have been included here.

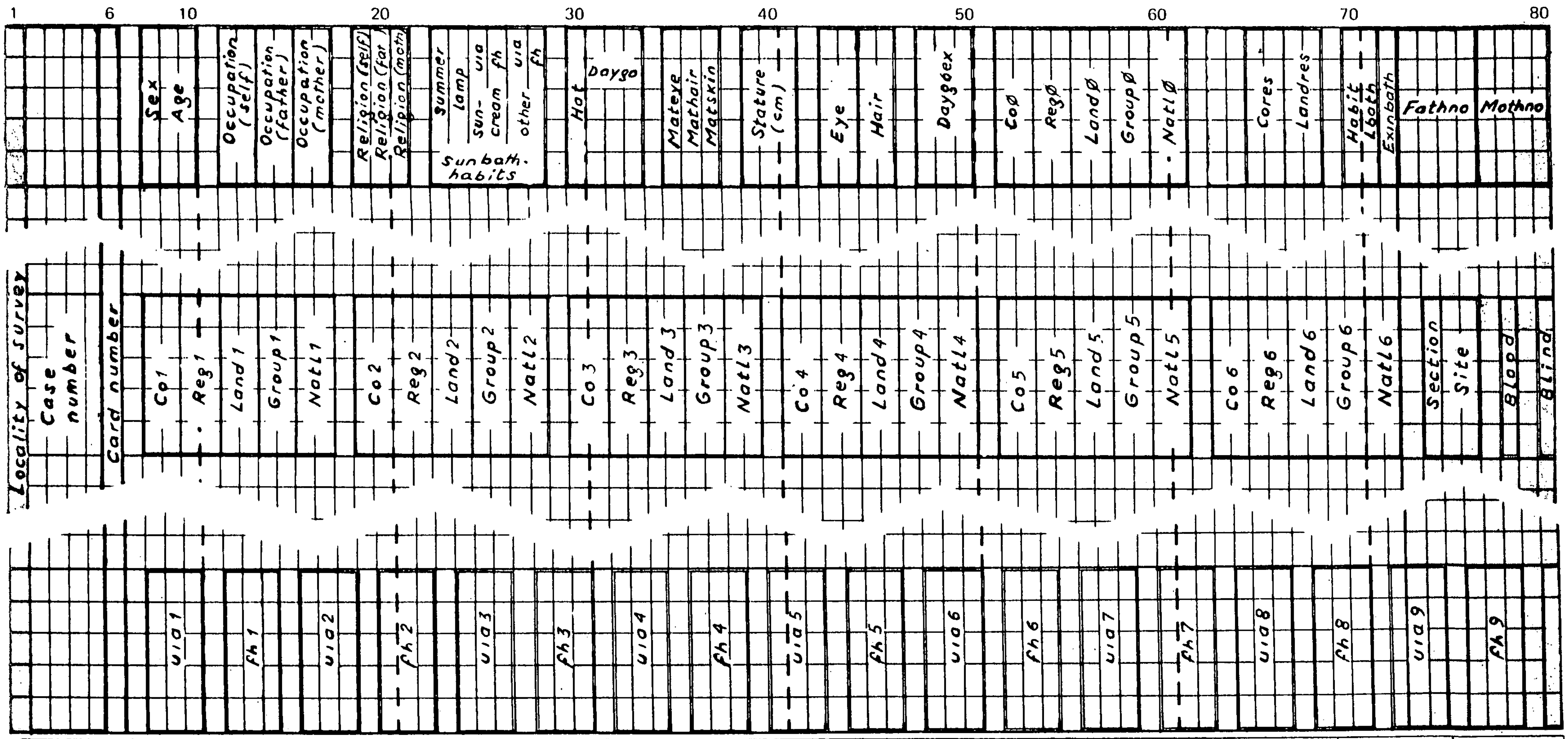
A copy of the model sheet, on which the codified information was transcribed, is shown in table II.3-3 --where also all primary variables are introduced. In table II.3-4 appear the variables listed in the same order they were coded. Its fourth column, under the label "columns", refers to table II.3-3 for a closer look into the nature and origin of the variables. In total, a hundred different primary variables were defined this way. A number of variable types appear repeatedly, once for the subject himself and once for each of the two or six immediate ancestors. They have been numbered from zero to six.

COLS.	PL/I	COLS.	FORTRAN	COLS.	JOB CONTROL	COLS.	DATA
2-72	Statement	1-5	Statement No.	1-71	Statement	1-80	Or according to FORMAT
73-80	Optional Sequence	6	Statement Continuation	73-80	Optional Sequence		statement in program
		7-72	Statement				
		73 80	Optional Sequence				

PROGRAM
PROGRAMMER

Table II.3-3. The variables and the coding sheet

PAGE OF
DATE



WRITTEN	0	O	I	1						
PUNCH	zero	letter O	letter	number 1						

```
ACCORDING TO YOUR INPUT FORMAT, VARIABLES ARE TO BE READ AS FOLLOWS

VARIABLE  FORMAT  RECORD    COLUMNS

LOC       F 1. 0        1     1-   1
ID        F 4. 0        1     2-   5
CDNO      F 1. 0        1     6-   6
SEX       F 1. 0        1     8-   8
AGE       F 3. 1        1     9-  11
IOWORK0   F 1. 0        1    12-  12
SOCEC0    F 1. 0        1    13-  13
IOWORK1   F 1. 0        1    14-  14
SOCEC1    F 1. 0        1    15-  15
IOWORK2   F 1. 0        1    16-  16
SOCEC2    F 1. 0        1    17-  17
CREDO0    F 1. 0        1    19-  19
CREDO1    F 1. 0        1    20-  20
CREDO2    F 1. 0        1    21-  21
SEOFTEN   F 1. 0        1    23-  23
SLOFTEN   F 1. 0        1    24-  24
CRUIA     F 1. 0        1    25-  25
CRFH      F 1. 0        1    26-  26
CRUIANOW  F 1. 0        1    27-  27
CRFHNOW   F 1. 0        1    28-  28
MAT       F 1. 0        1    30-  30
DAYGO     F 3. 0        1    31-  33
MATEYE    F 1. 0        1    35-  35
MATHAIR   F 1. 0        1    36-  36
MATSKIN   F 1. 0        1    37-  37
TALL      F 3. 2        1    39-  41
EYE       F 2. 0        1    43-  44
HAIR      F 2. 0        1    45-  46
DAYGOEX   F 3. 0        1    48-  50
CO0       F 2. 0        1    52-  53
REG0      F 2. 0        1    54-  55
LAND0     F 2. 0        1    56-  57
GROUP0    F 2. 0        1    58-  59
NATL0     F 2. 0        1    60-  61
CORES     F 2. 0        1    65-  66
LANDRES   F 2. 0        1    67-  68
HABIT     F 1. 0        1    70-  70
LEATH     F 1. 0        1    71-  71
EXINBATH  F 1. 0        1    72-  72
FATHNO    F 4. 0        1    73-  76
MOTHNO    F 4. 0        1    77-  80
LOC1      F 1. 0        2     1-   1
ID1       F 4. 0        2     2-   5
CDNO1     F 1. 0        2     6-   6
CO1       F 2. 0        2     8-   9
REG1      F 2. 0        2    10-  11
LAND1     F 2. 0        2    12-  13
GROUP1    F 2. 0        2    14-  15
NATL1     F 2. 0        2    16-  17
CO2       F 2. 0        2    19-  20
REG2      F 2. 0        2    21-  22
LAND2     F 2. 0        2    23-  24
GROUP2    F 2. 0        2    25-  26
NATL2     F 2. 0        2    27-  28
CO3       F 2. 0        2    30-  31
REG3      F 2. 0        2    32-  33
LAND3     F 2. 0        2    34-  35
GROUP3    F 2. 0        2    36-  37
NATL3     F 2. 0        2    38-  39
CO4       F 2. 0        2    41-  42
REG4      F 2. 0        2    43-  44
LAND4     F 2. 0        2    45-  46
GROUP4    F 2. 0        2    47-  48
NATL4     F 2. 0        2    49-  50
CO5       F 2. 0        2    52-  53
REG5      F 2. 0        2    54-  55
LAND5     F 2. 0        2    56-  57
GROUP5    F 2. 0        2    58-  59
NATL5     F 2. 0        2    60-  61
CO6       F 2. 0        2    63-  64
REG6      F 2. 0        2    65-  66
LAND6     F 2. 0        2    67-  68
GROUP6    F 2. 0        2    69-  70
NATL6     F 2. 0        2    71-  72
SECT      F 1. 0        2    74-  74
SITE      F 2. 0        2    75-  76
BLOOD     F 1. 0        2    78-  78
BLIND     F 1. 0        2    80-  80
LOC2      F 1. 0        3     1-   1
ID2       F 4. 0        3     2-   5
CDNO2     F 1. 0        3     6-   6
UIA1      F 3. 1        3     8-  10
FH1       F 3. 1        3    12-  14
UIA2      F 3. 1        3    16-  18
FH2       F 3. 1        3    20-  22
UIA3      F 3. 1        3    24-  26
FH3       F 3. 1        3    28-  30
UIA4      F 3. 1        3    32-  34
FH4       F 3. 1        3    36-  38
UIA5      F 3. 1        3    40-  42
FH5       F 3. 1        3    44-  46
UIA6      F 3. 1        3    48-  50
FH6       F 3. 1        3    52-  54
UIA7      F 3. 1        3    56-  58
FH7       F 3. 1        3    60-  62
UIA8      F 3. 1        3    64-  66
FH8       F 3. 1        3    68-  70
UIA9      F 3. 1        3    72-  74
FH9       F 3. 1        3    76-  78
ACCY      F 1. 0        3    80-  80

THE INPUT FORMAT PROVIDES FOR 100 VARIABLES.  100 WILL BE READ
IT PROVIDES FOR  3 RECORDS ('CARDS') PER CASE.  A MAXIMUM OF   80 'COLUMNS' ARE USED ON A RECORD.
```

Table II.3-4. List of primary variables in the order they were presented to the computer.

Such is the case of the variables iowork0 to iowork2 (indoors/outdoors work) and socec0 to socec2 (socio-economic status). The information stored in these two groups of variables has been extracted from the answers to questions 16 to 18.

The information obtained through question number 64 gave origin to variable hat, with two values: 0 for "no" and 1 for "yes". Although this was usual coding strategy, it was later found practical to create a new variable, newhat, with the complementary values so that, also in line with the regular practice throughout this work, 0 would stand for 'no tanning behaviour'(hat=1) and 1 would stand for 'tanning behaviour'(hat=0). Questions 59 and 60 became variables sboften to crfhnow, while variables daygo and daygoex, together with habit, lbath and exinbath, have their origin in the structure of questions 59, 65 and 66. Variable habit refers to what area or areas of the skin (uia, fh or both) the subject of the experiment used to expose to summer radiation. Whenever the answer to question 59 was not sufficiently informative on that respect, it was supposed that the subject's habitual sunbathing behaviour included exposure of both forehead and inner arm, if he/she was under 50/55, otherwise only the forehead ( ). This means that the maximum number of assumptions made while coding this variable is equal to 1. In a similar way, lbath refers to the areas exposed during the last sunbathe. Here, two assumptions were found necessary: 1) either the forehead or the forehead and the inner arm were exposed, but never the inner arm alone, 2) whenever variable lbath had unknown value (missing information)

This age border should be accurate enough, at least for Sweden. It is perhaps somewhat high for Britain and for certain sectors of the Spanish population, but both samples are almost devoid of old individuals.

it was assumed that only the forehead was exposed, if the climatic circumstances of the place for exposure were not summer-like or variable age was 50/55 or beyond, or that forehead and inner arm were exposed versus only forehead when the circumstances were summer-like and the age as above. Here the maximum number of assumptions made at any one time was also 1. Exinbath aims at the possible existence of a prolonged, extra intensive, late exposure to radiation (scouting, military service, etc.), independent or not of the last sunbathe. 'Late' was explained as no longer than four months. No more than 6 individuals, all of them Spaniards, were in that situation.

When considering the meaning of question 65, especial emphasis must be put on the possibility of the coexistence of two different 'last' sunbathes, both of them important, depending on the area of the body under consideration: one during summer and the other off-season, the second one often affecting the forehead only. In that way, variable daygo was taken to represent the period elapsed since the last summer exposure, while variable daygoex corresponds to the time elapsed since the last off-season sunbathe. When the information about the date of the last exposure was missing, it was assumed to correspond to the last summer exposure. This, in turn, had at times (1) to be guessed, when the subject was a frequent exposer, otherwise -with missing information- it was considered unknown. The maximum amount of assumptions

---

(1) When the information was totally missing, dates of 20th August, for adults, and 10th September, for children. Often, no exact date was given, instead it was rather vaguely referred to some wider period. In those cases the following average dates were assumed: June/July - 25th, August - 20th, September - 10th, end of ... (any month) - 25th, end of summer-time - 20th September (Britain, Sweden) or 10th October (Spain).

made here was 1 for daygo, and 2 for daygoex - since this variable drags with itself all of daygo's assumptions. In line with all this, two new variables resulted, daysuia and daysfh, corresponding to the time elapsed (in days) since the last intake of UV radiation on the upper inner arm and the forehead respectively. The conversion strategy is as follows:

```
IF      (DAYGOEX EQ 0 AND LBATH EQ 9) LBATH=0
IF      (DAYGOEX EQ 0) DAYSFH=DAYGO
IF      (DAYGOEX NE 0) DAYSFH=DAYGOEX
IF      (DAYGOEX EQ 0 AND LBATH EQ 0) DAYSUIA=DAYGO
IF      (DAYGOEX EQ 0 AND LBATH EQ 2) DAYSUIA=999
IF      (DAYGOEX NE 0 AND LBATH EQ 0) DAYSUIA=DAYGOEX
IF      (DAYGOEX NE 0 AND LBATH EQ 2) DAYSUIA=DAYGO
IF      (DAYGOEX NE 0 AND LBATH EQ 9) DAYSUIA=999
```

The maximum amounts of assumptions made correspond to those for daygo, daygoex and lbath in logical combination, which makes a total of 2 for daysfh and 3 for daysuia.

The need for quantifying in some way the radiation intakes led to the creation of three more variables: uvoften, habitu and habitf. Uvoften was conceived as a three-level variable (values 0,1,2) by composition of sboften and sloften into one. It merely categorises frequency of exposure without referring it to any particular bodily region. The maximum amount of assumptions made at this variable with any case is 1.

```
IF      (SBOFTEN EQ 1 AND SLOFTEN EQ 1) UVOFTEN=2
IF      (SBOFTEN EQ 1 AND SLOFTEN EQ 0) UVOFTEN=1
IF      (SBOFTEN EQ 0 AND SLOFTEN EQ 1) UVOFTEN=1
IF      (SBOFTEN EQ 0 AND SLOFTEN EQ 0) UVOFTEN=0
IF      ((SBOFTEN EQ 0 AND SLOFTEN EQ 9) OR
        (SLOFTEN EQ 0 AND SBOFTEN EQ 9)) UVOFTEN=0
IF      ((SBOFTEN EQ 1 AND SLOFTEN EQ 9) OR
        (SLOFTEN EQ 1 AND SBOFTEN EQ 9)) UVOFTEN=1
IF      (SBOFTEN EQ 9 AND SLOFTEN EQ 9) UVOFTEN=9
```

By bringing variable habit into the picture, habitu and habitf were produced, also with three categories. These represent levels of exposure at the inner arm and the forehead respectively. The transformations are the following:

```
85  IF      (HABIT EQ 0 OR HABIT EQ 1) HABITU=UVOFTEN
86  IF      (HABIT EQ 2) HABITU=0
87  IF      (HABIT EQ 9) HABITU=9
88  IF      (HABIT EQ 0 OR HABIT EQ 2) HABITF=UVOFTEN
89  IF      (HABIT EQ 1) HABITF=0
90  IF      (HABIT EQ 9) HABITF=UVOFTEN
```

Here variables habit and uvoften determine the maximum number of assumptions made for habitu and habitf as additive conditions of 0 and 1 with 0 and 1, making a maximum of 2 for either variable.

A final set of secondary variables, intended for fitting regression curves to complex associations between variables, was designed by making up a number of mathematical functions of daysuia, daysfh and age: powers, inverse and logarithmic functions.

```
187 COMPUTE          DU1=DAYSUIA
188 COMPUTE          DU2=DAYSUIA**2
189 COMPUTE          DU3=DU1*DU2
190 COMPUTE          DU4=DU2**2
191 COMPUTE          DU5=DU2*DU3
192 COMPUTE          DF1=DAYSFH
193 COMPUTE          DF2=DAYSFH**2
194 COMPUTE          DF3=DF1*DF2
195 COMPUTE          DF4=DF2**2
196 COMPUTE          DF5=DF2*DF3
197 COMPUTE          A1=AGE
198 COMPUTE          A2=AGE**2
199 COMPUTE          A3=AGE*A2
200 COMPUTE          DUIN=1/DAYSUIA
201 COMPUTE          DFIN=1/DAYSFH
202 COMPUTE          DULG=LG10(DAYSUIA)
203 COMPUTE          DFLG=LG10(DAYSFH)
```

During the course of survey it would eventually come out that some of the subjects had lived long periods of their lives in other countries, under climatic conditions which could significantly differ from those at their present sojourn - for instance, British people grown up in Eastern Africa. That information was registered in the questionnaire (question no. 61), and stored in two more variables -- cores and landres (county and land of past residence). However, since only extremely few cases were detected, no especial use was made of it.

For variables eye and hair - colour of eyes and hair (corresponding to questions 54 and 55) - two different categorization criteria have been applied.

For finer analysis purposes several of the categories in the first system have merged together, producing a second one with basically four subdivisions: light (including albino), medium, dark and very dark. In a similar fashion, the information about mating preferences (question no. 63) stored in variables mateye, mathair and matskin was referred to three differently pigmented phenotypes: light, medium and dark. The nature of the categories will be examined in more detail in another section.

The last variable, accy (accuracy), has to do with the total maximum of unrelated assumptions per case made while coding variables habit,lbath, daygo and daygoex. That number is 4, which corresponds to a figure of 5 for the set habitu, habitf, daysuia and daysfh --as compared to their theoretical figures of 5 and 9.

A complete selection of cases from the Swedish, Spanish and British samples --with listwise deletion of missing values and at least three autochthonous grandparents as admission requirement-- produced the following distribution of cases (table II.3-5), where none of the first four aforementioned (habit, lbath, daygo, daygoex) had an unknown value:

		No. of assumptions			
Subfiles	N	0	1	2	3
Swe+Aswe	561	490	19	29	23
Spa+Aspa	158	140	5	9	4
Gb+Agb	78	70	3	2	3

Table II.3-5. Distribution of cases according to number of assumptions for variables habit, lbath, daygo and daygoex.

144 cases among the Swedes, 49 among the Spaniards and 9 among the British were missing cases, because of one or more variables with unknown values per case. No cases with four assumptions appear in the distribution since that situation, meaning no answers to questions 59 and 65, undermines the whole basis for guessing and the case automatically becomes a missing one.

Variables blood and blind store information about the results of the saliva (blood group) and colour blindness tests, the second of which will not at all be dealt with in this work.

Variables co to natl, numbered from 0 to 6, inform about the geographical and ethnical roots of the individual and of their immediate ancestors. Based on those variables are gplandsk, reino and ethnos --secondarily designed in order to study the geographical diversity of pigmentation among the Swedes, the Spaniards and the British respectively. They identify the region or ethnic group into which at least three of the grandparents belonged. In the case of the Spaniards and the British, with smaller sample sizes, information about the geographical or ethnical affiliations of the grandparents can be replaced by that concerning both parents. A closer look at the nature of the regional partitioning will be postponed until later.

Finally, variables fathno and mothno have their origin in the answer to question 67, which --after codification-- was transformed into an eight-digit number, that --depending on the nature and position of 2 or 3 blocks of ciphers within it-- informs about the identities of any possible relatives and the degree of consanguinity. Eight-zeroed values --meaning no detected blood relatives left in the sample-- qualify a case for admission into the subfile, while all other relatives eliminated at random would be referred to the selected identification number of the selected case (id).

For the sake of simplicity, variables symmetrically represented at both sites, the inner arm and the forehead, will often be referred to in common as habit-, cr- or cr-now.

Merely for purposes of simplification, all these variables can be classified into the following groups:

1. Identification variables: id (case no.), cdno (card no.), sex, age (=A1), A2, A3.
2. Access (fathno, mothno) and accuracy (accy) variables.
3. Location variables: loc (locality), sect (i.e. school section), site (i.e. school).
4. Socioeconomic variables: iowork0 to iowork2, socec0 to socec2, credo.
5. Behavioural (radiation intake) variables:
   - a. Exposure variables: habit, lbath, exinbath; sboften, sloften, uvoften, habitu, habitf; cruia, crfh, cruianow, crfhnow, hat; du1 to
   - b. Time variables: daygo, daygoex, daysuia, daysfh; du1 to du5, df1 to df5; duin, dfin; dulg, dflg.
6. Mating preference variables: mateye, mathair, matskin.
7. Geographical variables: co0 to co6, reg0 to reg6, land0 to land6, group0 to group6, natl0 to natl6; cores, landres; gplandsk, reino, ethnos.
8. Genetic variables: uia1 to uia9, fh1 to fh9; eye, hair, tall, blood, blind.

Summary

A survey combining tests of pigmentation and saliva was planned and carried out in three countries: Sweden, Spain and Britain. The methodology, the questionnaire and the nature of the variables have been introduced, and reference has been made to the possible complications arising from the use of three -perhaps four-different spectrophotometers. Most data in this research are, however, the outcome of one single spectrophotometer. Several assumptions were found necessary for some variables in order to prevent them from heavily reducing the size of the samples, and the logics of the process was exposed in some detail.

A classification of the variables for practical purposes was proposed.

CHAPTER III

III.1. Preliminary results.

Tables B.1 and B.2 show some elementary statistics for the Swedish, Spanish and British samples. Means and standard deviations will often enough play an important role in statistical analyses in this research, consequently no comment will be made about them at this stage. Instead, the fulfilment of the homogeneity criterion by the variances will be dealt with when the occasion comes. The normality criterion, however, is directly linked to the figures for skewness and kurtosis and their general suitability will be succinctly reviewed in this section.

It is one of the requirements to satisfy when using parametric statistics that the distribution of scores in the population be normal or that, otherwise, sample sizes be big. Any of these two conditions automatically guarantees the normality of the sampling distribution of means. Thus, when considering fulfilment of the normality criterion, it is licit to disregard the character of the population if sample sizes are big. The character of the distribution of scores is, however, of crucial importance when sample sizes are small. Unfortunately, the character of the population is rarely known, and -since it has to be studied through the samples and small ones constitute a poor representation of the parental population- the statistician finds himself deprived of his only means of exploring the structure of the population, precisely when he needs it most. Still, at times there are compelling reasons for suspecting normal distribution of the scores; while on other occasions no very good reasons can be advanced for the population not to be normal, and so it is assumed that to be the case (Hays, 1981), even without enough evidence to support the assumption. In the present research it will be shown that the first alternative fully applies to the minor subdivisions of the samples -once proved that the samples themselves fulfil the normality criterion for most of the filters- since there is no apparent reason for the population to be normal at one level but not at the other. The same line of thought can presumably be applied transversaly as well, since there is no apparent reason for the population to be normal for readings at all filters but one or two. Under those circumstances, it seems reasonable to attribute any departure from normality at the sample level merely to the mechanics of random sampling.

Since analysis of variance and certain applications of regression analysis --the parametric methods most extensively used in this work-- require the fulfilment of the normality criterion even within each of the treatment populations, the composite samples have been subdivided for study into four subssamples, according to the possible combinations of the categories of variables habit- and cr-. Indeed, this subdivision does not reproduce the smallest possible cells which will arise during the course of the analyses, since other variables will be involved as well, but further partitioning would originate too small subsamples and, consequently, reduce representativeness. Thus, as mentioned before, it will be assumed --if the criterion of normality is fulfilled by the samples and the subsamples at most of the filters-- that the populations or sections of the populations from which they were extracted are also normal, any possible deviation from normality being due merely to chance.

Among the author's data, gross departures from normality -as classified in tables B.1 and B.2- are few and normally restricted to the last filters. For the 'pure' subfiles (Swe, Spa and Gb), two filters among the Swedish males, four among the Swedish females and one among the Spanish females --considering inner arm and forehead-- present either deviant skewness or kurtosis or both. For the composite subfiles (1) two among the Swedish females and one among the Spanish males are in a similar situation. Subfile York -where only measurements on the inner arm were taken- presents at every filter gross departures from normality for males, but only agreement with the requirement for females. This peculiar situation is possibly due to the impact of age on pigmentation, since the male group is constituted exclusively by a group of children and adolescents aged 10 to 18 and by their fathers (with no intermediate ages in between), while the females are only the children's mothers. The signs of skewness figures reinforce the credibility of this interpretation.

Some authors are, indeed, skeptical about the wisdom of computing the skewness and kurtosis figures for small samples, and Mc Nemar (1959) gives the value of hundred as defining the borderline between small and big samples in this context. Yet, in the absence of a perfect alternative, skewness and kurtosis have been calculated and used as shown above. The sizes of some of the subsamples, however, are smaller than any tabulated value, and this situation presents a problem. There, in the absence of evidence to the contrary, it was considered that the criterion of normality was satisfied whenever the estimated value did not exceed the tabulated value corresponding to the closest N. Otherwise the question was left open.

---

(1) These are Swe+Aswe, Spa+Aspa and Gb+Agb. Only those cases with at least three autochthonous grandparents are included in them.

III.2. The structure of the samples.

Unless otherwise pointed out, only individuals with three indigenous grandparents will be included in Aswe, Aspa and Agb (briefly, a 3/4-criterion of 'purity'). However, since the information compiled in the variables introduced in this section is much less abundant than that on reflectophotometric readings, the application of the 3/4-criteria here would produce a major reduction in the number of valid cases. With that subsequent loss of representativeness our chances of finding the real nature of the inter-relationships between variables diminish as well. Besides, the nature of these variables is not such that a significant change in statistical value is likely to result, and a 2/4-criterion of 'purity' (two or three indigenous grandparents) has tentatively been introduced here. It will be shown that no significant shift from the frequencies within the 'pure' groupings is caused by the addition of the corresponding 2/4-groups. The variables introduced here are sex and age, socioeconomic factors, some of the 'somatic' variables (tall, eye and hair) and most of the radiation intake variables. The variables are shown graphically in fig. A.1.

1) Sex

Grouping together both kinds -pure and semipure- the combined samples present the following sex-ratios: 67.437 (Swedes), 94.615 (Spaniards) and 88.462 (British). The figures for their respective populations are 98.912, 95.363 and 94.363 respectively.

2) Age

Combining both sexes and both kinds, some 60 per cent of Swedes are between fifteen and twenty years old, while the rest is not too unevenly distributed between ages four and seventy five. Around 73 per cent of the Spaniards are between twenty and twenty five years old, while 16 per cent are between fifteen and twenty; none is younger than seventeen and very few are older than forty. The ages of the British are more concentrated: 85 per cent are between fifteen and twenty five, none is younger than eighteen and practically none is older than thirty five. The distribution of frequencies in each case departs significantly from normality (table III.2-1).

Sve		Spa		Gb		
♂	♀	♂	♀	♂	♀	
22.595	28.604	23.087	22.293	22.303	20.717	mean
12.844	17.723	7.183	5.987	6.808	3.728	st. dev.
3.641	-0.239	13.260	24.591	12.813	4.179	kurt.
2.099	1.112	3.425	4.641	3.252	2.111	skew.
259	391	104	116	33	46	N

Asve		Aspa		Agb		
♂	♀	♂	♀	♂	♀	
19.250	22.614	22.789	25.429	19.923	19.833	mean
13.372	14.954	4.906	13.501	2.565	2.317	st. dev.
7.350	4.081	1.581	4.227	9.744	1.693	kurt.
2.644	2.148	1.562	2.336	2.973	1.459	skew.
60	83	19	14	13	6	N

Table III.2-1. Age (frequency distributions). Kurtosis figures are referred to zero.

3) Credo

With the exception of the combined British samples, within which a non-negligible amount of Catholics and some Jews were present, the other samples displayed nearly total homogeneity of religious creed, the only exception being contributed in the Swedish case by 'non-pure' Swedes.

4) SocecO

Around 75 per cent of the Swedes, 90 per cent of the Spaniards and 80 per cent of the British belong to social class VIII, constituted by people without a regular income of their own (i.e. students and housewives). Apart from this, the Swedes present the widest ranging gamut of social strata, while among Spaniards only the lower and middle classes are represented and practcally only the middle class among the British (the few exceptions entirely due to non-'pure' British). This is presumably a reflection of the fact that most of the Spanish and British subjects were University students, the pattern may however change to a great extent after reconversion of all VIII-classed subjects to other strata according to their parents′ or husbands′ incomes.

In order to make the three socioeconomic structures comparable, they have been divided into three different classes (upper, middle and lower) plus one independent stratum, VIII. The classes are also subdivided in strata -I to VII (I highest)-, of which III to V constitute the middle class. Because of this, while the stratus-division of a basically continuous variable is a valid one, the subsequent class-division may not exactly correspond to that adopted in each country. This need not however to concern us.

5) Iowork

In an extremely small percentage of cases those tested were, during childhood, very likely to have been subject to prolonged and regular exposure to weather and radiation, due to their parents′ work (e.g. farming). This circumstance deserves consideration since it can even lead to a certain degree of acanthosis and permanent tan of the skin (Piers, 1948) which, when optimal, under experimental conditions has been shown to allow a 40-fold longer sun exposure without producing sunburn (Jung, 1975).

Among Swedish males there was an even smaller percentage of subjects who worked outdoors.

6) Tall

Information about the height of the testees was stored in variable tall. Application of the normality criteria, when appropriate, did not in general reveal significant departures from normality (table III.2-2).

Sve		Spa		Gb		
♂	♀	♂	♀	♂	♀	
1.805	1.664	1.744	1.617	1.763	1.628	mean
0.258	0.053	0.066	0.065	0.051	0.068	st. dev.
	0.072	-0.578	1.529 +	-1.398	-0.590	kurt.
	0.094	0.031	0.628 +	0.034	-0.095	skew.
226	368	100	111	30	42	N

Asve		Aspa		Agb		
♂	♀	♂	♀	♂	♀	
1.795	1.669	1.739	1.645	1.773	1.590	mean
0.062	0.058	0.043	0.064	0.052	0.068	st. dev.
-0.197	0.821	-1.431	0.846	-0.271	0.759	kurt.
-0.430	0.648	-0.063	0.872	0.550	0.530	skew.
45	72	19	14	12	6	N

Table III.2-2. Tall (frequency distributions).
Kurtosis figures are referred to zero.
The sign + indicates departure from normality.
Some samples were too small for comparison with the tabulated values (kurtosis, skewness) to be reliable.

A preliminary analysis of variance for the six male sub-samples fails to reveal any statistical significance at the 0.05 level (table III.2-3). A similar analysis for the females, however, shows significance at the 0.001 level. The application of two batteries of post hoc comparisons, one to each sex, by the scheffé method (Hays, 1981) to the composite Swedish, Spanish and British samples still fails to show significance among males, whereas Swedish females differ significantly from both Spanish and British females at the 0.001 level but the two last groups are not significantly different from each other at even the 0.05 level. The reason for the appearance of non-significance among males seems to be the relatively great size of male Swe's variance which inflates the SS_w-term intervening in both kinds of tests, plus the fact that the Scheffé method is a relatively conservative one. Indeed, male Swe's variance is not homogeneous with the other five though they are among themselves. Among females all six variances are homogeneous. Application of the t-test -with the pertinent

Between samples (2/4)

Tall	♂	♀
Swe	$\bar{x} = 1.805$ $\hat{s}^2 = 0.066$ $n = 226$	$\bar{x} = 1.664$ $\hat{s}^2 = 0.003$ $n = 368$
Aswe	$\bar{x} = 1.795$ $\hat{s}^2 = 0.004$ $n = 45$	$\bar{x} = 1.669$ $\hat{s}^2 = 0.003$ $n = 72$
Swe + Aswe	$\bar{x} = 1.803$ $\hat{s}^2 = 0.056$ $n = 271$	$\bar{x} = 1.665$ $\hat{s}^2 = 0.003$ $n = 440$
Spa	$\bar{x} = 1.744$ $\hat{s}^2 = 0.004$ $n = 100$	$\bar{x} = 1.617$ $\hat{s}^2 = 0.004$ $n = 111$
Aspa	$\bar{x} = 1.739$ $\hat{s}^2 = 0.002$ $n = 19$	$\bar{x} = 1.645$ $\hat{s}^2 = 0.004$ $n = 42$
Spa + Aspa	$\bar{x} = 1.743$ $\hat{s}^2 = 0.004$ $n = 119$	$\bar{x} = 1.625$ $\hat{s}^2 = 0.004$ $n = 153$
Gb	$\bar{x} = 1.763$ $\hat{s}^2 = 0.003$ $n = 30$	$\bar{x} = 1.628$ $\hat{s}^2 = 0.005$ $n = 42$
Agb	$\bar{x} = 1.773$ $\hat{s}^2 = 0.003$ $n = 12$	$\bar{x} = 1.590$ $\hat{s}^2 = 0.005$ $n = 6$
Gb + Agb	$\bar{x} = 1.766$ $\hat{s}^2 = 0.003$ $n = 42$	$\bar{x} = 1.623$ $\hat{s}^2 = 0.005$ $n = 48$
Bartlett's	F =77.863 df = 1 p 0.001 + (Swe,Aswe) F = 3.994 df = 4 p = 0.406 (all but Swedes)	F = 9.152 df = 5 p = 0.105
t-test (or z)	Swe-Aswe z = 0.520 p = 0.603 Spa-Aspa t = 0.329 df=117 p = 0.760 Gb-Agb t = 0.535 df=40 p = 0.600	Swe-Aswe z = 0.657 p = 0.511 Spa-Aspa t = 2.444 df=151 p = 0.016 + Gb-Agb t = 1.231 df=46 p = 0.230
Analysis of variance	SS df MS F p 0.3179 5 0.064 1.739 0.050 15.578 426 0.037	SS df MS F p 0.2591 5 0.051 15.319 0.001 + 2.148 635 0.003
Post-hoc comparisons (Scheffé)	$\frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{15.578}{426}\left(\frac{1}{N_1} + \frac{1}{N_2}\right)}} > \sqrt{5.F}$ $\sqrt{5.F} = 0.866$ (0.001) $= 0.743$ (0.010) $= 0.636$ (0.050) Sw-Sp $R = 0.546 < \sqrt{5.F_{0.050}}$ - Sw-Br $R = 0.223 < \sqrt{5.F_{0.050}}$ - Sp-Br $R = 0.128 < \sqrt{5.F_{0.050}}$ -	$\frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{2.148}{635}\left(\frac{1}{N_1} + \frac{1}{N_2}\right)}} > \sqrt{5.F}$ $\sqrt{5.F} = 0.263$ (0.001) $= 0.226$ (0.010) $= 0.193$ (0.050) Sw-Sp $R = 0.426 > \sqrt{5.F_{0.001}}$ + Sw-Br $R = 0.276 > \sqrt{5.F_{0.001}}$ + Sp-Br $R = 0.012 < \sqrt{5.F_{0.050}}$ -
t-test (or z)	Sw-Sp z = 3.871 p < 0.001 + Sw-Br t = 2.219 df=311 p = 0.028 + Sp-Br t = 2.244 df=58 p = 0.032 +	

Table III.2-3. Comparisons between samples.

correction for df whenever required (table III.2-3)- reveals significance, for males, between combined Swedes and Spaniards at better than the 0.001 level, but only at 0.028 and 0.032 for Swedes-British and Spaniards-British respectively.

All statistical differences between the 'pure' groups and their corresponding 2/4-groupings are far from significant, except among Spanish females ($p=0.016$). Some of the Spanish and British samples are small but their score distributions do not depart from normality (only two of the big samples do) and the homogeneity of variances condition did not have to be violated here, for which reasons the results of the z and t tests are totally reliable (Hays, 1981). The mean statures in metres for the combined Swedes, Spaniards and British are respectively: 1.803 ($s^2=0.056$), 1.743 ($s^2=0.004$) and 1.766 ($s^2= 0.003$) for males, and 1.665 ($s^2=0.003$), 1.625 ($s^2= 0.004$) and 1.623 ($s^2= 0.005$) for females. It would be wrong, however, at least in the case of British and Spaniards, to try to predict population statistics from these figures since students are everywhere normally taller than their counterparts. This may perhaps be especially true of Spain, where the advent of the living conditions reputedly associated to this generational increase in height is both less generalized and more recent than in either Sweden or Great Britain.

7) Eye

None of the Swedish, Spanish or British sub-samples, within each sex, showed significant differences with respect to their counterparts, for which reason they have been re-grouped into combined Swedes, Spaniards and British (table III.2-4). In order to be able to rely on the x^2-test some re-grouping of categories was necessary for Spaniards and British (mixed and light eyes together).

Swe + Aswe

♂

eye

1	2	3	6	7	8	
4	20	6	30	18	177	255
1	9	1	11	4	33	60
5	29	8	41	22	210	315

$x^2 = 2.080$
$p = 0.350$

hair

1	2	23	30	3-5	4-5	
2	56	46	1	145	1	251
0	17	10	0	34	0	61
2	73	56	1	179	1	312

$x^2 = 0.336$
$p = 0.861$

♀

1	2	3	6	7	8	
6	41	9	59	54	222	391
1	14	1	9	11	45	81
7	55	10	68	65	267	472

$x^2 = 1.897$
$p = 0.387$

1	2	23	30	3-5	4-5	
0	121	42	0	212	3	378
1	25	7	0	48	1	82
1	146	49	0	260	4	460

$x^2 = 0.270$
$p = 0.861$

Spa + Aspa

♂

1	2	3	6	7	8	
15	53	15	15	3	3	104
3	10	2	3	0	1	19
18	63	17	18	3	4	123

$x^2 = 0.000$
$p = 0.999$

1	2	23	30	3-5	4-5	
22	67	15	0	2	0	104
5	10	4	0	0	0	19
27	77	17	0	2	0	123

$x^2 = 0.152$
$p = 0.700$

♀

1	2	3	6	7	8	
17	57	11	21	2	8	116
1	7	1	1	0	4	14
18	64	12	22	2	12	130

$x^2 = 0.038$
$p = 0.840$

1	2	23	30	3-5	4-5	
16	81	17	0	2	0	116
2	10	2	0	0	0	14
18	91	19	0	2	0	130

$x^2 = 0.034$
$p = 0.860$

Gb + Agb

♂

1	2	3	6	7	8	
0	7	1	3	6	16	33
0	4	.3	2	0	4	13
0	11	4	5	6	20	46

$x^2 = 2.494$
$p = 0.120$
(1+2+3)

$x^2 = 0.090$
$p = 0.760$
(1+2)

1	2	23	30	3-5	4-5	
0	24	5	1	3	0	33
0	11	0	1	1	0	13
0	35	5	2	4	0	46

$x^2 = 0.218$
$p = 0.650$

♀

1	2	3	6	7	8	
4	11	6	8	4	13	46
0	1	1	2	1	1	6
4	12	7	10	5	14	52

$x^2 = 0.106$
$p = 0.750$

1	2	23	30	3-5	4-5	
0	30	9	3	4	0	46
0	3	1	1	1	0	6
0	33	10	4	5	0	52

$x^2 = 0.077$
$p = 0.780$

	1	2	3	6+7+8	1	2	23	30+3-5	4-5
Swe+Aswe	1.525	10.673	2.287	85.515	0.389	28.368	13.601	56.995	0.647
Spa+Aspa	14.229	50.198	11.462	24.111	17.787	66.403	14.229	1.581	0.000
Gb+Agb	4.082	23.469	11.224	61.225	0.000	69.388	15.306	15.306	0.000

Eye

Hair

Table III.2-4. Proportions of the different categories for pigmentation of eyes and hair.

Legend.

1. Eye colour:
   1 = black and dark brown, 2 = medium and light brown, 3 = mixed, 6 = greenish, 7 = greyish, 8 = bluish.
2. Hair colour:
   1 = black, 2 = medium and dark brown (with/without a reddish tint), 23 = light brown, 30 = ash blond, 3-5 = reddish blond, light blond, platino blond and albino, 4-5 = reds.

The proportions of brown (including dark), mixed and light eyes, both sexes together, were respectively: 12.198 per cent, 2.287 per cent and 85.515 per cent (Swedes); 64.427 per cent, 11.462 per cent and 24.111 per cent (Spaniards); 27.551 per cent, 11.224 per cent and 61.225 per cent (British).

8) Hair

The same kind of re-grouping with similar results for the x^2-test was made for hair (table III.2-4).

The proportions of dark (including black), light brown and light haired individuals were respectively: 28.757 per cent, 13.601 per cent and 57.642 per cent (Swedes); 84.190 per cent, 14.229 per cent and 1.581 per cent (Spaniards); 69.388 per cent, 15.306 per cent and 15.306 per cent (British).

9) Duia and dfh

In spite of the time of year during which the measurements were made (mainly late autumn and winter), the Swedes appear concentrated between roughly the eighth and the thirty fifth weeks counted backwards from the testing day (both weeks included). About 3/5 of the total fall in the second half of this range.

Most of Spaniards had sunbathed between thirty and forty weeks ago, the range extending closer to the origin of time for the forehead.

The same is true for the British for the period between twenty and forty weeks backwards from the testing day. But here, the distributions for uia and fh are practically identical.

With the exception of Asve, males and females, all subsamples which are not too small for normality criteria to be applied show significant deviations from normality (table III.2-5).

10) Cr-, cr-now, sboften, sloften and hat

In every case the distribution differences within each pair of homologous sub-samples are far from significant, except for variable crfhnow (Swedish females: p=0.067; Spanish males: p=0.079) (table III.2-6). The sub-samples were consequently recombined into just Swedes, Spaniards and British. All

♂ Sve ♀		♂ Spa ♀		♂ Gb ♀		
25.014	22.878	39.814	37.622	34.704	30.791	mean
13.578	10.387	22.017	16.639	15.930	9.775	st. dev.
24.564	31.514	11.060	24.995	7.269	17.904	kurt.
3.799	3.044	3.432	4.997	2.599	3.384	skew.
219	337	70	74	27	43	N

♂ Asve ♀		♂ Aspa ♀		♂ Agb ♀		
22.200	20.550	48.900	34.714	46.600	28.667	mean
9.983	9.633	32.385	1.976	22.244	2.887	st. dev.
-1.251	-1.474	4.244	0.185	1.771	-	kurt.
-0.484	-0.359	2.188	0.370	1.461	1.732	skew.
25	20	10	7	5	3	

♂ Sve ♀		♂ Spa ♀		♂ Gb ♀		
23.430	20.827	28.633	26.743	33.821	30.568	mean
14.145	11.295	24.060	20.712	16.314	9.773	st. dev.
20.494	21.586	8.362	9.706	6.691	17.727	kurt.
3.280	2.240	2.380	2.116	2.360	3.351	skew.
235	371	98	109	28	44	N

♂ Asve ♀		♂ Aspa ♀		♂ Agb ♀		
22.200	16.958	44.818	28.000	46.600	28.667	mean
9.983	10.486	33.573	13.435	22.244	2.887	st. dev.
-1.251	-1.640	3.873	0.630	1.771	-	kurt.
-0.484	0.112	1.864	-1.550	1.461	1.732	skew.
25	24	11	9	5	3	N

Table III.2-5. Duia, dfh (frequency distributions). Kurtosis figures are referred to zero.

these behavioural variables are dichotomous and the allotment of cases within the combined samples differs significantly ($p < 0.001$) from a fifty-fifty split, except for the following variables: hat (Swedes and British, both sexes: n.s.), sboften (British males: n.s.; British females: p=0.017), crfhnow (British females: p=0.022), crfh (British females: n.s.).

The picture then, if our samples accurately represent the populations from which they were extracted (table III.2-7), is that of people among which not less than 67 per cent (Swedish males) sunbathe 'often' (except for British males, n.s.) whereas few, never more than 7.5 per cent (Swedish females), use a sunlamp 'often'. While getting irradiated, not more than 40 per cent (Swedish females)

SWE + ASWE (2/4) ♂

eruia

	0	1	
	189	38	227
	40	7	47
	229	45	234

$x^2 = 0.009$
$p = 0.920$

229	45

$s = -11.055$
$p < 0.001$ +

eruianow

	0	1	
	228	0	228
	46	0	46
	274	0	274

$p = 1$

274	0

$s = -16.495$
$p < 0.001$ +

sboften

	0	1	
	78	155	233
	16	35	51
	94	190	284

$x^2 = 0.016$
$p = 0.904$

94	190

$s = -5.637$
$p < 0.001$ +

sloften

	0	1	
	226	6	232
	49	2	51
	275	8	283

$x^2 = 0.003$
$p = 0.956$

275	8

$s = -15.812$
$p < 0.001$ +

erfh

	0	1	
	198	26	224
	40	5	45
	238	31	269

$x^2 = 0.026$
$p = 0.875$

238	31

$s = -12.560$
$p < 0.001$ +

erfhnow

	0	1	
	226	2	228
	46	0	46
	272		274

$x^2 = 0.097$
$p = 0.752$

272	2

$s = -16.521$
$p < 0.001$ +

hat

	0	1	
	118	123	241
	21	36	57
	139	159	298

$x^2 = 2.256$
$p = 0.134$

139	159	298

$s = -1.101$
$p = 0.271$

SWE + ASWE (2/4) ♀

eruia

	0	1	
	209	146	355
	42	24	66
	251	170	421

$x^2 = 0.345$
$p = 0.555$

251	170

$s = -3.899$
$p < 0.001$ +

eruianow

	0	1	
	341	13	354
	60	6	66
	401	19	420

$x^2 = 2.631$
$p = 0.106$

401	19

$s = -18.569$
$p < 0.001$ +

sboften

	0	1	
	43	325	368
	8	59	67
	51	384	435

$x^2 = 0.022$
$p = 0.887$

51	384

$s = -15.918$
$p < 0.001$ +

sloften

	0	1	
	336	26	362
	61	6	67
	397	32	429

$x^2 = 0.068$
$p = 0.791$

397	32

$s = -17.574$
$p < 0.001$ +

erfh

	0	1	
	229	119	348
	47	18	65
	276	137	413

$x^2 = 0.772$
$p = 0.371$

276	137

$s = -6.791$
$p < 0.001$ +

erfhnow

	0	1	
	266	80	346
	58	8	66
	324	88	412

$x^2 = 3.365$
$p = 0.067$

324	88

$s = -11.564$
$p < 0.001$ +

hat

	0	1	
	179	184	363
	32	44	76
	211	228	439

$x^2 = 1.035$
$p = 0.317$

211	228

$s = -0.764$
$p = 0.447$

Table III.2-6. The exposure variables: categories and frequencies.

Legend.
0 = no, 1 = yes.

SPA + AMPA (2/4) ♂

eruia

0	1	
93	7	100
18	1	19
111	8	119

$x^2 = 0.050$
$p = 0.823$

111	8

$z = -9.350$
$p < 0.001$ +

eruianow

0	1	
99	1	100
19	0	19
118	1	119

$x^2 = 0.871$
$p = 0.343$

118	1

$z = -10.634$
$p < 0.001$ +

sboften

0	1	
23	77	100
7	12	19
30	89	119

$x^2 = 0.971$
$p = 0.317$

30	89

$z = -5.317$
$p < 0.001$ +

sleften

0	1	
100	0	100
19	0	19
119	0	119

$p = 1$

119	0

$z = -10.817$
$p < 0.001$ +

erfh

0	1	
94	6	100
17	2	19
111	8	119

$x^2 = 0.050$
$p = 0.823$

111	8

$z = -9.350$
$p < 0.001$ +

erfhnow

0	1	
97	3	100
16	3	19
113	6	119

$x^2 = 3.111$
$p = 0.079$

113	6

$z = -9.717$
$p < 0.001$ +

hat

0	1	
71	31	102
14	3	17
85	34	119

$x^2 = 0.619$
$p = 0.438$

85	34

$z = -4.584$
$p < 0.438$

SPA + AMPA (2/4) ♀

eruia

0	1	
90	17	107
10	3	13
100	20	120

$x^2 = 0.069$
$p = 0.791$

100	20

$z = -7.212$
$p < 0.001$ +

eruianow

0	1	
103	7	110
14	0	14
117	7	124

$x^2 = 0.127$
$p = 0.751$

117	7

$z = -9.789$
$p < 0.001$ +

sboften

0	1	
14	97	111
4	10	14
18	107	125

$x^2 = 1.437$
$p = 0.236$

18	107

$z = -7.871$
$p < 0.001$ +

sleften

0	1	
110	1	111
14	0	14
124	1	125

$x^2 = 1.526$
$p = 0.220$

124	1

$z = -10.912$
$p < 0.001$ +

erfh

0	1	
74	33	107
7	6	13
81	39	120

$x^2 = 0.639$
$p = 0.438$

81	39

$z = -3.743$
$p < 0.001$ +

erfhnow

0	1	
74	36	110
12	2	14
86	38	124

$x^2 = 1.214$
$p = 0.273$

86	38	124

$z = -4.221$
$p < 0.001$ +

hat

0	1	
97	13	110
14	0	14
111	13	124

$x^2 = 0.804$
$p = 0.371$

111	13

$z = -8.711$
$p < 0.001$ +

GB + AGB (2/4) ♂

eruia

0	1	
27	5	32
11	1	12
38	6	44

$x^2 = 0.018$
$p = 0.888$

38	6

$z = -4.673$
$p < 0.001$ +

eruianew

0	1	
32	0	32
12	0	12
44	0	44

$p = 1$

44	0

$z = -6.485$
$p < 0.001$ +

sboften

0	1	
13	19	32
7	6	13
20	25	45

$x^2 = 0.229$
$p = 0.654$

20	25

$z = -0.596$
$p = 0.551$

sloften

0	1	
32	0	32
13	0	13
45	0	45

$p = 1$

45	0

$z = -6.559$
$p < 0.001$ +

erfh

0	1	
24	8	32
11	1	12
35	9	44

$x^2 = 0.642$
$p = 0.438$

35	9

$z = -3.769$
$p < 0.001$ +

erfhnew

0	1	
30	2	32
11	1	12
41	3	44

$x^2 = 0.183$
$p = 0.655$

41	3

$z = -5.578$
$p < 0.001$ +

hat

0	1	
12	20	32
9	4	13
21	24	45

$x^2 = 2.574$
$p = 0.107$

21	24

$z = -0.298$
$p = 0.700$

GB + AGB (2/4) ♀

eruia

0	1	
35	11	46
2	2	4
37	13	50

$x^2 = 0.299$
$p = 0.584$

37	13

$z = -3.253$
$p < 0.001$ +

eruianow

0	1	
44	1	45
3	1	4
47	2	49

$x^2 = 0.788$
$p = 0.371$

47	2

$z = -6.286$
$p < 0.001$ +

sboften

0	1	
15	31	46
1	3	4
16	34	50

$x^2 = 0.060$
$p = 0.807$

16	34

$z = -2.404$
$p = 0.017$,+

sloften

0	1	
44	2	46
4	0	4
48	2	50

$x^2 = 0.181$
$p = 0.371$

48	2

$z = -6.364$
$p < 0.001$ +

erfh

0	1	
28	17	45
1	3	4
29	20	49

$x^2 = 0.848$
$p = 0.360$

29	20

$z = -1.143$
$p = 0.253$

erfhnow

0	1	
30	15	45
3	1	4
33	16	49

$x^2 = 0.029$
$p = 0.863$

33	16

$z = -2.286$
$p = 0.022$ +

hat

0	1	
21	25	46
4	2	6
25	27	52

$x^2 = 0.286$
$p = 0.584$

25	27

$z = -0.139$
$p = 0.889$

protect their upper inner arm with some kind of cream and not more than 33 per cent (Swedish females) protect their foreheads in the same way (except British females' 41 per cent, n.s.). Not more than 6 per cent (Spanish females) used some kind of cream on the inner arm while being tested and not more than 33 per cent (British females) retained some make-up on their foreheads during the test. Spaniards (especially girls) clearly favour bare foreheads, while British and Swedes do not globally show any preferances.

As a whole, greater proportions of women than men expose themselves often to radiation (natural and artificial), protect their skins with cream or oils during the exposure and were using cosmetics while being tested. The differences are not, however, significant in all cases: excepting hat -which only departs from the fifty-fifty split within Spaniards- all variables show extremely significant differences between sexes among Swedes (apart from sloften: p=0.014); all but sloften -hat included- show or approach significance among Spaniards and only for crfh and crfhnow do the between-sex differences approach or even show significance among the British. Without doubt some of the bizarre British sunbathing behaviour may be due to the small size of the samples which have by chance picked up some rare proportions or which are not big enough mathematically to produce a significant x^2.

When comparing samples, within each sex (table III. 2-7), a different complementary picture -broadly similar for males and females- emerges. According to it Swedes and Spaniards indulge in frequent sunbathing in higher proportions than the British, and more Swedes use sunlamps than either the British or Spaniards (also British females use them to a greater extent than Spanish females). As for the use of protective oils and creams, it is mostly Swedes who

Between sexes		♂		Between samples	♀		
	cruia	0	1		0	1	
x^2 =43.471 p = 0.000 +	Sw.	229 83.577	45 16.423	x^2 = 5.886 p = 0.015 +	251 59.620	170 40.380	x^2 = 22.017 p = 0.000 +
x^2 = 4.791 p = 0.029 +	Sp.	111 93.277	8 6.723	x^2 = 0.061 p = 0.807	100 83.333	20 16.667	x^2 = 3.308 p = 0.070
x^2 = 1.518 p = 0.221	Br.	38 86.364	6 13.636	x^2 = 1.174 p = 0.273	37 74.000	13 26.000	x^2 = 1.414 p = 0.236
	cruianow	0	1		0	1	
x^2 =11,102 p 0.001 +		274	0	x^2 = 0.185 p = 0.655	401 95.476	19 4.524	x^2 = 0.096 (tot.) p = 0.951
x^2 = 3.023 p = 0.083		118 99.160	1 0.840	x^2 = - p = 1	117 94.355	7 5.645	
x^2 = 0.408 p = 0.527		44	0	x^2 = 0.270 p = 0.584	47 95.918	2 4.082	
	sboften	0	1		0	1	
x^2 =47.440 p = 0.000 +	Sw.	94 33.099	190 66.901	x^2 = 2.094 p = 0.150	51 11.724	384 88.276	x^2 = 0.420 p = 0.527
x^2 = 3.850 p = 0.048 +	Sp.	30 25.210	89 74.790	x^2 = 1.736 p = 0.190	18 14.400	107 85.600	x^2 =13.829 p = 0.000 +
x^2 = 1.075 p = 0.294	Br.	20 44.444	25 55.556	x^2 = 4.829 p = 0.028 +	16 32.000	34 68.000	x^2 = 5.988 p = 0.015 +
	sloften	0	1		0	1	
x^2 = 6.055 p = 0.014 +	Sw.	275 97.137	8 2.827	x^2 = 2.136 p = 0.150	397 92.541	32 7.459	x^2 = 6.520 p = 0.011 +
x^2 = 0.001 p = 0.975	Sp.	119	0	x^2 = 0.387 p = 0.527	124 99.200	1 0.800	x^2 = 0.373 p = 0.527
x^2 = 0.410 p = 0.527	Br.	45	0	x^2 = - p = 1	48 96.000	2 4.000	x^2 = 0.687 p = 0.403
	crfh	0	1		0	1	
x^2 =39.961 p = 0.000 +	Sw.	238 88.476	31 11.524	x^2 = 1.606 p = 0.206	276 66.828	137 33.172	x^2 = 0.880 (tot.) p = 0.638
x^2 =23.525 p = 0.000 +	Sp.	111 93.277	8 6.723	x^2 = 1.964 p = 0.157	81 67.500	39 32.500	
x^2 = 3.580 p = 0.058	Br.	35 79.545	9 20.455	x^2 = 5.097 p = 0.024 +	29 59.184	20 40.816	
	crfhnow	0	1		0	1	
x^2 =59.644 p = 0.000 +	Sw.	272 99.270	2 0.730	x^2 = 5.725 p = 0.018 +	324 78.641	88 21.359	x^2 = 4.069 p = 0.046 +
x^2 =25.146 p = 0.000 +	Sp.	113 94.958	6 5.042	x^2 = 5.572 p = 0.018 +	86 69.355	38 30.645	x^2 = 2.584 p = 0.107
x^2 = 7.995 p = 0.005 +	Br.	41 93.182	3 6.818	x^2 = 0.003 p = 0.940	33 67.347	16 32.653	x^2 = 0.006 p = 0.938
	hat	0	1		0	1	
x^2 = 0.092 p = 0.764	Sw.	139 46.644	159 53.356	x^2 =20.026 p = 0.000 +	211 48.064	228 51.936	x^2 =66.178 p = 0.000 +
x^2 =11.602 p = 0.001 +	Sp.	85 71.429	34 28.571	x = 0.025 p = 0.875	111 89.516	13 10.484	x = 0.021 p = 0.887
x^2 = 0.004 p = 0.950	Br.	21 46.667	24 53.333	x = 7.709 p = 0.006 +	25 48.077	27 51.923	x =33.502 p = 0.000 +

Table III.2-7. The exposure variables: frequencies, comparisons between sexes and between samples.

Legend.

1. Samples and recombinations from preceding table.
2. In the between samples calculations, the chi-square values correspond in the specified order to the comparisons Sw-Sp, Sw-Br and Sp-Br respectively. In the between sexes comparisons they correspond to those within Sw (Swe+Aswe), Sp (Spa +Aspa) and Br (Gb+Asb).
3. Frequencies below the observed values are relative (%).
4. In a pair of cases, the global (tot.) chi-square value was found to be non-significant (highly so) and no further comparisons were made.

protect their upper inner arms in this fashion, followed by the British and then by Spaniards, while -if considering the forehead- the British come first, followed by Swedes and then by Spaniards. On the subject of eventual interference with the reflectance test, owing to the presence in situ of creams and cosmetics, it will be said that very few people had them on their arms but they were more frequent on their foreheads: for the inner arm there are no practical differences, but for the forehead the British come first, colsely followed by Spaniards and -at a certain distance- by Swedes. Significance is not always attained. Among males, only for the following variables and cases is significance reached or approached: cruia (Swedes vs. Spaniards -0.015), sboften (Spaniards vs. British -0.028), crfh (Spaniards vs. British -0.024), crfhnow (Swedes vs. Spaniards -0.017- and Swedes vs. British -0.018) and hat (Spaniards vs. Swedes - 0.001- and Spaniards vs. British -0.006). Among females the same situation is true for: cruia (Swedes vs. Spaniards -<0.001- and Swedes vs. British -0.070), sboften (Swedes vs. British -<0.001- and Spaniards vs. British -0.015), sloften (Swedes vs. Spaniards -0.011- and perhaps, had the British sample been greater, also British vs. Spaniards), crfhnow (Swedes vs. Spaniards -0.046- and perhaps, as above, Swedes vs. British) and hat (Spaniards vs. Swedes -<0.001- and Spaniards vs. British -<0.001).

Summary

Six samples have been extracted from the Swedish, Spanish and British populations, with a good coverage of social strata in the Swedish case. In spite of conforming to two different criteria of 'purity', no significant differences could be elicited between the samples in each pair for most of the characters considered - the socioeconomic, behavioural and pigmentary variables (excepting the reflectance readings) - for which reason they were combined together into three composite samples.

Application of the normality criteria, whenever pertinent, revealed significant deviations from normality - except in the case of variable tall.

With respect to the behavioural variables, no significant differences between 'pure' and 2/4 'pure' samples could be elicited, but some appeared between samples and between sexes. As average, Swedes had sunbathed more recently (minimum 8 weeks) than either Spaniards (minimum 30 weeks) or the British (minimum 20 weeks). Swedes and Spaniards are more frequent sunbathers than the British, and men less than women - within each sample. The use of protective creams in connection with sunbathing is more extended among Swedes, and even the British, than among Spaniards. Cosmetics are mostly used on the forehead, with the British and the Spaniards using them more frequently than the Swedes. There practically no differences between samples concerning their use on the inner arm. The Spaniards expose their foreheads significantly more than either the Swedes or the British.

For all these variables, the picture of similarities and divergencies follows similar lines in both sexes.

III.3. Patterns of exposure. Associations between variables.

In order to pave the way towards a deeper insight into the nature of the samples it is necessary to become acquainted not only with its distributions of frequencies but also with any existing associations between variables. The subject of the associations - or correlations - between the independent variables and pigmentation, the dependent one, will be treated in another chapter; here only the associations between the independent variables will be studied. Those existing between behavioural variables are shown in table C.1 (appendix C).

It is clear that variables sboften and sloften are not associated in any way, although significance levels steadily increase with sample size. Because of this and since their effects are additive, and also trying to keep the number of independent variables as low as possible, they were reconverted into a new composite variable, uvoften, according to the procedure shown below.

```
IF      (SBOFTEN EQ 1 AND SLOFTEN EQ 1) UVOFTEN=2
IF      (SBOFTEN EQ 1 AND SLOFTEN EQ 0) UVOFTEN=1
IF      (SBOFTEN EQ 0 AND SLOFTEN EQ 1) UVOFTEN=1
IF      (SBOFTEN EQ 0 AND SLOFTEN EQ 0) UVOFTEN=0
IF      ((SBOFTEN EQ 0 AND SLOFTEN EQ 9) OR
        (SLOFTEN EQ 0 AND SBOFTEN EQ 9)) UVOFTEN=0
IF      ((SBOFTEN EQ 1 AND SLOFTEN EQ 9) OR
        (SLOFTEN EQ 1 AND SBOFTEN EQ 9)) UVOFTEN=1
IF      (SBOFTEN EQ 9 AND SLOFTEN EQ 9) UVOFTEN=9
```

It was still felt that this was not sufficient since some people preferentially expose only certain areas of their skins to radiation. This kind of information is stored in variable habit. Accordingly, uvoften, in combination with habit, was transformed into variables habitu and habitf which convey information on the level of UV-radiation intake at the inner arm (habitu) and the forehead (habitf) respectively. The logical paths of conversion are as following:

```
IF      (HABIT EQ 0 OR HABIT EQ 1) HABITU=UVOFTEN
IF      (HABIT EQ 2) HABITU=0
IF      (HABIT EQ 9) HABITU=9
IF      (HABIT EQ 0 OR HABIT EQ 2) HABITF=UVOFTEN
IF      (HABIT EQ 1) HABITF=0
IF      (HABIT EQ 9) HABITF=UVOFTEN
```

1. Raw/Corrected χ^2 (df)
2. Level of significance (χ^2)/Fisher's exact probability (Sign. at 1 % level: +/-)
3. Cramer's V/Phi
4. Kendall's tau b/c
5. Level of significance (τ)

	♂						♀					
	SWE + ASWE (3/4)		SPA + ASPA (3/4)		GP + AGP (3/4)		SWE + ASWE (3/4)		SPA + ASPA (3/4)		GP + AGP (3/4)	
aboften-aloften	2.222 0.136 0.120 0.120 0.137	(1) - 252		(1) 112		(1) 38	2.620 0.106 0.098 0.098 0.106	(1) - 386	0.000 1.000 0.038 0.038 0.324	(1) - 121	0.000 1.000 0.087 -0.087 0.862	(1) - 49
cruia - habitu	22.217 0.000 0.304 0.214 0.000	(2) ⊕ 240	0.179 0.672 0.080 0.080 0.673	(1) - 112	0.206 0.448	(1) - 37	10.409 0.006 0.167 0.127 0.002	(2) ⊕ 373	0.089 0.102	(2) - 117	0.180 0.165	(2) - 49
crfh - habitf	0.143 0.000	(2) ⊕ 236	1.270 0.260 0.149 0.149 0.262	(1) - 112	0.221 0.353	(1) - 37	16.914 0.000 0.214 0.160 0.000	(2) ⊕ 368	0.121 0.080	(2) - 117	0.266 0.065	(2) - 46
cruianow - habitu		(2) 241	0.000 1.000 0.055 0.055 0.564	(1) - 112		(1) - 37	0.025 0.147	(2) - 372	0.033 0.431	(2) - 120	0.045 0.654	(2) - 48
crfhnow - habitf	0.010 0.578	(2) - 241	0.000 1.000 0.046 0.046 1.000	(1) - 112	0.220 0.547	(1) - 37	2.125 0.345 0.076 0.034 0.357	(2) - 366	0.070 0.314	(2) - 120	0.035 0.914	(2) - 48
habitf - newhat	0.093 0.159	(2) - 240	0.377 0.539 0.083 -0.083 0.541	(1) - 108	1.131 0.288 0.231 0.231 0.294	(1) - 37	2.236 0.327 0.078 0.033 0.466	(2) - 363	0.042 0.429	(2) - 116	0.018 0.988	(2) - 49
habitu - cruia - cruianow (cruianow=0)	0.198 0.000	(2) ⊕ 238	0.192 0.662 0.082 0.082 0.663	(1) - 111	0.206 0.448	(1) - 37	9.249 0.010 0.161 0.118 0.005	(2) ⊕ 357	0.084 0.131	(2) - 110	0.161 0.230	(2) - 46
(cruianow=1)		0		(0) 1		0	0.095 0.927	(2) - 13		(2) 7		(2) 2
habitf - crfh - crfhnow (crfhnow=0)	0.146 0.000	(2) ⊕ 234	0.984 0.321 0.143 0.143 0.324	(1) - 106	0.200 0.453	(1) - 35	12.979 0.002 0.214 0.150 0.000	(2) ⊕ 283	0.100 0.242	(2) - 79	0.230 0.211	(2) - 32
(crfhnow=1)		(0) 2	/1.000 0.200 1.000	- 6		(1) 2	0.155 0.124	(2) - 80	0.067 0.885	(1) - 37	/0.262 0.364 0.395	- 16

Table III.3-1. Associations between behavioural variables.

Legend.

1. In some cases the number of rows and/or the number of columns, owing to empty cells, were too small for certain statistical tests to be applied, in which case they were omitted.
2. All significance levels are two-tailed.
3. Statistics 1 to 4 show two alternatives each. The most proper was in every case estimated.
4. Due to too small sample size and/or too low cell frequencies, using x^2 was not always advisable. For that reason Kendall's tau has also been calculated. (Siegel, 1956; Kendall, 1970).
5. Cramer's V/Phi is always based on the raw chi-square value, as given by the SPSS crosstabs subprogram. Since the function of this statistic is to give an idea of the association's strength, which Kendall's tau also gives, no attempt was made to recalculate it whenever the use of the corrected chi-square was found appropiate.
6. The Kendall rank correlation coefficients have been calculated considering ties and correction for continuity (Kendall, 1970).
7. Each of the variables can be considered as ordinal. All variables are dichotomous except habitu and habitf, which have three categories, of which one is frequently empty.

Within the samples there is a clear concentration of the less frequent categories of variables slofteň, cr- and cr-now (which correspond with those using quartz lamps creams and cosmetics) in the top-ranking categories (1 and 2) of variables sboften and habit- (table III.3-1). In other words, there are, in absolute numbers, more users of sunlamps, tanning oils and cosmetics or skin creams among those exposing themselves often to UV-radiation. Without doubt, and especially when considering cruianow and crfhnow, this may be partly due to the high proportions of exposers among Swedes and Spaniards (both sexes) and - to a certain extent - among British females as well. Significance is only attained by Swedes (♂ and ♀) at better than the 0.01 level for all tabulations involving cruia, crfh, habitu and habitf, even when cruianow and crfhnow are controlled for. Spanish and British females approach significance at the 0.05 level for the tabulation crfh-habitf. The use of hats and hair fringes does not show any traits of significant association with exposure (habitf-newhat).

The proportions of exposers (variables habitu and habitf) differ little from those previously obtained for sboften. They are also very similar when, within each sex, comparing the inner arm with the forehead. The results are shown in table III.3-2. Among men, at both sites, exposers are commonest among Spaniards (around 75 per cent) and least frequent among the British (around 54 per cent), while Swedes fall in between (about 65 per cent). Among women, Swedes belong most often to that category (around 88 per cent), closely followed by Spaniards (around 85 per cent) and last by the British (about 71 per cent). Differences between proportions are significant at both sites only between Spaniards and the British, in the case of men. Among women,

				♂	♀	
Swe + Aswe **(Sw.)**	$z_{♂}$= -4.64	p=0.00	0	84 34.855	44 11.796	128
	$z_{♀}$=-14.71	p=0.00	1	157 65.145	329 88.204	486
	x^2= 45.79	p=0.00		241	373	614
Spa + Aspa **(Sp.)**	$z_{♂}$= -5.20	p=0.00	0	28 25.000	18 15.000	46
	$z_{♀}$= -7.58	p=0.00	1	84 75.000	102 85.000	186
	x^2= 3.04	p=0.08		112	120	232
Gb + Agb **(Br.)**	$z_{♂}$= -0.33	p=0.74	0	17 45.946	14 28.571	31
	$z_{♀}$= -2.86	p=0.00	1	20 54.054	35 71.429	55
	x^2= 2.06	p=0.16		37	49	86

1.26 .26
2.99 .08 4.84 .03

	Sw.	**Sp.**	**Br.**	
0	84	28	17	♂
1	157	84	20	
				habitu
0	44	18	14	♀
1	329	102	35	

0.58 .44 3.34 .07
8.91 .00

				♂	♀	
	$z_{♂}$= -4.90	p=0.00	0	82 34.025	42 11.413	124
Swe + Aswe **(Sw.)**	$z_{♀}$=-14.75	p=0.00	1	159 65.975	326 88.587	485
	x^2= 44.54	p=0.00		241	368	609
	$z_{♂}$= -5.20	p=0.00	0	28 25.000	17 14.167	45
Spa + Aspa **(Sp.)**	$z_{♀}$= -7.76	p=0.00	1	84 75.000	103 85.833	187
	x^2= 3.68	p=0.06		112	120	232
	$z_{♂}$= -0.33	p=0.74	0	17 45.946	14 54.054	31
Gb + Agb **(Br.)**	$z_{♀}$= -2.74	p=0.01	1	20 54.054	34 70.833	54
	x^2= 1.87	p=0.17		37	48	85

1.50 .22
2.50 .11 4.84 .03

	Sw.	**Sp.**	**Br.**	
0	82	28	17	♂
1	159	84	20	
				habitf
0	42	17	14	♀
1	326	103	34	

0.41 .53 4.18 .04
10.02 .00

Table III.3-2. Differences in the proportions exposers/ non-exposers, between sexes (within sample) and between samples (within sex).

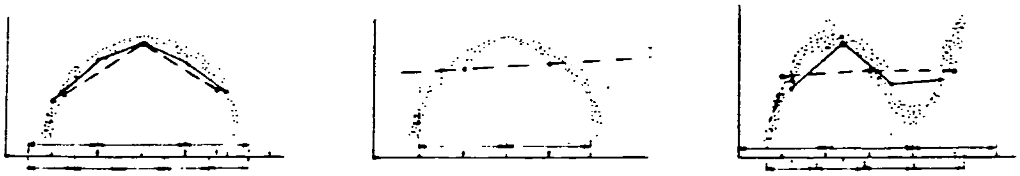
Legend.

1. 0 = non-exposer. 1 = exposer.
2. Within each pair of figures attached to the 2x3 cross-tabulation tables , the first one corresponds to the chi-square statistics and the second one to its p.
3. 3/4-criterion of 'purity' applied to the samples.

differences are significant at both sites between Swedes and the British and also between Spaniards and the British at the forehead. All accepted significance levels are better than 0.05, and in some other instances, the differences approach significance at that level. (Swedes vs. Spaniards: inner arm; Spaniards vs. the British: forehead).

When comparing sexes at each site, they differ significantly only among Swedes (q=0.000), at both the inner arm and the forehead, but approach significance among the Spaniards. Within each sex and site, the proportions exposers/non-exposers differ significantly from the fifty-fifty split among Swedes and Spaniards (both sexes and sites) and among British females (both sites).

The Swedish sample to a much greater extent than the other two present a great dispersal of values for the age variable. Sunbathing habits are to be expected to change somewhat with age. And since among them habitu and habitf are presumed to be of the most importance, in addition to being the only two non-dichotomous values so far, it seems convenient to study their association, if any, with age. Since habitu and habitf appear broadly similar, in fact they even present almost identical frequency distributions, only age-habitu will be studied and the general features of the conclusion will - for the moment - be extended to age-habitf as well. The SPSS one-way (analysis of variance) subprogram allows us to study differences between subgroups as well as the existence of curvilinear and linear trends. It must be borne in mind, however, that if the predominant underlying trend for the variation of habitu with age is curvilinear - especially if it includes one or more inflexion points - there is a great risk that habitu's categorization will distort the nature of the variability, or even let it pass undetected. Figure III.3-1 sufficiently ilustrates the point for two of the most simple cases.



a) quadratic trend

$Y = B_2X^2 + B_1X + A$

I. five categories
II. three categories

b) quadratic trend

$Y = B_2X^2 + B_1X + A$

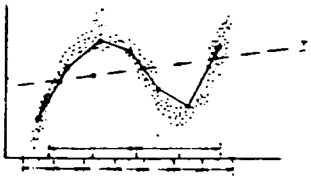
I. two categories

c) cubic trend

$Y = B_3X^3 + B_2X^2 + B_1X + A$

I. four categories
II. three categories

Fig. III.3-1. In graphs (a), (b), (c) and (d) the clouds of points represent for two different samples the values of variable Y as a function of variable X. Both variates are continuous. The best fits are a quadratic curve and a cubic curve. However, if X is dealt with as a categoric variate the goodness of fit depends directly on the number of categories and or their relationship to inflection points maxima and minima. The number of categories may be too small for eliciting the real trend and, instead, a severely distorted one may be detected - for instance, at (b) I, (c) II and (d) II. In general. if the subgroup means in a oneway analysis of variance are to characterise those categories, a number of them equal at least to the degree of the best fit plus one is recommended. Notice that the categories of X may correspond to unequal intervals of the underlying continuous variation - for example, at (a) II. Indeed, it may turn out impossible to guarantee anything else.



d) cubic trend

$Y = B_3X^3 + B_2X^2 + B_1X + A$

I. seven categories
II. two categories

We have no way to increase habitu's sensitivity to variation with age, in case the number of categories proves to be inadequate, but we can study graphically that variation by plotting the changes in relative proportions between habitu's categories, with 1 and 2 conveniently combined together (fig. III.3-2). Since category number 2 includes so few cases, the nature of the conclusions will not be altered significantly. The function regressed on age is really a combination of number of cases and categoric values, in fact habitu's mean within each agegroup, which implies that habitu has been dealt with as interval-level, one more reason to make it dichotomous for the present case. At each point the function plotted reveals, at that agegroup, its average proximity to the one or the other condition, exposer versus non-exposer. The trends are strikingly linear among Swedes for both sexes, and the lines run practically parallel to the horizontal (age) axis. Hence, it is permissible to use the analysis of variance in relative safety. No similar scattergrams were plotted for Spaniards and the British, since the agegroups which could possibly introduce curvilinearity into the picture are empty.

The use of the one-way analysis of variance requires the fulfilment of three assumptions: 1) normal distribution of scores within each treatment population, 2) homogeneity of variance across treatment populations belonging to the same population, and 3) independence between errors associated with any pair of observations. Since the data within each treatment population correspond to independent observations it will be assumed that the third requirement has been met. Unfortunately, the age variable in all samples shows gross departures from normality, while homogeneity of variance is at times absent from the samples, at the 0.05 level. Considerable departures from normality can be neglected provided that group sizes are relatively large, while heterogeneity of variance may be disregarded whenever group sizes are equal or a correction to the d.f. value - for two-group comparisons - is otherwise applied (Hays, 1981). We shall then not rely too heavily on conclusions drawn from analysis of samples containing small-sized groups (fewer than thirty cases) or divided into more than two categories.

The results (tables III.3-3) show a general trend for decreasing exposure of the inner arm to radiation with increasing age, although only among

	N	$\bar{x}$	s	Bartlett's F p	F/t p	N	$\bar{x}$	s	Bartlett's F p	F/t p
Swe+Aswe o	85	22.035	11.793			47	33.255	22.395		
	171 163	22.626 22.423	13.487 13.127	1.952 0.163	0.118 0.732 -	346 319	26.884 26.962	16.642 16.789	8.255 0.004	1.880 • 0.062 -
	8	26.750	20.240	2.579 0.076	0.484 0.617 -	27	25.963	15.040	4.346 0.013	2.803 0.062 -
	79	21.823	11.255			43	34.023	21.617		
	152	23.309	13.668	3.686 0.055	0.691 0.407 -	317	27.814	16.934	4.965 0.026	1.810 • 0.078 -
	6	24.833	18.713			4	25.000	32.383		
	19	17.158	10.741	2.693 0.101	1.614 0.217 -	29	16.724	7.718	20.540 0.000	0.509 • 0.652 -
Spa+Aspa o	28	26.857	11.696			18	31.389	15.707		
	84	22.107	4.220	51.211 0.000	2.104 • 0.044 -	103 102	21.204 21.245	2.727 2.708	145.290 0.000	2.744 • 0.016 -
						1	17.000		144.894 0.000	19.216 0.000 +
	23	26.957	12.640			14	29.357	13.954		
	77	22.052	4.192	52.301 0.000	1.831 • 0.076 -	97	21.258	2.796	104.913 0.000	2.166 • 0.046 -
	5	26.400	6.656			4	38.500	21.626		
	7	22.714	4.821	0.463 0.497	1.251 0.290 -	6	20.333	0.817	25.261 0.000	1.679 • 0.188 -
Gb+Agb o	17	21.000	3.708			14	22.071	4.548		
	21	21.095	3.961	0.075 0.784	0.006 0.940 -	35 34	20.029 20.029	3.111 3.157	2.903 0.089	1.542 • 0.150 -
						1	20.000		2.677 0.102	1.605 0.212 -
	13	21.462	4.115			14	22.071	4.548		
	19	21.263	4.134	0.000 0.985	0.018 0.895 -	32	20.125	3.210	2.338 0.126	2.760 0.104 -
	4	19.500	1.291							
	2	19.500	0.707	0.320 0.577	0.000 1.000 -					

Table III.3-3. Oneway anova: age-habitu.

Legend.

1. Swe+Aswe, Spa+Aspa and Gb+Agb have been studied under two alternatives: 'habitu' as a dichotomous variable (first and second rows), and habitu as a trichotomous variable (first, third and fourth rows). Conclusions based on the results of calculations involving the trichotomous alternative are not always reliable.
2. In some cases (marked •) the Student-t has been calculated instead of parameter F.
3. Significance (+/-) has been referred to level 0.05.

agegroup	habitu	n	habitu's mean
1	0	0	
	1	2	1.000
	2	0	
2	0	2	
	1	5	0.750
	2	1	
3	0	13	
	1	30	0.698
	2	0	
4	0	62	
	1	91	0.605
	2	4	
5	0	16	
	1	43	0.742
	2	3	
total		272	

agegroup	habitu	n	habitu's mean
1	0	2	
	1	2	0.500
	2	0	
2	0	1	
	1	9	0.900
	2	0	
3	0	6	
	1	56	0.913
	2	7	
4	0	21	
	1	150	0.888
	2	16	
5	0	24	
	1	111	0.835
	2	10	
total		415	

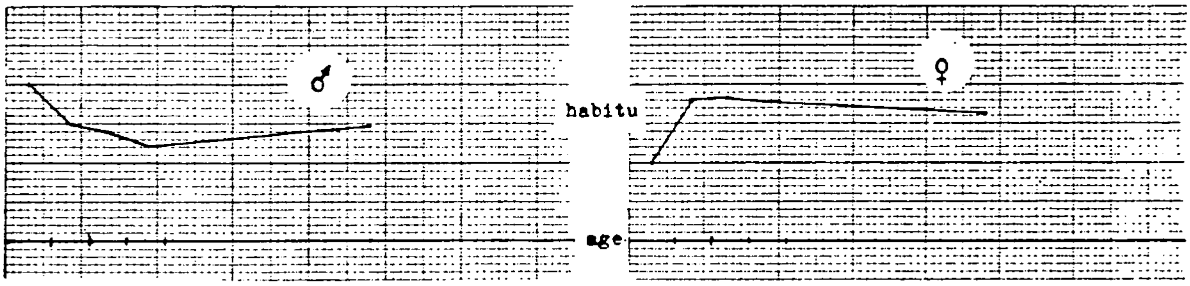


Fig. III.3-2. Variability of habitu with age (agegroup).

Legend.
1. Habitu=1 and habitu=2 have been pooled together.
2. The upper limits of agegroups 1 to 5 are 6, 11, 16, 21 and - for this survey - 75 years of age.

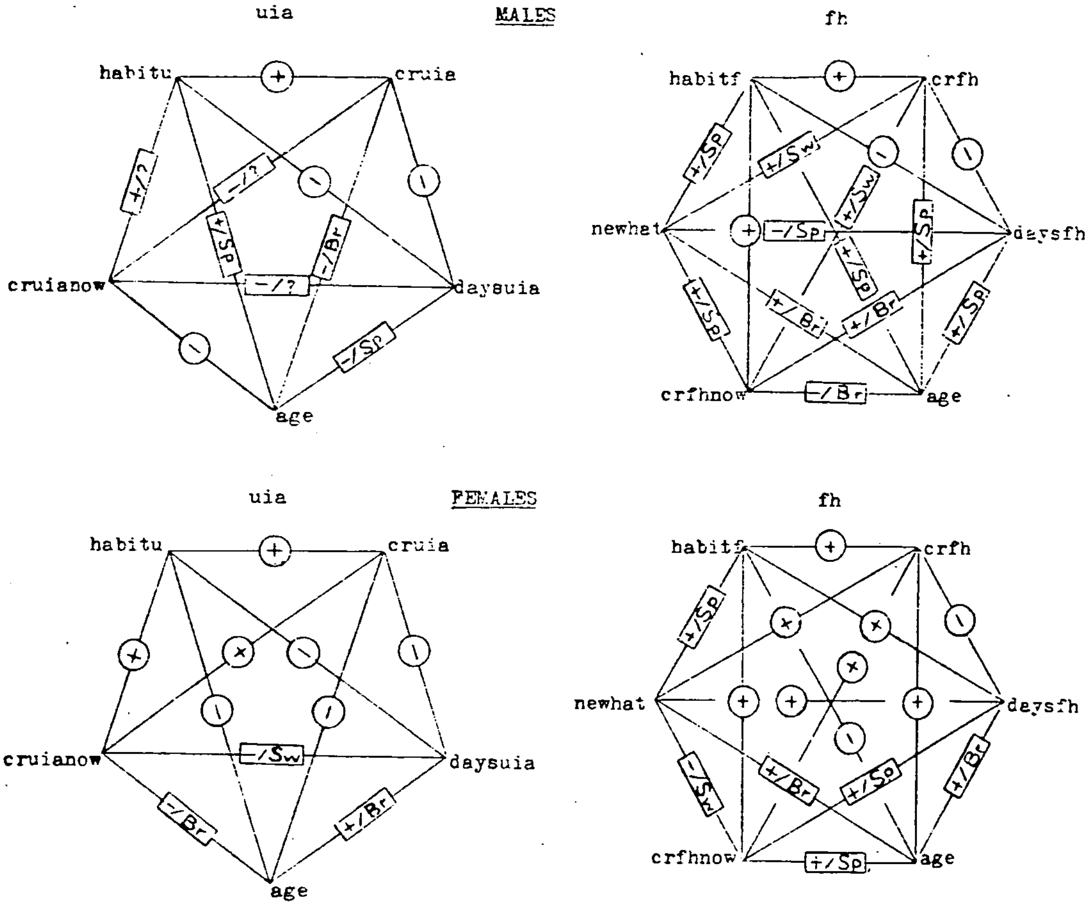


Fig. III.3-3. Kinds of associations between independent variables: + for positive correlation, - for negative correlation. (All variables, except age and days- , are dichotomous). (All correlations are simple) Sw, Sp and Br stand respectively for Swedes, Spaniards and British. To the right hand side of / they indicate exceptions.

Spaniards (♂, ♀) is significance attained (at better than the 0.05 level). Swedish females approach significance at that level, while all other samples are far removed from any acceptable levels. Among Swedish and British males at least within the bigger samples the opposite tendency predominates: increasing exposure with age. These results corroborate, thus, what was previously obtained for the scattergrams. Differences between categories are significant among Spaniards - males and females - at better than the 0.05 level, with Swedish females coming close.

All correlations between primary independent variables have been explored as well as a preliminary step to a multiple regression analysis, to be dealt with later. The results (table C.1) for the samples have for convenience been arranged into four polygons (fig. III.3-3), one for each site and place. All four have the following in common: the correlations between days-, on the one hand, and cr- and habit-, on the other, are negative; while the correlations between habit-, on the one hand, with cr- and cr-now (when this variable is not devoid of information), on the other, are positive. In other words, users normally had had their last exposure more recently and tended both to use protecting oils and to have worn some kind of cream during the test. The rest of the correlations are of less constant type, especially among men. Significance at the 0.05 level or better is only attained in a handful of cases, normally when either habitu or habitf are involved. Significant correlations are: Habit- with cr-.

Habit- with cr-. For Swedish males at both sites.
All women at the forehead.
Habit- with days-. Among Swedish and Spanish males at both sites. Approached by British males at both sites.

Habit- with age. Spanish males and Spanish and British females, all at both sites (but the first only approach significance).
The rest are considerably less simetric:
Cr- with cr-now. Among Swedish females at both sites and Spanish females at the forehead.
Cr- with days-. Among Swedish females at the inner arm and Spanish females at the forehead. Approached by Swedish males at the forehead.
Cr-now with age. Among Swedish females at the forehead. Approached by British females at the inner arm.
Days- with age. Among Spanish males and females and Swedish females at both sites.
Newhat with crfhnow. Among Spanish males and Swedish females (at the forehead).
Newhat with age. Among Swedish males and females (at the forehead).

Summary

Sunbathing activities and the use of sun creams appear to be positively associated among Swedes,(both sexes and sites), but no significant associations could be elicited among the British or the Spaniards.

The proportions of exposers vs. non-exposers (new variables habitu and habitf) appear to differ very little from those for sboften, and are very similar when comparing sites within each sex. This denotes the small extent of the use of sunlamps in these populations and the existence of parallel patterns of exposure for inner arms and foreheads.

Exposure of the inner arm to radiation seems in general to decrease slowly with age, but significance was only detected among the Spaniards (both sexes).

The intricate pattern of intercorrelations existing between age and the behavioural variables is better studied through the diagrams in figure III.3-3.

CHAPTER IV

IV.1. The impact of exposure on pigmentation.

Although genetics is the main factor in determining pigmentation, the importance of the environment - sensu lato - in modifying it can hardly be denied. The visible effects of UV radiation on human skin are well known to everybody. Exhaustive research has been conducted on aspects of radiation effects at the histological and cellular level. Briefly surveying what it has been reported elsewhere (Edwards & Duntley, 1939; Thomson, 1951; Jansen, 1953; Lee & Lasker, 1959; Harmse, 1964; Ramsay & Challoner, 1976), the sequence of events after irradiation of a screen area and subsequent withdrawal from further radiation, seem to be as following: erythema comes as a first sequel, immediately followed by hyperemia (increased blood flow, with displacement of the haemoglobinic balance towards the oxygenic side) - detectable by increased skin temperature and increased pulse rate. Diminished sweating rate, accompanied by vesicular rash, can also appear. The new skin colour is, until now, pinkish-red and the only part of the reflectance curve affected by the new condition is the blue-green, which is lower. Melanin starts forming, however, and lowers both ends of the spectrum, but its effects on the middle region are partly masked by the intensive absorption exerted by the blood. When melanin reaches the uppermost layers of the epidermis the whole spectrum becomes affected, specifically the blue end. Colour has shifted to a darker and less reddish hue. Meanwhile the hyperemic condition has started receding: blood flow goes on diminishing, the proportion of reduced haemoglobin increases and long-lasting blood stagnation takes place. With this last haemoglobin shift, the relative depletion of the central region becomes less pronounced. All these changes can go on during extremely long periods of time. In for instance Edwards and Duntley's experiment, hyperemia is maximal at 11 hours, melanin at 19 days and blood stagnation persisted for longer than nine months. Nine and a half months after irradiation - a single one hour exposure to the August mid-day sun - the reflectance curve had not yet returned to its original values (Edwards & Duntley, 1939).

In spite of all theoretical knowledge of the effects of the external environment on pigmentation, we have made little progress concerning the numerical evaluation of the relationship. There are two main obstacles. Firstly, we rarely have enough precise information concerning UV radiation levels in the environment, and, secondly, human habits - including the frequency and extent of exposure to radiation - do not easily lend themselves to quantification. We are not better off concerning the influence of the internal milieu on pigmentation. No attempt was made to obtain information on either hormone-mediated abnormalities or cyclic changes of the internal environment, the human body itself, or the potential effects of nutrition in skin colour. Since certain parts of the questionnaire were at this point controversial enough to some of those tested and since the whole test was already time-consuming, the experimenter felt it was advisable not to add any further questions. The impact of age ~~days~~ and sex on pigmentation will be considered in more detail in other sections. Here we will concentrate mainly on the effects of behaviour on pigmentation.

When considered individually one would suspect frequency of exposure to radiation to be the best predictor among all variables regarding the influence from the external environment. We have, besides, defined three categories for variables habitu and habitf, but the highest of them corresponds to those cases frequently exposed to not only solar radiation (uvoften=1) but also artificial radiation (sloften=1) at the proper site. Since this last category has very few cases in any sample, we wonder whether it would not be advisable to integrate categories 1 and 2 into one (exposers) as opposed to non-exposers. Accordingly, we will explore variable uia9's variation across habitu's categories and extend our conclusions to the forehead as well. This should be a valid strategy for purposes of orientation and any existing trend should appear more clearly at the inner arm where, because of its being normally unexposed, differences between exposers and non-exposers should be maximal.

Table IV.1-1 shows the result from a one-way analysis of variance for Swedes, Spaniards and the British. For purposes of comparison 'pure' Swedes, Spaniards and the British as well as Asve, Aspa and Agb have been included along with the 3/4 samples. The results for two and three categories are included in the table. The third category is represented by only 8 and 27 cases within the big Swedish samples (3/4 selective criterium) and by either none or just one within the other samples. The homogeneity of variance assumption is a valid one for all composite samples except for the Spanish females, and for all individual samples except for Asve -males and females- ans Spa -females. In all these cases, however, substituting the F-test by a simple t-test for two samples with a df correction for unequal number of scores, a full-scale violation of the requirement could be avoided. No serious violation of the normality assumption has presumably taken place either at this level, at least for the composite samples, since at an inferior level the groups selected by combining categories of habitu and cruia (table

	♂					♀				
	N	$\bar{x}$	$\hat{s}$	Bartlett's F p	F/t p	N	$\bar{x}$	$\hat{s}$	Bartlett's F p	F/t p
Swe + Aswe	84	65.914	4.035			47	65.915	4.323		
	165 157	65.373 65.472	3.812 3.733	0.361 0.548	1.084 0.299 -	335 308	64.754 64.626	4.309 4.375	0.154 0.694	3.034 0.082 -
	8	63.438	5.035	0.905 0.405	1.591 0.206 -	27	66.207	3.192	2.049 0.129	3.221 0.041 +
Swe	79	66.189	3.672			43	66.023	3.907		
	146	65.370	3.884	0.316 0.574	2.360 0.126 -	308	64.723	4.400	0.974 0.324	3.378 0.067 -
Aswe	5	61.580	7.066			4	64.750	6.702		
	19	65.395	3.289	4.643 0.032	1.174 + 0.284 -	27	65.100	3.132	4.165 0.042	0.103 + 0.926 -
Spa + Aspa	28	62.596	4.387			18	63.500	2.419		
	84	60.348	3.917	0.537 0.464	6.512 0.012 +	103 102	62.233 62.250	4.161 4.178	6.494 0.011	1.804 + 0.080 -
						1	60.500		6.635 0.010	0.877 0.419 -
Spa	23	62.965	4.375			14	63.143	2.357		
	77	60.278	3.975	0.338 0.573	7.725 0.007 +	97	62.309	4.248	5.781 0.016	1.092 + 0.280 -
Aspa	5	60.900	4.506			4	64.750	2.533		
	7	61.114	3.363	0.380 0.538	0.009 0.926 -	6	61.000	2.214	0.061 0.805	6.171 0.038 +
Gb + Agb	17	64.082	3.354			14	65.500	3.216		
	21	64.971	3.246	0.018 0.892	0.685 0.413 -	35 34	64.143 64.068	3.072 3.085	0.039 0.843	1.900 0.175 -
						1	66.700		0.032 0.858	1.289 0.285 -
Gb	13	64.808	3.295			14	65.500	3.216		
	19	65.126	3.379	0.009 0.925	0.067 0.797 -	32	64.516	2.552	1.010 0.315	1.233 0.273 -
Agb	4	61.725	2.621							
	2	63.500	0.707	1.195 0.286	0.796 0.423 -					

Table IV.1-1. Oneway anova: uia9-habitu.

Legend.

1. Swe+Aswe, Spa+Aspa and Gb+Agb have been studied under two alternatives: 'habitu' as a dichotomous variable (first and second rows), and habitu as a trichotomous variable (first, third and fourth rows). Conclusions based on the results of calculations involving the trichotomous alternative are not always reliable.
2. In some cases (marked *) the Student-t has been calculated instead of parameter F.
3. Significance (+/-) has been referred to level 0.05.

B.2) present good figures for normality at the ninth filter (except for British males and females - kurtosis).

There is a general trend for increasing pigmentation with greater exposure to radiation, which goes unchallanged as long as none of the sub-groups' sizes is smaller than thirty (at times not even then) although significance is not always attained. Its validity for the composite samples is practically universal, the only clear exception being British males (n.s.), with significance either approached or attained by Swedes (♀) and Spaniards (♂ and ♀) - especially by the Spanish males. The same is true also for Swe (♀), Spa (♂) - most evident again - and Aspa (♀). The trend does not, however, appear as significant when the correlations between uia9 and habitu (dicategoric) are examined (table C.2), although it does for the four/five first filters (eventually some of the others as well) among Swedes (♂ and ♀) and Spaniards (♂). There is also a positive correlation between cruia and habitu, eventually significant (Swedish ♂: 0.002) or close (Swedish ♀: 0.074, Spanish ♀: 0.082), whose effect on the correlation between pigmentation and habitu has not been removed and which could in principle be expected to be additive and reinforce habitu's impact on pigmentation. This is not, however, always the case as will be seen later.

Because of practical limitations concerning the size of the sub-groups, deciding whether predictor habitu should retain its three categories is really a valid issue only for the two composite Swedish samples. The greatest contrasts exist between categories 0 and 2 for Swedish males and between 0 and 1 plus 2 and 1 for Swedish females. A LDS post hoc comparison reveals them as significant at only the 0.10 level. Inspection of the polynomial trends when the number of categories is fully arbitrary is not of real assistance, since the best available fit is a function of the elected number, which in turn means that any best fit might have to be discarded whenever changing our choice to a higher number of categories. Under those conditions, abandoning the perfect linearity of the dichotomous state (a practical advantage when dealing later with regression analysis) in favour of the conditional suitability of a curvilinear fit, which is not significantly better at detecting between-groups differences, does not seem fully justified. An additional objection is that habitu's third category - in conjunction with the other predictors (four for the inner arm) - automatically enlarges the number of sub-groups already existing by a figure equal to the total number of combinations which can be performed with those four variables' categories. This results in a major reduction in the average number of cases per sub-group, which, in its turn, is not desirable in regression and analysis of variance calculations. Therefore, while studying the changes in pigmentation across habitu's three categories is not devoid of interest, the disadvantages brought about be retaining the third category are not sufficiently counterbalanced by the advantages. A similar argument is applicable to habitf as well.

An important aspect of the previous discussion is that it considers a very relevant methodological matter, namely that of defining and quantifying the behavioural variables. Obviously, as long as behavioural traits have to be dealt with under non-laboratory conditions, we will be unable to control and evaluate them, in terms of either degree or pattern of recurrence. Even with a post hoc categorization, when relying on the human mind to recollect past activities as the only standard in the evaluation of variables, will the accuracy of the quantification be seriously jeopardized, subject - as it will be - to failing memory and subjectivity. At best, a basically continuous variation will have been correctly categorized into two/three positions which is itself a very unsatisfactory procedure. One theoretical way out of the problem would be exactly reproducing the experiment under laboratory conditions, involving persuading hundreds of persons to participate in an experiment that, for scientific rigour, would repeatedly require their collaboration for several months. Another possibility contemplates augmenting the number of categories to six/seven or more. For instance, for sboften and sloften (two of habit-'s foundations): very often, often, moderately, at times, seldom, never. Here, however, subjectivity in comprehending these categories and evaluating one's own behaviour would enlarge the number of misplaced cases and greatly endanger any potential improvement. Such partition would statistically demand from each sample a much bigger size than that which the experimenter considered to be a reasonable expectation and, in addition, it was felt, it would have been resented as too tedious by those tested. For all these reasons and under the present circumstances, the idea of structuring the basic behavioural variables into more than two categories was abandoned as non realistic.

The graphics in figures IV.1-1 and IV.1-2, a to f, illustrate the relationships between pigmentation and the most important behavioural variables. The simple beta regression coefficients - represented at the nine filters - have been extracted from table C.2, since for bivariate regression the beta regression coefficients are identical with the bivariate correlation coefficients. The partial beta

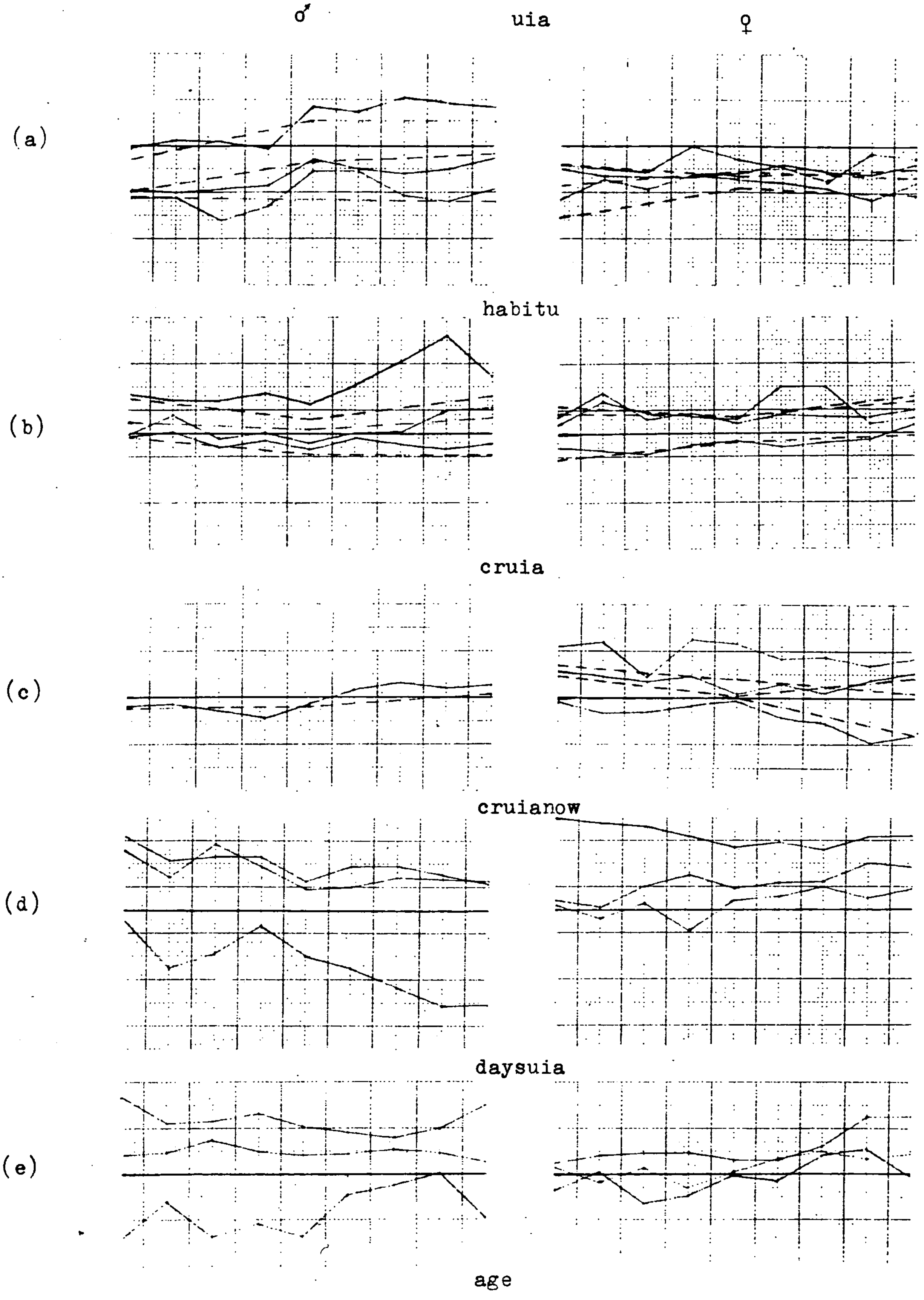


Fig. IV.1-1. The exposure variables and pigmentation. Beta regression coefficients: simple (—) at filters 1 to 9 and partial (- -) at filters 1, 5 and 9. Site: the inner arm.

Sex	♂		♀		Site
Swe+Aswe	207 (—)	235 (--)	319 (—)	364 (--)	uia
Spa+Aspa	76	112	78	117	
Gb+Agb	31	37	45	48	

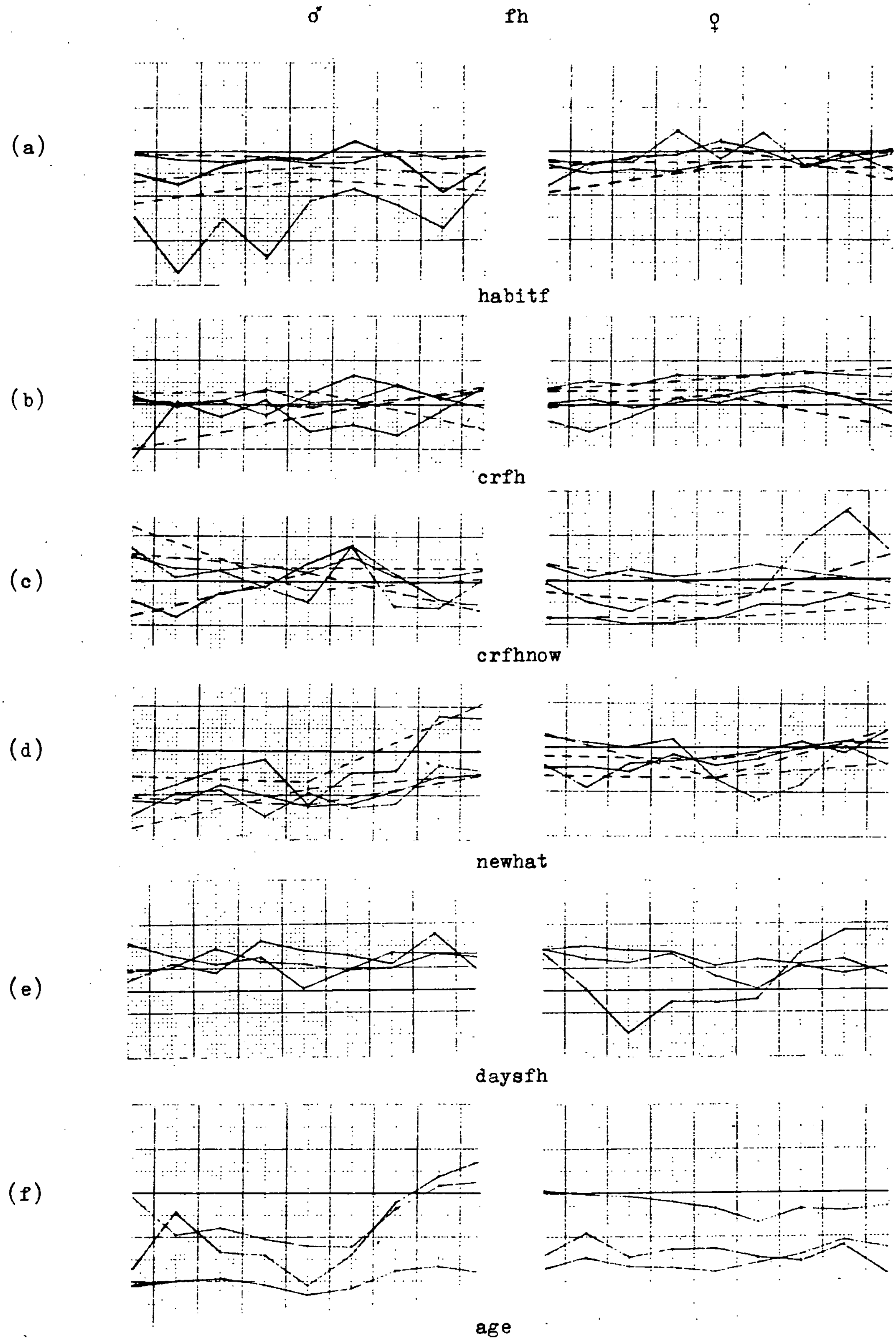


Fig. IV.1-2. The exposure variables and pigmentation. Beta regression coefficients: simple (—) at filters 1 to 9 and partial (- -) at filters 1, 5 and 9. Site: the forehead.

Sex	♂		♀		Site
Swe+Aswe	211 (—)	223 (--)	327 (—)	339 (--)	fh
Spa+Aspa	104	108	105	111	
Gb+Agb	32	36	46	48	

regression coefficients - at filters 1, 5 and 9 - have also been plotted for comparison (table D.1). In each case the effect of the other behavioural variables has been removed from the correlation with pigmentation. No correction for the effects of age and daysuia/fh has been attempted in this section.

All independent variables here have two categories labeled 0 (no trait) and 1 (trait). Recalling that in the case of variable newhat the trait is exposure of the forehead, one could perhaps expect sub-groups possessing the trait to be normally darker than those which do not. The pattern is, however, far from homogeneous, with women presenting the most coherent picture. We will look at the situation for males and females separately, leaving variables cruianow and crfhnow to be studied independently.

1. Variables habitu, cruia, habitf, crfh and newhat.

1.a. Males.

Neither frequent sunbathers nor users of protective creams and lotions consistently reflect less light at every filter, often at no filter at all. Among the present samples, this is true of the British for habitu (green and red regions) of the British and Spaniards for cruia, of Swedes (blue and red) and Spaniards (blue and green) for crfh and of the British (red region) for newhat. In all other cases exposers and users are darker. Levels of significance (table C.2) deteriorate with decreasing size of the sample, but there is no clearly consistent trend between both ends of the VL spectrum. When comparing analogous variables, the significance levels are consistently better at the inner arm, but no attempt was made to see whether differences between corresponding coefficients were significant or not. That was only logical since differences between exposers and non-exposers at the forehead must necessarily be much more diffuse than at the inner arm. When considering the variables, the best significance levels are offered by newhat, then by habit- and then by cr-.

For variable newhat, Swedes and Spaniards show good significance figures (often at the 0.001 level) throughout the first seven filters. For habitu, Swedes and Spaniards have rather good levels which, much weakened, reappear again at filters 7 and 8. For habitf, non-significance is the rule (with an occasional 0.062 at fh8 for Spaniards) except for the British sample (significant or relatively close to it at filters 2, 3, 4 and 8). For cruia non significance again, but the British either come close or start an approcach at filters 7 and 8. For all other variables and at all other filters and samples the coefficients are far from significance. Even if the partial regression coefficients come from bigger samples their introduction in the picture does not alter it substantially - although a couple of coefficients change sign (Spaniards: uia5-cruia, Swedes: uia5-crfh) - except for the fact that now all pigmentation-habitf coefficients for the British sample have been taken out of the 0.100-0.000 significance zone.

No matter how good or bad their significance levels, the regression coefficients reflect the variables' real importance in the sample context. For this reason it should be enlightening to have a closer look at them and their mutual relationships when partial correlations are considered. The resulting pattern among Swedes and Spaniards is similar (fig. IV.1-1 and IV.1-2, a to c) in spite of underlying differences in the signs of the newhat-daysfh age-daysuia, age-daysfh and habitu-age coefficients (fig. III.3-3). The contradiction is, however, more apparent than real since at least one of the pair of coefficients in each case is very low. In both samples exposers at either site are darkest, which agrees well with the fact that they have as a rule sunbathed more recently (good significance) and with a positive often good correlation between pigmentation and daysuia. Bare foreheads are also darker in both samples, in accordance with the fact that bare foreheads had been exposed more recently to radiation (although only the Swedish figure was significant). Users of protective creams are lighter at the inner arm among Spaniards, darker among Swedes and both lighter and darker - depending on the wavelength - at the forehead (low coefficients all over). Considering the underlying correlations and those of days- and age with pigmentation, pigmentation-cruia for Spaniards and pigmentation-crfh for Swedes are apparently not coherent with the rest, until age-days- is introduced into the picture.

Among the British, on the inner arm exposers are lighter at the red and green regions of the spectrum and on the forehead they are darker, which agrees well with days-'s and age's impact on habit-'s vía the correlations habitu-days-, habitf-days-, habitu-age and habitf-age. Users of creams are totally lighter or partially so, depending on whether the inner arm or the forehead are considered. The pattern is in agreement with that one offered by days- and age with pigmentation and with the underlying correlations of days- and age with cruia and crfh.

1.b. Females.

Unlike males, exposers are always darker (except fh5-habitf for Spaniards). Users are most often lighter: Spaniards and the British at the inner arm and Spaniards, Swedes and the British (green-red regions) at the forehead. Bare foreheads are darker at most filters (especially among Swedes and the British). Levels of significance deteriorate with decreasing sample size, but not clearly along the spectrum of visible light. In general, they are worse than among males. The significance levels are again normally better at the inner arm. Among the variables, the best significance levels belong to habitu, followed by newhat, habitf and then cr-.

Variable newhat never reaches significance at the 0.01 level but, for the three first filters among Swedes and filters number 6 and 7 among Spaniards, it varies between 0.09 and 0.01. Habitu (filters 1 to 5, plus 7 and 8) and habitf (filters 2 and 4)show significance levels which also fluctuate between 0.09 and the vicinity of 0.01. Cruia shows significant figures around 0.08 among Swedes (third filter) and Spaniards (sixth and seventh filters). For other variables, samples and filters significance figures are away from any currently accepted level. The introduction of the partial correlation coefficients does not alter the picture substantially, in spite of change of sign of two coefficients (Swedes: uia9-cruia and the British: uia9-habitf).

Considering now the partial correlations, exposers are at either site darker (practically without exception). Users of creams are lighter, except for Swedes at the inner arm and the British - partially - at the forehead. Bare foreheads are darker although never at the three filters. The patterns for habitu, cruia and crfh among the three samples agree well with the underlying relationships existing between those variables and days- plus age. For habitf, Swedes and Spaniards agree well also when considering the strength in their underlying correlations but the British need fuller explanation. When turning to newhat, only Swedes agree well with the correlations in the background.

2. Variables cruianow and crfhnow.

Extremely few men in the samples wear creams of some kind while been tested, either on the inner part of the upper arm or on the forehead (lowest: 0.73 %, Swedes; highest: 6.82 %, British), and few women wear them on the inner arm (lowest: 4.08 %, the British; highest: 5.65 %, Spaniards). With population frequencies of that general order of magnitude there is a distinctive chance for means within a sample's less common categories to depart considerably from the population values, consequently endangering the reliability of observed trends and associations. For this reason the results obtained for these two variables are not totally reliable. For women's foreheads the situation is comparable with that of other variables since the use of colouring creams, generally as make-up, is much more frequent.

When comparing corresponding samples, significance levels are always better for females. Within every sample they are also better atthe forehead, except among Spanish women where the opposite is true. When displayed, significance is normally shown by some of the first five or seven filters, but occasionally also by some of the four last filters - isolated. Within the significant block there is no clear trend as to whether significance figures improve or not towards the blue region of the spectrum. Also, when considering sample size the tendency is unclear, although the British show consistently the worst figures. Acceptable (or nearly so) figures vary normally between 0.060 and 0.020 but some reach even beyond the 0.010 level.

Only the Spanish females (cruianow) and the Swedish females (crfhnow) show blocks with at least acceptable significance levels. Introduction of the partial coefficients does not alter the pattern appreciably, except for the total extraction of the Spanish females (cruianow) and the British females (crfhnow) from the 0.100-0.000 significance zone.

When turning to the partial correlations, inner arms wearing creams are predominantly lighter, except for British females. Foreheads among males are also mainly lighter, except among Spaniards, whereas they are mostly darker among females. The pattern does not seem to fit well with the most visible of the underlying correlations, at the inner arm for Spaniards (males and females) and at the forehead for Spaniards and British (both males and females). It agrees well, on the other hand, with the assumption that most creams used by men at either site and by women on the inner arm are generally of the non-cosmetic kind (e.g. anti-acne salves, humidifying ointments, etc), and are instead mainly colourless or whitish, glossy and - presumably - efficient reflectants, while those applied by women on the forehead are normally coloured make-up.

Although some generalizations can be made, there seems to be little chance for extracting any sort of general pattern from what has been indicated. An independent variable's internal variation does not always produce the same kind of impact on the dependent variable, pigmentation, across samples or even along filters within each sample. One might perhaps expect that, within a certain sample and for a variable X_i, a change of a certain kind from category C_1 to category C_2 would always be accompanied by a definite sort of change in the independent variable, implying constancy in at least the direction of the effects along the spectrum. But this is not the case. Undoubtedly, greater sample sizes are likely to improve the picture somewhat, but it is very improbable that this is the only reason. Indeed, among physical objects not differing too much in colour, it is a common situation within a pair that one be lighter than the other at certain regions of the reflectance curve and darker at the remaining ones. When extrapolating to human skins arranged in dichotomies according to colour, it must be borne in mind that each category will include skins at different stages along the erythematic, hyperemic and melanizing processes, together in combination producing a complex average reflectance curve to which the observations above should be made extensive.

Edwards and Duntley's experiment (1939) provides us with a graphical account of how such a situation can arise for a variable such as for instance, habitu. Figure IV.1-3 illustrates a single skin's

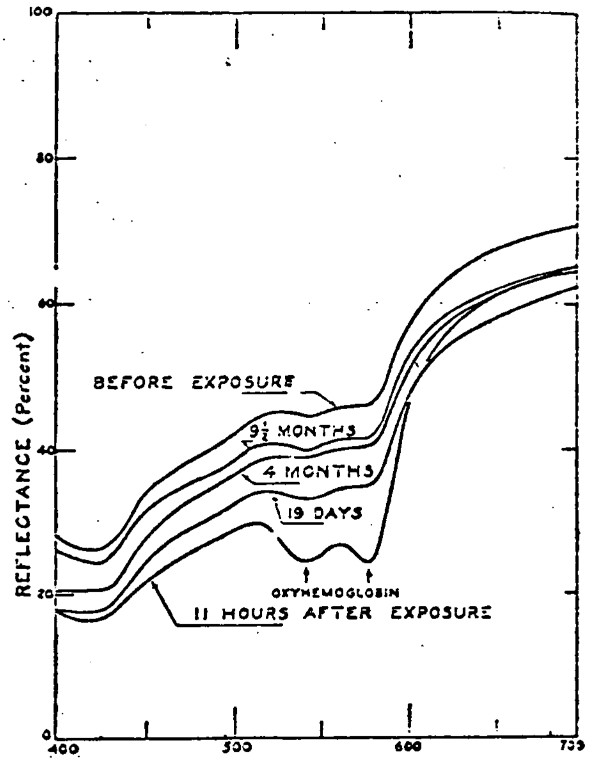


Fig. IV.1-3. Spectrophotometric curves of the skin after a single exposure to sunlight. Hyperemia (oxyhemoglobin) is maximal at 11 hours, melanin at 19 days and melanoid at 4 months. Blood stagnation, as registered by reduced hemoglobin, persists from the time of the early disappearance of hyperemia for over nine months.
(After Edwards & Duntley, 1939).

chromatic evolution after "a single one-hour exposure to the mid-day sun (in August)". Each pair of reflectance curves could in principle be taken to represent any of our samples with their two categories. For every intersection between the curves under consideration there will be a change of sign in the correlation coefficient. Certain curves are more likely to represent one of the categories than the other but within each pair, their relative position and the distance between them admit theoretically an infinite number of possibilities. Two of these have been plotted (fig. IV.1-5) for each of the ten basic available combinations. It can be shown, fig. IV.1-4, that for dicategoric independent variables with values 0 and 1, the dependent variable's regression on them is expressed at each wavelength by a correlation coefficient equal to

$$\Delta y \cdot (s_x / s_y) \qquad \text{(IV.1-1)}$$

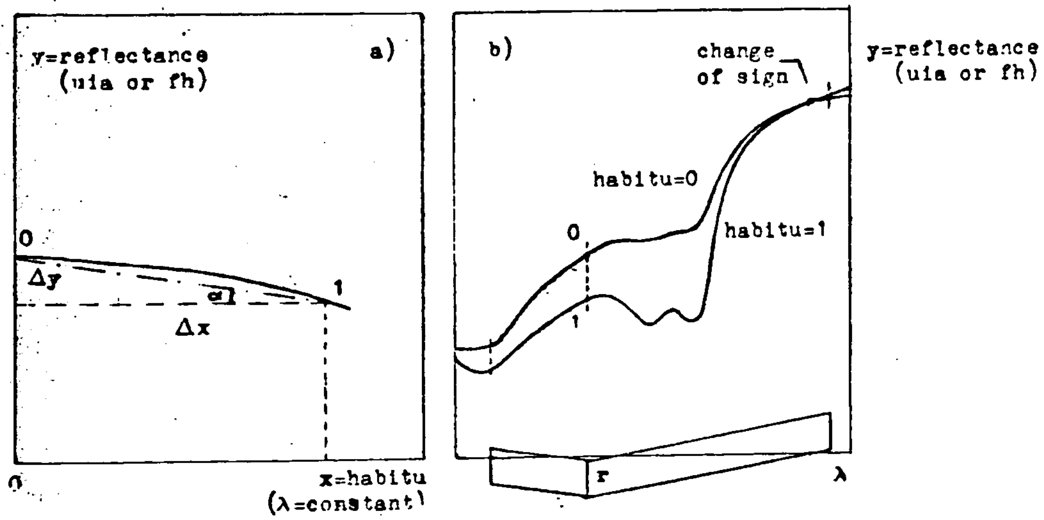


Fig. IV.1-4.

If the independent variable is dichotomous and its two values differ by one unit, the regression coefficient for bivariate correlation, $B=\Delta y/\Delta x$, is equal to Δy.
Since for bivariate correlation the correlation coefficient, r, is identical to the beta regression coefficient, $beta=B.(s_x/s_y)$, its value will be

$$r = \Delta y . \frac{s_x}{s_y}$$

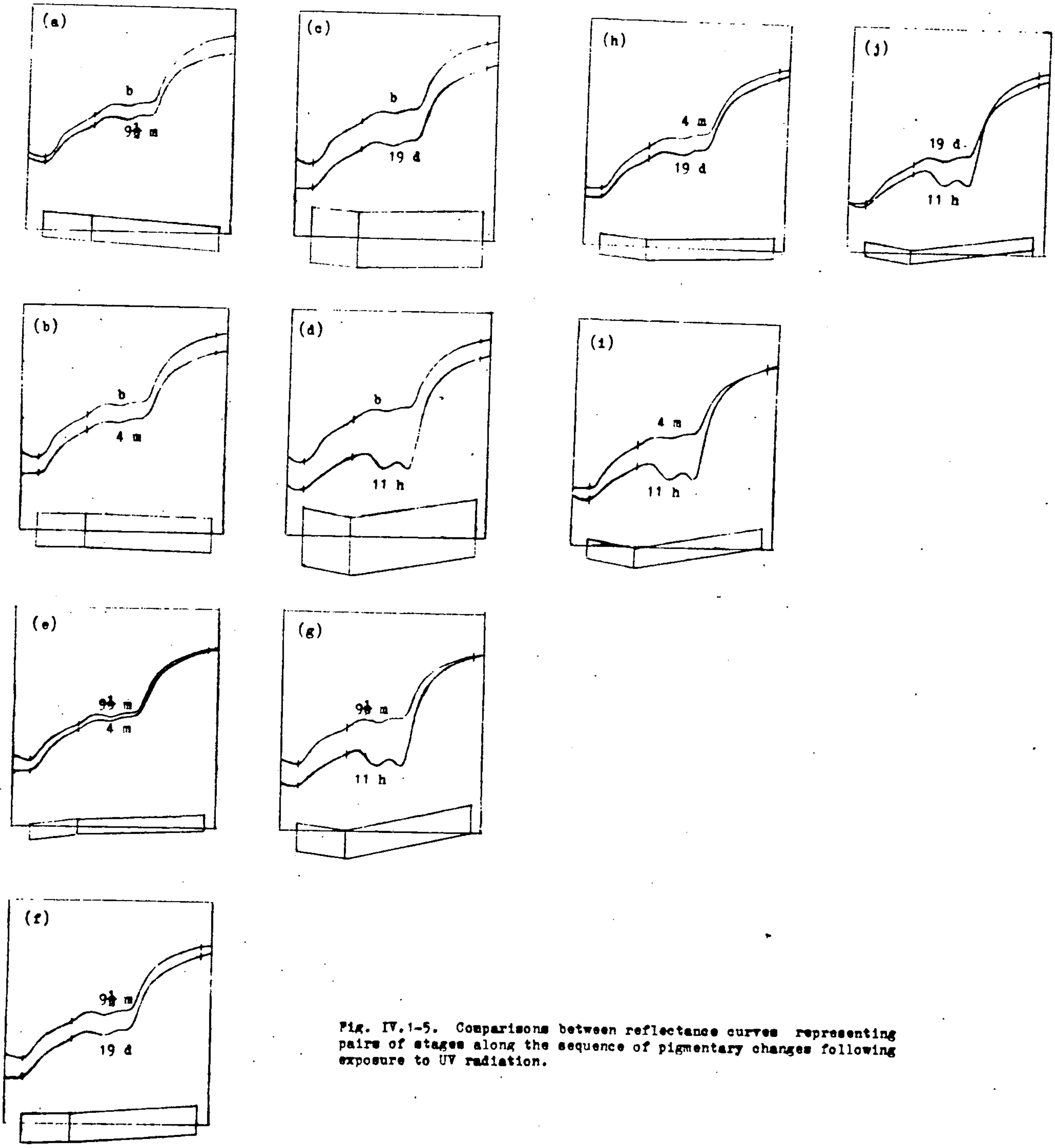


Fig. IV.1-5. Comparisons between reflectance curves representing pairs of stages along the sequence of pigmentary changes following exposure to UV radiation.

where Δy is the algebraic difference between the dependent variable's means for categories $C_0(\bar{x}=0)$ and $C_1(\bar{x}=1)$, y_1-y_0, at the appropiate wavelength, and s_y and s_x are their standard deviations. Y_1 and y_0 can be measured in deviation scores or gross scores. The sign of the correlation coefficient depends thus entirely on Δy's sign, while s_x is constant within each sample and s_y's role is to modify Δy's numerical value.

Any kind of agent producing dispersal/concentration and/or group displacement of the reflectance values, differentially manifested across categories of variable X_i and along wavelengths, would tend to diversify the bivariate correlation values along the spectrum, removing them from those existing if the individuals in both categories were subjected to the same behavioural conditions. Erythema, hyperemia and melanization are such agents. Erythema causes depletion of the blue and green regions of the spectrum, while hyperemia produces mainly decrease of reflectance in the green region and melanization depletes first the red region and afterwards the whole spectrum, but specifically the blue end. In addition, the three of them - by introducing new mechanisms to which each body constitution responds in its own specific way - introduce internal variation into the picture. Since they affect different regions of the spectrum, that at which the greatest difference between categories will take place mainly depends on the relative importance of the aforementioned factors at the time the measurements were taken - which leads logically to the introduction of variable time in the picture, since this one regulates the evolution of the three processes. This analysis will for the moment be postponed to another section. In graphics a to j (fig. IV.1-5) each pair of curves stands for the average reflectance curves representing the two

	Swe + Aswe						Spa + Aspa						Gb + Agb					
	♂			♀			♂			♀			♂			♀		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
	Habit- Cr- Cr-now (Newhat) Total	Age	Days-	Habit- Cr- Cr-now (Newhat) Total	Age	Days-	Habit- Cr- Cr-now (Newhat) Total	Age	Days-	Habit Cr- Cr-now (Newhat) Total	Age	Days-	Habit- Cr- Cr-now (Newhat) Total	Age	Days-	Habit- Cr- Cr-now (Newhat) Total	Age	Days-
	235			364			112			117			37			48		
1	.04123 .00041 4.163	(A1) 0.723	(Dulg) 17.556	.00967 .00874 .00830 2.671	(A3) 0.449	(Dulg) 20.340	.04785 .00315 .00019 5.120	(A1) 11.696	(Du1) 6.760	.02094 .01309 .01901 5.303	(A3) 0.325	(Duin) 0.397	.00095 .02344 2.440	(A1) 7.848	(Duin) 0.810	.08103 .01415 9.518	(A3) 0.689	(Du1) 0.176
5	.00868 .00773 1.640	(A2) 0.792	(Duin) 4.666	.02084 .00177 .00015 2.276	(A3) 0.518	(Dulg) 10.112	.04995 .00040 .00164 5.199	(A1) 4.326	(Dulg) 0.903	.00811 .00755 .00675 2.241	(A3) 0.221	(Duin) 0.828	.01438 .00350 1.788	(A3) 7.784	(Duin) 8.703	.02781 .00561 3.342	(A3) 0.073	(Du1) 0.903
9	.00332 .00776 1.109	(A2) 0.325	(Duin) 2.822	.01114 .00023 .00619 1.756	(A1) 6.300	(Dulg) 10.693	.05991 .00431 .00268 6.290	(A1) 9.242	(Dulg) 2.132	.01223 .01930 .00048 3.201	(A3) 1.369	(Dulg) 0.774	.02031 .02438 4.469	(A3) 4.884	(Dulg) 17.140	.03915 .01854 .02502 8.271	(A3) 0.221	(Du1) 3.460
	223			339			108			111			36			48		
	.00005 .00183 .01194 .04546 5.928	(A1) 17.640	(Dflg) 2.434	.00209 .00130 .03312 .00167 3.818	(A3) 8.066	(Dfin) 4.203	.01484 .00124 .00632 .11327 13.567	(A3) 0.292	(Dfin) 7.896	.00369 .00932 .00422 .00422 2.146	(A3) 0.058	(Df1) 3.648	.06165 .03260 .05655 .01374 16.454	(A1) 11.972	(Df1) 0.281	.04272 .00116 .00060 .01705 6.153	(A1) 11.834	(Dflg) 3.725
	.00251 .00042 .00220 .05762 6.275	(A1) 21.252	(Dflg) 2.958	.00184 .00200 .03382 .00250 4.016	(A3) 6.554	(Df5) 1.323	.00165 .00374 .00674 .02820 4.032	(A1) 5.856	(Dfin) 2.190	.00158 .01161 .00023 .01888 3.230	(A1) 0.449	(Dflg) 2.016	.03457 .00557 .00171 .02017 6.202	(A1) 17.724	(Dfin) 4.000	.00488 .00103 .00584 .01850 3.025	(A1) 13.104	(Dflg) 1.742
	.00012 .00542 .00315 .01255 2.123	(A1) 13.032	(Df1) 2.132	.00083 .01574 .00223 1.880	(A1) 13.888	(Dfin) 16.241	.01420 .00014 .00958 .01244 3.636	(A2) 0.348	(Dflg) 2.993	.01212 .02122 .00353 .00495 4.181	(A1) 0.348	(Df1) 1.124	.01431 .00953 .00044 .04269 6.696	(A1) 2.310	(Dfin) 2.993	.00883 .00349 .00919 .00602 2.754	(A1) 6.452	(Df5) 0.593

Table IV.1-2. Percentages of pigmentary variability explained by each of the behavioural variables (I) and by the two best predictors among all functions of age (II) and days- (III).

Legend.

1. Totals are referred to 100. All other figures are referred to 1.
2. No corrections for the intercorrelations between predictors have been made.

categories of one of those diversifying agents - habitu, for instance. y is plotted on ordinates. By displacing the curves respect to each other, a whole family of y's can be obtained.

A corresponding absence of a general pattern makes itself felt when considering the individual and combined contributions of the behavioural variables to variation within the dependent variable. The values are given in table IV.1-2. Other than saying that, when comparing homologous samples, the behavioural variables are as a rule more efficient in producing internal variation among men than among women at both sites (only clear exception: the British at the inner arm), there is little room for homogeneity of effects in the picture. Among women it is always among the British that the greatest percentage of pigmentary variation is explained by the combined effects of the behavioural variables. Among men the same is true for Spaniards at the inner arm and for the British at the forehead. Twice among the British and once among Spaniards, percentages appear which seem rather too high when compared with the others. Partly at least, this can be owed to the effect of variables days- and age which has not been removed from the correlations between pigmentation and the behavioural variables. In all these cases some higher-than-normal correlations crop up between some or all of the variables involved. Whenever some of those high percentages appear they are mainly the result of habitu's contribution - at the inner arm - or of newhat's contribution - at the forehead, among Spaniards. Since Swedes are not represented in either case, this seems to suggest that among them the distinction between exposers and non-exposers is not as clear-cut as among Spaniards and the British, where habitu stands for most of the explained variance. Such explanation can hardly be accepted at the forehead, among Spaniards, where the distinction exposers/non-exposers does not make much sense, rather is the intensity of the Spanish sun - via variable newhat - possibly to be held responsible for most of the explained variance. To conclude, it would also seem that at the forehead - under the cloudy sky of Britain - it is again persistence and not the sun's strength which is responsible for the higher-than-normal explained percentages.

Summary

The problems involved in the choice of a strategy for the categorization of the exposure variables, and the reasons for deciding in favour of the dichotomous alternative for habitu and habitf have been dealt with in some detail.

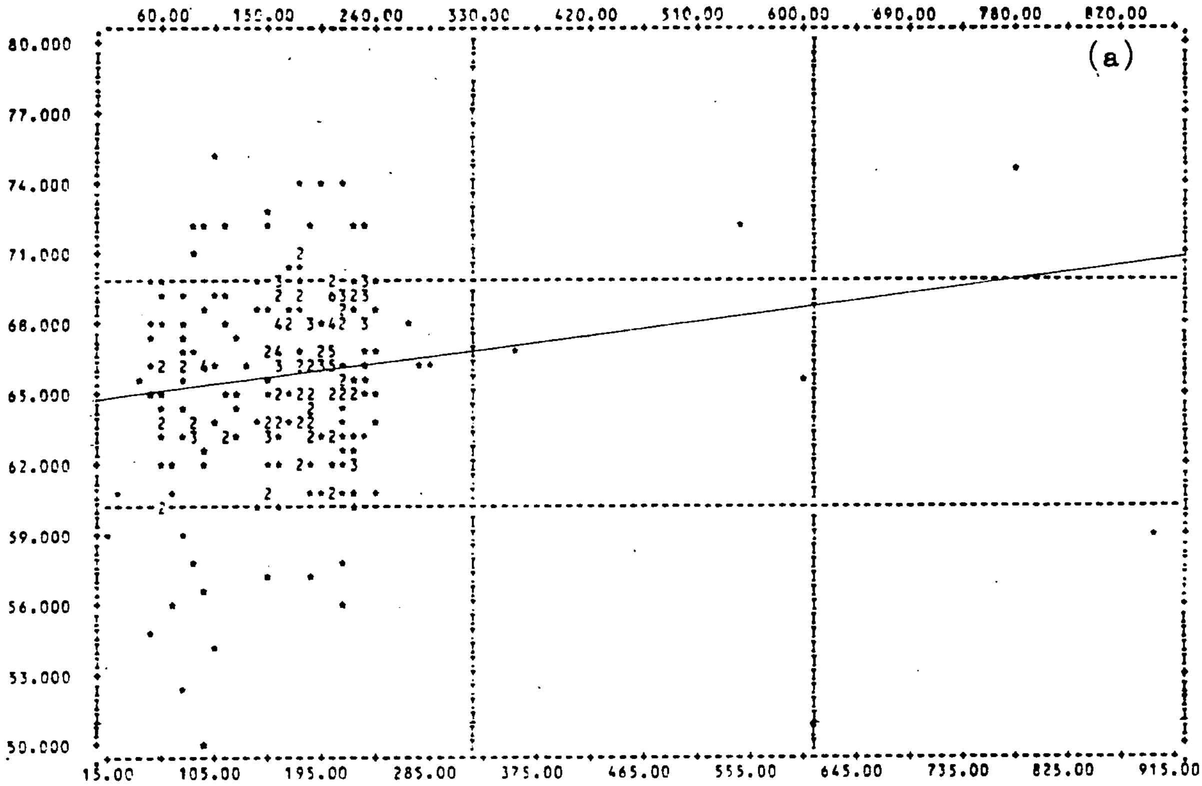
In order to attain a better understanding of the dynamics of the pigmentation process, the sequence of changes caused in the skin by exposure to UV-radiation has been succintly reviewed in this section. Besides, the possibility of using this knowledge as a tool - in explaining the apparent deviation at certain filters from the generalized trends - has been emphasised. Its ultimate application must, however, be validated against formula IV.1-1.

Table X-1 (and the text of the conclusion section) resume in schematic form the most important traits of the correlations between the behavioural variables and pigmentation (filters 1 to 9).

IV.2. The natural decay of tan.

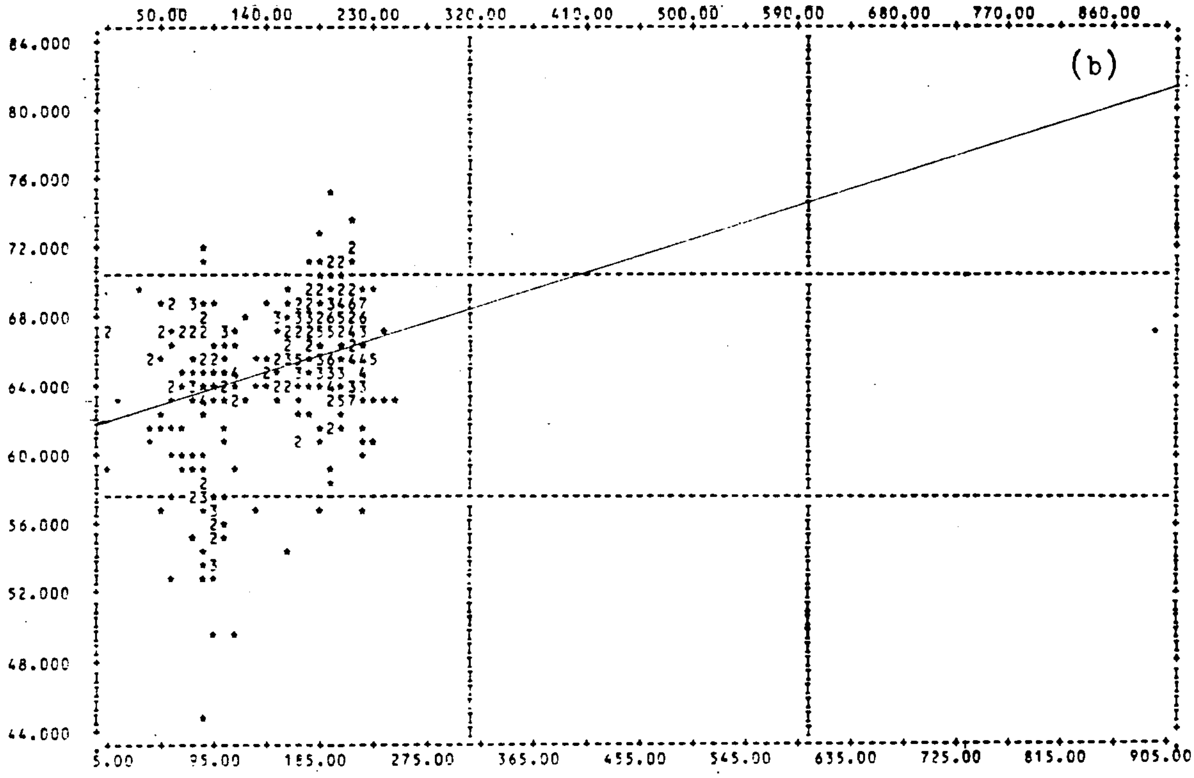
The nature and evolution of the changes initiated by UV-irradiation of human skin has already been examined elsewhere. In agreement with that knowledge, the scattergram uia9-daysuia has been selected as the most suitable tool to graphycally study the correlation of pigmentation with the time period elapsed since the last exposure to radiation. As frequently done through this chapter, only the ninth filter will be considered for a detailed study of that kind, the others been merely reported without - usually - much further elaboration. Considering for all nine filters the statistical information gradually accumulating at each of them, without the existence of an appropiate methodology to deal with it as a single unit in order to obtain results which are meaningful not only from a mathematical point of view, but also from a physical - is not only extremely cumbersome but it fails to lead to any conclusion or result of general, conceptual physical validity. Nine filters are simply eight too many for informing on melanin concentration and infinitely too few to represent a colour, if not to inform about it. Instead, reflectance readings only at the ninth filter were selected since these have been shown to be independent on variations in blood content and linearly related to the inverse of melanin concentration (Jansen, 1953; Harrison & Owen, 1956/7; Harmse, 1954), for which reason - in combination with the unexposed nature of the selected spot - they seem to provide a perfect tool for studying the gradual changes in melanin content with increasing time distance from the last exposure.

Whenever the bivariate correlation coefficient was found to be significant (at the 0.05 level) the linear fit was plotted (fig. IV.2-1, a to f). Among Swedes, males and females, and the British males the distribution of reflectance readings with daysuia can, thus, be approached by a straight line. The



♂

```
CORRELATION (R) - 0.16017   R SQUARED      -  0.02566   SIGN      - 0.01011
STD OF EST      - 3.81411   INTERCEPT (A) - 64.57527   SLOPE (B) - 0.00681

The regression line cuts the margin of the plot at
  a value of    64.67737 on the left margin
  a value of    70.80391 on the right margin

PLOTTED VALUES - 257   EXCLUDED VALUES - 0   MISSING VALUES - 50
```

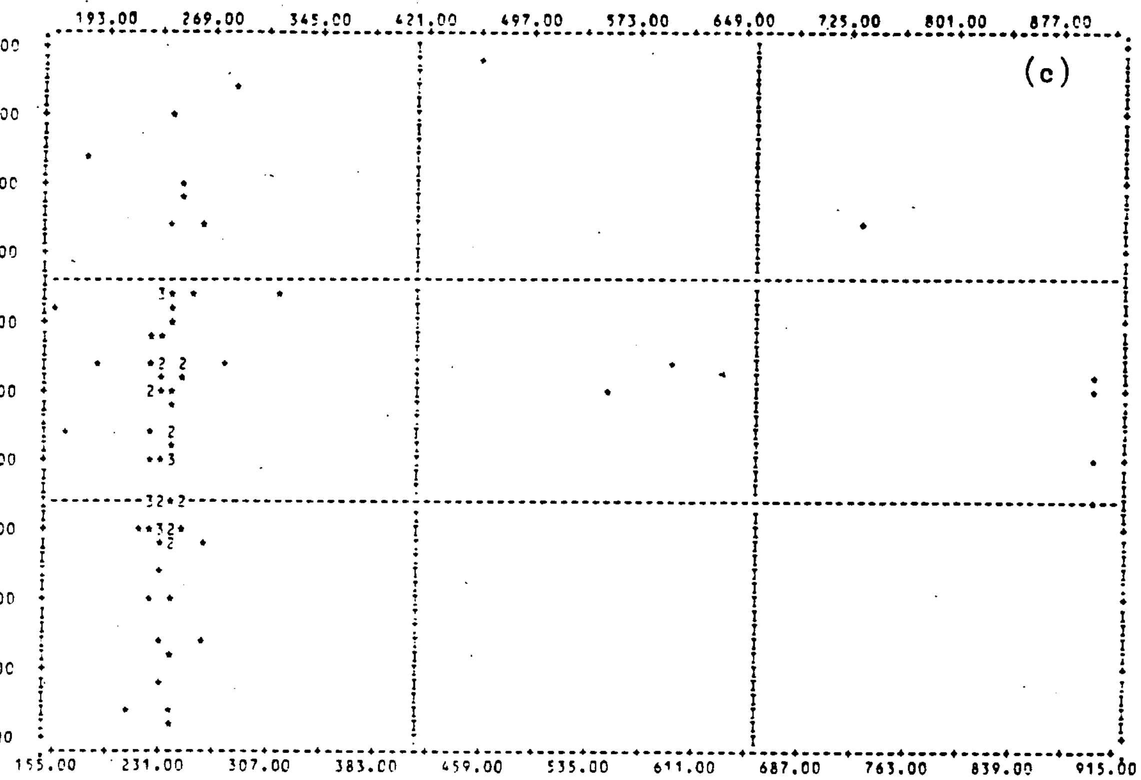


♀

```
CORRELATION (R) - 0.33371   R SQUARED      -  0.11136   SIGN      - 0.00000
STD OF EST      - 4.10786   INTERCEPT (A) - 61.65527   SLOPE (B) - 0.02072

The regression line cuts the margin of the plot at
  a value of    61.75887 on the left margin
  a value of    80.40822 on the right margin

PLOTTED VALUES - 364   EXCLUDED VALUES - 0   MISSING VALUES - 80
```

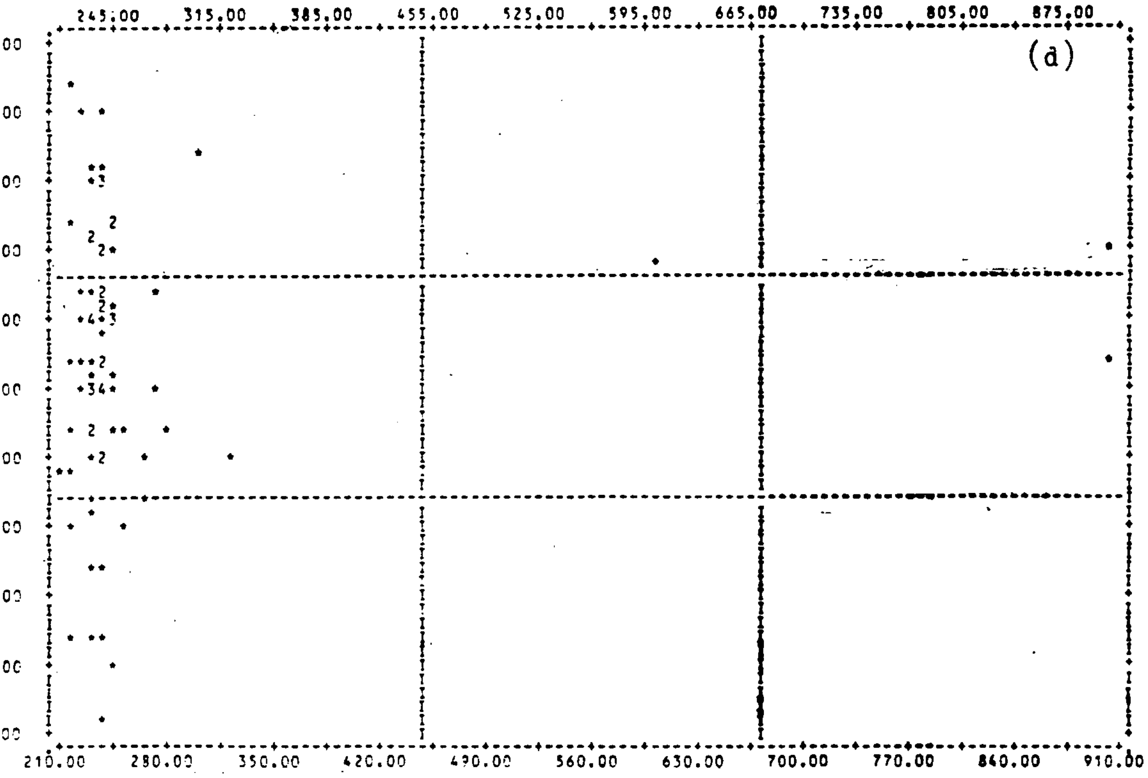
(Swe+Aswe)

Fig. IV.2-1. uia9-daysuia.
Pigmentary variability with time elapsed since last exposure.
Time on abscissae (in days) and reflectance on ordinates.



♂

```
CORRELATION (R) - 0.11553   R SQUARED      -  0.01335   SIGN      - 0.30748
STD OF EST      - 4.12138   INTERCEPT (A) - 60.26958   SLOPE (B) - 0.00290

The regression line cuts the margin of the plot at
  a value of     60.71880 on the left margin
  a value of     62.92146 on the right margin

PLOTTED VALUES - 80   EXCLUDED VALUES - 0   MISSING VALUES - 36
```

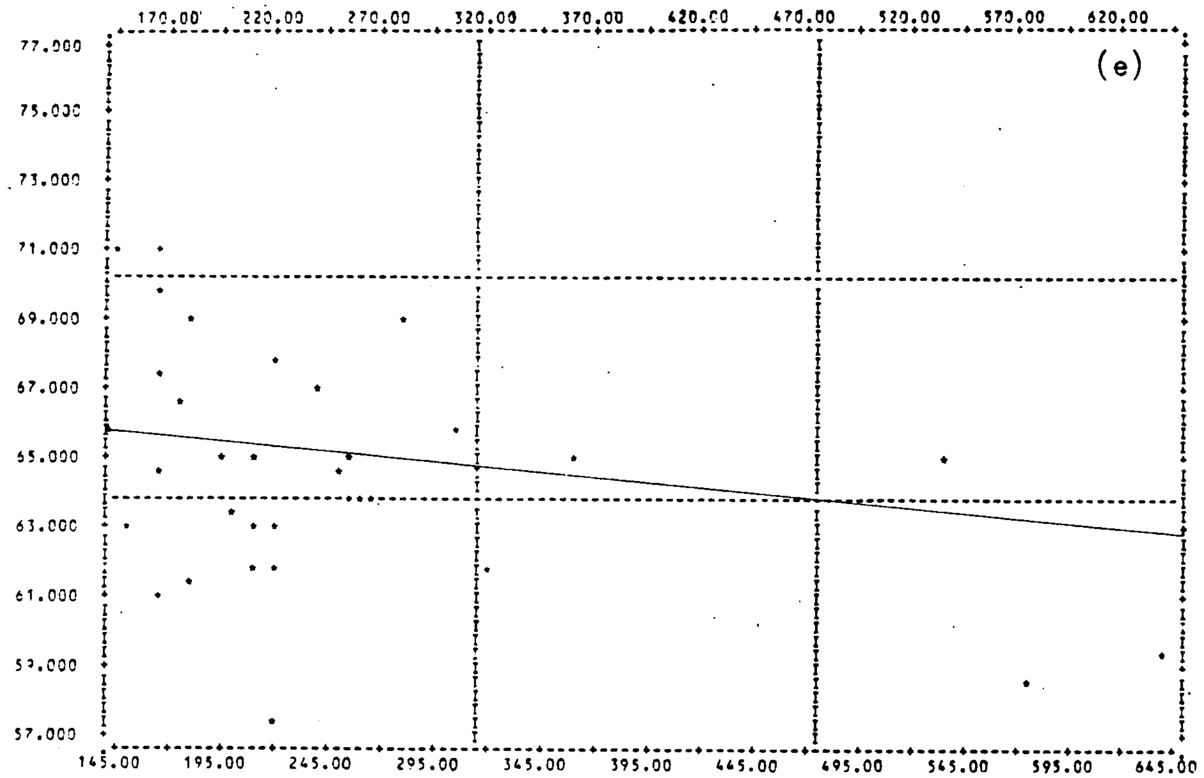


♀

```
CORRELATION (R) - 0.08702   R SQUARED      -  0.00757   SIGN      - 0.43982
STD OF EST      - 3.83417   INTERCEPT (A) - 62.14650   SLOPE (B) - 0.00299

The regression line cuts the margin of the plot at
  a value of     62.77336 on the left margin
  a value of     64.86295 on the right margin

PLOTTED VALUES - 81   EXCLUDED VALUES - 0   MISSING VALUES - 45
```

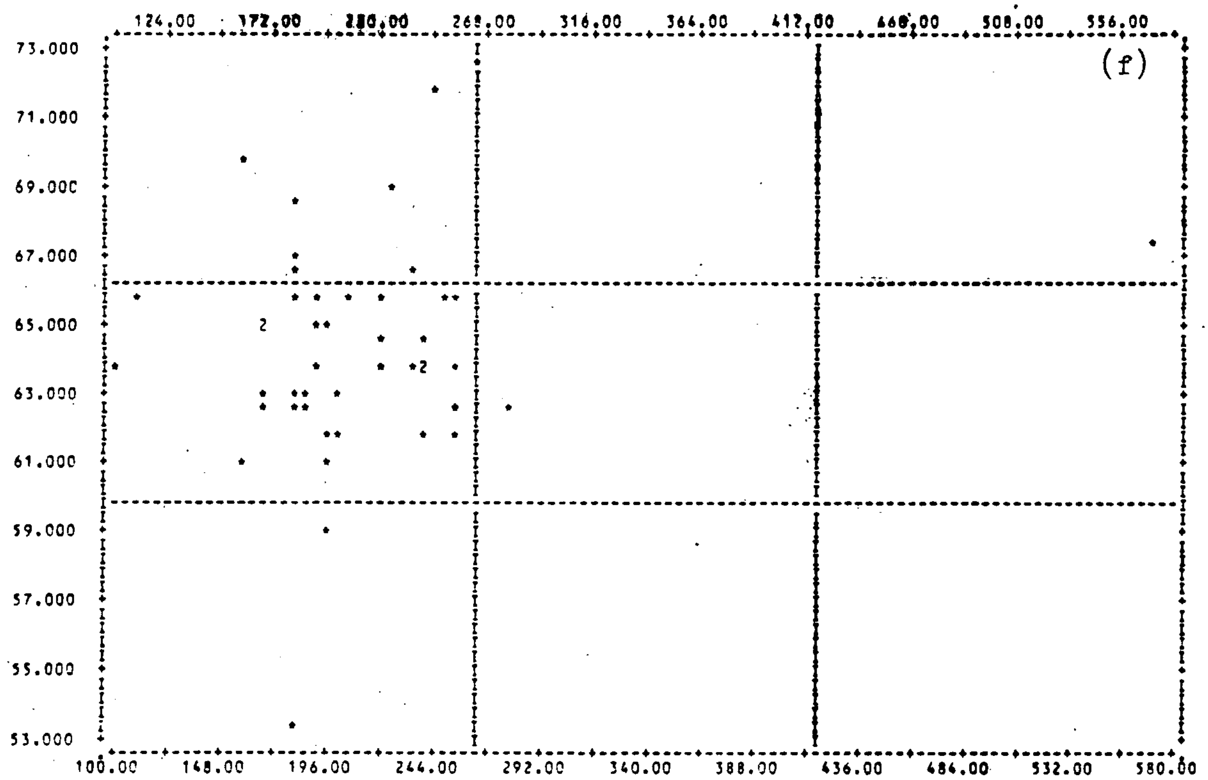
(Spa+Aspa)

Fig. IV.2-1. uia9-daysuia.
Pigmentary variability with time elapsed since last exposure.
Time on abscissae (in days) and reflectance on ordinates.



♂

```
CORRELATION (R) - -0.40960   R SQUARED      -  0.16778   SIGN        -  0.01991
STD OF EST      -  3.11993   INTERCEPT (A) - 67.52376   SLOPE (B) - -0.01148

The regression line cuts the margin of the plot at
  a value of     65.85883 on the left margin
  a value of     62.92146 on the right margin

PLOTTED VALUES - 32   EXCLUDED VALUES-- 0   MISSING VALUES - 7
```



♀

```
CORRELATION (R) - 0.18519   R SQUARED      -  0.03430   SIGN       - 0.21788
STD OF EST      - 3.17832   INTERCEPT (A) - 62.56840   SLOPE (B) - 0.00897

The regression line cuts the margin of the plot at
   a value of    63.46581 on the left margin
   a value of    67.77355 on the right margin

PLOTTED VALUES - 46   EXCLUDED VALUES - 0   MISSING VALUES - 4
```

(Gb+Agb)

Fig. IV.2-1. uia9-daysuia.
Pigmentary variability with time elapsed since last exposure.
Time on abscissae (in days) and reflectance on ordinates.

sizes of the scattergram samples were in some cases bigger than those providing the coefficients for table C.2, since here more cases were deleted because of one or more variables presenting missing values, and in one intance (Swedes, males) the character of the significance figure changed: non significant in table C.2. The corresponding values for the forehead are as follows: significant R among Swedish males, approach to significance among Spanish males and British females. The sign of the coefficient is positive (positive slope, $\alpha \leqslant 90^{0}$) in all cases, with the exception of the British males at the inner arm (significant).

In figure IV.2-2, a to f, the data of the scattergrams have been rearranged by plotting only means in ordinates; time has been expressed in weeks. The adequacy of a linear fit appears obvious to the naked eye in some of them, but some other underlying trends are suggested as well: plynomial, generally ascending or descending curves. The polynomial trends can be explored by means of the oneway subprogram, one of the SPSS choices, which implies treating the independent variable as categorical. Unfortunately many of daysuia's numerous categories include extremely few cases, which makes it very difficult to check the fulfilment of the normality (everywhere) and homogeneity of variance (three of the big samples) requirements within the samples' subgroups (table IV.2-1). Since none of the subgroups is big, nor is it possible to apply the correction for unequal sizes when homogeneity of variance is bad, the reliability of the F-test for differences between means is seriously jeopardized. For this reason a post hoc battery of Scheffé tests has also been tried for greater reliability. With the post hoc comparisons the probability of overlooking a true difference (type II error) is greater, but it is safer than applying a battery of t-test com-

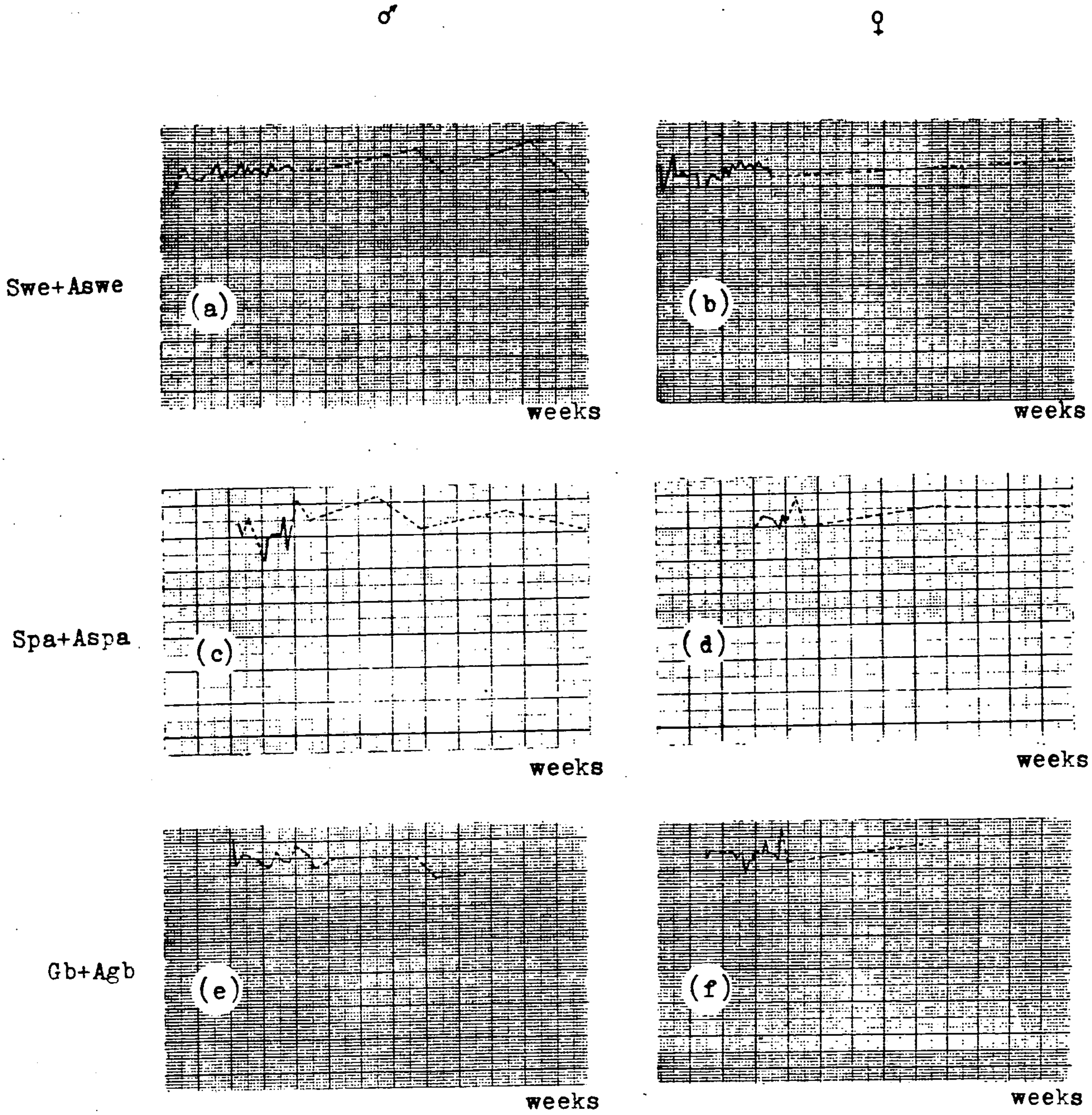


Fig. IV.2-2. uia9–daysuia.
Pigmentary variability with time elapsed since last exposure.
Time on abscissae (in weeks) and mean reflectances on ordinates.

uia9-daysuia (oneway anova)

N	k	Bartlett's F	F	x^1	x^2	x^3	x^4	x^5
		p	p			Deviations		
258	112	1.427	1.570	0.005 +	0.003 +	0.268	0.018 +	0.332
		0.023 +	0.005 +	0.010 +	0.020 +	0.020 +	0.030 +	0.029 +
Scheffé (0.01, 0.05): -								
366	132	1.457	2.824	0.000 +	0.000 +	0.012 +	0.000 +	0.001 +
		0.006 +	0.000 +	0.000 +	0.000 +	0.000 +	0.000 +	0.000 +
Scheffé (0.01, 0.05): -								
80	36	1.559	1.669	0.249	0.040 +	0.251	0.170	0.002 +
		0.083	0.054	0.053	0.074	0.074	0.078	0.215
Scheffé (0.01, 0.05): -								
81	33	1.060	0.525	0.487	0.866	0.717	0.792	0.546
		0.388	0.972	0.970	0.961	0.953	0.941	0.934
Scheffé (0.01, 0.05): -								
32	23	0.936	0.456	0.078	0.983	0.282	0.318	0.977
		0.456	0.795	0.905	0.886	0.909	0.926	0.907
Scheffé (0.01, 0.05): -								
46	27	1.038	2.680	0.097	0.932	0.186	0.888	0.050 +
		0.411	0.015 +	0.016 +	0.013 +	0.013 +	0.010 +	0.012 +
Scheffé (0.01, 0.05): -								

Table IV.2-1. Oneway anova: uia9-daysuia.
Polynomial trends in the decay of tan.
Significance referred to the 0.05 level.

parisons when type I errors are considered (Hays, 1981). They are, besides, known to be relatively insensitive to departures of normality and variance and to be exact for unequal group sizes. On the other hand, the analysis of polinomial trends should be orientative enough and, since this is the section's main concern, no further attempt will be made to improve the shortcomings of the method.

Although the F-test revealed some significant differences between means among Swedes (both sexes) and British (females) and almost significant among Spanish males, none of the Scheffé comparisons ($\alpha = 0.01$ and $\alpha = 0.05$) elicited any significant inequalities.

The two biggest samples (Swedes, males and females) display clear acceptance of the linear trend at the 0.05 level or better, while British males and females come relatively close. One of the last two (British males) presents, as a matter of fact, a significant correlation (p = 0.022, 0.020) between the two variables, as mentioned above (table C.2, fig. IV. 2-1e). Of the aforementioned samples, Swedes (♂ ,♀) and British females - closely followed by Spanish males - signal, by means of significant deviations from linearity, the existence of underlying curvilinear trends. Accordingly, some or eventually all of the powers of daysuia (most often the quadratic trend) had to be admitted among them as well. In three of them - Swedes and British females - the existence of significant deviations from the last and fifth power suggests the presence of some other source of curvilinear trend. Generally ascending and perhaps even descending curves were conjectured before. Consequently, the logarithmic and inverse functions - which have the kind of gentle slope apparently demanded by the distribution of means along time - have been tried as well. The correlations with both functions were accepted as significant (table C.3) by Swedes, males and females, and British males.

None of the polynomial trends above the linear level showed significance at the forehead within any sample (as judged from the correlations in table C.3). On the other hand, the same table shows significance for the correlations between uia9 and the logarithmic and inverse functions among British females, coming relatively close among Spanish males for both functions and among Swedish males for the logarithmic function. The logarithmic and inverse functions appear normally with respectively positive and negative signs, except for British males (viceversa).

Table C.3 presents the bivariate correlations between reflectance readings at all filters and each of the functions proposed as predictors up to now. Let us resume the situation in a few words. At both sites there is often a tendency for the correlation coefficients to decrease in absolute value along the spectrum until they reach a minimum, normally at the fifth filter (but even the fourth or the sixth). This tendency is more marked within the big samples and it does have erratic oscillations along the way. No attempt was made to determine the trend's degree of significance. The trend is often broken by, among others, the second and the last filters. Significance does not normally appear beyond the quadratic level and it is perhaps somewhat better for the logarithmic than for the inverse function. It is better among men than among women, and better at the inner arm than at the forehead. Among Swedes, males and females, significance shows up at most filters along the spectrum, while within the other samples it appears eventually among either the first filters (Spaniards) or the last ones (British).

Within each filter, coefficients normally decrease with increasing polynomial order. D~in and d~lg often appear together as significant or non-significant. Significance figures deteriorate with decreasing size of the sample.

As a whole, significance is displayed, as explained, at the inner arm among Swedes (males and females), Spanish males and British males. At the forehead it shows up among Swedes (males and females), Spanish males, British males (only for dfin and dflg), Spanish females (not at all for dfin) and British females. In general, the polynomial and logarithmic trends display positive correlations with pigmentation, while the inverse function puts up a negative correlation, but exceptions crop up here and there (especially among the polynomial trends): within all samples at the forehead and within Spanish females and British, males and females, at the inner arm. Among British males every coefficient has inverted its sign with respect to the general rule.

Table IV.1-2 gives the percentages of variation explained at filters 1, 5 and 9 by the time variables which, in each case, were selected as the best predictors. It is immediately obvious that no homogeneity of effects exists when percentages are compared between either sexes or sites or even within each sample. A few generalizations are possible. The time variables seem to be more efficient at explaining variation among men than among women, with two exceptions: Swedes at the inner arm and British at the forehead, where the opposite is true. In all cases except Spanish males and females and British males, they are also more efficient at explaining variation at the inner arm than at the forehead. Comparisons between samples within each sex show that at the inner arm the greatest percentages of variation in pigmentation are explained among Swedes, males and females, and the smallest among Spaniards, males and females. At the forehead the greatest are explained among Spanish males and British females and the smallest among Swedes, males and females. In general, the best predictors resulted for the logarithmic and inverse functions, while the first polynomial power was best at a few filters and the fifth power in a couple.

Summary

The possibility of existence of linear and curvilinear trends underlying the correlations between pigmentation and time elapsed since the last exposure to radiation has been explored - chiefly by means of the oneway analysis of variance and the scattergram technique.

The reasons for temporarily selecting uia9 as our only dependent variable have also been discussed.

Again, for a resume of the patterns shown up by the correlations between the dimensions time and pigmentation see section X.

IV.3. The effect of ageing on pigmentation.

Generally speaking, pigmentation at unexposed areas diminishes steadily with advancing age, while at exposed areas, such as the forehead, the possible existence of a similar trend is overcome by the continuous impact of the environment, resulting in increasing pigmentation with age. Studies within different racial stocks have by now proved that these trends are not, however, uniformly maintained throughout life. In most cases it has been reported either on variation during puberty or on trends through adulthood, with the result that information on other periods is lacking. It can be confidently assumed that, in general, pigmentation during the whole pre-pubertal period increases in areas normally studied (the upper inner arm and the forehead) and that at the onset of puberty the trends, at least at the inner arm, change. Correnti (1966) found out that, among his Palermo subjects, puberty - betrayed by maximum internal relative variation (CV) - started at around the ages of 11 for girls and 14 for boys. The border lines vary, however, in human groups, and improved nourishment and tropical or subtropical climatic conditions seem somehow to be associated with earlier onset of puberty. Basically during this time, while pigmentation decreased among girls and boys from before the age of 11, for girls, and from the age of 12, for boys, at the axillary region , it continuously increased at the areolar region. Correnti suggested a pubertal displacement of melanin from one area to the other.

Similar results were observed at different unexposed areas of the arm by Garn et al. (1956) among white boys aged 12½ to 16, by Omoto with a Japanese twin sample, by Kalla (196?) among "Baniya" males aged 10 to 16 and by Kalla (1970) among Tibetan boys and girls. In the last article it was reported that, during the pubertal period, the reversal of the trend from darkening to lightening - which among Palermi-

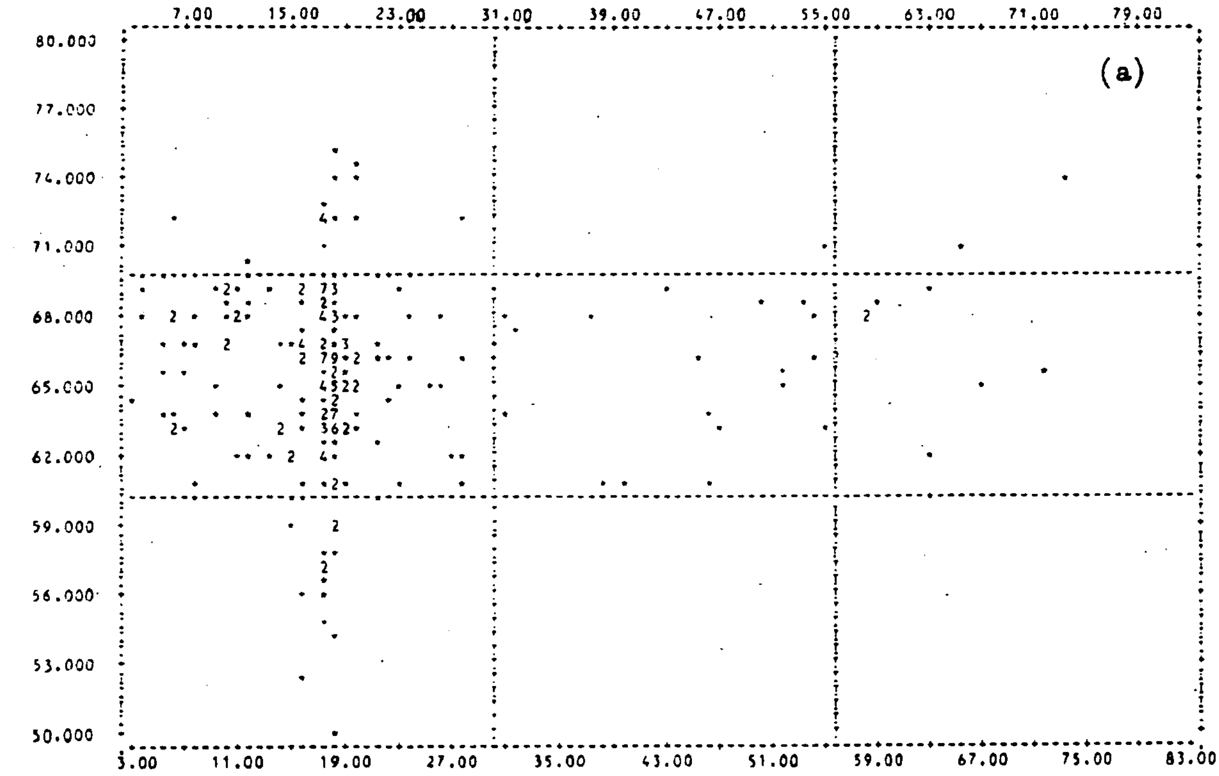
N	k	Bartlett's F	F	x^1	x^2	x^3	x^4	x^5
		p	p			Deviations		
294	52	1.005	0.894	0.122	0.016 +	0.653	0.170	0.863
		0.460	0.677	0.728	0.874	0.858	0.883	0.863
Scheffé (0.01, 0.05): -								
427	67	2.511	1.101	0.000 +	0.266	0.016 +	0.479	0.541
		0.000 +	0.289	0.800	0.809	0.912	0.906	0.897
Scheffé (0.01, 0.05): -								
116	16	1.426	2.577	0.001 +	0.534	0.013 +	0.616	0.602
		0.147	0.003 +	0.040 +	0.031 +	0.104	0.079	0.059
Scheffé (0.01, 0.05): -								
125	18	2.056	1.257	0.099	0.828	0.711	0.357	0.318
		0.030 +	0.235	0.309	0.256	0.210	0.195	0.186
Scheffé (0.01, 0.05): -								
39	12	0.778	0.525	0.113	0.962	0.576	0.491	0.417
		0.540	0.869	0.972	0.952	0.939	0.935	0.947
Scheffé (0.01, 0.05): -								
50	10	0.375	0.582	0.818	0.265	0.411	0.941	0.481
		0.916	0.804	0.733	0.785	0.778	0.669	0.613
Scheffé (0.01, 0.05): -								

Table IV.3-1. Oneway anova: uia9-age.
Polynomial trends in the variability of pigmentation with age.
Significance referred to the 0.05 level.

tans is at the axillary region placed in the prepubertal period, at between 12 and 13 for boys and before 11 for girls - at the medial upper arm lies among Tibetans between 12 and 13 for girls, while among boys (in spite of some oscillations) the general trend after the interval 13-14 is one of increasing pigmentation.

The samples in the present study range over a greater age span but are ill suited for the analysis of pigmentary changes. One-year subgroup sizes are too small and the author does not feel that subdivision into intervals wider than one year is good practice for this purpose. Therefore no such division has been attempted. Instead, general trends will be explored.

In figure IV.3-1, a to f, reflectance readings at the ninth filter have been plotted against age. The ninth filter and the inner arm have been selected for the same reasons as in the previous section. The coefficients obtained for the scattergrams and those from table C.2 show very close agreement with each other, in spite of the different sizes of the samples. According to them and to the results of the oneway analysis (table IV.3-1), the first polynomial trend (linear) is accepted at very good significance levels by Swedish females and Spanish males at the inner arm. At the forehead and according to table C.2, Swedish males and females and British females display significant bivariate correlation, which betrays acceptance of the linear trend. The sign of the coefficient is positive in all cases at the inner arm except among British males and females. At the forehead it is negative except among Spanish and British males. At none of the exceptions is the coefficient's numerical value significant. Inner arms and foreheads become, in other words, respectively lighter and darker except within the samples pointed out above, at the ninth filter.



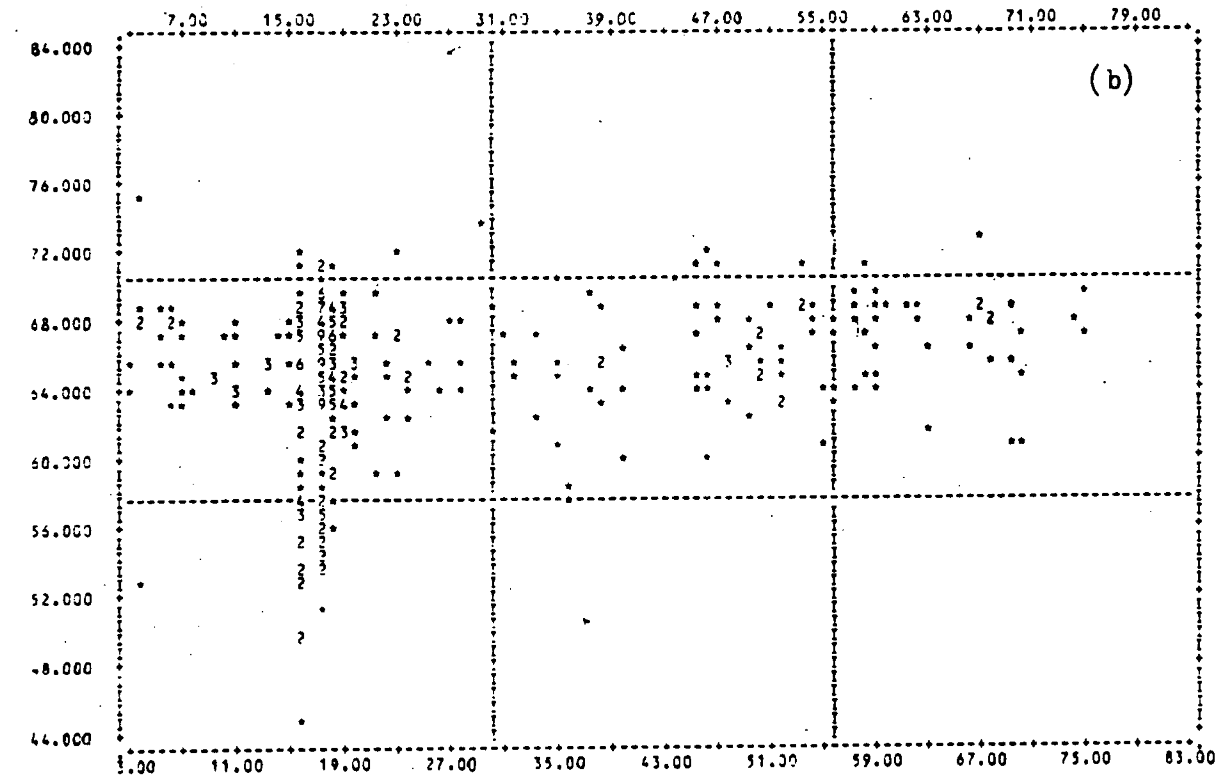
♂

CORRELATION (R) - 0.05629   R SQUARED - 0.00317   SIGN - 0.36881

STD OF EST - 3.85786   INTERCEPT (A) - 65.39842   SLOPE (B) - 0.01642

The regression line cuts the margin of the plot at
a value of 65.44766 on the left margin
a value of 66.76097 on the right margin

PLOTTED VALUES - 257   EXCLUDED VALUES - 0   MISSING VALUES - 50



♀

CORRELATION (R) - 0.21150   R SQUARED - 0.04473   SIGN - 0.00005

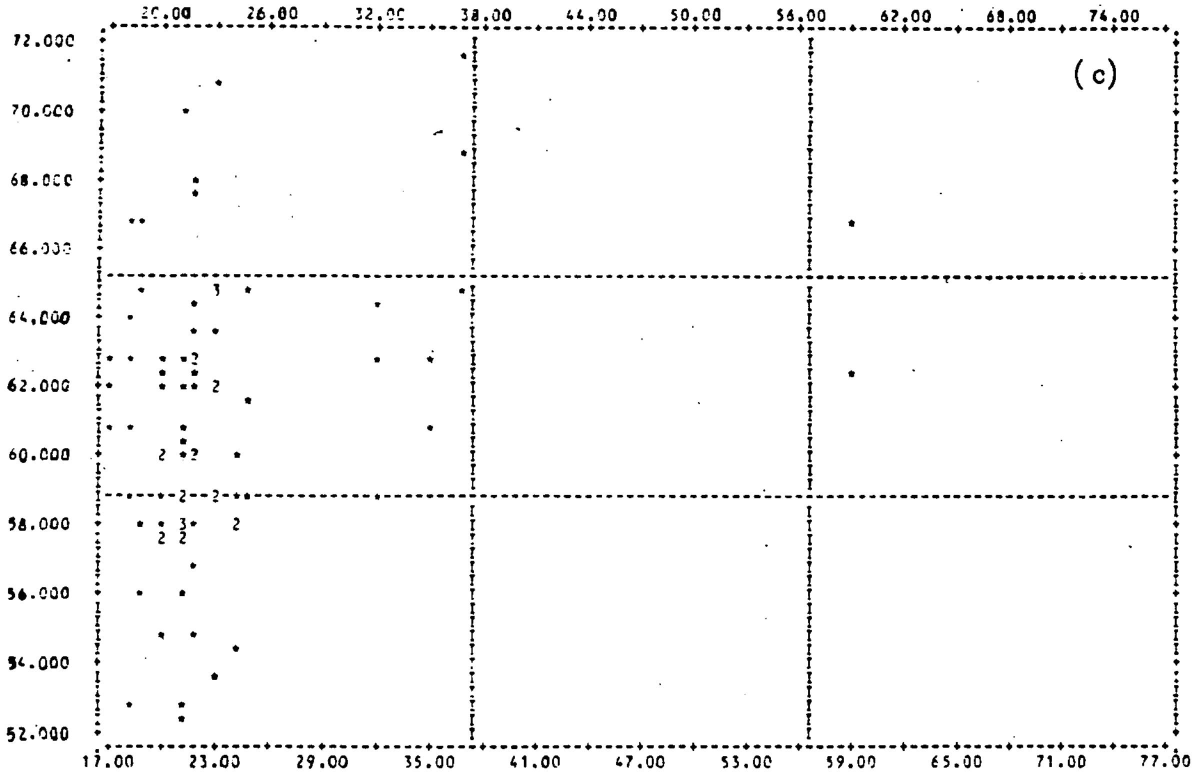
STD OF EST - 4.25907   INTERCEPT (A) - 63.50803   SLOPE (B) - 0.05304

The regression line cuts the margin of the plot at
a value of 63.66714 on the left margin
a value of 67.91043 on the right margin

PLOTTED VALUES - 364   EXCLUDED VALUES - 0   MISSING VALUES - 80

Fig. IV.3-1. uia9-age.
Pigmentary variability with age.
Age on abscissae (in years) and reflectance on ordinates.

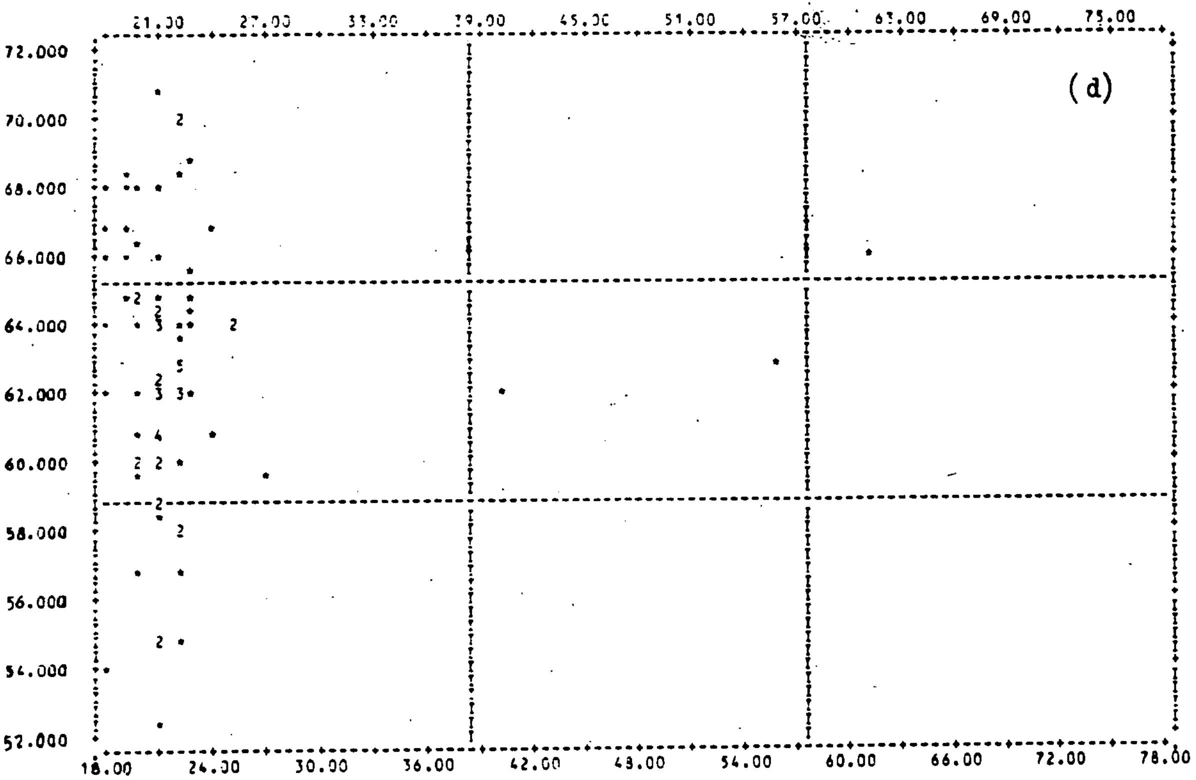
Swe+Aswe



♂

```
CORRELATION (R) - 0.29117   R SQUARED      - 0.08478   SIGN      - 0.00878
STD OF EST      - 3.96938   INTERCEPT (A) - 57.22959   SLOPE (B) - 0.16464
The regression line cuts the margin of the plot at
  a value of    60.02849 on the left margin
  a value of    69.90700 on the right margin
PLOTTED VALUES - 80   EXCLUDED VALUES - 0   MISSING VALUES - 36
```

o

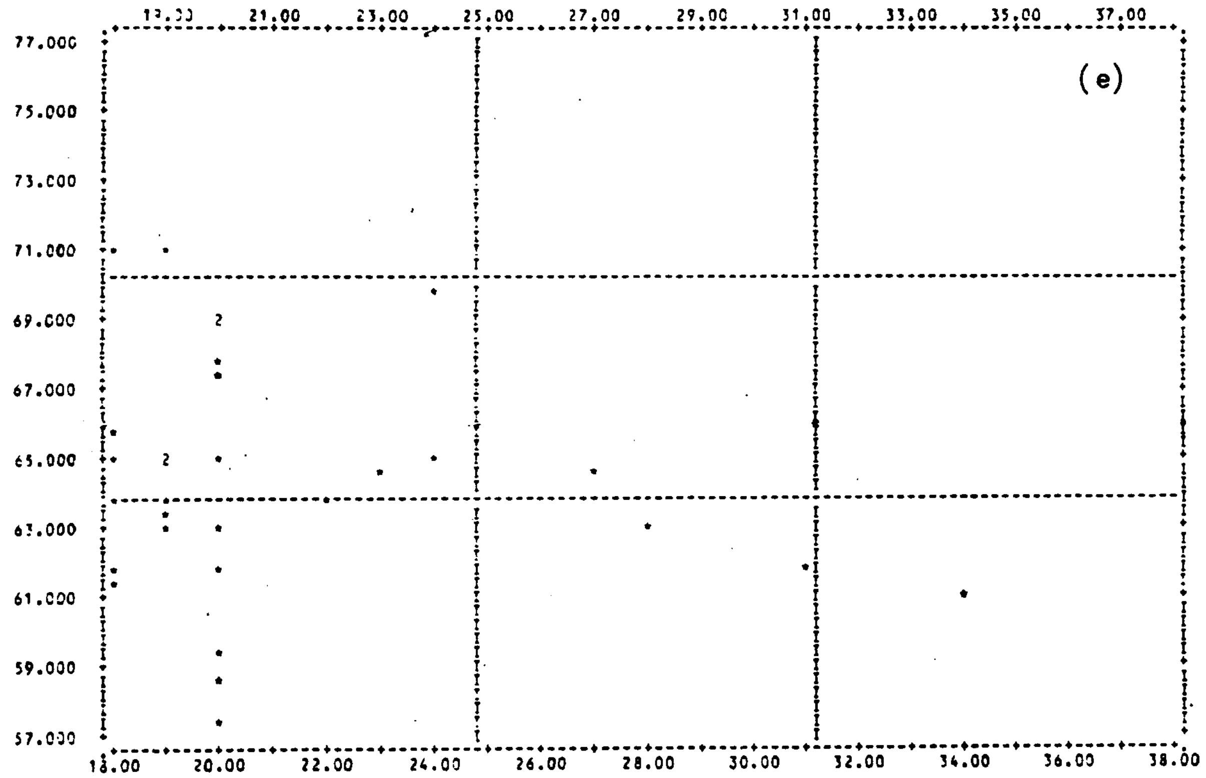


♀

```
CORRELATION (R) - 0.09241   R SQUARED      - 0.00854   SIGN      - 0.41191
STD OF EST      - 3.83230   INTERCEPT (A) - 61.87323   SLOPE (B) - 0.04592
The regression line cuts the margin of the plot at
  a value of    62.69978 on the left margin
  a value of    65.45500 on the right margin
PLOTTED VALUES - 81   EXCLUDED VALUES - 0   MISSING VALUES - 45
```

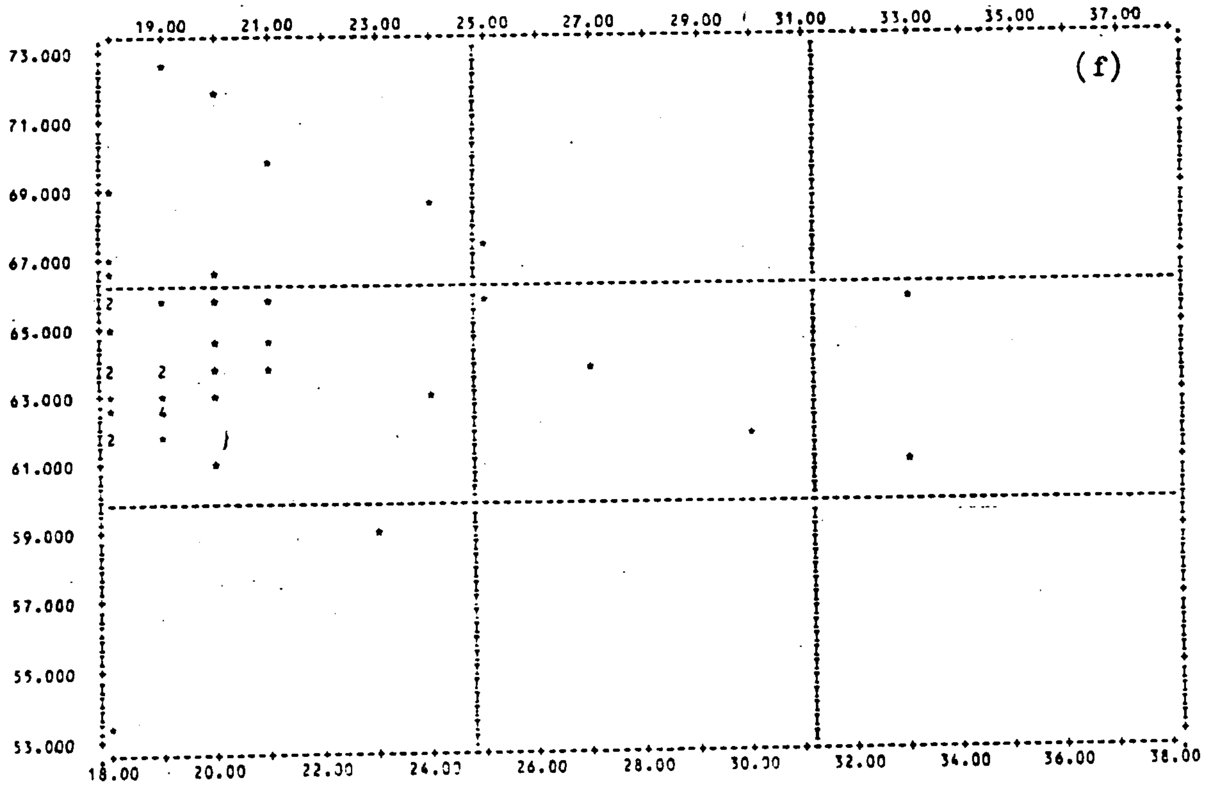
Fig. IV.3-1. uia9-age.
Pigmentary variability with age.
Age on absissae (in years) and reflectance on ordinates.

Spa+Aspa



♂

```
CORRELATION (R) - -0.19288   R SQUARED     -  0.03720   SIGN        -  0.29020
STD OF EST       -  3.35576   INTERCEPT (A)- 68.14657   SLOPE (B) - -0.16724
The regression line cuts the margin of the plot at
  a value of     65.13615 on the left margin
  a value of     61.79126 on the right margin
PLOTTED VALUES - 32   EXCLUDED VALUES - 0   MISSING VALUES - 7
```



♀

```
CORRELATION (R) - -0.01637   R SQUARED     -  0.00027   SIGN        -  0.91402
STD OF EST       -  3.23383   INTERCEPT (A) - 64.75695   SLOPE (B) - -0.01398
The regression line cuts the margin of the plot at
  a value of     64.50537 on the left margin
  a value of     64.22583 on the right margin
PLOTTED VALUES - 46   EXCLUDED VALUES - 0   MISSING VALUES - 4
```

Gb+Agb

Fig. IV.3-1. uia9-age.
Pigmentary variability with age.
Age on abscissae (in years) and reflectance on ordinates.

We are not better off than in the previous section concerning the requirements of normality and homogeneity of variance. All this undermines the reliability of the F-test for comparisons between means and, consequently, Scheffé post hoc comparisons have been employed as well. Significant F-values for comparisons between mean reflectances for one-year subgroups were only found among Spanish females, but the Scheffé comparisons failed to reveal any significant differences.

In figure IV.3-2, a to f, only mean reflectances at each age have been plotted. The existence of some sort of higher polynomial trend is strongly suggested in some of them. However, only the quadratic among Swedish males and the cubic among Swedish females and Spanish males attained significance. None of the figures for deviation from linearity demanded either a better fit. After a look at the diagrams of figure IV.3-2, it was felt that with the polynomial functions disappeared our best chances for a fit in terms of age for Spanish females and British, males and females. No other curves were tried.

Table C.3 presents the results of the bivariate correlations between reflectance readings at any filter and the three first polynomial functions. Within each sample and filter, correlation coefficients often decrease in numerical value with ascending polynomial order, but there are more exceptions than cases following the rule: at the inner arm, all samples but Spanish males present exceptions at five filters at least, while at the forehead exceptions on the same scale appear among Spanish males and British males and females. Significant or close-to-significant figures crop up along the third filter for Swedish males, among the four or five first filters and the two last ones for Spanish males and at the third and fourth and the three last filters for Swedish females. At the

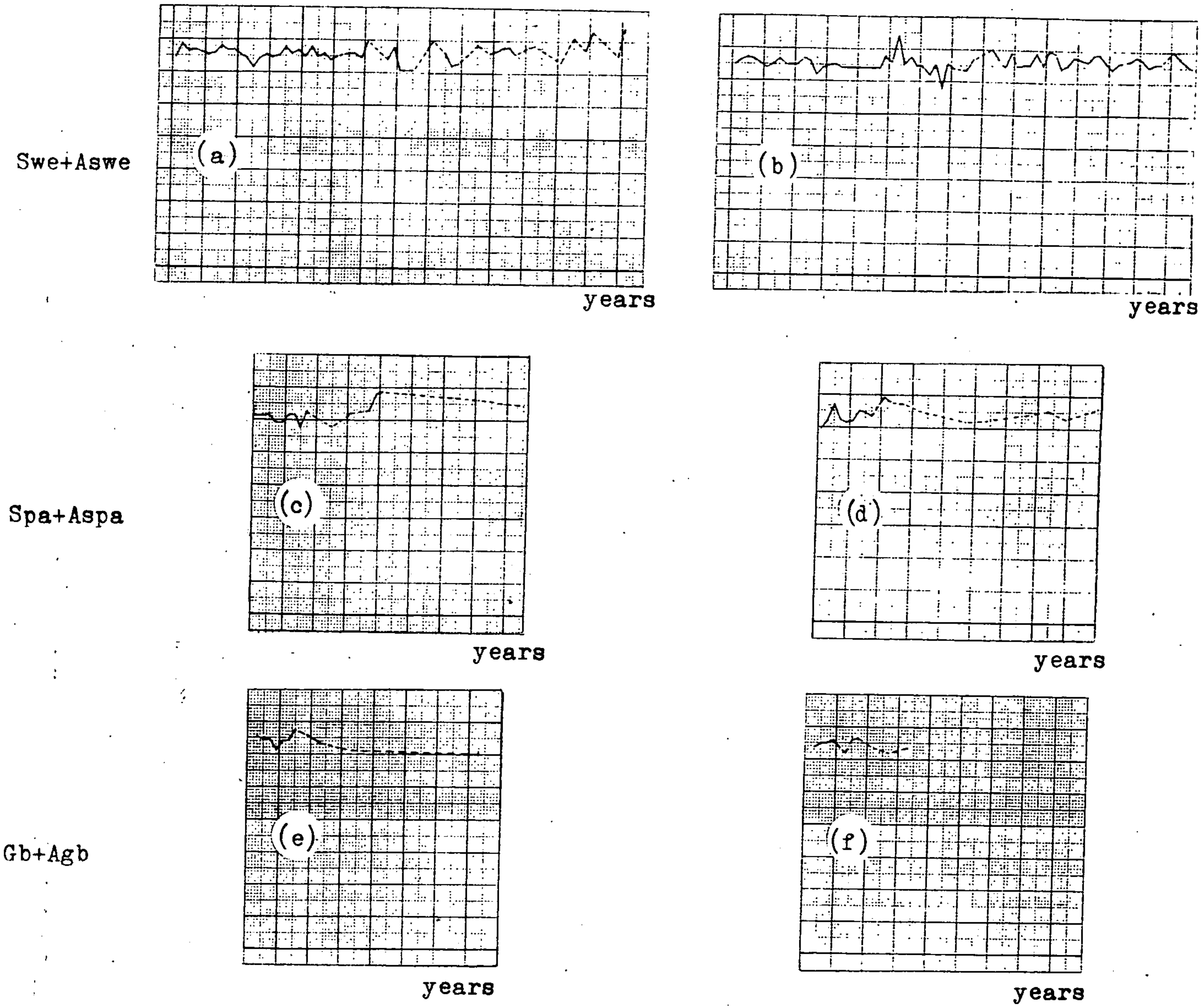


Fig. IV.3-2. uia9-age.
Pigmentary variability with age.
Age on abscissae (in years) and reflectance on ordinates.

forehead, they appear at most filters between the second and the sixth for Spanish males, at the first and middle filters for British males and all over - with the best figures at the end - among British females, and at all filters for Swedish males and females.

Within each polynomial order, the numerical value of the coefficients normally reaches a minimum at the fifth filter (or even the fourth or the sixth). Significance figures are normally best among men and better at the forehead than the inner arm. In general, significance deteriorates with decreasing size of the sample, but size does not seem so restrictive at the forehead.

Table IV.1-2 gives the percentages of variation explained at filters 1, 5 and 9 by the polynomial functions selected in each case as best predictors. As with the days- variables, there is little room for homogeneity of effects. As a whole, anyway, the age variables are more efficient in explaining variation among men than among women, with only two exceptions at the ninth filter: Swedes at the inner arm and British at the forehead. They also explain more variation at the forehead than at the inner arm, with the exception of Spaniards, males and females. When comparing samples, within each sex, the greatest percentages of variation are explained by Spanish males and Swedish females and the smallest by Swedish males and British females, at the inner arm. At the forehead, more variation is explained among Swedes, males and females, and less among Spaniards, males and females.

Summary

Certain polynomial trends were elicited underlying the correlations between uia9 and age.

The general patterns of correlation at all filters are as before resumed in section X.

IV.4. Sexual dimorphism and pigmentation.

Men of different races have repeatedly been reported as darker - significantly or not - than their female counterparts at different exposed areas: back and palm of the hand (Rijn-Tournel, 1966), the forearm (Barnicot, 1958), the forehead (Leguebe, 1961; Garn, 1956). At sites which among Westerners are less exposed, such as the inner arm, the situation is, however, not equally uniform. While Congolese males were still found to be darker than Congolese females by Rijn-Tournel, he, Leguebe (1961) and Rigters-Aris (1972) found Belgian and Dutch males to be lighter than their females at the upper inner arm. On the other hand, at a normally unexposed area subject to differential exposure according to sex, such as the areolar region, Garn discovered that American white males were darker than females. Among some Middle East populations (Sunderland, 1967; 1973) it has also been reported that males are lighter than females at both inner arm and forehead. Otherwise there is overwhelming evidence from different parts of the world all presenting females as lighter than males at both inner arm and forehead: English and Irish (Hulse, 1973); Smith and Mitchell, 1973; Sunderland et al., 1973), mature Sikhs (Kahlon, 1973), caste Indians (Kalla, 1969), Southern 'white' Brazilians (Harrison et al., 1967), North African and Middle East groups (Sunderland, 1973; Lourie, 1970), South American Indians (Weiner, 1963; Harrison and Salzano, 1966), Khoisanids and Rehoboth Basters (Weiner et al., 1964), Bantu and Cape Coloured (Wassermann, 1968), Tchad natives (Hiernaux, 1972), etc. Although the reasons for the existence of exceptions to this rule are in most cases debatable, it would seem that the first place to look for them is ethnographic: what kind of differences are there in labour and leisure activities between the two sexes which could produce differential exposure?

With only three exceptions - Swedes at the inner arm, filters 3, 8 and 9 - in the present work, all males are darker than females at both sites (table IV.4-1). The differences, with numerous exceptions among the Swedes and the British at the inner arm, are normally significant. They are also better at the forehead than at the inner arm. Within Swe, Spa and Gb ('pure' samples) the differences between sexes follow a similar pattern, with two exceptions: fh8 among Spaniards (n.s., p=0.092) and uia9 among the British (males lighter than females, although not significantly).

The distribution (or absence) of non-significant and inverted differences between means in the Swedish and Spanish samples, at the inner arm, accords well with their sunbathing habits. The proportions of exposers among Swedes differ significantly (p=0.000) between males and females (table III.3-2), but the significance level only reaches 0.083 among Spaniards. In both cases, females belong to the exposer category more often than males. Since the proportions of exposers within each sex and sample also depart significantly from the 50 % ratio (p=0.000 everywhere) upwards, females among Swedes do have every opportunity to reverse the normal trends, but apparently that was not enough among Spaniards. Among the British at the inner arm there are four non-significant differences (one of them an inversion, among the 'pure' British, in spite of a non-significant difference in the proportion of exposers between the sexes, but it has been previously elicited that among British women, when compared with men, relatively high percentages of reflectance readings' internal variance are explained by the combined effects of the behavioural variables. This may be the explanation, other factors

	$\bar{x}$ (♂) $\bar{x}$ (♀) P	$\hat{s}$ $\hat{s}$ p	N N sign.	$\bar{x}$ (♂) $\bar{x}$ (♀) P	$\hat{s}$ $\hat{s}$ p	N N sign.	$\bar{x}$ (♂) $\bar{x}$ (♀) P	$\hat{s}$ $\hat{s}$ p	N N sign.
uia1	34.539	5.036	302	30.388	4.688	116	35.054	5.028	39
	35.253	5.091	432	32.675	4.979	126	37.886	5.319	50
	3.527	0.061	-	13.482	0.000	+	6.515	0.012	+
uia2	43.562	5.441	302	38.166	5.083	116	41.031	4.982	39
	43.731	5.416	432	40.587	5.345	126	43.814	5.845	50
	0.171	0.679	- .	12.955	0.000	+	5.975	0.017	+
uia3	44.327	5.689	302	38.526	5.249	116	43.323	4.475	39
	44.063	5.589	432	40.462	5.390	125	45.562	5.034	50
	0.392	0.532	-	7.965	0.005	+	4.771	0.032	+
uia4	43.762	5.294	301	38.156	4.897	116	42.503	4.307	39
	44.025	5.266	432	40.896	4.929	125	45.120	4.726	50
	0.441	0.507	-	18.710	0.000	+	7.257	0.009	+
uia5	41.233	5.036	301	36.691	4.423	116	40.554	4.889	39
	42.227	4.952	432	39.281	5.434	125	42.402	4.952	50
	7.052	0.008	+	16.311	0.000	+	3.086	0.083	-
uia6	46.358	4.734	301	41.857	4.717	115	44.564	3.858	39
	47.228	4.848	432	44.866	5.545	125	46.758	4.095	50
	5.829	0.016	+	20.340	0.000	+	6.613	0.012	+
uia7	57.345	4.977	299	52.501	4.590	116	56.454	4.308	39
	57.600	4.858	429	54.502	4.887	125	57.436	4.200	50
	0.476	0.490	-	10.698	0.001	+	1.176	0.281	-
uia8	64.063	4.299	299	56.789	4.306	116	62.197	3.135	39
	63.753	4.513	429	60.518	3.983	125	62.864	3.512	50
	0.863	0.353	+	10.483	0.001	+	0.866	0.355	-
uia9	65.595	3.947	295	60.973	4.151	116	64.456	3.319	39
	64.956	4.347	429	62.532	3.975	125	64.600	3.148	50
	4.078	0.044	+	8.867	0.003	+	0.043	0.835	-▴
fh1	28.749	4.889	302	21.723	3.628	111	27.056	3.439	39
	29.774	4.906	433	23.578	4.012	125	30.096	3.561	50
	7.798	0.005	+	13.912	0.000	+	16.452	0.000	+
fh2	35.912	5.229	302	28.174	4.170	111	31.631	3.620	39
	37.141	5.417	433	30.350	4.219	125	35.114	3.915	50
	9.541	0.002	+	15.833	0.000	+	18.514	0.000	+
fh3	36.379	5.532	302	28.368	4.083	111	34.828	4.162	39
	37.355	5.528	433	30.251	4.596	124	36.990	4.369	50
	5.541	0.018	+	11.062	0.001	+	5.591	0.018	+
fh4	35.792	5.334	301	28.087	3.837	111	33.828	4.036	39
	37.746	5.425	433	30.597	4.421	124	33.828	4.036	50
	23.497	0.000	+	21.705	0.000	+	14.760	0.000	+
fh5	34.046	5.482	301	27.876	5.396	111	32.390	5.032	39
	35.955	5.421	433	30.072	4.169	124	35.176	4.328	50
	21.730	0.000	+	11.982	0.001	+	7.870	0.005	+
fh6	39.468	5.819	301	32.135	4.444	111	36.728	3.839	39
	41.272	5.327	433	35.639	4.787	124	40.028	3.672	50
	18.284	0.000	+	33.850	0.000	+	17.005	0.000	+
fh7	52.662	5.704	299	45.063	4.428	111	50.795	4.393	39
	54.111	5.027	428	46.807	4.756	124	53.848	3.593	50
	12.508	0.000	+	8.471	0.003	+	12.676	0.001	+
fh8	61.526	4.915	299	53.085	4.628	111	59.172	4.182	39
	62.447	4.391	430	54.554	4.639	124	62.368	3.519	50
	6.752	0.010	+	5.888	0.015	+ .	15.315	0.000	+
fh9	63.891	4.066	295	56.619	4.021	111	62.300	3.190	39
	64.374	3.987	430	57.508	4.375	124	64.710	3.211	50
	2.508	0.114	-	2.634	0.104	-	12.413	0.000	+
	Swe + Aswe (3/4)			Spa + Aspa (3/4)			Gb + Agb (3/4)		

Table IV.4-1. Between-sex differences in pigmentation. The marks '.' and '▴' at fh8 (Spaniards) and uia9 (British) indicate disagreement between the composite and the 'pure' samples, concerning the existence of significance (.) and the sign of the difference between the reflectance figures for males and females (▴).

not withstanding, since in all other cases the between-sex differences in percentages of explained variance are either favourable to men or not very different if favourable to women. The situation at the forehead agrees better with the expected, especially among the British, newhat and crfhnow have been mentioned as the most important predictors at the forehead. Significantly more women than men go with bare foreheads among Spaniards, while the use of cosmetics is important among Swedish females. Both factors are then presumably responsible for the appearance of non-significant differences (no inversions) at the last filter among Swedes and Spaniards (eventually at fh8 as well, among 'pure' Spaniards). Among the British, females differ significantly from males only for variable crfhnow. Other factors being the same, no departures from the expected were elicited among the British.

In addition, in the case of Swedes, the time elapsed since the last sunbathe until the day of the test (daysuia, daysfh) is also a factor to reckon with (table III.2-5). Here, the shortness of the period (alsways shorter among females) may also have contributed to the appearance of deviations from the general rule.

Summary

As a whole, then, between-sex differences agree well with the expectances, and the existing deviations are readily explained by the influence of environmental factors (mainly differences in exposure patterns). These factors have, however, not been introduced in the statistical calculations. The task of determining whether or not its inclusion can significantly shift in an unexpected direction the pattern of differences elicited in this section will be dealt with in chapter VI.

Summary

Thus, the conclusions reached in this chapter add further support to the thesis that, within any population, women are to be expected to be lighter than men, and that any eventual deviation from that rule is probably to be looked at as either the effect of differential exposure to environment or the direct result of other external factors, such as the use of cosmetics, or both.

CHAPTER V

V. Exposure, age and pigmentation. A regression model.

1. That the geographical distribution of skin colour is far from being random was early held by Biassuti (1941), Fleure (1945), Schwidetzky (1952) and later by others (Barnicot, 1959; Garn, 1964). They felt that there was a meaningful pattern in the world distribution of pigmentation of the skin: its gradient seems to be in a close relationship with latitude. This relationship has recently been evaluated by Roberts and Kahlon (1976) by multiple regression analysis and found capable of explaining around eighty per cent of the total variance at any wavelength. Work of that kind requires processing a great body of data from many different geographical regions. The present work will not deal with the study of between-population variance, as Roberts and Kahlon did, but mainly with within variance by means of pouring in information on the behavioural aspects of exposure to UV-radiation and analysing its impact on pigmentary variability.

The limitations imposed by the SPSS analysis of variance subprogram upon the number of processable factors and covariates, together with the fact that - for most applications of the aforementioned subprogram - it is necessary to assume that the covariate-by-factor interaction is zero, make the use of a multiple regression subprogram most appropiate. The best set of predictive variables will be found and an equation for the regression of pigmentation on the independent variables will be proposed. The dependent and independent variables have already been introduced elsewhere. As mentioned before, habit, sboften and sloften have been reconverted into a pair of variables -habitu (for the uia) and habitf (for the fh) - with three categories each, while, instead of hat, its complementary - newhat - was utilized. In order to improve the predictive ability of some of the dimensions underlying the whole set of independent variables, certain functions of some of the primary variables - age and daysuia/daysfh - have been incorporated into the analysis, as will be seen later. Consequently, the bivariate correlations within each of these three sets of predictors are very high, eventually exceeding r=0.900. High and moderate correlations appear occasionally between the days- sets, on the one hand, and the age set, on the other (highest 0.76); or between habit- and the days- and age sets (highest 0.49 for both). Otherwise, except for newhat with age (Swedish males: 0.359) and crfh with crfhnow (Spanish females: 0.324), most correlation coefficients have absolute values under 0.30 and even 0.10. The SPSS program does not deal with curvilinear regression, and so the step above is found to be highly convenient also in this respect, but the high intercorrelations create a problem, however, since multicollinearity - very high intercorrelation between some or all of the independent variables - can oause ambiguity in the calculation of the regression coefficients. Two ways out of the problem are available: 1) substitute the set of highly intercorrelated variables by a new one, which is a composite function of them all, and 2) use only one of them to represent the common underlying dimension.

The second option is provided, as part of the standard statistical procedure, by a variant within the SPSS regression subprogram itself. The stepwise inclusion method selects among the available variables the best subset of predictors that will yield an optimal regression equation with - if desired - as few terms as possible. The variables are entered in single steps, from best to worst, provided that they meet the statistical criteria (n, F, T) established by the researcher. The variable that explains the greatest amount of variance unexplained by the variables alalready in the equation is entered at each step. The first parameter, n, is the maximum number of independent variables which are to be accepted into the equation. F is the minimum value of the F ratio which the researcher is willing to accept for each new variable's regression coefficient. 1-T is the maximum proportion of variance which a variable is allowed to have in common with others already in the equation if it is to be admitted. T is thus the selective agent according to the aforementioned option 2). The emphasis has then been placed on T (0.85, 0.95 and 0.99 have been tentatively tried) while rather loose restrictions have been selected for n and F. The minimum available value, 0.01, has been adopted for F and n has been made equal to 14, the maximum number of independent variables presented.

A rather more demanding question is that of the assumptions to be met. For inferences beyond the sample level (Hays, 1981), these are:

1) The errors are normally distributed with expectations of zero for each treatment-combination population.
2) The errors have exactly the same variance for each treatment-combination population.
3) The errors are independent, both within each treatment-combination and across treatment-combinations.
4) The regression of the dependent variable on any of the predictor variables is linear.

All these assumptions presuppose as a basic requirement that the samples be drawn at random from their respective populations, a condition which has hopefully been satisfied as already referred to. The two first requirements, on the other hand, mean that for each possible combination of independent variables the scores must come from corresponding sections of the population, presenting both homoscedasticity of variance and normal distribution. Fulfilment of the third assumption requires the attainment of acceptable independence between the predictors and that the data within each treatment-combination correspond to independent observations. It has been shown within the samples,for treatment-combinations at the two-variable level (table B.2), that the normality of distribution requirement normally holds, and it was shown at the one-variable level that homoscedasticity of variance generally holds as well (tables IV.1-1, IV.2-1 and IV.3-1). Owing to the high number of predictors and treatments, many of the treatment-combinations (arrays) contain extremely low quantities of scores within the samples, and it becomes utterly impossible to study score distribution and variance within the corresponding sections of the populations. In the absence of contradictory evidence it will be supposed that distribution and variance do not behave at those levels worse than they did for the whole populations - as studied through the samples at the one and two-variable levels. The possibility of an eventual violation of the normality and homoscedasticity requirements should, thus, be borne in mind and, at that respect, a remark must be made here on a feature of the regression analysis: namely, that the need for assumptions is not the same for all possible applications of the regression analysis (Mc Nemar, 1959; Hays, 1981). At any rate, the ultimate check of the smoothness with which the assumptions question has been dealt with is provided by direct examination of the residuals.

The fourth requirement is at the core of the problem since the SPSS regression subprogram does not handle non-linear correlations. If, however, variable Y shows curvilinear regression on variable X, and f(X) is the function relating both to each other, Y's regression on X will be linear and of the form Y = A + B.f(X). Thus, the first step to undertake, prior to the analysis of regression itself, is the systematic exploration of the nature of the relationships between the dependent variable, pigmentation, and each of the independent ones, in order to find the appropiate f(X) for each case. This has already been done in another chapter, and - in addition to deciding to keep habitu and habitf as dichotomies, together with the rest of the behavioural variables - new predictors have been proposed: several powers of age and days- plus the logarithmic and inverse functions of daysuia and daysfh.

T's lowest values have been selected as 0.85 and 0.95, which implies that at each step no more than respectively 15 and 5 per cent of the variance of each independent variable, eventually to be admitted into the regression equation, may be explained by variables already in it. These percentages, however, correspond to correlation coefficients of 0.387 and 0.224 respectively, significant at better than the 0.001 and 0.050 levels respectively (among Swedes and Spaniards). There exist between the independent variables, as pointed out before, numerous cases of correlation at those levels and even higher, which has been considered safer to avoid. Even within the British samples, where the 0.05 level of significance corresponds to a coefficient of 0.354, the recurrence of the phenomenon may lead to decreased reliability of the results concerning the relative importance of the variables, as indicated by the partial regression coefficients (Nie et al., 1975). On the other hand, a too-strict selection of predictors might provoke an underestimation of the multiple correlation coefficients. Consequently, the best available equation has been picked out from each model by the simple procedure of leaving out all predictors admitted after the minimum SEE (standard error of estimation) has been reached. Afterwards, the best fit has been selected out of the three possibilities. In no case had a

	T = 0.99			Behav. only			Durbin-Watson st. T = 0.95			uia
Swe + Aswe	1.75832	231	- - -	1.52937	215	+ + ?	1.73813	183	? - -	♂
	1.62233	183	? ? -				1.62763	183	? ? ?	
	1.64584	231	? ? -				1.56358	183	+ ? ?	
	1.66747	229	? - -				1.62505	182	? ? -	
	1.67759	182	? - -	1.45803	214	+ + +	1.60555	182	? ? ?	
	1.64127	182	? ? -				1.63909	182	? ? -	
	1.72859	180	? - -				1.72141	180	? - -	
	1.63649	180	? ? -				1.62723	180	? ? ?	
	1.67241	174	? - -	1.41822	205	+ + +	1.68110	174	? - -	
Spa + Aspa	1.93096	108	- - -	1.85435	108	- - -	1.91456	108	- - -	
	1.40179	51	+ ? ?				1.48428	51	? ? ?	
	1.89622	108	- - -				1.96971	108	- - -	
	2.11917	108	- - -				2.11457	108	- - -	
	2.06719	108	- - -	2.00647	108	- - -	2.06079	108	- - -	
	2.12603	106	- - -				2.12445	106	- - -	
	2.11145	108	- - -				2.15236	108	- - -	
	2.03974	108	- - -				2.07333	108	- - -	
	1.94848	108	- - -	1.81861	108	- - -	1.94848	108	- - -	
Gb + Agb	1.73224	35	- - -	1.68440	35	- - -	1.35658	26	? ? ?	
	1.16478	27	+ + ?				1.21091	26	+ ? ?	
	1.80728	35	- - -				1.49609	26	? ? -	
	1.97294	35	- - -				1.86917	26	- - -	
	1.82579	27	- - -	2.11547	35	- - -	2.06487	26	- - -	
	1.68238	27	- - -				1.75152	26	- - -	
	2.02282	27	- - -				2.09584	26	- - -	
	2.66562	27	- - - + + ?				2.18984	26	- - -	
	1.96799	27	- - -	2.14494	35	- - -	1.84396	26	- - -	
Swe + Aswe	1.83699	255	- - -	1.72472	324	? - -	1.85534	252	- - -	♀
	2.06666	255	- - -				2.07356	252	- - -	
	1.94674	255	- - -				1.95873	252	- - -	
	1.86470	255	- - -				1.87377	252	- - -	
	1.95569	271	- - -	1.78929	324	- - -	1.97646	252	- - -	
	1.82448	255	- - -				1.82448	255	- - -	
	1.73106	268	- - -				1.74516	265	- - -	
	1.63705	254	? ? -				1.68704	251	? ? -	
	1.66067	254	? ? -	1.26287	320	+ + +	1.71929	251	?	
Spa + Aspa	1.98281	114	- - -	2.10446	108	- - -	2.04735	108	- - -	
	1.98072	114	- - -				2.05975	108	- - -	
	2.13803	114	- - -				2.22220	108	- - -	
	2.12943	46	- - -				2.15393	47	- - -	
	2.02515	47	- - -	2.04573	108	- - -	2.02515	47	- - -	
	1.95481	47	- - -				2.09125	108	- - -	
	1.98627	47	- - -				2.17857	108	- - -	
	2.10590	114	- - -				2.09629	108	- - -	
	2.01559	114	- - -	2.12133	108	- - -	2.05220	108	- - -	
Gb + Agb	2.10294	47	- - -	2.05363	47	- - -	2.25543	41	- - -	
	1.89465	41	- - -				2.04517	39	- - -	
	1.99948	47	- - -				2.26196	39	- - - ? - -	
	2.15386	39	- - -				2.15080	41	- - -	
	1.73960	47	- - -	1.73021	47	- - -	1.93195	41	- - -	
	1.68105	47	? - -				1.95345	39	- - -	
	1.89115	47	- - -				2.18055	39	- - -	
	1.84840	47	- - -				2.15696	39	- - -	
	2.07765	39	- - -	2.02249	45	- - -	2.07265	39	- - -	

Table V.1-1. Durbin-Watson statistics for the regression of pigmentation on age and the behavioural variables. All filters. Same parameter specifications as for Table D.1.
Males and females separate.

	T = 0.99			Behav. only			Dürbin-Watson st. T = 0.95			fh
	1.53316	201	+ + ?	1.60115	190	? ? ?	1.58527	193	? ? ?	
	1.57927	201	+ ? ?				1.61875	193	? ? ?	
	1.40704	201	+ + +				1.44320	193	+ + +	
	1.68196	200	? - -				1.72790	192	? - -	
Swe + Aswe	1.48224	192	+ + ?	1.52412	191	+ + ?	1.48224	192	+ + ?	
	1.54671	200	+ ? ?				1.53701	192	+ ? ?	
	1.65391	198	? ? -				1.65760	190	? ? -	
	1.65124	198	? ? -				1.69446	190	? ? -	
	1.69982	193	? - -	1.62852	185	? ? ?	1.63615	186	? ? -	
	2.00825	95	- - -	2.08416	102	- - -	2.00571	95	- - -	
	2.09001	102	- - -				2.08514	99	- - -	
	1.89146	99	- - -				1.98401	95	- - -	
	1.75244	99	- - -				1.80305	95	- - -	
Spa + Aspa	1.81171	102	- - -	1.88639	102	- - -	1.86101	95	- - -	♂
	2.00335	109	- - -				1.76414	95	- - -	
	1.78973	99	- - -				1.80736	95	- - -	
	1.70980	102	? - -				1.61075	99	? ? ?	
	1.95897	98	- - -	1.93263	102	- - -	1.97300	99	- - -	
	2.74309	37	- - -	2.95831	33	- - -	2.83443	35	- - -	
	2.43402	37	- - -				2.06728	35	- - -	
	2.24392	37	- - -				2.23681	35	- - -	
	2.37829	37	- - -				2.28412	35	- - -	
Gb + Agb	1.90548	37	- - -	2.15669	33	- - -	1.85810	35	- - -	
	1.94054	27	- - -				1.84235	27	- - -	
	2.00495	37	- - -				1.63915	35	? ? -	
	2.05611	27	- - -				2.14737	27	- - -	
	1.86777	28	- - -	1.58090	33	? ? -	1.92923	28	- - -	
	1.68550	349	? - -	1.58405	285	+ ? ?	1.66222	301	? ? -	
	1.55908	349	+ + ?				1.61175	301	? ? ?	
	1.65085	349	? ? -				1.65283	301	? ? -	
	1.64328	349	? ? -				1.66837	301	? ? -	
Swe + Aswe	1.67723	349	? - -	1.46122	285	+ + ?	1.72134	301	? - -	
	1.75548	322	- - -				1.78998	301	- - -	
	1.75885	316	- - -				1.79407	295	- - -	
	1.71615	344	? - -				1.74408	298	? - -	
	1.77904	344	- - -	1.26418	282	+ + +	1.70776	297	? ? -	
	2.26428	110	- - -	2.07315	98	- - -	2.29638	88	- - -	
	2.09402	112	- - -				1.98613	90	- - -	
	2.14221	112	- - -				2.11866	90	- - -	
	2.13137	112	- - -				2.18443	90	- - -	
Spa + Aspa	2.25990	99	- - -	2.25216	98	- - -	2.27695	90	- - -	♀
	1.90490	99	- - -				1.83076	88	- - -	
	1.63992	99	? ? -				1.62806	90	? ? -	
	1.82528	108	- - -				1.92818	90	- - -	
	1.78615	99	- - -	1.88561	98	- - -	1.80378	88	- - -	
	2.33843	43	- - -	2.65416	45	- - -	2.36990	41	- - -	
	2.54229	45	- - -				2.15719	41	- - -	
	2.22417	43	- - -				2.23929	41	- - -	
	2.34686	43	- - -				2.41360	41	- - -	
Gb + Agb	2.44968	43	- - -	2.59196	45	- - -	2.47268	41	- - -	
	2.32591	43	- - -				2.36902	41	- - -	
	2.44339	43	- - -				2.52704	41	- - -	
	1.99529	43	- - -				2.06028	41	- - -	
	1.85537	43	- - -	2.05695	45	- - -	1.83810	41	- - -	

Table V.1-1. Durbin-Watson statistics for the regression of pigmentation on age and the behavioural variables. All filters. Same parameter specifications as for Table D.1.
Males and females separate.

combination which was not contained in either the 0.95 or the 0.99 models to be elected. The results appear in table D.2 . This modus operandi is made possible by the stepwise nature of the procedure, and it constitutes, together with the possibility of objectively dealing with the collinearity problem, its most important advantage and the main reason for chosing it.

Errors of measurement or failure to fulfil the assumptions result in serial correlation among the residuals (Johnston, 1972; Nie et al., 1975). When not internally neutralized because of opposite signed autocorrelations contributed by two or more independent variables, it can be detected by means of the Durbin-Watson test (Durbin and Watson, 1950 and 1951). As one of the options within the subprogram, the Durbin-Watson statistic to each complete regression model is calculated by request. The results of the test for the 0.95 and 0.99 models are, as a whole, quite satisfactory (table V.1-1), especially at the inner arm and - curiously enough - within the smaller samples. The scattergrams which plot residuals versus predicted Y values do not show any of the aberrations consistently associated with the persistence of linearity or curvilinearity not accounted for by the predictors (fig. V.1-1). Any existing 'abnormalities' are instead presumably to be associated with occasional failure in fulfiling the normality and homogeneity of variance assumptions or perhaps even to undetected errors of measurement, limitations upon which no further control can be effected.

The mean, standard deviation and number of cases of each of the variables dealt with in the present section are shown in table V.1-1. Unknown cases have been deleted listwise.

The number of variables producing (after selection accordning to the optimum SEE) the best fit is normally between one and three. The identity of these pre-

	♂			♀		
	mean	**s.d.**	**N**	**mean**	**s.d.**	**N**
fh1	28.488	4.828	211	29.720	4.609	327
fh2	35.795	5.072		37.021	5.066	
fh3	36.212	5.603		37.283	5.162	
fh4	35.578	5.219		37.719	5.131	
fh5	33.600	5.312		35.864	5.024	
fh6	39.037	5.420		41.131	4.977	
fh7	52.236	5.764		54.202	4.683	
fh8	61.436	4.895		62.553	4.160	
fh9	63.725	4.328		64.380	3.818	
daysfh	161.261	102.789		141.055	78.807	
age	22.664	13.275		27.028	17.096	
habitf	0.701	0.459		0.899	0.502	
crfh	0.142	0.350		0.358	0.480	
newhat	0.465	0.500		0.480	0.500	
crfhnow	0.005	0.069		0.217	0.413	
fh1	21.666	3.502	104	23.384	4.096	105
fh2	28.157	4.150		30.169	4.290	
fh3	28.383	4.229		30.063	4.568	
fh4	28.097	3.857		30.514	4.403	
fh5	27.882	5.509		30.018	4.306	
fh6	32.168	4.570		35.583	4.904	
fh7	44.968	4.585		46.643	4.947	
fh8	53.235	4.634		54.331	4.592	
fh9	56.566	4.127		57.386	4.379	
daysfh	208.029	182.460		191.048	144.904	
ago	23.154	7.170		22.352	6.914	
habitf	0.779	0.417		0.886	0.320	
crfh	0.067	0.252		0.343	0.477	
newhat	0.712	0.455		0.914	0.281	
crfhnow	0.048	0.215		0.295	0.458	
fh1	27.022	3.366	32	29.844	3.408	46
fh2	31.456	3.596		34.776	3.649	
fh3	34.681	4.0034		36.685	4.155	
fh4	33.572	3.841		36.894	3.878	
fh5	32.319	5.031		35.083	4.039	
fh6	36.309	3.498		39.987	3.395	
fh7	50.906	4.295		53.530	3.557	
fh8	59.084	4.485		62.161	3.519	
fh9	62.413	3.223		64.424	3.113	
daysfh	246.688	124.538		209.544	66.543	
age	21.094	3.880		20.674	3.754	
habitf	0.625	0.492		0.739	0.444	
crfh	0.250	0.440		0.413	0.498	
newhat	0.344	0.483		0.478	0.505	
crfhnow	0.063	0.246		0.348	0.482	

	♂			♀		
	mean	**s.d.**	**N**	**mean**	**s.d.**	**N**
uia1	34.291	4.758	207	35.215	5.039	319
uia2	43.603	4.856		43.611	5.253	
uia3	44.210	5.464		44.074	5.409	
uia4	43.699	4.879		43.940	5.106	
uia5	41.076	4.669		42.235	4.826	
uia6	46.124	4.276		47.113	4.717	
uia7	57.330	4.408		57.306	4.899	
uia8	63.981	4.241		63.542	4.595	
uia9	65.746	3.568		64.827	4.276	
daysuia	173.652	96.907		156.875	70.940	
age	22.546	13.133		27.511	17.325	
habitu	0.691	0.463		0.897	0.305	
cruia	0.169	0.376		0.420	0.494	
cruianow	0.0	0.0		0.038	0.191	
uia1	31.044	4.480	78	33.167	4.706	78
uia2	38.613	5.028		41.256	5.057	
uia3	38.789	5.054		41.130	5.461	
uia4	38.200	4.684		41.641	4.880	
uia5	36.996	4.341		39.778	5.332	
uia6	42.417	4.682		45.071	5.915	
uia7	52.680	4.415		54.780	4.954	
uia8	58.756	4.282		60.912	4.034	
uia9	60.954	4.075		62.917	3.875	
daysuia	284.821	166.374		259.974	113.540	
age	23.487	7.383		22.846	7.839	
habitu	0.756	0.432		0.859	0.350	
cruia	0.064	0.247		0.192	0.397	
cruianow	0.013	0.113		0.039	0.194	
uia1	35.358	4.905	31	37.651	5.434	45
uia2	41.200	4.867		43.560	5.685	
uia3	43.761	4.143		45.291	5.124	
uia4	43.068	3.761		44.933	4.802	
uia5	41.068	4.515		42.269	5.048	
uia6	45.129	3.332		46.642	4.197	
uia7	56.684	4.028		57.298	4.340	
uia8	62.345	3.090		62.764	3.634	
uia9	64.639	3.418		64.467	3.234	
daysuia	252.581	121.977		210.956	66.594	
age	21.161	3.925		20.711	3.788	
habitu	0.613	0.495		0.733	0.447	
cruia	0.129	0.341		0.244	0.435	
cruianow	0.0	0.0		0.044	0.208	

Table V.1-2. Means, standard deviations and number of cases of the samples involved in the regression analysis of table D.2. Males and females separate.

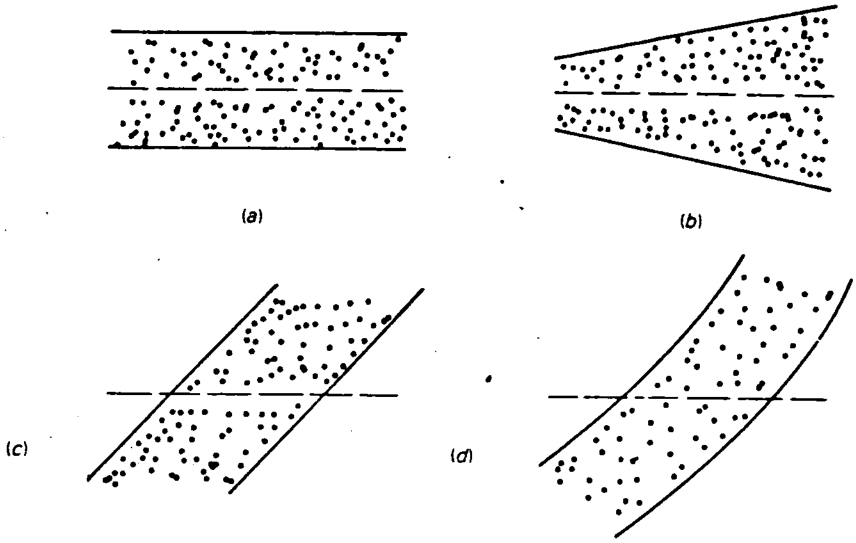


Fig. V.1-1. Scatterplots of residuals. In each of the graphics the vertical axis represents the residuals while the horizontal axis represents the variable against which the residuals are being plotted. The diagrams (a) to (d) show four basic patterns that might emerge. (b), (c) and (d) betray 'abnormalities' that require correction. The pattern of (b) indicates that the variance of residuals depends upon the value of the variable plotted on the horizontal axis. The pattern of (c) is indicative of a linear relationship between the residuals and the variable on the horizontal axis. The arched pattern of (d) is indicative of a curvilinear relationship between the residuals and the variable plotted on the horizontal axis. Only the straight band pattern of (a) indicates relative freedom from abnormalities. (After Nie et al., 1975).

dictors presents a regular pattern only within the bigger samples, Swedish males and females. Among Swedes, two of the three first places are occupied by some function of days- (normally d-in or d-lg) and one of the powers of age, except for females at the inner arm where age's place is taken by cruianow or by no predictor at all. The remaining position, when there is one, belongs usually to habitu, habitf or crfh. Among Spaniards, the usefulness of the behavioural variables as predictors (most of them, except habitf and crfhnow) has increased at the expenses of the functions of age and days-, particularly among females at the inner arm where they have completely replaced them. The number of predictors has decreased with respect to Swe+Aswe. A further fall characterizes the British samples. Here, habit- often takes the first position from the functions of age and days-, except among males at the inner arm and females at the forehead, where those two kinds still occupy them in block. As a whole, the picture agrees well with what has already been reported in the preceding chapters.

It must be emphasized that, owing to the idiosyncrasy of the stepwise regression method, it is by no means safe to look at the predictors in the regression equation as representing the variates most highly correlated with the independent one. This assertion is only true of that entered in the first place. Since a predictor's partial correlation coefficient is only adjusted for variables entered into the regression model prior to its own admission, it may introduce within itself other variates' correlations with the independent one, and so indirectly represent other underlying dimensions and their effects, as well as its own. This is often the case between habit- and cr-, on the one hand, and between the functions of age and days-, on the other. Thus, it is neither safe to look at the variables in an equation as unequivocally representing all dimensions worthy of consideration. It may well be the case that one or more of the predictors stand, combined or separate, for one or more dimensions which, apparently, were not considered at all.

Among Swedes, variables age and days- range over very wide values, a fact that creates the mathematical ground for an easier manifestation of correlations. In addition, the average last radiation intake lies much closer to the test day than within the other samples, which works in the same direction as increased score dispersion within days-, and a certain proportion of the Swede's sunbathing activities very often takes place in Southern Europe's holiday resorts. At home, under skies which are overcast during most of the year, it is relevant to consider how often and methodically exposure takes place. Consequently, habit- and crfh become important, although secondary to age and days- functions. Among the behavioural predictors the predominance of habitu is undisputed at the inner arm. But at the forehead, the distinction between exposers and non-exposers is somewhat blurred and crfh becomes relatively important as well. It has been pointed out that, generally, inner arms become lighter and foreheads darker with age, but among women cruianow has become a factor to reckon with, almost always reinforcing the usual trend. Crfhnow's and newhat's beta regression coefficients are often not smaller than crfh's, but they are prevented from admission because of their small T's.

Among Spaniards, as among the British, owing to the much shorter distribution range for age and to the relative remoteness of the average last radiation intake at the inner arm, the behavioural variables appear frequently in the first places. At the inner arm, the relevance of being or not being an exposer is enhanced in the radiation-rich Spanish climate, as revealed by habitu's beta regression coefficients. In comparison, cruia is less important. But exposer or not, there is no way for a forehead to escape regular irradiation unless it is normally covered. Here the determinant factors are the extent of the use of fringe and hats, especially among males, and of protective creams among females. Crfhnow and habitf are often either small or too highly correlated (low T) to predictors in the equation, in which case its admission is normally blocked.

Within the British samples, the average last radiation intake lies far behind in time and the days-dimension keeps its importance only among males at the inner arm and females at the forehead, although its admission is obstructed in the second case by low T's. Age is still of some importance everywhere - particularly at the forehead among females - but not at each filter. Among males at the inner arm and females at the forehead differences between exposers and non-exposers are small, as revealed by the sizes of their beta regression coefficients. Since proximity between the means for habit-'s two categories, in the two aforementioned cases, is not likely to go accompanied by high levels of radiation intake, days-'s importance can not be attributed there to the enhancing effects of intensive exposure on the pigmentation levels of cases widely dispersed along dimension days-. Instead, it is presumably to be seen as the effect of unusually high dispersion values on magnifying initially weak inter-individual differences (formula IV.1-1) by lengthening the maximum available inter-individual time distance between any two stages in the decaying processes of different pigmentation cases. In view of the results, there are reasons to suspect that - at least among the British - a male exposer is relatively unconcerned with his inner arm, since females do not fail to achieve much greater differences there; while female exposers are possibly not much more concerned with tanning their foreheads than their non-exposer counterparts - in spite of the information they fed into the questionnaire - or perhaps they are not very succesful at it.

In addition to the random drift of frequencies that often takesplace when samples are small, and which can affect the nature of our results by unduly augmenting or diminishing the weight of a certain category or subgroup of scores, it must also be borne in mind that failure on the experimenter's behalf to attain comparability of distributions for the different samples under study, may well affect the reliability of the results when working at the inferential level. This point is particularly well illustrated in the present study by the impact that the dispersion statistics' size for days- and age, or even the location of their means, have on the regression equations. Intercorrelations between independent variables and subsequent intermingling of their effects on the dependent variate can be controlled for, but there is no way to correct for either erratic frequencies or structural 'inconveniencies' within the predictors when extrapolating to the population level. The ideal sample should be as comprehensive in detail as possible and should present all kinds of conditions with scores and categories abundantly represented for the regression model to have a chance to evaluate them in a fully generalized context: a requirement seldom if ever approached. The author is well aware of the numerous shortcomings of the current work in this respect: scores and categories numerically underrepresented, mere dichotomies standing for full-scale continuous variation, dispersion ranges shorter than the real ones. All these limitations particularize the conclusions. They may be right for the samples, but less so for the populations from which they were extracted. This is especially true of the smaller samples: the Spaniards and, above all, the British.

The multiple R's for the inner arm (table V.1-3) tend to decrease from both ends of the spectrum towards the middle, reaching a minimum at the fifth filter (eventually at the sixth, instead), although the trend is not altogether consistent. No recognisable trends appear at the forehead, although the last two filters usually present the lowest figures. Multiple correlation coefficients vary for the inner arm between around 0.17 (uia9) and 0.45 (uia1), for Swedish males; 0.18 (uia6) and 0.38 (uia1), for Spanish males; and between 0.29 (uia4) and 0.59 (uia8), for British males. From around 0.34 (uia5) to 0.46 (uia1), for Swedish females; 0.14 (uia8) to 0.33 (uia7), for Spanish females; and from 0.15 (uia5) to 0.29 (uia8), for British females. At the

Swe+Aswe ♂					Spa+Aspa ♂					Gb+Agb ♂				
ΔR^2			R	R^2 unexp.	ΔR^2			R	R^2 unexp.	ΔR^2			R	R^2 unexp.
17.526	2.213	0.815	0.453	20.554	11.727	2.535		0.378	14.262	7.847	3.801		0.341	11.647
dulg	habitu	A1		17.988	A1	habitu			17.206	A1	cruia			21.257
11.707	3.133	0.968	0.398	15.808	6.165	1.355		0.274	7.520	9.743			0.312	9.743
duin	habitu	A1		19.854	dulg	cruia			23.375	duin				21.379
10.641	2.402	2.363	0.393	15.406	10.135	2.813		0.360	12.948	7.243	5.950		0.363	13.193
dulg	habitu	A1		25.260	habitu	A1			22.231	A1	dulg			14.902
7.030	2.119	1.273	0.323	10.421	6.946	4.393		0.337	11.339	5.066	3.474		0.292	8.540
dulg	habitu	A2		21.326	A1	habitu			19.451	A3	cruia			12.936
4.665	0.785	0.642	0.247	6.092	4.313			0.208	4.313	8.716			0.295	8.716
duin	du5	A2		20.468	A1				18.027	duin				18.612
7.080	0.725	0.780	0.293	8.584	3.345			0.183	3.345	12.830			0.358	12.830
duin	habitu	A1		16.716	A1				21.184	duin				9.675
7.109	1.089	1.148	0.306	9.346	4.627	1.468		0.247	6.095	20.650	5.032		0.507	25.682
duin	habitu	A1		17.617	habitu	A1			18.302	duin	cruia			12.056
3.418	0.753	0.851	0.224	5.022	5.843	2.425	1.991	0.320	10.259	21.729	13.416		0.593	35.144
duin	A2	habitu		17.080	habitu	A1	cruia		16.452	du5	cruia			6.191
2.820			0.168	2.820	9.228	1.712		0.331	10.940	17.100	9.466	2.836	0.542	29.402
duin				12.370	A1	cruia			14.785	dulg	A3	cruia		8.248
17.124			0.444	18.952	10.565			0.342	10.565					
dulg	habitu				A1									
11.277			0.385	14.005	4.930			0.248	4.930					
duin	habitu				dulg									
10.205	1.986	1.965	0.393	14.156	8.953			0.318	8.953					
dulg	habitu	A1			habitu									
6.576			0.303	8.258	5.721			0.264	5.721					
dulg	habitu				A1									
4.200			0.216	4.200	-									
duin														
6.626			0.266	6.626	-					9.824			0.358	9.824
duin										duin				
6.656			0.267	6.656	-					17.914			0.454	17.914
duin										duin				
2.947			0.185	2.947	4.604			0.242	4.604	19.030			0.593	30.512
duin					habitu					du5	cruia			
2.346			0.168	2.346	8.033			0.304	8.033	14.241			0.414	14.241
duin					A1					dulg				

Table V.1-3. The regression of pigmentation on age and the behavioural variables. Relative importance of the predictors. All filters. Same parameter specifications as for Table D.2.
Males and females separate.

Swe+Aswe ♀						Spa+Aspa ♀					Gb+Agb ♀			
ΔR²				R	R² unexp.	ΔR²			R	R² unexp.	ΔR²		R	R² unexp.
20.294 dulg	0.796 habitu	0.483 cr-now		0.459	21.573 19.911	4.884 cr-now			0.221	4.884 21.075	5.548 habitu		0.236	5.548 27.890
18.268 dulg	1.401 habitu	0.287 cr-now		0.447	19.955 22.085	5.851 cr-now	1.536 habitu	2.248 cruia	0.310	9.635 23.112	3.068 cruia		0.175	3.068 31.326
18.177 dulg	1.651 habitu			0.445	19.828 23.456	1.236 habitu	1.382 cruia		0.162	2.618 29.041	3.704 habitu		0.193	3.704 25.284
13.547 dulg	1.714 habitu	0.363 cr-now		0.395	15.624 22.000	6.177 cr-now			0.249	7.668 21.991	2.563 dulg		0.160	2.563 22.466
10.131 dulg	1.298 habitu			0.338	11.429 20.626	5.518 cr-now			0.235	5.518 26.859	2.303 habitu		0.152	2.303 24.893
10.973 dulg	0.605 habitu			0.340	11.578 19.676	3.958 cruia	2.547 cr-now	2.212 habitu	0.295	8.718 31.935	2.591 habitu		0.161	2.591 17.155
7.196 dulg	1.192 habitu	0.534 A1		0.299	8.922 21.861	3.751 cruia	3.655 habitu	3.179 cr-now	0.325	10.586 21.947	3.221 habitu		0.180	3.221 18.231
10.357 du1	3.471 A1	1.121 habitu		0.387	14.950 17.954	1.890 cr-now			0.138	1.890 15.965	5.341 habitu	2.798 cr-now	0.285	8.140 12.132
10.680 dulg	3.795 A1	0.644 cr-now	0.599 habitu	0.397	15.717 15.410	2.850 cr-now	A3		0.210	4.428 14.351	3.441 du1	2.380 cr-now	0.241	5.821 9.852
20.042 dulg				0.451	20.042	-					-			
18.010 dulg	habitu			0.444	19.160	4.612 cr-now			0.242	4.612	-			
17.919 dulg	habitu			0.445	19.321	-					-			
13.274 dulg	habitu			0.391	14.724	4.942 cr-now			0.249	4.942	-			
9.847 dulg	habitu			0.338	10.868	4.274 cr-now			0.235	4.274	-			
10.692 dulg				0.331	10.692	-					-			
6.903 dulg	habitu			0.290	7.808	-					-			
10.075 du1	3.208 A1	habitu		0.387	14.140	-					-			
10.398 dulg	A1			0.381	13.933	-					-			

Table V.1-3. The regression of pigmentation on age and the behavioural variables. Relative importance of the predictors. All filters. Same parameter specifications as for Table D.2.
Males and females separate.

Swe+Aswe ♂					Spa+Aspa ♂						Gb+Agb ♂				
$\triangle R^2$			R	R^2 unexp.	$\triangle R^2$				R	R^2 unexp.	$\triangle R^2$			R	R^2 unexp.
17.607 A1	2.126 dflg	0.835 cr-now	0.459	21.074 18.397	8.547 newhat	6.028 dfin	1.473 df5		0.401	16.048 10.297	11.984 A1	7.772 habitf	5.006 cr-now	0.498	24.762 8.525
16.272 A1	2.249 dflg		0.430	18.522 20.959	4.604 dfin	4.350 A2	4.276 cr-now		0.364	13.229 14.946	29.000 habitf			0.539	29.000 9.180
15.247 A1	5.040 dflg	0.421 crfh	0.455	20.709 24.894	6.348 dfin	4.044 A3	1.597 newhat		0.346	11.989 15.742	9.209 habitf	8.411 A3		0.420	17.620 13.203
17.393 A1	2.915 dflg	1.166 crfh	0.463	21.474 21.392	10.468 dfin	7.272 A3	4.859 newhat		0.475	22.599 11.513	22.274 habitf	8.977 A3		0.559	31.252 10.140
21.211 A1	2.734 dfin		0.489	23.945 21.458	5.841 A1	2.899 dfin	2.144 newhat		0.330	10.885 27.044	17.712 A1	4.097 habitf		0.467	21.809 19.787
18.286 A1	1.954 dflg	0.965 cr-now	0.461	21.204 23.151	6.575 newhat	4.982 A1	4.271 dfin	1.483 crfh	0.416	17.311 17.272	10.989 A3			0.332	10.989 10.892
12.138 A1	1.076 dflg	1.400 crfh	0.382	14.615 28.370	6.511 dfin	4.333 newhat	0.998 crfh		0.344	11.842 18.530	6.064 habitf			0.246	6.064 17.325
10.827 A1	3.256 dflg		0.375	14.082 20.589	3.382 habitf	1.571 dfin			0.223	4.953 20.408	14.435 dfin			0.380	14.435 20.083
13.009 A1	1.661 df1	0.159 crfh	0.394	15.487 15.830	2.998 dflg	1.626 cr-now			0.215	4.623 16.241	3.005 dfin			0.173	3.005 10.078
17.213 A1	dflg		0.444	18.961	7.651 newhat	dfin			0.382	12.884	9.050 A1			0.346	9.050
15.871 A1	dflg		0.430	17.738	3.669 dfin	3.482 A2	cr-now		0.364	10.626	26.663 habitf			0.539	26.663
14.842 A1	dflg		0.450	19.521	5.430 dfin	A3			0.322	8.618	-				
16.998 A1	dflg		0.451	19.542	9.590 dfin	6.521 A3	newhat		0.475	20.277	19.684 habitf			0.472	19.684
20.834 A1	dfin		0.489	23.214	4.918 A1				0.242	4.918	14.969 A1			0.421	14.969
17.895 A1	dflg		0.450	19.473	5.659 newhat	4.147 A1	dfin		0.398	13.304	-				
11.718 A1			0.348	11.718	5.595 dfin	newhat			0.329	9.079	-				
10.400 A1	dflg		0.375	13.256	2.435 habitf				0.184	2.435	11.852 dfin			0.380	11.582
12.593 A1	df1		0.383	13.850	-						-				

Table V.1-3. The regression of pigmentation on age and the behavioural variables. Relative importance of the predictors. All filters. Same parameter specifications as for Table D.2.
Males and females separate.

Swe+Aswe ♀			Spa+Aspa ♀			Gb+Agb ♀		
ΔR^2	R	R^2 unexp.	ΔR^2	R	R^2 unexp.	ΔR^2	R	R^2 unexp.
11.845 7.085 0.259 A1 dflg habitf	0.438	19.189 17.166	3.656 1.410 df1 erfh	0.225	5.066 15.927	8.035 2.193 A3 df1	0.320	10.228 10.426
8.433 6.272 0.768 A1 dflg habitf	0.393	15.473 21.689	3.260 2.523 dflg erfh	0.241	5.783 17.340	3.471 3.531 A3 newhat	0.265	7.001 12.385
11.268 6.735 0.434 A1 dflg habitf	0.429	18.437 21.734	2.685 1.698 dflg erfh	0.209	4.383 19.949	8.320 4.016 A1 df1	0.351	12.336 15.131
11.470 5.835 0.668 A1 dflg habitf	0.424	17.973 21.593	4.759 3.583 dflg erfh	0.289	8.342 17.765	6.591 A1	0.257	6.591 14.051
13.082 4.304 A1 dflg	0.417	17.386 20.853	2.096 2.958 3.178 newhat dflg erfh	0.287	8.232 17.013	6.553 A3	0.256	6.553 15.241
10.612 4.016 0.654 A1 dflg erfh	0.391	15.282 20.987	5.214 1.938 1.143 newhat erfh df5	0.288	8.295 22.052	10.066 A3	0.317	10.066 10.366
8.113 2.688 0.891 A1 dflg erfh	0.342	11.692 19.362	2.916 2.920 4.102 newhat dflg erfh	0.315	9.939 22.042	10.872 dfin	0.330	10.872 11.278
4.859 4.108 0.384 A1 dflg df5	0.306	9.351 15.690	2.075 2.834 erfh dflg	0.222	4.908 20.047	16.636 7.285 dfin er-now	0.489	23.921 9.423
6.432 A1 dflg	0.279	7.764 13.446	1.675 1.827 1.037 erfh df1 newhat	0.213	4.538 18.309	16.253 dfin	0.403	16.253 8.114
11.573 A1 dflg	0.435	18.430 -	-			-		
8.151 A1 dflg	0.384	14.179	-			-		
10.995 A1 dflg	0.424	17.497	-			-		
11.197 A1 dflg	0.416	16.794	3.834 dflg erfh	0.289	6.545	-		
12.815 A1 dflg	0.417	16.876	-			-		
10.337 A1 dflg	0.383	14.101	4.293 newhat	0.228	4.293	8.022 A3	0.317	8.022
7.830 A1 dflg	0.329	10.251	-			8.847 dfin	0.330	8.847
4.566 A1 dflg	0.299	8.404				14.741 dfin er-now	0.489	20.382
6.144 A1 dflg	0.279	7.194				14.350 dfin	0.403	14.350

Table V.1-3. The regression of pigmentation on age and the behavioural variables. Relative importance of the predictors. All filters. Same parameter specifications as for Table D.2.
Males and females separate.

forehead it ranges between 0.38 (fh8) and 0.49 (fh5), for Swedish males; between 0.22 (fh9) and 0.48 (fh4), for Spanish males; and between 0.17 (fh9) and 0.56 (fh4), for the British males. From 0.28 (fh9) to 0.44 (fh1), among Swedish females; from 0.21 (fh3) to 0.32 (fh7), among Spanish females; and from 0.26 (fh5) to 0.49 (fh8), for British females,

Males present higher R's than females, with the exception of Swedes at the inner arm where the opposite is true. Among males and females, multiple correlation coefficients at the inner arm are smaller than at the forehead, except for British males and Swedish females where the opposite relation is valid. Comparisons between samples produce the following results: for the inner arm and among males, British > Swedes > Spaniards; among females, Swedes > Spaniards > British. At the forehead and for both sexes, Swedes > British > Spaniards.

The percentages of variation (column R^2) explained by the best combination available vary within each sample, and between sexes and places, naturally in the same fashion as R. Highest at the inner arm is 35.144 per cent (British ♂) and lowest is 1.890 per cent (Spaniards ♀), while at the forehead 31.252 per cent (British ♂) is highest and 3.005 per cent (British ♂) is lowest.

The number of predictors admitted by the populations at the 0.05 level of significance is even more reduced. Normally the whole third and fourth columns, as well as parts of the second, are dropped (among Spaniards and the British even some of the first-position predictors). Among Swedes, at the inner arm, only functions of daysuia, eventually habitu or even A1, are accepted. At the forehead, nothing but A1 and functions of daysfh are admitted (in that order). Here, the adjusted R^2, a more conservative estimate of the percentage of variation explained, is used instead of the normal one.

The R^2 columns also contain the absolute figures of unexplained variance. Generally speaking, the greatest variances appear between the greenish-blue and reddish-orange filters. The greatest value can crop up anywhere between the second and the eight filters. The smallest one crops up often at the ninth filter. If the present work has succeeded in isolating every relevant sort of behaviourally induced variation, these values should stand for the effects of every possible non-behavioural dimension underlying colour diversity in man. In other words, they should reflect genetic diversity and the impact of geographical differences in radiation levels on pigmentation. We shall return to this point later.

2. In chapters VI and VII the variability of pigmentation of the skin across the categories of predictors such as sex, geographical location and blood groups - when the effects of other variables are being controlled for or held constant - will be investigated by means of the analysis of variance technique. To that purpose, a knowledge of the dimensions within which significant internal variability is likely to appear, when both sexes are pooled together, will be of invaluable assistance. Thus, two additional regression analyses have been performed on the data, with sex included now as one of the independent variables and with the same parameters as before.

The results obtained with T = 0.99 (table V.2-1) were, after careful consideration, selected as the best choice - since the high number of predictors admitted when T = 0.95 would have greatly jeopardized the safety of the conclusions attained, owing to the increased number of empty cells (known to be a major problem when analysis of variance is employed).

```
SUBFILE   SVE        ASVE

* * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * *   VARIABLE LIST  1
DEPENDENT VARIABLE..    UIA1                                                                           REGRESSION LIST 10

                                           SUMMARY TABLE
VARIABLE
                                  MULTIPLE R   R SQUARE  RSQ CHANGE   SIMPLE R             B                BETA
DULG                                0.42043     0.17676    0.17676     0.42043          9.285601            0.43206
SEX                                 0.44035     0.19430    0.01754     0.09521          1.329323            0.13296
(CONSTANT)                                                                             12.65497
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
* * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * *   VARIABLE LIST  1
DEPENDENT VARIABLE..    UIA2                                                                           REGRESSION LIST 11

                                           SUMMARY TABLE
VARIABLE
                                  MULTIPLE R   R SQUARE  RSQ CHANGE   SIMPLE R             B                BETA
DULG                                0.37257     0.13881    0.13881     0.37257          7.954005            0.35878
HABITU                              0.39245     0.15402    0.01521    -0.15317         -1.622609           -0.12955
CRUIANOW                            0.39657     0.15727    0.00325     0.07372          1.867657            0.05719
(CONSTANT)                                                                             27.71641
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
* * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * *   VARIABLE LIST  1
DEPENDENT VARIABLE..    UIA3                                                                           REGRESSION LIST 12

                                           SUMMARY TABLE
VARIABLE
                                  MULTIPLE R   R SQUARE  RSQ CHANGE   SIMPLE R             B                BETA
DULG                                0.37026     0.13710    0.13710     0.37026          8.465110            0.35699
HABITU                              0.39270     0.15421    0.01712    -0.16047         -1.826731           -0.13522
CRUIANOW                            0.39471     0.15579    0.00158     0.05601          1.392958            0.04988
(CONSTANT)                                                                             27.31172
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
* * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * *   VARIABLE LIST  1
DEPENDENT VARIABLE..    UIA4                                                                           REGRESSION LIST 13

                                           SUMMARY TABLE
VARIABLE
                                  MULTIPLE R   R SQUARE  RSQ CHANGE   SIMPLE R             B                BETA
DULG                                0.31120     0.09684    0.09684     0.31120          6.496433            0.29742
HABITU                              0.33335     0.11112    0.01428    -0.14437         -1.555512           -0.12291
CRUIANOW                            0.33899     0.11491    0.00378     0.07468          1.987351            0.06176
(CONSTANT)                                                                             31.10536
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
* * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * *   VARIABLE LIST  1
DEPENDENT VARIABLE..    UIA5                                                                           REGRESSION LIST 14

                                           SUMMARY TABLE
VARIABLE
                                  MULTIPLE R   R SQUARE  RSQ CHANGE   SIMPLE R             B                BETA
DULG                                0.24246     0.05878    0.05878     0.24246          5.233001            0.23635
SEX                                 0.27923     0.07796    0.01919     0.11273          1.295802            0.13494
(CONSTANT)                                                                             28.48064
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
* * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * *   VARIABLE LIST  1
DEPENDENT VARIABLE..    UIA6                                                                           REGRESSION LIST 15

                                           SUMMARY TABLE
VARIABLE
                                  MULTIPLE R   R SQUARE  RSQ CHANGE   SIMPLE R             B                BETA
DULG                                0.27229     0.07414    0.07414     0.27229          5.638441            0.28295
SEX                                 0.29819     0.08892    0.01478     0.09730          1.130162            0.12203
(CONSTANT)                                                                             32.79217
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
* * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * *   VARIABLE LIST  1
DEPENDENT VARIABLE..    UIA7                                                                           REGRESSION LIST 16

                                           SUMMARY TABLE
VARIABLE
                                  MULTIPLE R   R SQUARE  RSQ CHANGE   SIMPLE R             B                BETA
DULG                                0.23949     0.05736    0.05736     0.23949          4.755847            0.23136
HABITU                              0.25725     0.06618    0.00882    -0.11305         -1.117694           -0.09422
(CONSTANT)                                                                             42.02778
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
* * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * *   VARIABLE LIST  1
DEPENDENT VARIABLE..    UIA8                                                                           REGRESSION LIST 17

                                           SUMMARY TABLE
VARIABLE
                                  MULTIPLE R   R SQUARE  RSQ CHANGE   SIMPLE R             B                BETA
DULG                                0.24936     0.06217    0.06217     0.24936          4.675717            0.23862
HABITU                              0.26900     0.07236    0.01019    -0.12086         -1.168936           -0.10315
CRUIANOW                            0.27168     0.07381    0.00145     0.04936          1.102545            0.03820
(CONSTANT)                                                                             54.56151
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
* * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * *   VARIABLE LIST  1
DEPENDENT VARIABLE..    UIA9                                                                           REGRESSION LIST 18

                                           SUMMARY TABLE
VARIABLE
                                  MULTIPLE R   R SQUARE  RSQ CHANGE   SIMPLE R             B                BETA
DULG                                0.25730     0.06620    0.06620     0.25730          4.396841            0.24961
SEX                                 0.27182     0.07389    0.00769    -0.10985         -0.7207689          -0.08804
(CONSTANT)                                                                             56.89243
```

Table V.2-1. The regression of pigmentation on age and the behavioural variables. Relative importance of the predictors. All filters. Same parameter specifications as for table D.2.
Males and females pooled together.

```
 SUBFILE   SPA        ASPA

 * * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * *    VARIABLE LIST  1
 DEPENDENT VARIABLE..    UIA1                                                                                REGRESSION LIST 10

                                              SUMMARY TABLE
 VARIABLE
                                    MULTIPLE R  R SQUARE  RSQ CHANGE   SIMPLE R              B                     BETA
 SEX                                  0.23445    0.05497   0.05497     0.23445         2.293508                 0.24171
 A1                                   0.29772    0.08864   0.03367     0.17474         0.1134709                0.18361

 (CONSTANT)                                                                           25.96685
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

 * * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * *    VARIABLE LIST  1
 DEPENDENT VARIABLE..    UIA2                                                                                REGRESSION LIST 11

                                              SUMMARY TABLE
 VARIABLE
                                    MULTIPLE R  R SQUARE  RSQ CHANGE   SIMPLE R              B                     BETA
 SEX                                  0.24438    0.05972   0.05972     0.24438         2.480561                 0.23770
 DUIN                                 0.27905    0.07787   0.01815    -0.12633      -854.7843                 -0.13862
 CRUIANOW                             0.30934    0.09569   0.01782     0.15010         4.340660                 0.13403
 (CONSTANT)                                                                           39.67359
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

 * * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * *    VARIABLE LIST  1
 DEPENDENT VARIABLE..    UIA3                                                                                REGRESSION LIST 12

                                              SUMMARY TABLE
 VARIABLE
                                    MULTIPLE R  R SQUARE  RSQ CHANGE   SIMPLE R              B                     BETA
 SEX                                  0.21441    0.04597   0.04597     0.21441         2.371687                 0.21782
 DUIN                                 0.29515    0.08711   0.04114    -0.19543     -1314.759                  -0.20408
 CRUIANOW                             0.29804    0.08883   0.00172     0.05401         1.405134                 0.04159
 (CONSTANT)                                                                           41.74003
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

 * * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * *    VARIABLE LIST  1
 DEPENDENT VARIABLE..    UIA4                                                                                REGRESSION LIST 13

                                              SUMMARY TABLE
 VARIABLE
                                    MULTIPLE R  R SQUARE  RSQ CHANGE   SIMPLE R              B                     BETA
 SEX                                  0.33595    0.11286   0.11286     0.33595         3.350701                 0.32738
 CRUIANOW                             0.36195    0.13101   0.01815     0.14279         4.697545                 0.14160
 A1                                   0.37392    0.13982   0.00881     0.07211         0.6261428E-01            0.09413
 (CONSTANT)                                                                           33.38644
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

 * * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * *    VARIABLE LIST  1
 DEPENDENT VARIABLE..    UIA5                                                                                REGRESSION LIST 14

                                              SUMMARY TABLE
 VARIABLE
                                    MULTIPLE R  R SQUARE  RSQ CHANGE   SIMPLE R              B                     BETA
 SEX                                  0.28274    0.07994   0.07994     0.28274         2.772249                 0.27240
 CRUIANOW                             0.32285    0.10423   0.02429     0.17931         5.143203                 0.16285
 A1                                   0.33645    0.11320   0.00896     0.07346         0.6250895E-01            0.09496
 (CONSTANT)                                                                           32.74918
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

 * * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * *    VARIABLE LIST  1
 DEPENDENT VARIABLE..    UIA6                                                                                REGRESSION LIST 15

                                              SUMMARY TABLE
 VARIABLE
                                    MULTIPLE R  R SQUARE  RSQ CHANGE   SIMPLE R              B                     BETA
 SEX                                  0.24717    0.06109   0.06109     0.24717         2.620829                 0.23472
 CRUIANOW                             0.28271    0.07992   0.01883     0.15776         4.964115                 0.14449
 A2                                   0.30704    0.09427   0.01435     0.10810         0.1145257E-02            0.11998
 (CONSTANT)                                                                           39.11576
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

 * * * * * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * *    * * * * * * *   VARIABLE LIST  1
 DEPENDENT VARIABLE..    UIA7                                                                                REGRESSION LIST 16

                                              SUMMARY TABLE
 VARIABLE
                                    MULTIPLE R  R SQUARE  RSQ CHANGE   SIMPLE R              B                     BETA
 SEX                                  0.23650    0.05593   0.05593     0.23650         2.202665                 0.22977
 CRUIANOW                             0.26883    0.07227   0.01634     0.14745         3.922491                 0.13165
 DUIN                                 0.29916    0.08950   0.01723    -0.11963      -745.2997                 -0.13179
 (CONSTANT)                                                                           53.49133
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -    - - - - - - - - - - - - - - -

 * * * * * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * *    * * * * * * *   VARIABLE LIST  1
 DEPENDENT VARIABLE..    UIA8                                                                                REGRESSION LIST 17

                                              SUMMARY TABLE
 VARIABLE
                                    MULTIPLE R  R SQUARE  RSQ CHANGE   SIMPLE R              B                     BETA
 SEX                                  0.24621    0.06062   0.06062     0.24621         2.173096                 0.25110
 A1                                   0.27971    0.07824   0.01762     0.12759         0.4471162E-01            0.13283
 (CONSTANT)                                                                           54.45561
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -    - - - - - - - - - - - - - - -

 * * * * * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * *    * * * * * * *   VARIABLE LIST  1
 DEPENDENT VARIABLE..    UIA9                                                                                REGRESSION LIST 18

                                              SUMMARY TABLE
 VARIABLE
                                    MULTIPLE R  R SQUARE  RSQ CHANGE   SIMPLE R              B                     BETA
 SEX                                  0.24965    0.06232   0.06232     0.24965         2.119896                 0.23680
 A1                                   0.31625    0.10002   0.03769     0.18482         0.1042333                0.19427
 (CONSTANT)                                                                           56.37776
```

```
SUBFILE   68          AGB
* * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * *   VARIABLE LIST  1
                                                                                                         REGRESSION LIST 10
DEPENDENT VARIABLE..    UIA1
                                            SUMMARY TABLE

VARIABLE                              MULTIPLE R  R SQUARE  RSQ CHANGE  SIMPLE R            B                BETA

SEX                                     0.21349    0.04558   0.04558     0.21349       2.216997            0.20461
A3                                      0.22632    0.05129   0.00571    -0.16363      -0.1132187E-03      -0.13415
(CONSTANT)                                                                             34.33344
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
* * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * *   VARIABLE LIST  1
                                                                                                         REGRESSION LIST  1
DEPENDENT VARIABLE..    UIA2
                                            SUMMARY TABLE

VARIABLE                              MULTIPLE R  R SQUARE  RSQ CHANGE  SIMPLE R            B                BETA

SEX                                     0.21388    0.04575   0.04575     0.21388       2.336140            0.21154
A3                                      0.21987    0.04835   0.00260    -0.06072      -0.3649823E-04      -0.05102
(CONSTANT)                                                                             39.27131
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
* * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * *   VARIABLE LIST  1
                                                                                                         REGRESSION LIST 12
DEPENDENT VARIABLE..    UIA3
                                            SUMMARY TABLE

VARIABLE                              MULTIPLE R  R SQUARE  RSQ CHANGE  SIMPLE R            B                BETA

A1                                      0.18458    0.03407   0.03407    -0.18458      -0.2198770          -0.17596
SEX                                     0.23649    0.05593   0.02186     0.15835       1.430837            0.14810
(CONSTANT)                                                                             46.98333
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
* * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * *   VARIABLE LIST  1
                                                                                                         REGRESSION LIST 13
DEPENDENT VARIABLE..    UIA4
                                            SUMMARY TABLE

VARIABLE                              MULTIPLE R  R SQUARE  RSQ CHANGE  SIMPLE R            B                BETA

SEX                                     0.20618    0.04251   0.04251     0.20618       1.806983            0.19949
A3                                      0.25246    0.06374   0.02122    -0.15503      -0.6023124E-04      -0.14584
(CONSTANT)                                                                             42.21304
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
* * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * *   VARIABLE LIST  1
                                                                                                         REGRESSION LIST 14
DEPENDENT VARIABLE..    UIA5
                                            SUMMARY TABLE

VARIABLE                              MULTIPLE R  R SQUARE  RSQ CHANGE  SIMPLE R            B                BETA

A3                                      0.13058    0.01705   0.01705    -0.13058      -0.9381752E-04      -0.12521
SEX                                     0.17521    0.03070   0.01365     0.12269       1.144966            0.11684
(CONSTANT)                                                                             43.90563
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
* * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * *   VARIABLE LIST  1
                                                                                                         REGRESSION LIST 15
DEPENDENT VARIABLE..    UIA6
                                            SUMMARY TABLE

VARIABLE                              MULTIPLE R  R SQUARE  RSQ CHANGE  SIMPLE R            B                BETA

SEX                                     0.19118    0.03655   0.03655     0.19118       1.489877            0.18826
A3                                      0.20163    0.04065   0.00410    -0.07277      -0.3470697E-04      -0.06413
(CONSTANT)                                                                             44.00467
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
* * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * *   VARIABLE LIST  1
                                                                                                         REGRESSION LIST 16
DEPENDENT VARIABLE..    UIA7
                                            SUMMARY TABLE

VARIABLE                              MULTIPLE R  R SQUARE  RSQ CHANGE  SIMPLE R            B                BETA

DUIN                                    0.20368    0.04149   0.04149     0.20368       643.9731            0.20805
CRUIANOW                                0.22291    0.04970   0.00821    -0.08069      -2.363967           -0.09071
(CONSTANT)                                                                             53.98229
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
* * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * *   VARIABLE LIST  1
                                                                                                         REGRESSION LIST 17
DEPENDENT VARIABLE..    UIA8
                                            SUMMARY TABLE

VARIABLE                              MULTIPLE R  R SQUARE  RSQ CHANGE  SIMPLE R            B                BETA

CRUIA                                   0.18361    0.03371   0.03371     0.18361       1.563695            0.18385
A1                                      0.19532    0.03815   0.00444     0.06594       0.5974030E-01       0.06661
(CONSTANT)                                                                             61.04694
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
* * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * *   VARIABLE LIST  1
                                                                                                         REGRESSION LIST 18
DEPENDENT VARIABLE..    UIA9
                                            SUMMARY TABLE

VARIABLE                              MULTIPLE R  R SQUARE  RSQ CHANGE  SIMPLE R            B                BETA

DUS                                     0.17910    0.03208   0.03208    -0.17910      -0.3726026E-13      -0.18453
CRUIANOW                                0.22475    0.05029   0.01821    -0.12765      -2.756613           -0.13505
(CONSTANT)                                                                             64.76599
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

```
SUBFILE    SVE          ASVE

VARIABLE              MEAN        STANDARD DEV      CASES

FH1                29.2590              4.7333        490
FH2                36.5882              5.0271        490
FH3                36.9318              5.3505        490
FH4                36.8992              5.2681        490
FH5                35.0312              5.3877        490
FH6                40.3439              5.2419        490
FH7                53.4227              5.2158        490
FH8                62.1466              4.5214        490
FH9                64.0851              4.0676        490
NEWHAT              0.4714              0.4997        490
DF1               158.6612             86.9811        490
DF2             32723.6531          62074.2235        490
DF3           9869455.4286        52265936.6698       490
DF4        4916182767.5184  4548542384 6.8835       490
DF5        ******************************          490
A1                 25.2102             15.8347        490
A2                885.7816           1203.0341        490
A3              41030.5204          79766.0350        490
DFIN                0.0097              0.0139        490
DFLG                2.1357              0.2658        490
HABITF              0.8122              0.3909        490
CRFH                0.2653              0.4419        490
CRFHNOW             0.1286              0.3351        490
UIA1               34.8835              4.9038        490
UIA2               43.6514              5.0529        490
UIA3               44.1749              5.4045        490
UIA4               43.9476              4.9784        490
UIA5               41.9133              4.7091        490
UIA6               46.7933              4.5419        490
UIA7               57.4098              4.6755        490
UIA8               63.7549              4.4662        490
UIA9               65.2471              4.0149        490
DU1               163.6657             84.2704        490
DU2             33880.0163          61844.3236        490
DU3          10108452.1143       52240398.8550        490
DU4        4964770086.2000  45481059794.8180        490
DU5        ******************************          490
A1                 25.2102             15.8347        490
A2                885.7816           1203.0341        490
A3              41030.5204          79766.0350        490
DUIN                0.0083              0.0098        490
DULG                2.1624              0.2279        490
HABITU              0.8082              0.3941        490
CRUIA               0.3122              0.4639        490
CRUIANOW            0.0245              0.1547        490
SEX                 1.6000              0.4904        490
```

```
SUBFILE    SPA          ASPA

                      MEAN        STANDARD DEV      CASES

                   22.9960              3.8883        150
                   29.6560              4.1119        150
                   29.6320              4.1117        150
                   29.8173              4.2979        150
                   29.3327              4.7341        150
                   34.1247              6.7503        150
                   46.3347              4.6560        150
                   54.1887              4.5877        150
                   57.3353              4.2572        150
                    0.8133              0.3909        150
                  263.2533            151.1634        150
                92000.3600         157165.6078        150
              47148062.5200     144995147.4160        150
         *****************130463341866.6532        150
         ******************************             150
                   23.2733              7.7181        150
                  600.8200            581.8158        150
                18385.6333          36623.0202        150
                    0.0071              0.0197        150
                    2.3600              0.2739        150
                    0.8000              0.4013        150
                    0.1867              0.3909        150
                    0.1733              0.3798        150
                   32.0327              4.7697        150
                   40.0187              5.2349        150
                   39.9740              5.4615        150
                   39.9673              5.1342        150
                   38.4800              5.1051        150
                   43.8500              5.5537        150
                   53.8553              4.2059        150
                   59.8407              4.3413        150
                   61.9693              4.1419        150
                  273.9000            165.1473        150
                95948.5000         157057.9374        150
              48731697.3733     145112877.4565        150
         *****************130486264378.0239        150
         ******************************             150
                   23.2733              7.7181        150
                  600.8200            581.8155        150
                18365.6333          36523.0202        150
                    0.0041              0.0008        150
                    2.4071              0.1380        150
                    0.8000              0.4013        150
                    0.1267              0.3337        150
                    0.0267              0.1616        150
                    1.4933              0.5016        150
```

```
SUBFILE    GB           AGB

VARIABLE              MEAN        STANDARD DEV      CASES

FH1                28.6447              3.6751         76
FH2                33.3921              3.9942         76
FH3                35.8526              4.2251         76
FH4                35.4724              4.1955         76
FH5                33.9474              4.6827         76
FH6                38.4645              3.8656         76
FH7                52.4408              4.1037         76
FH8                60.9750              4.1651         76
FH9                63.6013              3.3265         76
NEWHAT              0.4211              0.4970         76
DF1               227.9342             94.7474         76
DF2             60812.9605          69491.7121         76
DF3          20219907.8289       43784305.1386        76
DF4        8463771749.2632  26765558212.0273         76
DF5        ******************************           76
A1                 20.8947              3.8248         76
A2                451.0263            188.8398         76
A3              10133.8947           7234.7164         76
DFIN                0.0049              0.0014         76
DFLG                2.3328              0.1375         76
HABITF              0.6842              0.4679         76
CRFH                0.3289              0.4730         76
CRFHNOW             0.2368              0.4280         76
UIA1               36.7158              5.3136         76
UIA2               42.5974              5.4557         76
UIA3               44.6671              4.7795         76
UIA4               44.1724              4.4762         76
UIA5               41.7789              3.9432         76
UIA6               46.0250              3.9156         76
UIA7               57.0474              4.1991         76
UIA8               62.5734              3.4072         76
UIA9               64.5168              3.2990         76
DU1               227.9342             94.7474         76
DU2             60812.9605          69491.7121         76
DU3          20219907.8289       43784305.1386        76
DU4        8463771749.2632  26765558212.0273         76
DU5        ******************************           76
A1                 20.8947              3.8248         76
A2                451.0263            188.8398         76
A3              10133.8947           7234.7164         76
DUIN                0.0049              0.0014         76
DULG                2.3328              0.1375         76
HABITU              0.6842              0.4679         76
CRUIA               0.1974              0.4007         76
CRUIANOW            0.0263              0.1611         76
SEX                 1.5921              0.4947         76
```

Table V.2-2. Means, standard deviations and number of cases of the samples involved in the regression analysis of table V.2-1.

Some elementary statistics for the pooled samples are shown in table V.2-2.

The bigger size of the pooled samples is presumably the reason of the greatly improved uniformity in regression patterns. In general, for the inner arm (the only site studied), multiple R's are somewhat smaller than those shown by table V.1-3. This may be the effect of some predictors displaying at certain filters opposite-signed correlations with pigmentation for men and women. R's variation along the spectrum is now more uniform, as measured by the difference between its maximal and minimal values (difference which augment with decreasing sample size). R values generally diminish with sample size (a not too common condition at V. 1-3). Among Swedes and the British there is a trend for decreasing R's from both ends of the spectrum towards the middle region, with the highest values within the first half of the VL range. Sex is now an important predictor, practically present everywhere; the others are collected among those available at table V.1-3, with eventual exchanges among the Spaniards and the British between functions of days- and age (which for those samples show high to acceptable correlations with each other).

Summary

A stepwise regression analysis has been performed on the samples: first, with males and females separate - after, with both sexes pooled together. Bigger sample size was presumably the factor responsible for the greater uniformity of regression patterns in the last case. The most important trends elicited in the first regression analysis are summarised in section X, in the text.

Owing to the mechanics of the method, each of the variables in a regression equation may stand, alone or in combination with others, for one or more dimensions which have, apparently, not been reckoned with.

CHAPTER VI

VI.1. The geographical distribution of pigmentation.

Although corrections have been made for the effects of the behavioural variables in pigmentation diversity, nowhere have geographical differences in UV-radiation been taken into account in explaining that diversity. The samples come from three well defined areas: Scandinavia (Sweden), Northwestern Europe (Britain) and Southwestern Europe (Spain). The three countries cover some 14, 11 and 8 latitude degrees respectively. Their southernmost tips lie respectively at 55^{0} $25'$ N, 50^{0} N and 36^{0} N. Britain and Sweden are mostly elongated countries spreading in a South-North direction, but Spain extends East-Westwards about as much as South-Northwards. Most of the inhabited areas of Sweden and Britain are low country, with often overcast skies and respectively less than 2100 and 1800 hours of sunshine a year (fig. VI.1-4 and VI.1-7), while around thirty per cent of Spaniards live at an average altitude of 2000 feet, under often cloudless skies (for the, whole country, from 1700 hours per year into well beyond 3000 hours) and intensive radiation (fig. VI.1-6). Climate varies accordingly, from microthermal - with severe snowy winters and all-season rain, in Scandinavia and Britain - to mesothermal - with mild winters and all-season rain or, more often, rain deficiency, in Spain. It has been calculated that, taking into account such factors as length of day and angular elevation of the sun, maximum insolation of the nothern hemisphere is experienced on June 21st along latitude $43\frac{1}{2}^{0}$ N (along the Spanish northern coast); on other dates the corresponding latitude lies further south. Britain and Scandinavia, on the other hand, lie well beyond the latitude limit for UV-induced formation of vitamin D in winter (around 40^{0}), but - owing to annual variation in the sun's angular elevation - fully within the latitude limit in summer (around 87^{0}). These facts alone ought to suggest that considerable variation is to be expected, not only between the populations of the three countries, but probably within them as well.

With this in mind, and without forgetting the limitations imposed by the size of the samples, it was decided that the arrangements providing the most suitable basis for further elaboration were the traditional 'landskap' partition, in Sweden, and the historical 'región' division, in Spain. The Spanish 'región' is further subdivided into administrative entities called 'provincias', which, together with the Swedish 'län' - a modernized revision of the 'landskap' unit - correspond approximately to the English county. They have not only administrative relevance but a certain degree of historic and demographic uniqueness as well. In Britain, owing to the reduced size of the samples, the only subdivision which could be undertaken was ethnic: English, Welsh, Scots and Irish. Figure VI.1-1, VI.1-2 and VI.1-3 illustrate the aforementioned subdivisions for the three countries.

The individuals in the Swedish sample come mainly from Southern Sweden. Not less than 60 per cent of all Swedes had at least three grandparents from the southern region, Götaland, of which 51 per cent came from Skåne (Scania). They all lived in Malmö or nearby and probably most had lived there the major part of their lifetime. On the other hand, most of the British and Spanish subjects were tested at the Universities of Durham and Madrid respectively, where they were only transitorily established, often far away from their habitual locations. Around 73 per cent of Spaniards had at least three grandparents from central Spain; while roughly 77 per cent of the British subjects had at least three known English grandparents (mostly from western and northern England), whilst the fourth might be Scottish, Irish or Welsh.

Fig. VI.1-1. Sweden. (a) Historical division into 'landskap'. (b) Administrative division into 'län'. (After Beckman, 1959).

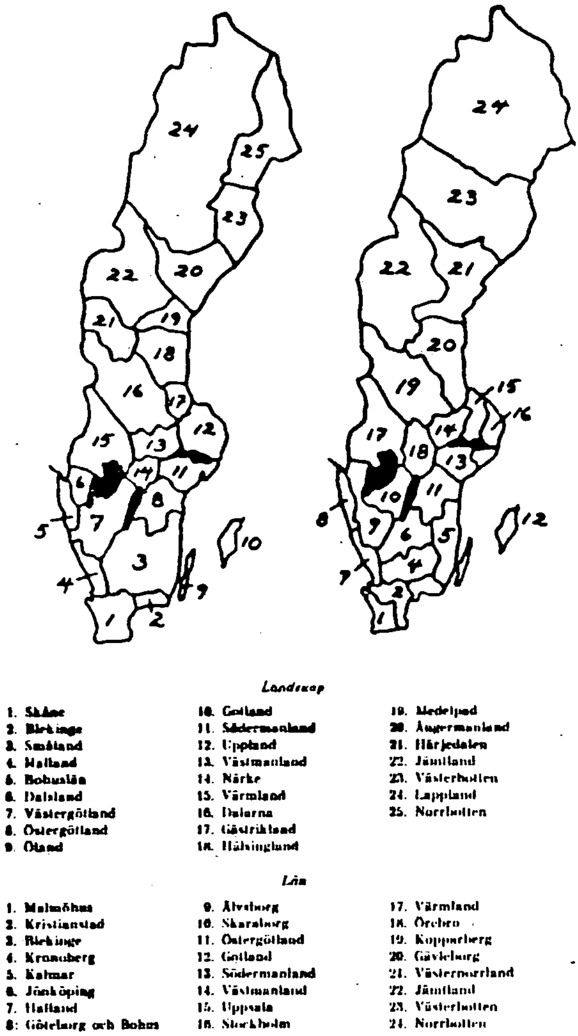


Fig. VI.1-3. Counties and regions of Great Britain and Ireland. (After Arpi et al., 19).

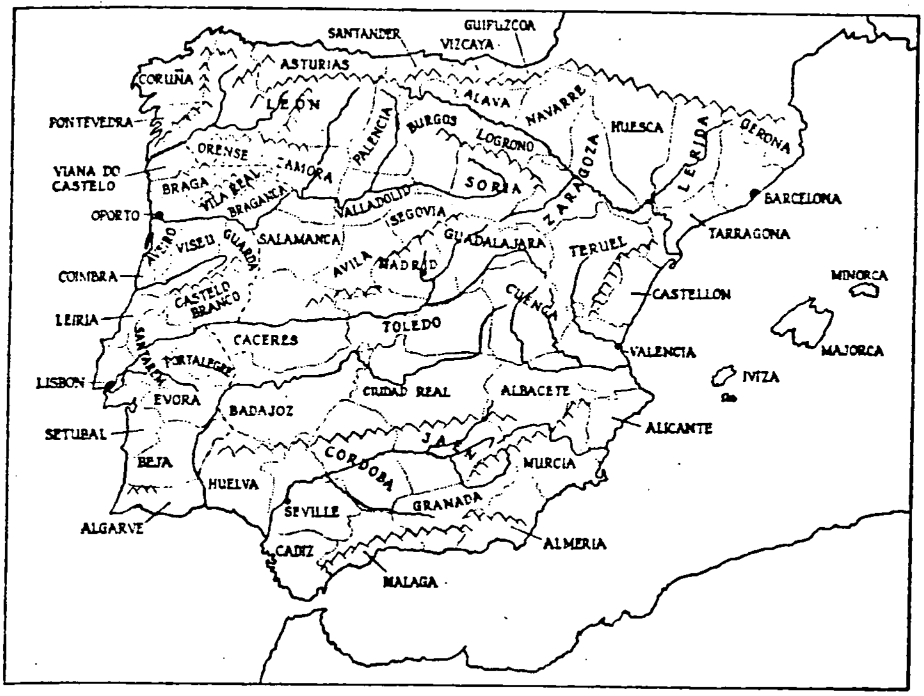


Fig. VI.1-2. Spain. (a) 'Provincias' and 'regiones' of Spain and Portugal. (After Savory, 1968).

In order to detect the effects of geographically determined environmental differences on pigmentary variability, only 'pure' Swedes will be examined. Owing to the smallness of the samples, a special allowance was made in the case of the British and Spaniards, in order to avoid further reduction in the size of the samples: individuals were admitted into one or other of the geographical areas whenever either at least three of their grandparents had been born in it, or their parents had, In addition, not only 'pure' Spaniards but also those with one foreign grandparent were admitted. Owing to the genetical structure of the immigrant element in Britain, that concession was not made in the British case, since it would have implied a high risk of introducing genes for heavy pigmentation in the sample. The group coded 99 (regionally unlocated cases) has been suppresed in the Spanish case, being of no utility - owing to both lack of location and lack of 'purity'.

In order to follow as closely as possible Pearson's and the IBP's recommendations on necessary sample sizes for eliciting significance (Pearson & Hartley, 1956; Weiner & Lourie, 1969), the provisional regional arrangement for Spaniards was substituted by a more suitable one with more clear historical connections. Old established anthropological knowledge of especially the pigmentary variability of the Spanish population (Sánchez, 1912; Hoyos, 1952; Fusté & Pons, 1960) and its history (Font Rius, 1974; Bagué, 1974) served as a basis for this subdivision. In the Swedish case, the seemingly greater anthropological uniformity of the population presented some difficulties for operating a priori in the same way. Since the problem with group sizes is less acute, an exploratory analysis will first be performed on the data before eventually adopting any other measures.

Since it is not advisable to apply regression equations to samples other than those for which they were deduced (Hays, 1981), the regression analysis approach will be replaced here by an analysis of variance. The sets of predictors obtained for uia1, uia5 and uia9 in section V will be used as factors and covariates. In an attempt to keep cell sizes as big as possible, while performing the analysis of variance, both sexes have been pooled together and the number of factors has been kept down to two. This led to the supression of variable cruianow among Spaniards at the fifth filter. Since cruianow's beta regression coefficient is positive and its contribution to total explained variation is significant ($p < 0.05$) (Hays, 1981), the supression's net effect is to enhance the values of both residual variance and between-levels differences. The first increment is linear and the second is quadratic. Therefore, in a t-test the calculated t values will be smaller and so will the chances for the appearance of significance. The inclusion of the variable sex as one of the predictors allows us to check whether the corrections imposed on pigmentation by the independent variables have somehow altered the nature of the between-sex differences previously found in another section. In one single case, however, the variable sex was not accepted as a predictor (for uia9, among the British). Since its simple correlations with the other predictors were not too high (-0.180, the highest) and T was elected as 0.95, it is to be inferred that the main reason for non-acceptance was low predictive capability ($r=-0.026$, with uia9). This is wholly in line with previous results, where the t-test between sexes was not found to be significant among the British (3/4-criterion of 'purity') at the ninth filter.

Among Swedes, a preliminary analysis of variance

```
SUBFILE     SVE
   * * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * *

                   UIA1
              BY   GPLANDSK
                   SEX
            WITH   DULG

                                                   SUM OF                    MEAN              SIGNIF
 SOURCE  OF VARIATION                              SQUARES      DF          SQUARE       F       OF F

 COVARIATES                                       2198.117       1        2198.117  112.016     0.000
    DULG                                          2198.117       1        2198.117  112.016     0.000

 MAIN EFFECTS                                      492.026      17          28.943    1.475     0.100
    GPLANDSK                                       427.557      16          26.722    1.362     0.157
    SEX                                             76.803       1          76.803    3.914     0.049

 2-WAY INTERACTIONS                                 63.796       7           9.114    0.464     0.860
    GPLANDSK SEX                                    63.796       7           9.114    0.464     0.860

 EXPLAINED                                        2753.941      25         110.158    5.614     0.000

 RESIDUAL                                         8379.177     427          19.623

 TOTAL                                           11133.078     452          24.631

 COVARIATE     RAW  REGRESSION  COEFFICIENT
 DULG                  10.799

    653   CASES WERE PROCESSED.
    200   CASES ( 30.6 PCT ) WERE MISSING.

 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

  * * * * * * * M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S  * *
                 UIA1
            BY   GPLANDSK  (pooled)
                 SEX
          WITH   DULG
 * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

 GRAND MEAN =      34.94                    ADJUSTED FOR           UNADJUSTED
                                            INDEPENDENTS           DEV'N  ETA
                                            + COVARIATES
 VARIABLE  +  CATEGORY              N       DEV'N BETA/t              t                  t
 GPLANDSK
 I
     1             (Sk)            232     -0.210  1.518
     4+5+7+15      (SW)             19     -1.815  0.742           0.605
     2+3+8+10      (SE)             23     -0.796  2.937  0.01 +   3.460  0.01 +   3.087   0.01
     12+16-25      (N)              12      3.838  2.646  0.01 +                   2.005   0.05
     99            (uncl.)         167      0.335                                   1.212
 II
     1             (Sk)            232     -0.210  0.988
     2+3+4         (S.Göt)          31     -1.047  0.325           0.951
     5+7+8+10      (N.Göt)          10     -1.570  2.552  0.01 +   2.891  0.01     2.689   0.01
     12-25         (Sv+Norr)        13      3.185  2.234  0.01 +
     99            (uncl.)         167      0.335

     SEX
         1                         176     -0.53                   -0.28
         2                         277      0.34                    0.18
                                                   0.09                    0.05
 MULTIPLE R SQUARED                                0.242
 MULTIPLE R                                        0.492
```

Table VI.1-1. The geographical distribution of skin colour in Sweden, subdividing the south according to precipitation (I) and latitude (II)

Legend.

1. 99 = unclassified or unlocated cases.
2. A case is allocated to a certain area (gplandsk) whenever not less than three grandparents are born there.

```
SUBFILE     SVE
  * * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * *

                  UIA5
               BY GPLANDSK
                  SEX
             WITH DULG

                                       SUM OF                  MEAN               SIGNIF
SOURCE  OF VARIATION                   SQUARES       DF        SQUARE       F     OF F

COVARIATES                             985.923        1        985.923   45.365   0.000
   DULG                                985.923        1        985.923   45.365   0.000
MAIN EFFECTS                           383.881       17         22.581    1.039   0.414
   GPLANDSK                            299.937       16         18.746    0.863   0.613
   SEX                                  85.934        1         85.934    3.954   0.047
2-WAY INTERACTIONS                     138.280        7         19.754    0.909   0.499
   GPLANDSK SEX                        138.280        7         19.754    0.909   0.499
EXPLAINED                             1508.086       25         60.323    2.776   0.000
RESIDUAL                              9279.965      427         21.733
TOTAL                                10788.051      452         23.867

COVARIATE    RAW  REGRESSION  COEFFICIENT
DULG              7.233

    653  CASES WERE PROCESSED.
    200  CASES ( 30.6 PCT ) WERE MISSING.

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 * * * * * * * M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S * *
                UIA5
             BY GPLANDSK  (pooled)
                SEX
           WITH DULG
 * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

GRAND MEAN =      41.74                 ADJUSTED FOR          UNADJUSTED
                                        INDEPENDENTS          DEV'N  ETA
                                        + COVARIATES
VARIABLE  +  CATEGORY           N       DEV'N BETA/t            t               t

GPLANDSK
I
    1              (Sk)                  0.050 \ 0.845           \ 0.721          \
    4+5+7+15       (SW)                 -1.045 / 0.252           X 2.570  0.02 +  \ 2.407   0.0
    2+3+8+10       (SE)                 -0.682 \ 2.980  0.01 + /                  X
    12+16-25       (N)                   3.372 < 2.489  0.02 +                   / 0.842
    99             (uncl.)              -0.095 /                                /
II
    1              (Sk)                  0.050 \ 0.872            \
    2+3+4          (S.Göt)              -0.727 / 0.414            / 0.982         \ 2.380   0.0
    5+7+8+10       (N.Göt)              -1.429 \ 2.367  0.05 + \                  X 2.557   0.0
    12-25          (Sv+Norr)             3.212 < 2.464  0.02 + / 0.879           /
    99             (uncl.)              -0.095 /

    SEX
        1                               -0.56                   -0.41
        2                                0.36                    0.26
                                                0.89                      0.07

MULTIPLE R SQUARED                              0.127
MULTIPLE R                                      0.356
```

Table VI.1-1. The geographical distribution of skin colour in Sweden, subdividing the south according to precipitation (I) and latitude (II)

Legend.

1. 99 = unclassified or unlocated cases.
2. A case is allocated to a certain area (gplandsk) whenever not less than three grandparents are born there.

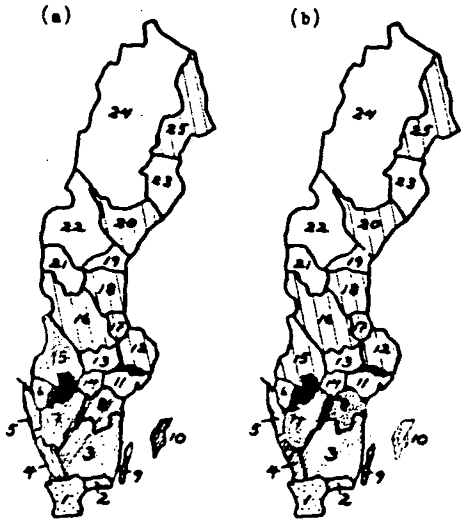
```
SUBFILE     SVE
  * * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * *

                   UIA9
                BY GPLANDSK
                   SEX
              WITH DULG

                                              SUM OF                        MEAN               SIGNIF
SOURCE  OF VARIATION                          SQUARES       DF             SQUARE       F       OF F

COVARIATES                                    928.862        1            928.862    55.702    0.000
   DULG                                       928.862        1            928.862    55.702    0.000

MAIN EFFECTS                                  357.274       17             21.016     1.260    0.214
   GPLANDSK                                   255.427       16             15.964     0.957    0.503
   SEX                                         84.458        1             84.458     5.065    0.025

2-WAY INTERACTIONS                            127.533        7             18.219     1.093    0.367
   GPLANDSK SEX                               127.533        7             18.219     1.093    0.367

EXPLAINED                                    1413.672       25             56.547     3.391    0.000

RESIDUAL                                     7120.512      427             16.676
TOTAL                                        8534.184      452             18.881


COVARIATE      RAW  REGRESSION  COEFFICIENT
DULG                7.020

   653  CASES WERE PROCESSED.
   200  CASES ( 30.6 PCT ) WERE MISSING.
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 * * * * * * *  M U L T I P L E    C L A S S I F I C A T I O N    A N A L Y S I S  * *
                  UIA9
             BY   GPLANDSK  (pooled)
                  SEX
             WITH DULG
 * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

GRAND MEAN =       65.14                        ADJUSTED FOR             UNADJUSTED
                                                INDEPENDENTS             DEV'N  ETA
                                                + COVARIATES
VARIABLE  +  CATEGORY                   N       DEV'N BETA/t               t                  t

GPLANDSK
I
   1             (Sk)                           -0.050 > 0.472
   4+5+7+15      (SW)                            0.410 > 0.908                 \
   2+3+8+10      (SE)                           -0.739 > 2.710  0.01 +         > 2.690  0.01 + \  1.854
   12+16-25      (N)                             3.202 < 2.716  0.01 +         /                X 0.690
   99            (uncl.)                        -0.112                                         /
II
   1             (Sk)                           -0.050 > 0.935                 \ 1.088          \
   2+3+4         (S.Göt)                        -0.780 < 1.457                 X 2.833  0.01 +  > 2.657  0.01 +
   5+7+8+10      (N.Göt)                         1.384 < 0.965                 /               > 0.932
   12-25         (Sv+Norr)                       3.042 < 2.683  0.01 +                         /
   99            (uncl.)                        -0.112

   SEX
        1                                        0.56                       0.72
        2                                       -0.35                      -0.46
                                                        0.10                           0.13

MULTIPLE R SQUARED                                      0.151
MULTIPLE R                                              0.388
```

Table VI.1-1. The geographical distribution of skin colour in Sweden, subdividing the south according to precipitation (I) and latitude (II)

Legend.

1. 99 = unclassified or unlocated cases.
2. A case is allocated to a certain area (gplandsk) whenever not less than three grandparents are born there.

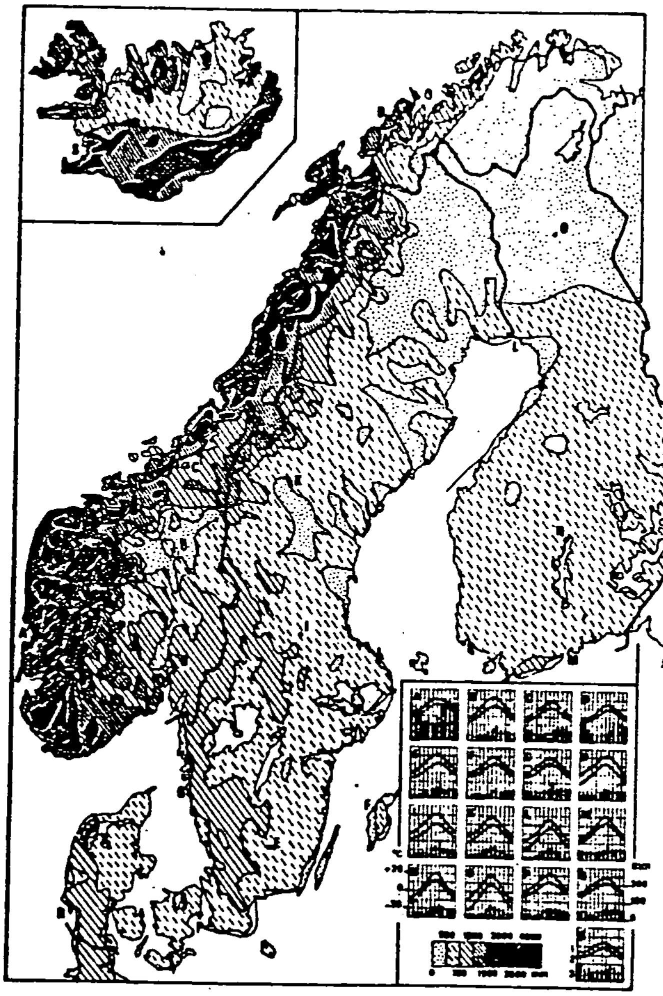
for uia1, uia5 and uia9 as criterion variables and the predictors, with the addition of gplandsk (landskap), as factors and covariates, failed to reveal significant internal differences between geographical locations (table VI.1-1). Some of the groups produced by the landskap subdivision are, however, too small and it may be that they hinder the appearance of statistically significant diversity. In order to check that point, two new arrangements have been tried. One of the groupings follows latitudinal variation, whereas the other agrees mostly with the partitioning of south Sweden into two climatic areas - with higher precipitation index in the southwest. In figure VI.1-4 the nature of the arrangements has been illustrated together with some climatological maps for comparison. Skåne, has, in both cases, been left alone as this subsample was relatively big. The nature of the regional differences has been explored by means of t-tests; using in each case as common or composite variance in the denominator the corresponding residual mean square from the preliminary analysis of variance. As a result, a partition into two main blocks emerges for all filters and for each arrangement. On the other hand, there is the northernmost block, Svealand plus Norrland (with the exclusion of Värmland, which goes to the southern block in the climatic arrangement), which is significantly lighter. On the other hand, is the southern block which is composed of several regions. No significant diversity was observed here between the different groups, neither along latitude nor across climatic regions. It is, however, very likely that bigger samples would elicit significant differences. At the ninth filter, between the northern and the southern block, dislodged from the last one, there is a buffer region (northern Götaland vs. the southwest), which does not significantly differ from either one. A veritable transition-



Landskap

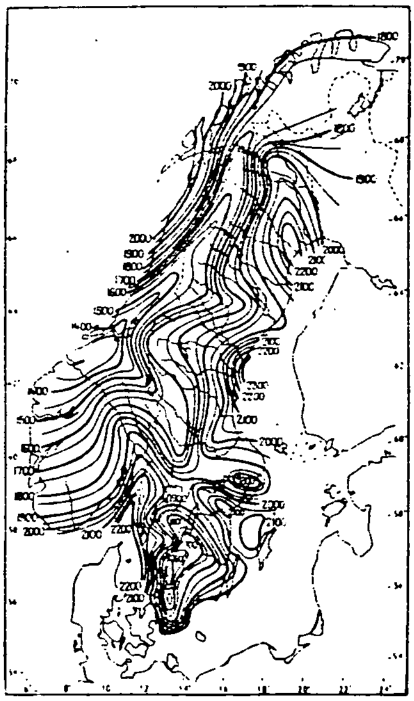
1. Skåne
2. Blekinge
3. Småland
4. Halland
5. Bohuslän
6. Dalsland
7. Västergötland
8. Östergötland
9. Öland
10. Gotland
11. Södermanland
12. Uppland
13. Västmanland
14. Närke
15. Värmland
16. Dalarna
17. Gästrikland
18. Hälsingland
19. Medelpad
20. Ångermanland
21. Härjedalen
22. Jämtland
23. Västerbotten
24. Lappland
25. Norrbotten

Subdivision of Sweden into areas for the study of skin colour: (a) according to precipitation. (b) according to latitude.



(c) Annual and monthly precipitation levels at selected places. 1. Maximal day temperature. 2. Minimal day temperature. 3. Monthly precipitation. (After Alexandersson, 1972).

(e) . Mean isotherms, January (after Kendrew, 1953).



(d) Annual number of hours of bright sunshine in Scandinavia. (After Ångström et al., 1974).

Fig. VI.1-4. Climatic conditions and pigmentation in Sweden.

al zone. The results are displayed graphically in figure VI.1-5. The group with the unlocated cases always occupies one of the positions closest to Skåne, in agreement with the supposition that its internal distribution of cases (according to origin) runs parallel to that of the Swedish sample. The relative positioning of the regions within the southern block is pretty constant for filters uia1 and uia5, with northern Götaland and the southwest (latitude vs. climate) respectively as the darkest regions, but for uia9 the situation is different. Within the arrangement accordning to latitude, southern Götaland (together with the unlocated group and Skåne) emerges as the darkest region, while northern Götaland leaves the southern block and takes an intermediate place between north and south. On the other hand, when considering the subdivision accordning to climatic zones, the southeast (again with the unlocated group and Skåne) - enclosing the driest areas south of Norrland - becomes darkest while, as before, the much more cloudy southwest

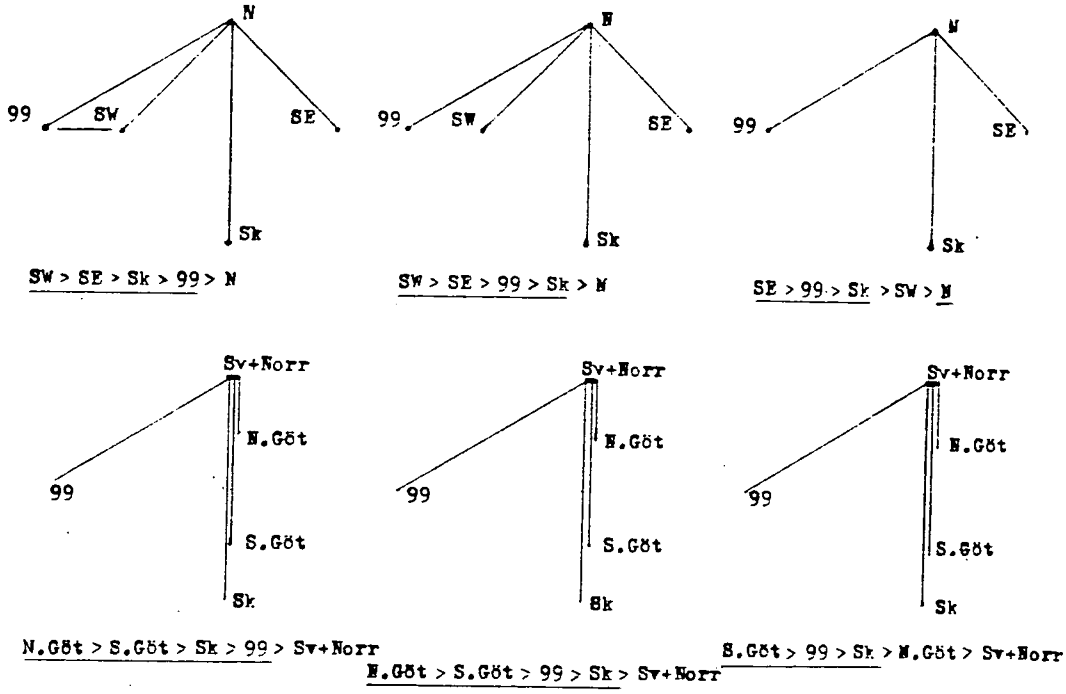


Fig. VI.1-5. Pigmentation of the skin in Sweden.

departs from the southern block adopting an intermediate position between north and south.

It is very unfortunate that group sizes are so small, since that puts greater demands on the absolute value of the difference between means which is required for significance. It would be interesting to see whether bigger samples could confirm the nature of the differences already suggested by the present work. Significance figures are better within the subdivision according to precipitation, but since this also includes a latitudinal component it would be wrong to conclude that cloudiness is more important than latitude at determining pigmentary diversity, A look at figure VI.1-5 suggests precisely the opposite, since all significant differences between regions (location groups) align themselves in a north-south direction. The results, however, convey the inescapable feeling that there is also in all probability an underlying significant west-eastward diversity, at least in the southern part of the country, where western Götaland (with the addition of Värmland) corresponds to the area with next maximum precipitation in Sweden, while eastern Götaland is the zone of maximum annual duration of sunshine (allowance made for the bright summer nights in northern Scandinavia).

Among Spaniards, the reduced size of the samples prevented, to an even greater extent than in the Swedish case, the arranging of the material into small geographical divisions to be used after analysis as clustering units. Instead a subdivision into four wide regions was imposed on the sample. These were: the Cantabrian north and northwest, the eastern region (including also Aragón), the southern region (also including Extremadura and the province of Murcia) and the centre (basically the hinterland with a few minor substractions). Canarias (one case) and Balea-

```
SUBFILE     SPA
  * * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * *

                 UIA1
              BY REINO
                 SEX
            WITH A1

                                          SUM OF                   MEAN            SIGNIF
SOURCE  OF VARIATION                      SQUARES       DF         SQUARE      F     OF F

COVARIATES                                196.467        1        196.467    8.990   0.003
   A1                                     196.467        1        196.467    8.990   0.003

MAIN EFFECTS                              515.862        4        128.966    5.901   0.000
   REINO                                  230.928        3         76.976    3.522   0.016
   SEX                                    316.386        1        316.386   14.477   0.000

2-WAY INTERACTIONS                         33.113        2         16.557    0.758   0.470
   REINO SEX                               33.113        2         16.556    0.758   0.470

EXPLAINED                                 745.445        7        106.492    4.873   0.000

RESIDUAL                                 4611.145      211         21.854

TOTAL                                    5356.590      218         24.572

COVARIATE    RAW  REGRESSION  COEFFICIENT
A1                   0.144

    256  CASES WERE PROCESSED.
     37  CASES ( 14.5 PCT ) WERE MISSING.

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  * * * * * * * M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S * *
               UIA1
           BY  REINO
               SEX
          WITH A1
 * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

GRAND MEAN =       31.52                    ADJUSTED FOR            UNADJUSTED
                                            INDEPENDENTS            DEV'N  ETA
                                            + COVARIATES
VARIABLE  +  CATEGORY               N       DEV'N  BETA/t             t               t

REINO

    0               (Centre)       161      -0.450
    1               (North)          1       8.660                  1.307
    2               (South)         44       0.590                  2.493  0.02 +
    3               (East)          13       2.910      1.573

SEX
    1                              104      -1.270                    -1.140
    2                              115       1.150                     1.030
                                                   0.25                           0.22
MULTIPLE R SQUARED                                 0.133
MULTIPLE R                                         0.365
```

Table VI.1-2. The geographical distribution of skin colour in Spain.

Legend.

1. Unlocated and unknown cases are pooled together and excluded from the calculations.
2. A case is allocated to a certain area (reino) whenever either not less than three grandparents or both parents are born there.

```
SUBFILE     SPA
 * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * *

                     UIA5
                 BY  REINO
                     SEX
               WITH  A1

                                              SUM OF                      MEAN              SIGNIF
SOURCE  OF VARIATION                         SQUARES        DF          SQUARE         F     OF F

COVARIATES                                    83.711         1          83.711     3.613    0.059
   A1                                         83.711         1          83.711     3.613    0.059

MAIN EFFECTS                                 556.885         4         139.221     6.009    0.000
   REINO                                     226.652         3          75.551     3.261    0.022
   SEX                                       374.047         1         374.047    16.146    0.000

2-WAY INTERACTIONS                            23.357         2          11.678     0.504    0.605
   REINO SEX                                  23.357         2          11.678     0.504    0.605

EXPLAINED                                    663.953         7          94.850     4.094    0.000

RESIDUAL                                    4888.289       211          23.167

TOTAL                                       5552.242       218          25.469

COVARIATE    RAW  REGRESSION  COEFFICIENT
A1                 | 0.094

    256  CASES WERE PROCESSED.
     37  CASES ( 14.5 PCT ) WERE MISSING.

------------------------------------------------------------------------------
 * * * * * * * M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S * *

                     UIA5
                 BY  REINO
                     SEX
               WITH  A1
 * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

GRAND MEAN =      37.988                   ADJUSTED FOR             UNADJUSTED
                                           INDEPENDENTS             DEV'N  ETA
                                           + COVARIATES
VARIABLE  +  CATEGORY              N       DEV'N  BETA/t               t               t

 REINO

   0            (Centre)         161       -0.320                 0.550
   1            (North)            1       11.060                 2.133  0.05 +
   2            (South)           44        0.130   1.652
   3            (East)            13        2.640

SEX
   1                             104       -1.390                    -1.250
   2                             115        1.250                     1.130
                                                    0.26                       0.24

MULTIPLE R SQUARED                                  0.115
MULTIPLE R                                          0.340
```

Table VI.1-2. The geographical distribution of skin colour in Spain.

Legend.
1. Unlocated and unknown cases are pooled together and excluded from the calculations.
2. A case is allocated to a certain area (reino) whenever either not less than three grandparents or both parents are born there.

```
SUBFILE     SPA
  * * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * *

                   UIA9
               BY  REINO
                   SEX
             WITH  A1

                                                 SUM OF                       MEAN                SIGNIF
 SOURCE  OF VARIATION                            SQUARES        DF           SQUARE          F       OF F

 COVARIATES                                      149.166         1          149.166      9.346      0.003
    A1                                           149.166         1          149.166      9.346      0.003

 MAIN EFFECTS                                    257.703         4           64.426      4.037      0.004
    REINO                                        105.651         3           35.217      2.207      0.088
    SEX                                          173.072         1          173.072     10.844      0.001

 2-WAY INTERACTIONS                               73.029         2           36.515      2.288      0.104
    REINO    SEX                                  73.029         2           36.515      2.288      0.104

 EXPLAINED                                       479.898         7           68.557      4.296      0.000

 RESIDUAL                                       3367.566       211           15.960

 TOTAL                                          3847.464       218           17.649


 COVARIATE     RAW  REGRESSION  COEFFICIENT
  A1                 0.126

    256  CASES WERE PROCESSED.
     37  CASES ( 14.5 PCT ) WERE MISSING.

 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

  * * * * * * * M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S  * *
                  UIA9
              BY  REINO
                  SEX
            WITH  A1
  * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

 GRAND MEAN =      61.79                      ADJUSTED FOR               UNADJUSTED
                                              INDEPENDENTS               DEV'N  ETA
                                              + COVARIATES
 VARIABLE  +  CATEGORY                  N     DEV'N BETA/t                  t              t

 REINO

     0              (Centre)          161     -0.140                      0.103
     1              (North)             1      9.210                      1.189
     2              (South)            44     -0.070   1.031
     3              (East)             13      0.840

SEX
     1                                104     -0.940                          -0.820
     2                                115      0.850                           0.740
                                                       0.21                             0.19

MULTIPLE R SQUARED                                     0.106
MULTIPLE R                                             0.325
```

Table VI.1-2. The geographical distribution of skin colour in Spain.

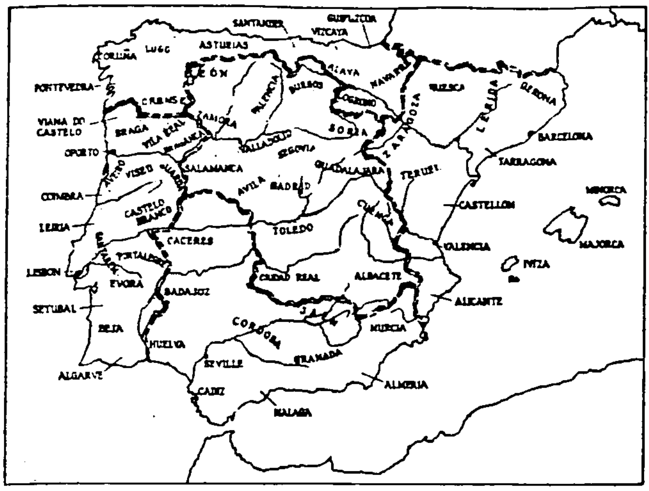
Legend.

1. Unlocated and unknown cases are pooled together and excluded from the calculations.
2. A case is allocated to a certain area (reino) whenever either not less than three grandparents or both parents are born there.

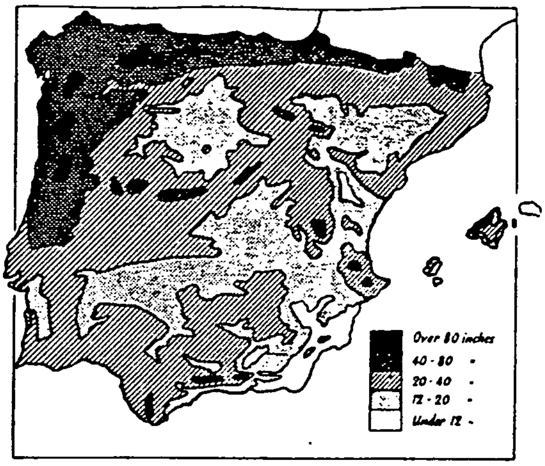
res (zero cases) were integrated into the south and the east respectively. The maps of figure VI.1-6 illustrate the arrangement and the climatic conditions. Excepting the mountain ranges, which are colder and with more abundant rain and snowfall, three main climatological areas can be distinguished in Spain: 1) the temperate north and northwest from the mountains to the seaboard, with continuous rainfall, comparable with southwestern England and Wales but with much higher insolation, 2) the often steppe-like Meseta and Ebro depression (this one included within the eastern region), with scant and unreliable precipitation, high insolation and extreme seasonal, even diurnal, temperature contrasts and 3) the meridional and oriental coastal districts, with mild winters and somewhat cooler summers than the Meseta (excepting the Guadalquivir depression, the hottest major area i Europe), high insolation, scarce precipitation and summer drought. In the southeast, between the eastern and the southern coasts, north African climate and orography make an encroachement into Iberia through the desertic landscape of Almeria and the eastern half of Murcia. Dessication, initiated in northern Africa, has also left its scars in the peninsula's landscape and its climate. Thus, deforestation has accelerated since Reconquista times (1) (Cabo & Vigil, 1979), presumably making the climate drier than it ever was in antiquity.

The analysis of variance technique (table VI.1-2) revealed, among Spaniards, the existence of significant pigmentation variability when geographical location (reino) is used as an independent variable, and the effects of other variables are controlled for. As before, the t-test technique has afterwards been

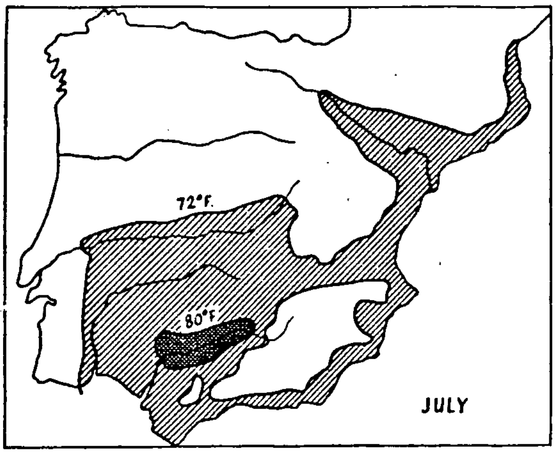
(1) Reconquista, from 'reconquest'; seen with Christian eyes, the period of wars against the Muslims between 711 and 1492.



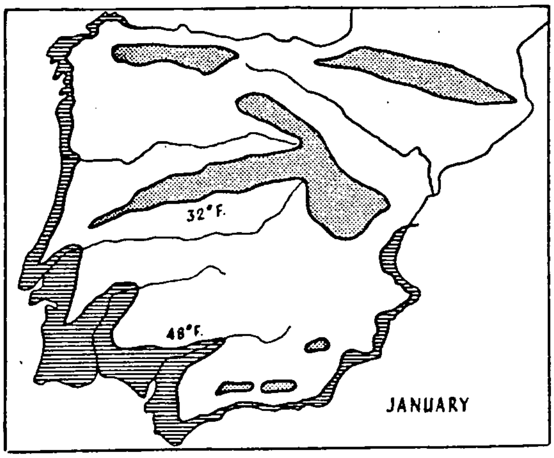
(a) Subdivision of Spain into areas for the study of skin colour.



(b) Rainfall in the Iberian Peninsula. (After Way, 1962).

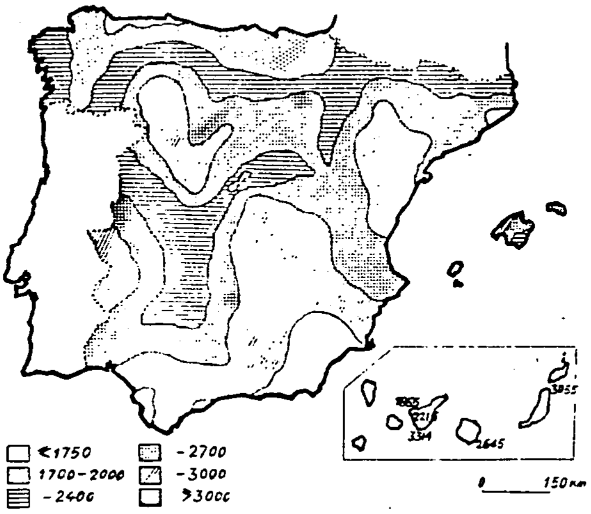


July Temperature



January Temperature

(c) Mean temperatures of January and July. (After Way, 1962).



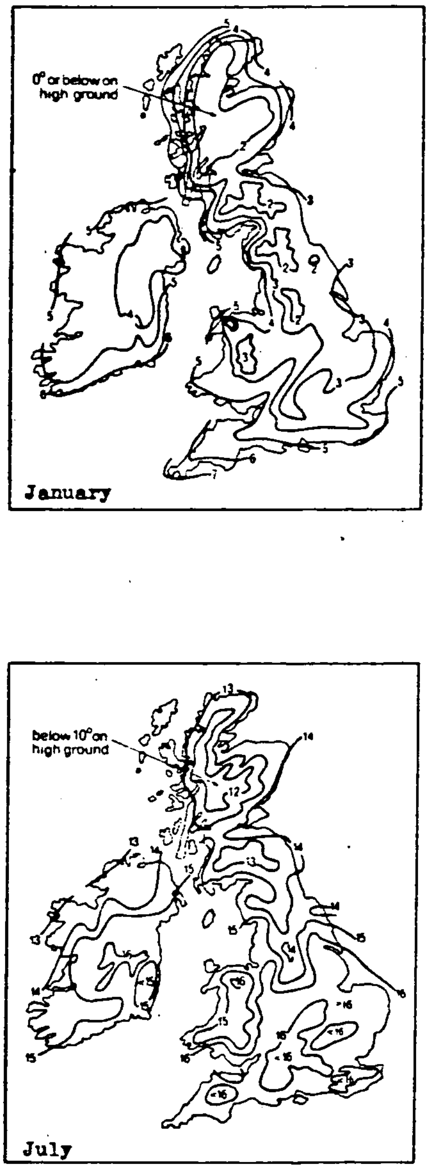
(d) Mean annual number of sunshine hours . (After Cabo & Vigil, 1979)

Fig. VI.1-6. Climatic conditions and pigmentation in Spain.

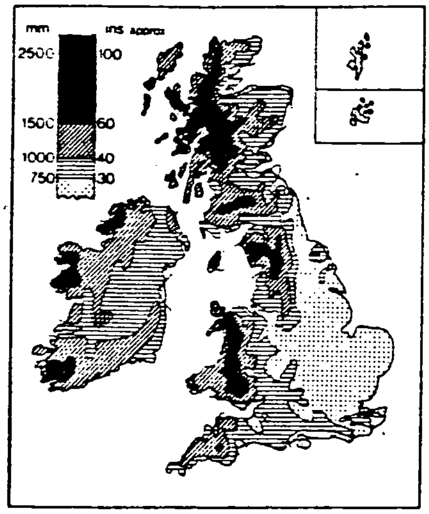
applied in order to elicit significant differences. At each filter, the eastern region was found to be lightest while the central one was darkest. Differences were significant at filters numbers one and five (at better than the 0.05 level) and came close to significance at the ninth filter.

If nothing other than climatic factors were responsible for differences in pigmentation, a generally longitudinal gradient, with the lightest skins in the west, should be expected in Britain, with the superimposition of a north-southward darkening trend in the southern half of England (figure VI.1-7). Historically, however, most light elements brought in by successive invasions have concentrated in the eastern parts of the country, while remnants of older populations, apparently richer in darker complexions, have often taken refuge in the remote west (fig. VI.1-8). That may already be reflected in our results (table VI.1-3), as a consequence of the numerical predominance of English subjects (with a high percentage of people from the eastern lowlands) in the British sample, but because of the coarseness of the partition (imposed by the small size of the sample) and because of the non-significant character of the differences, no relevant conclusions can be inferred.

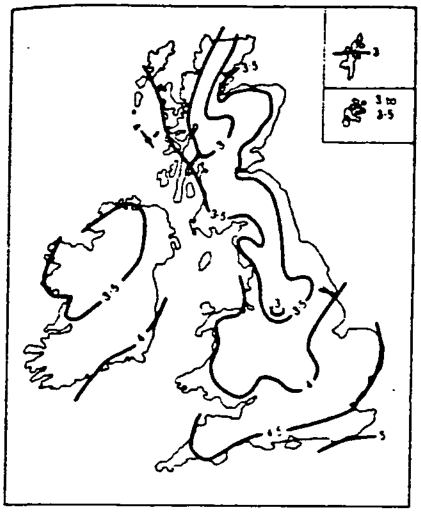
When turning to the effects of variable sex in pigmentation it is seen that, when other variables are controlled for, differences between the sexes are significant at all three filters, among Swedes (before at only five and nine) and among Spaniards (as before), while among the British the effects of sex were not significant at all (before they were at the first filter). Thus, correcting for the action of the other predictors and the geographical variables produced some minor changes only in a couple of cases: expected one of them, unexpected the other. Other



(c) Isotherms for July and January. (After Dury, 1978)



(a) Mean annual precipitation. (After Dury, 1978).



(b) Mean daily duration of bright sunshine in hours. (After Dury, 1978).

Fig. VI.1-7. Climatic conditions in Great Britain and Ireland.

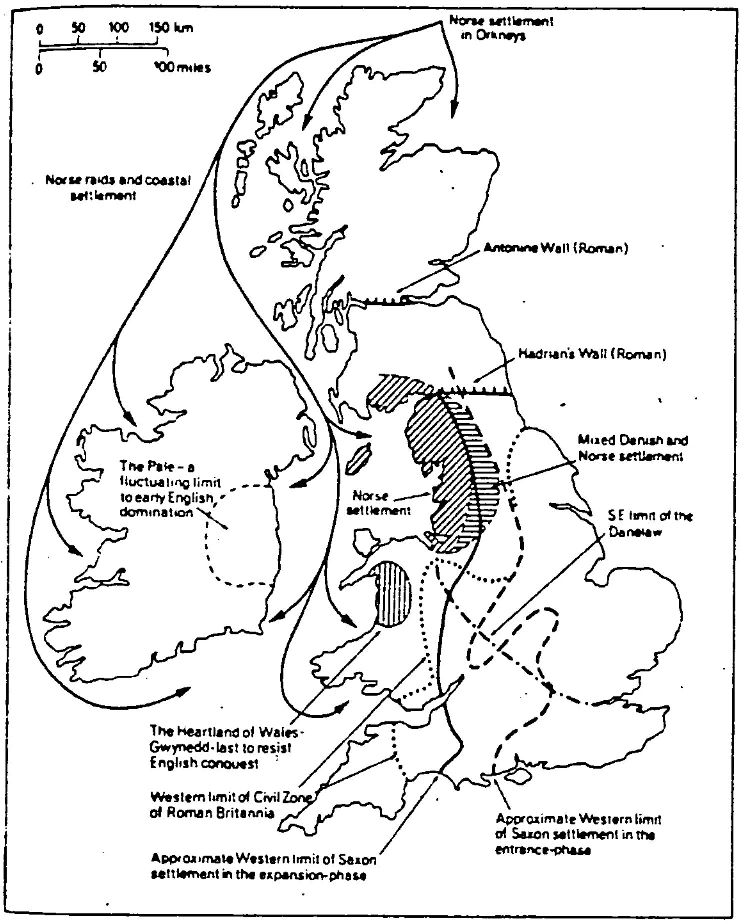


Fig. VI.1-8. Some directions and limits of early settlement and control. (After Dury, 1978).

'abnormalities' have before been elicited among the British. The reason for the departure from expected conditions among them can only be conjectured. We will return to this point later.

Among Swedes, the variable dulg is the most important at explaining pigmentary variability. Its effects are always significant (p=0.000). Nowhere were interactions between factors found to be significant. There is no need to worry about interactions between factors and covariates (not considered by the SPSS anova subprogram) since the nature of the regression method used for selecting them warrants that no two highly or even moderately correlated variables will be accepted together. Thus, more than geographical location and more even than sex, the

```
SUBFILE   GB

* * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * *
              UIA1
           BY ETHNOS
              SEX
         WITH A3
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                                      SUM OF                    MEAN            SIGNIF
SOURCE OF VARIATION                  SQUARES        DF         SQUARE       F     OF F

COVARIATES                           197.345         1        197.345   8.461    0.005
   A3                                197.345         1        197.345   8.461    0.005

MAIN EFFECTS                         122.371         3         40.790   1.749    0.165
   ETHNOS                             34.665         2         17.433   0.747    0.477
   SEX                                65.962         1         65.962   2.828    0.097

2-WAY INTERACTIONS                     3.542         1          3.542   0.152    0.698
   ETHNOS    SEX                       3.542         1          3.542   0.152    0.698

EXPLAINED                            323.257         5         64.651   2.772    0.024

RESIDUAL                            1702.561        73         23.323

TOTAL                               2025.818        78         25.972


COVARIATE   RAW REGRESSION COEFFICIENT

A3                -0.000

    79 CASES WERE PROCESSED.
     0 CASES (   0.0 PCT) WERE MISSING.

SUBFILE   GB

* * *    M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S   * * *
             UIA1
        BY   ETHNOS
             SEX
        WITH A3
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

GRAND MEAN =    37.09                                                  ADJUSTED FOR
                                                          ADJUSTED FOR  INDEPENDENTS
                                               UNADJUSTED  INDEPENDENTS  + COVARIATES
VARIABLE + CATEGORY                    N      DEV'N  ETA   DEV'N   BETA  DEV'N   BETA

ETHNOS
      3                               61       0.35                       0.30
     31                                2      -4.09                      -3.31
     99                               16      -0.83                      -0.73
                                                     0.16                        0.13

SEX
      1                               33      -1.51                      -1.11
      2                               46       1.08                       0.80
                                                     0.25                        0.19

MULTIPLE R SQUARED                                                               0.158
MULTIPLE R                                                                       0.397
```

Table VI.1-3. The geographical distribution of skin colour in Britain.

Legend.

1. 99 = unlocated cases.
2. A case is allocated to a certain ethnic group whenever not less than three grandparents belong to it.

```
SUBFILE   GB

* * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * *
                UIAS
           BY   ETHNOS
                SEX
         WITH   A3
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                                     SUM OF                MEAN              SIGNIF
SOURCE OF VARIATION                  SQUARES      DF       SQUARE      F      OF F

COVARIATES                           147.087       1      147.087    7.375   0.008
   A3                                147.087       1      147.087    7.375   0.008

MAIN EFFECTS                          54.632       3       18.211    0.913   0.439
   ETHNOS                             28.553       2       14.277    0.716   0.492
   SEX                                16.916       1       16.916    0.848   0.360

2-WAY INTERACTIONS                     0.001       1        0.001    0.000   0.994
   ETHNOS    SEX                       0.001       1        0.001    0.000   0.994

EXPLAINED                            201.720       5       40.344    2.023   0.085

RESIDUAL                            1455.927      73       19.944

TOTAL                               1657.646      78       21.252


COVARIATE    RAW REGRESSION COEFFICIENT

A3                -0.000

     79 CASES WERE PROCESSED.
      0 CASES (  0.0 PCT) WERE MISSING.
SUBFILE   GB

* * *   M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S   * * *
                UIAS
           BY   ETHNOS
                SEX
         WITH   A3
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
GRAND MEAN =     42.02
                                                               ADJUSTED FOR    ADJUSTED FOR
                                                   UNADJUSTED  INDEPENDENTS    INDEPENDENTS
VARIABLE + CATEGORY                       N        DEV'N  ETA  DEV'N   BETA    + COVARIATES
                                                                               DEV'N   BETA
ETHNOS
     3                                   61         0.32                        0.29
    31                                    2        -3.02                       -2.76
    99                                   16        -0.83                       -0.75
                                                          0.15                          0.13

SEX
     1                                   33        -0.91                       -0.56
     2                                   46         0.65                        0.40
                                                          0.17                          0.10

MULTIPLE R SQUARED                                                                      0.122
MULTIPLE R                                                                              0.349
```

Table VI.1-3. The geographical distribution of skin colour in Britain.

Legend.

1. 99 = unlocated cases.
2. A case is allocated to a certain ethnic group whenever not less than three grandparents belong to it.

```
SUBFILE   GB

* * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * *
                    UIA9
            BY      ETHNOS
                    CRUIANOW
          WITH      DUS
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                                         SUM OF                     MEAN           SIGNIF
SOURCE OF VARIATION                      SQUARES      DF          SQUARE       F     OF F

COVARIATES                                10.527       1          10.527   1.113    0.295
   DUS                                    10.527       1          10.527   1.113    0.295

MAIN EFFECTS                              18.020       3           6.007   0.635    0.595
   ETHNOS                                  2.156       2           1.078   0.114    0.892
   CRUIANOW                               16.610       1          16.610   1.756    0.190

EXPLAINED                                 28.546       4           7.137   0.755    0.559

RESIDUAL                                 605.338      64           9.458

TOTAL                                    633.884      68           9.322


COVARIATE    RAW REGRESSION COEFFICIENT

DUS                -0.000

     79 CASES WERE PROCESSED.
     10 CASES ( 12.7 PCT) WERE MISSING.

DUE TO EMPTY CELLS OR A SINGULAR MATRIX,
HIGHER ORDER INTERACTIONS HAVE BEEN SUPPRESSED.

SUBFILE   GB

* * *   M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S   * * *
                  UIA9
          BY      ETHNOS
                  CRUIANOW
        WITH      DUS
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

GRAND MEAN =      64.87                                                ADJUSTED FOR
                                                          ADJUSTED FOR   INDEPENDENTS
                                               UNADJUSTED  INDEPENDENTS  + COVARIATES
VARIABLE + CATEGORY                   N      DEV'N   ETA  DEV'N   BETA  DEV'N   BETA

ETHNOS
    3                                52       0.08                        0.10
   31                                 2      -0.12                       -0.26
   99                                15      -0.25                       -0.32
                                                     0.05                          0.06

CRUIANOW
    0                                68       0.06                        0.06
    1                                 1      -3.87                       -4.06
                                                     0.15                          0.16

MULTIPLE R SQUARED                                                                 0.045
MULTIPLE R                                                                         0.212
```

Table VI.1-3. The geographical distribution of skin colour in Britain.

Legend.

1. 99 = unlocated cases.
2. A case is allocated to a certain ethnic group whenever not less than three grandparents belong to it.

time elapsed since the last sunbathe is decisive in determining intra-populational variation in pigmentation. As mentioned before in another section, dimensions not directly appearing among the variables accepted as independent may, however, be represented by one of them. The representation's efficiency depends directly on the strength of the correlation between the pair of variables standing for the effects of those two dimensions. However, the higher the correlation between those two the greater the reason for not accepting more than one of them, since their effects will overlap to an increasingly significant degree.

Among, Spaniards, variable A1 takes dulg's place. Although age's effects are significant at filters number one and nine (p=0.059 at the fifth filter), its importance at those filters is only secondary to sex. Interactions are not significant. At the fifth filter, geographical location (reino) was found to be more important than age.

Among the British, age is clearly more relevant than sex in accounting for variation in pigmentation at filters one and five. Only the effects of age were significant. At the ninth filter, apart from ethnos, two new variables were accepted as independent instead of sex. None of their effects were significant. Neither were the interactions. This inconsistency of character in the internal structure of the British sample may, presumably, be interpreted as a side-effect of the very reduced size of the sample. It may serve as a warning against the dangers of attaching too much importance to results extracted from small samples.

Before the 50's observations on skin colour were done by means of visual methods (either direct or comparative), which involved an element of considerable subjectivity, and was, consequently, not very accurate. Skin colour in Scandinavia in general (Coon, 1939) and in Sweden in particular (Lundborg & Linders, 1926) is, since those days, reputedly considered very uniform, a feature which the results from the present work also seem to suggest. Pigmentary variability within British populations is known to be considerable, after much reflectophotometric work done among them during the last twenty years. However, a certain percentage of it (presumably small) is, in the author's oppinion, due to eventual mis-calibration of the spectrophotometers and/or to differences between them (normally in the choice of filters) (Fernández, in print). We will return to this in the last chapter. For Spain, as for Sweden, with the only exception of some reflectometric work done among Spanish Gipsies, there is no previous instrumentally obtained information on skin colour. The traditional anthropological evidence speaks, however, for considerable variability, which only partially follows the country's climatic features.

In Sweden, comparison of the regional reflectance curves show Skåne and the southeast to appear 'whiter' (slightly more horizontal) than the southwest, which is in turn 'redder' (fig. VI.1-9). The

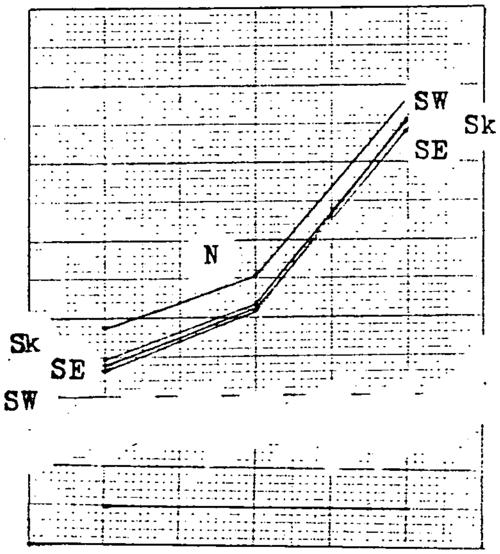


Fig. VI.1-9. Regional reflectance curves. Sweden .

reflectance curves for the southeast and for Skåne are parallel (with Skåne, as a whole, lighter), while lightest and 'whitest' is the north (1). Although the size of the regional groups, first, and absence of significance, in the second place, do not allow many generalizations, it is worth investigating whether greater redness of skin is not to be associated to the windy and rainy wheather of the atlantic type of the western seaboard. A similar situation was found in Ireland (Sunderland et al., 1973), where Ballinlough and Rossmore, both in the western half of the Island, were 'redder' than Carnew, in the southeast. (Ballinlough was, besides, absolutely lightest). The Swedish southwestern region is, like the Irish one, richer in red hair (together with Skåne), while the southeast includes one of the blondest areas in Sweden. In addition, Beckman (1959) found a serological duality in southern Sweden (fig. VI.1-10), according to which Skåne and the southwest, with their relatively high frequencies of 0 and D-negatives, suggest a greater than average influx of Paleolithic and, according to Beckman, also Megalithic blood, while the southeastern region would reveal eastern influence (high B, low A_2, low M and D-negatives), perhaps partially owed to the Finns but basically older than them.

In Spain, according to the army medical Sánchez Fernández (1912), the regions with the darkest skins are all but one wholly or partially included in the Meseta (fig. VI.1-11). He lists the following: one from Pontevedra (Galicia) to Palencia (León), another between the central Pyrenees and the Guadarrama mountains (north of Madrid and Guadalajara), a third one including Extremadura and Toledo (in the south-

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(1) It must be stressed here that no Lapps (not even half-breeds) who could alter the northern region's status, were measured.

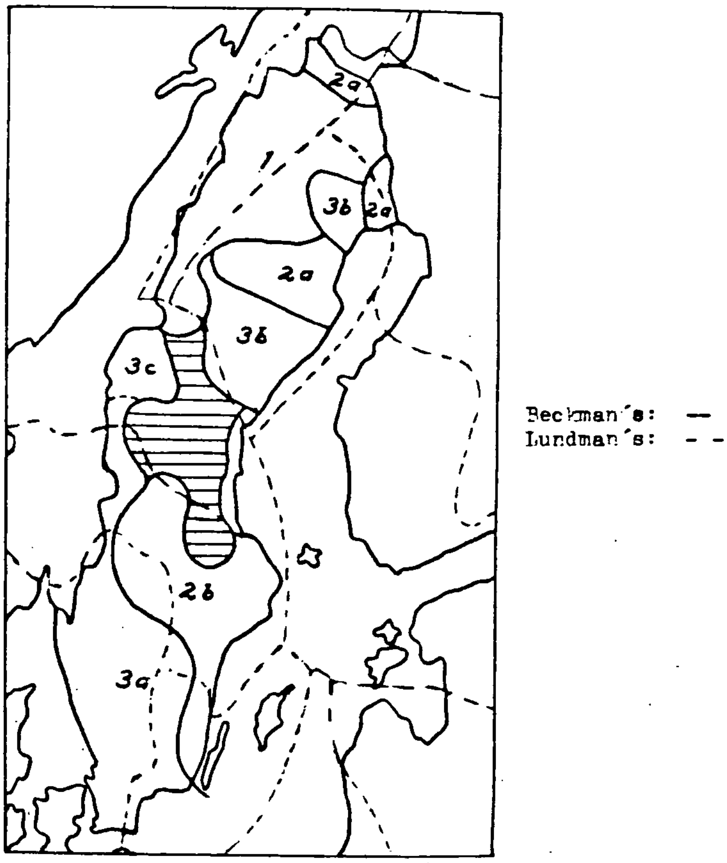


Fig. VI.1-10. Classification of the Swedish population into genetically different subpopulations. (After Beckman, 1959). Lundman's subdivision, based on anthropometrical data has been superimposed for comparison (after Lundman, 1946).

western corner of the Meseta) and the fourth one which extends across Almería, Granada and Málaga (in eastern Andalucía). In general the provinces along the Portuguese frontier are darkest and the Cantabrian and Mediterranean ones (except the southeast)are lighter. A striking feature, which is fully supported by the present research, is the contrast between the hinterland, a massive core of highly pigmented individuals, and most of the coastal districts, which include the lightest skinned province in Spain (Alicante, in the east).

It is, indeed, remarkable that small samples,

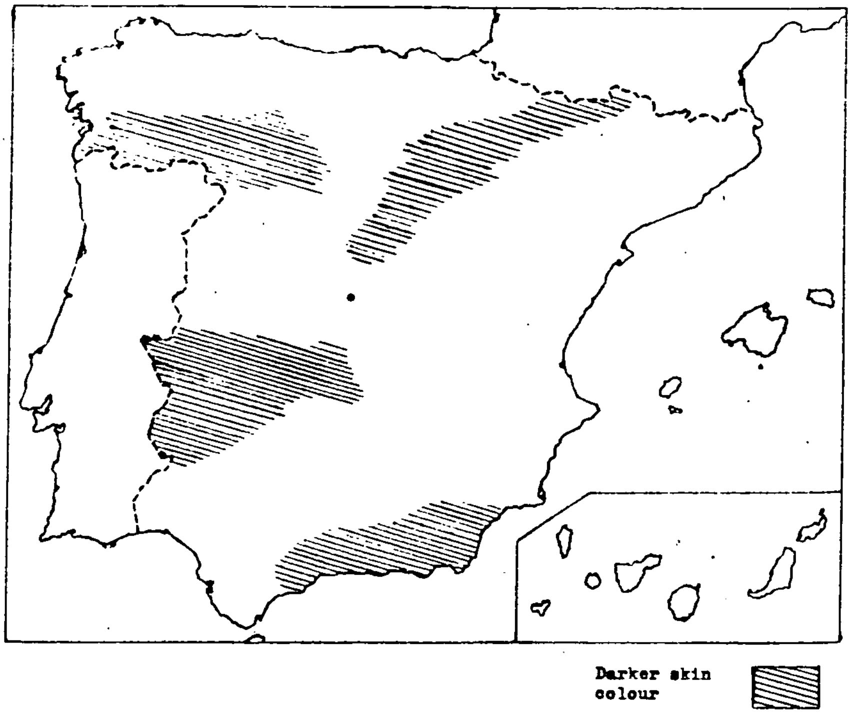


Fig. VI.1-11. Pigmentation in Spain.
(Tentative after Sánchez Fernández, 1912).

like these, should exhibit such a high degree of agreement with expectation (in terms of ecological factors or of current knowledge). It is hoped that future investigations will help either to verify or to discard at least some of the points which emerged during the course of this research.

Summary

The analysis of variance technique elicited the existence of significant differences between geographical areas, within the two biggest samples, when other factors were controlled for. The results, in spite of the reduced size of the geographical partitions, are mainly in agreement with the expected in terms of climatic factors and current knowledge.

Dimensions days-, age and - eventually - sex were found to be more important than geographical location in accounting for internal pigmentary variability.

VI.2. Distribution of hair colour and eye colour.

While sample sizes for hair and eye colour are of the same order of magnitude as in the preceding section, the method of measurement is not equally accurate and, since the field is secondary to the main subject of this work, the only reason for studying the geographical distribution of those two variables is documenting the skin colour of our samples within a wider context.

In tables VI.2-1 and VI.2-2, a and b, variables hair and eye have been rearranged according to the same geographical regions as in section VI.1. The deviations of the regional observed frequencies from the expected values (corresponding in each case to those of the remaining population) in most cases seemed too small for significance, and so only Skånes deviation was investigated using the chi-square technique. Differences are only significant for variable eye ($p=0.043$), with Skåne emerging as darker-eyed than the other regions. After Skåne comes first the north, then the southeast and - in the last place - the southwest. For variable hair, the regions can be arranged in order of increasing fairness as follows: north, southeast, Skåne and southwest. The differences are, however, not significant.

Among Spaniards, after removing the northern area (reino 1), which only contains one observation, significance was attained for variable hair ($p=0.036$). The eastern region is fairer than average, while both the centre and, especially, the south are darker (although the centre's deviation is not significant). With respect to variable eye, although the differences are again not significant, the south emerges as darker than the east, which in turn is darker than the centre.

Thus, the comparatively dark pigmentation of the skin of Scanians finds a counterpart for eye colour, while the evidence for hair colour is inconclusive.

(a) Eye

1	SE	SW	N	99	
48 39.289	5 4.015	2 3.011	3 2.561	19 28.104	77
226 234.711	23 23.985	19 17.989	15 15.419	177 167.896	460
274	28	21	18	196	537

x^2 (1, rest) = 4.091
df = 1   p = 0.043 +

x^2 (SW, rest) = 0.105
df = 1   p = 0.675

(b) Hair

1	SE	SW	N	99	
79 76.557	8 7.390	4 5.912	9 6.503	54 57.639	154
180 182.443	17 17.610	16 14.088	13 15.497	141 137.361	367
259	25	20	22	195	521

x^2 (1, rest) = 0.139
df = 1   p = 0.710

x^2 (SE, rest) = 0.909
df = 1   p = 0.340

Table VI.2-1. Distribution of eye colour (a) and hair colour (b) in Sweden

Legend.

1. 1 = Skåne; 99 = unclassifiable; SE, SW and N as in section VI.1.
2. First row: observed frequencies. Second row: expected frequencies.

(a) Eye

1	2	3	Centre	
0 0.764	34 33.600	10 9.927	124 123.709	168
1 0.236	10 10.4	3 3.073	38 38.291	52
1	44	13	162	220

x^2 (2, 3, centre) = 0.011
df = 2   p = 0.995

(b) Hair

1	2	3	Centre	
1 0.846	40 37.2	8 10.991	137 136.964	186
0 0.155	4 6.8	5 2.009	25 25.036	34
1	44	13	162	220

x^2 (2, 3, centre) = 6.606
df = 2   p = 0.036 +

Table VI.2-2. Distribution of eye colour (a) and hair colour (b) in Spain

Legend.

1. 1 = north, 2 = south, 3 = east. (All as in section VI.1).
2. First row: observed frequencies. Second row: expected frequencies.

This is fully in agreement with the results obtained in older, more extensive surveys (fig. VI.2-1).

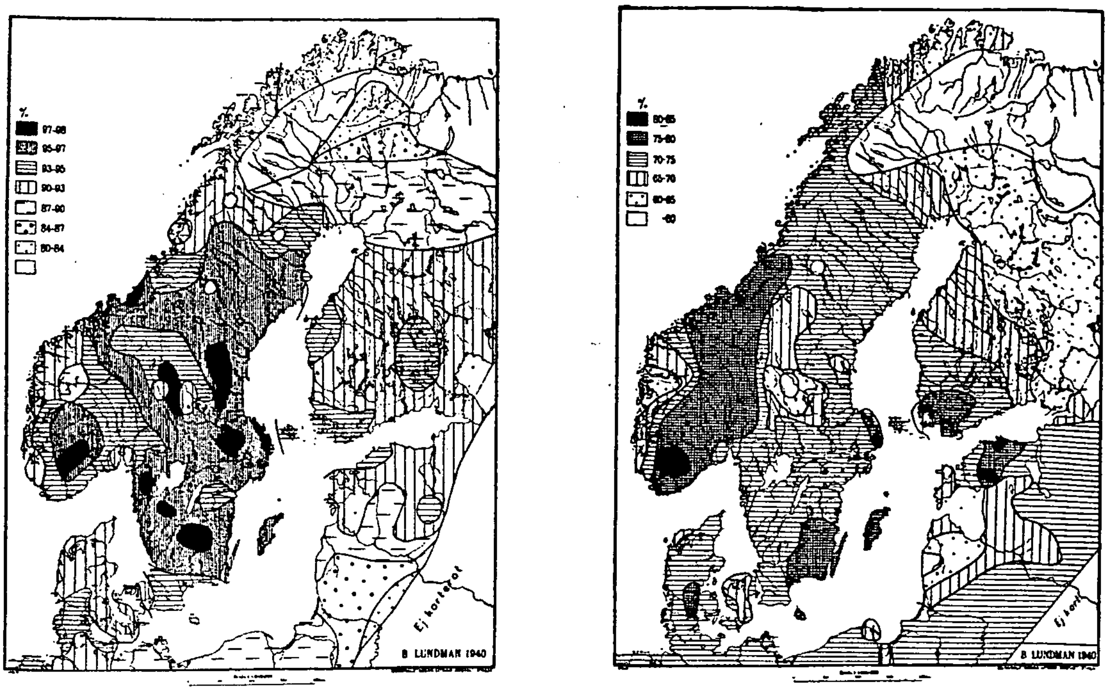
The same situation is observed among Spaniards, for whom it is known that blondism of hair and eyes, among Aragonese and Andalusians, and of hair alone, along the eastern coastal zone, are more frequent than among the inhabitants of the Meseta (fig. VI.2-2). Again, as among Swedes, pigmentation of the skin appears to conform to expectancies better than do pigmentation of hair and eyes.

As a whole, hair colour seems more variable than eye colour among Spaniards, while the opposite is true among Swedes. However, since sample sizes are small, it is rather risky to elaborate any further.

Summary

Between geographical areas, as revealed by the x^2-technique, variability of hair colour and eye colour in Sweden and Spain is - when existent - mostly in agreement with established knowledge.

Pigmentation of the skin is shown to follow ecological variability more closely than eye colour and hair colour do.



(a)
Light and mixed eyes in men (%).
(No. 1-8 of Martin-Schultz's scale).

(b)
Light hair among 22-year old men (%).
(No. 1-3 and 7-26 of Fischer's scale, and no. I-VI and A-Q of Fischer's and Saller's scale).

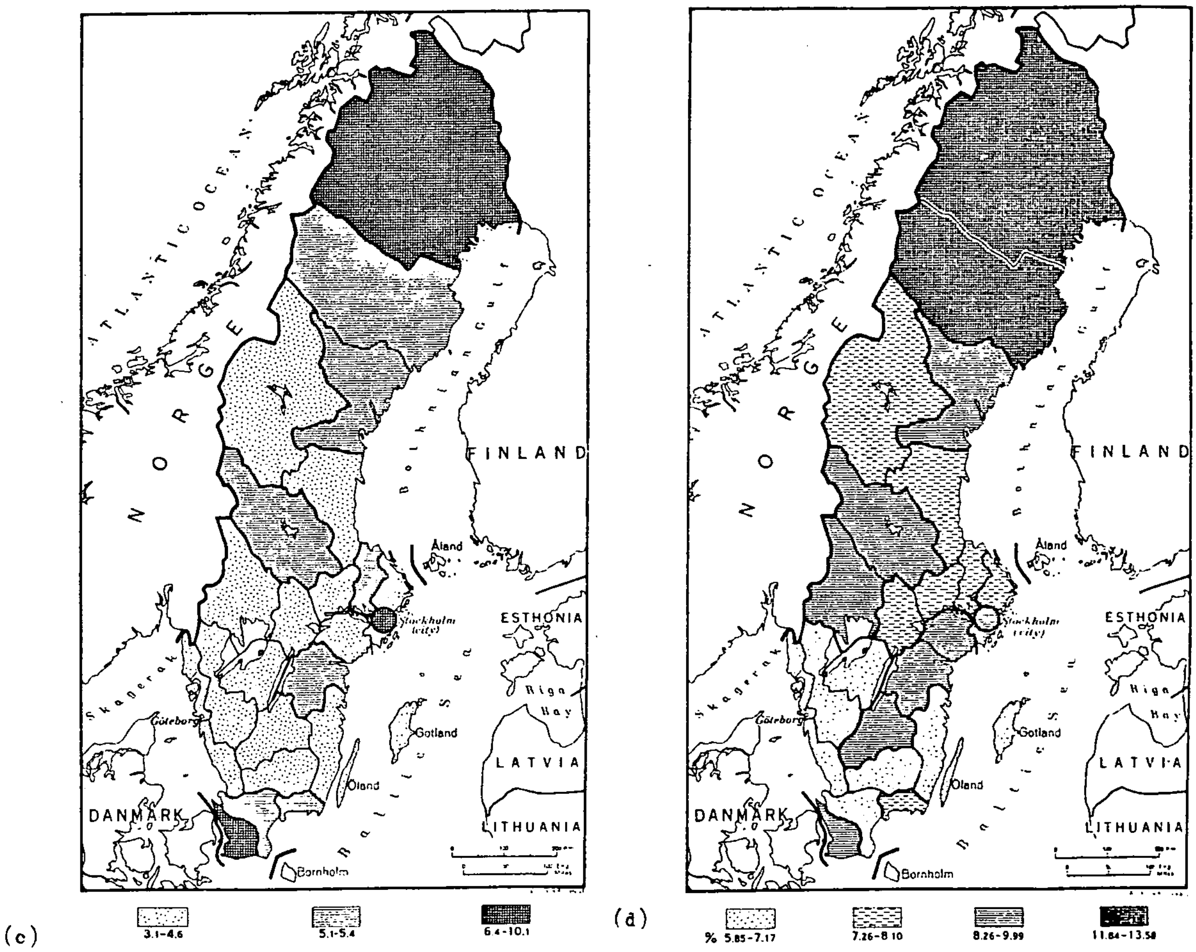
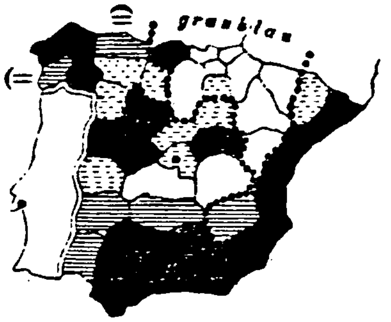
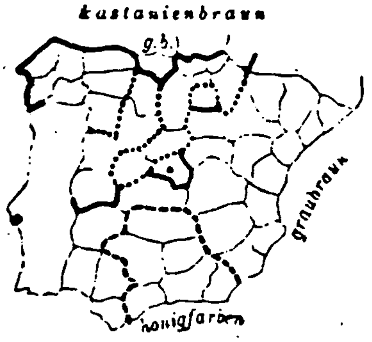


Fig. VI.2-1. Distribution of hair colour (a) and eye colour (b) in Sweden. (After Lundman, 1944). For comparison, distribution of brown eyes (c) and of "predominantly dark types" (d) by 'län' (After Lundborg & Linders, 1926).
Legend.
1. Lundman himself considered his map for hair colour not totally accurate (Lundman, 1967).
2. As "predominantly dark types" are included those with light eyes and dark (head) hair and those with dark eyes and medium brown (head) hair - or darker combinations.

1.



2.



1: Blau, graublau, grau und hell. ☐ = 1/4 (= 1/3 Navarra, Zaragoza, Guipuzcoa). ▨ = 1/5. ☰ = 1/6. ■ = braun. ..... Grenze der graublauen (garzos) mehr als blauen (azules). (= Graublau und blau gleichmässig.) — Vizcaya: bl., gr.-bl. = 1/7. Vizcaya: bl., gr.-bl., gr. = 1/5. Vizcaya: bl., gr.-bl., gr., hell = 1/4. Asturia: bl., gr.-bl. = 1/8. Asturia: bl., gr.-bl., hell = 1/6. Badajoz: bl. = 1/10. Badajoz: bl., hell und veilchenbl. = 1/6. Santander: bl., gr.-bl. = 1/8.

2: ..... Grenze der Kastanienb. mehr als graubraunen (pardos). _ _ _ Grenze der Honigfarben mehr als graubraunen = 1/8. —— Grenze der Kastanienbraunen = 1/6.

I	II	III	II+III	IV	
17.7	33.0	12.4	45.4	36.9	Total
14.5	65.9	0.0	65.9	19.6	Catalunya
16.9	61.0	5.2	66.2	16.9	Murcia
15.4	61.5	0.0	61.5	23.1	Canarias
12.1	61.3	2.3	63.6	24.3	Valencia
10.7	54.4	7.1	61.5	27.8	Andalucía
21.1	52.6	5.3	57.9	21.0	Baleares
18.8	42.5	3.4	45.9	35.3	Extremadura
21.4	41.3	5.4	46.7	31.9	Castilla la Nueva
21.1	30.3	1.8	32.1	46.8	Castilla la Vieja
34.9	25.8	2.2	28.0	37.1	Aragón
18.8	23.0	2.1	25.1	56.1	León
19.1	22.5	3.4	25.9	55.0	Asturias
11.7	21.3	48.2	69.5	18.8	Granada +
39.2	11.4	0.0	11.4	49.4	Vascongadas, Navarra
12.3	7.8	0.8	8.6	79.1	Galicia

(a)
Distribution of eye colour in Spain. (After Hoyos & Aranzadi, 1893-4). 3261 individuals (♂).

Legend.
1. I = blue, grey, green. II = grey-brown ('pardo').
   III = honey-coloured. IV = black, dark brown.
2. Granada + = Córdoba, Jaén, Almería, Granada and Málaga.

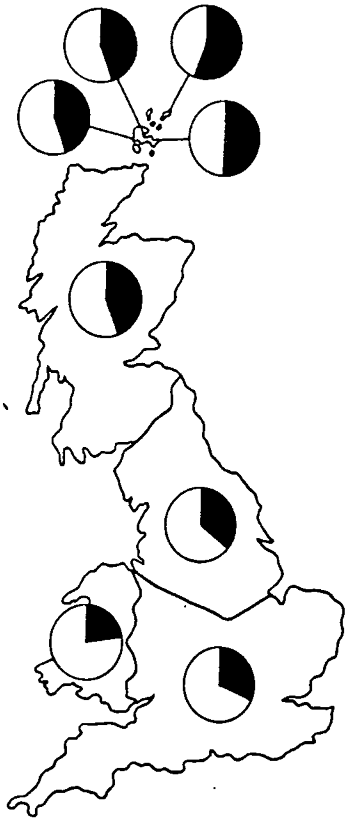
(In the impossibility of finding any of the two or three old works extensively dealing with the distribution of hair, eye and skin colour in Spain, the author will only reproduce the data which he has been able to gather through incomplete quotations in other sources).

Blond hair colour occurs in Spain with a frequency of 14.5 per cent (presumably including light brown). Traces of blondism are visible in 17 per cent of the population, while black hair amounts to 29 per cent. The province with least blonds is Palencia (4 %) and with most is Zaragoza (30 %); in general, the provinces along the Portuguese frontier are among the darkest, and those along the Mediterranean and Cantabric seaboards among the lightest. The Mediterranean coast has more blonds than the Cantabrian.

Fig. VI.2-2. Distribution of eye colour (a) and hair colour (b) in Spain.

(b)
Distribution of hair colour in Spain.

(a)
Distribution of eye colour in Britain.
(After Boyce et al., 1973).
Legend.
1. Shaded: grey, intermediate, dark-blue and light blue eyes (Martin categories 12, 14-16).



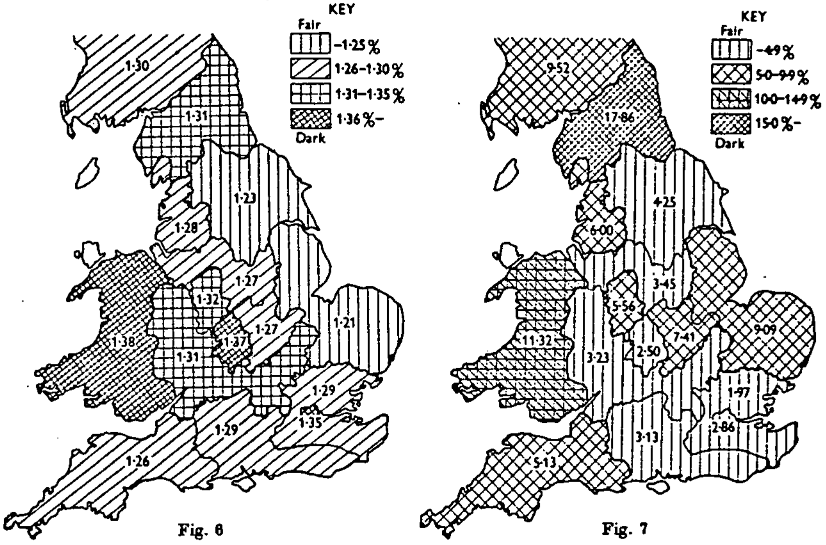


Fig. 6

Fig. 7

(b)
Distribution of hair colour in Britain. Based on spectrophotometric work of 1000 hair samples. (After Sunderland, 1954). Left; regional distribution of dark-to-light hairs (variance method); zero percentage reflectance taken as origin. Right, regional distribution of red-hair frequencies (R-values below 47.0 taken to denote red hair).

Fig. VI.2-3. Distribution of eye colour (a) and hair colour (b) in Britain.

CHAPTER VII

VII.1. Skin colour and stature.

In spite of the evident deficiencies of precision introduced by the method for gathering information on stature, it was considered they were not likely to affect the sign of any eventual correlation existing between variables tall and pigmentation of the skin, but merely its magnitude - and that only in a marginal way. Levels of significance will probably remain for the most part uninfluenced. Consequently, a partial correlation analysis was performed for each of the 3/4-samples between variable uia9, controlled for predictors, and variable tall (table VII.1-1).

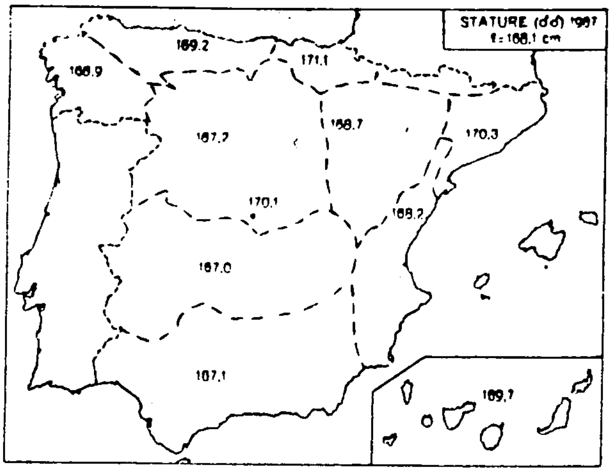
		uia9 with tall by predictors		
		partiel corr.	df=N-2	sign.
SWE+ASWE	♂	0.286	178	0.000 +
	♀	-0.073	250	0.247 -
SPA+ASPA	♂	-0.036	92	0.733 -
	♀	-0.136	111	0.150 -
GB+AGB	♂	0.094	21	0.669 -
	♀	0.275	37	0.091 -

Table VII.1-1. Correlations between pigmentation, corrected for predictors, and stature.

Figures VII.1-1 to VII.1-3 illustrate the geographical distribution of stature in Sweden, Spain and Great Britain.

Significance showed up only among Swedish males (p=0.000). All other values lie far away from any acceptable level, except for British females (p= 0.091). Both coefficients are positive. Unfortunately, sample size is small in both cases: 37 British, 180 Swedes. It would be extremely interesting to check on bigger samples. Explaining an eventual cor-

(a) Division into regions according to Hoyos Sainz (1952)



(b) Distribution of stature for military recruits. (Values in cm).

Year	Stat.	Region	Stat.	Stat.
1958	166.4	I	166.9	168.2
1959	166.6	II	167.0	166.9
1960	166.7	III	167.1	166.8
1961	166.9	IV	167.2	167.1
1962	167.2	V	168.2	168.2
1963	167.4	VI	168.7	168.4
1964	167.6	VII	169.2	168.8
1965	167.7	VIII	169.7	169.6
1966	167.8	IX	170.1	169.1
1967	168.1	X	170.3	170.0
		XI	171.1	170.8

Fig. VII.1-2. Distribution of stature in Spain. (After Valls 1980). (a) Statistics for 1967 conscripts. (b) and (c) Statistics for other years.

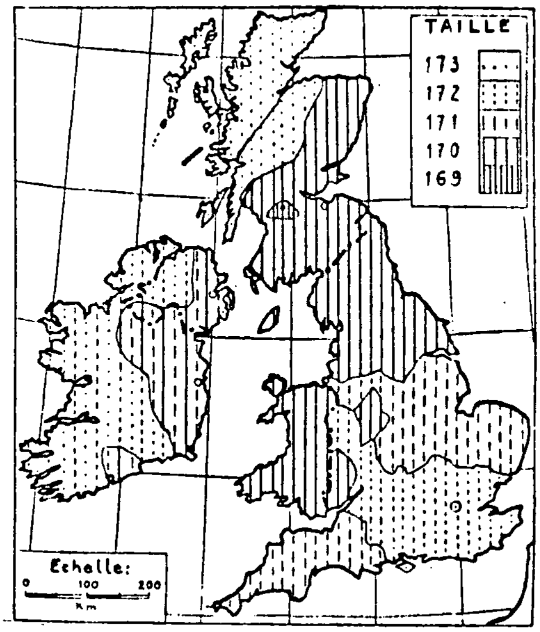


Fig. VII.1-3. Distribution of stature in Britain. (After Coon, 1939 and Martin, 1939. In Sauter 1952).

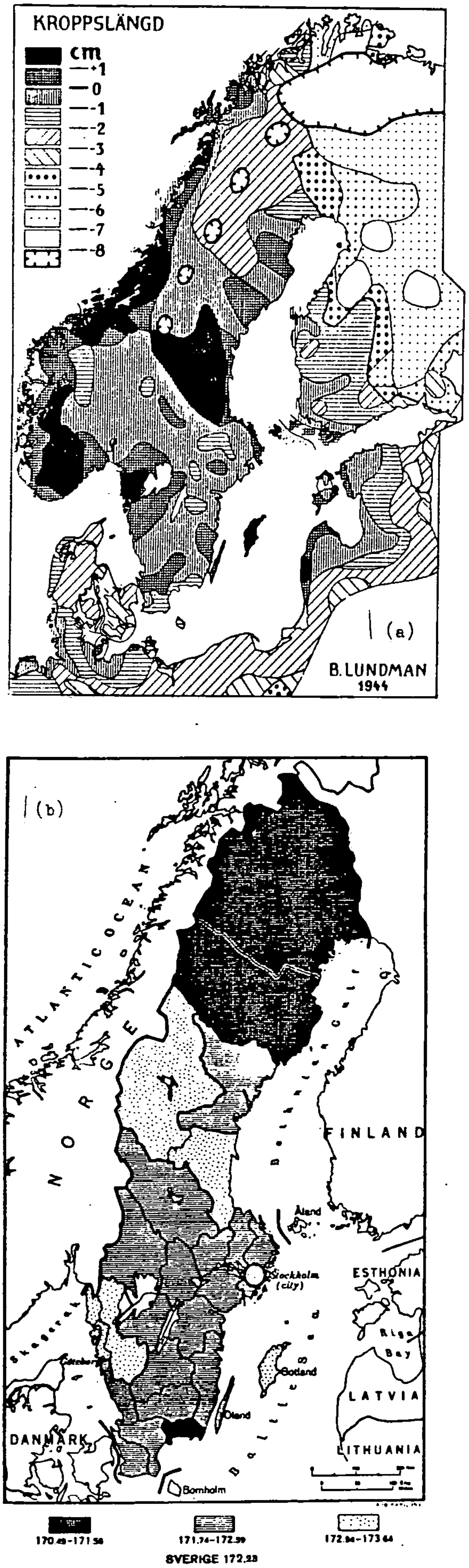


Fig. VII.1-1. Distribution of stature in Scandinavia. (a) Given as average deviations from the total mean for more than 1.000,000 subjects. (After Lundman 1946). (b) By län, based on 47,000 male Swedes. (After Lundborg & Linders, 1926) relation of such a sort among the British in terms of tall Iron Age nordics and shorter and darker Neolithic mediterraneans, although it may be basically correct, is probably oversimplified as blood groups and anthropometry seem to converge in suggesting the existence of a submerged more archaic type, with presumed mesolithic connections, especially important in the more isolated areas of the western districts (as well as in southwestern and western Ireland) (Mourant, 1976; Coon, 1939). If Coon's conclusions on his skin fairness and tall stature (both superior to the nordic local type) are correct, his intrusion in the picture would only serve to reinforce the correlation. A non-totally dissimilar type (the so-called Tydal type) has been reported from central Norway and parts of Sweden (Bryn, 1921; Lundman, 1952), also relatively isolated districts (fig. VII.1-4), but no independent reference to his skin colour is made,

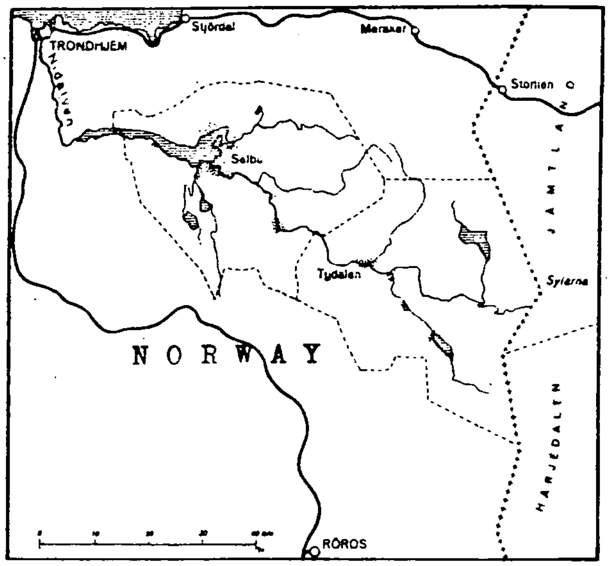


Fig. VII.1-4. (a) Tydal (Tydalen) in Tröndelag. The small dots indicate inhabited areas. (After Bryn, 1921).

although it seems to be darker. The existence of this type in Scandinavia is today a strictly localized phenomenon, although it is likely to have contributed in a non-negligible way to the population in, at least, central Scandinavia. Our sample has, however, practically no individuals from that area. With that exception, all other alien elements in Scandinavia, past or present, are on average shorter and presumably also darker than the Swedes, contributing then, as in the case before, to the appearance of a positive correlation between stature and pigmentation of the skin.

VII.2. Pigmentation of the skin, eyes and hair.

In eye colour and hair colour Sweden and Spain occupy two polar positions, with light pigmentation absolutely prevailing in the first country while dark is totally dominant in the second one. Britain lies somewhere in between. In this section an attempt will be made at finding any eventual associations between skin colour, as measured at the ninth filter with the reflectophotometer, and pigmentation of hair and iris of the eye. The same predictors as were used before at eliciting geographically induced pigmentary variability, will again be utilized as factors and covariates in an analysis of variance.

For several reasons it was advisable to reduce the original number of hair and eye colour categories to four in both cases. These reasons were: 1) to minimize the deficiencies in accuracy inherent to classification of colour by the naked eye, 2) to reduce the risks for the appearance of empty cells or cells with very few cases, 3) the new arrangement of categories for hair colour has a ranking character which fits well with Gardner's results (Gardner, 1934), to be dealt with immediately. For the new arrangement, which is fully in accord with chapter III, eye colour has been divided into the following categories: (1) darks, (2) medium and light browns, (3) mixed and (4) greens, greys and blues. For hair colour, the new categories, less readily convertible to the old ones, are: (1) black, (2) dark and medium brown, with or without a certain reddish tint, (3) light brown, ash blond, blond, reddish blond and dark red, (4) light blond, platinum blond, albino plus medium to light red.

It is a common notion among laymen that red-haired people have unusually light skins and that they freckle instead of tanning. That would be so in spite of pure red hair, even the lightest one, not appearing particularly light when compared with light blonds. Gardner (1934) with the assistance of a Hardy redording spectrophotometer, succeeded in illustrating the issue for hair in an elegant way (fig. VII.2-1).

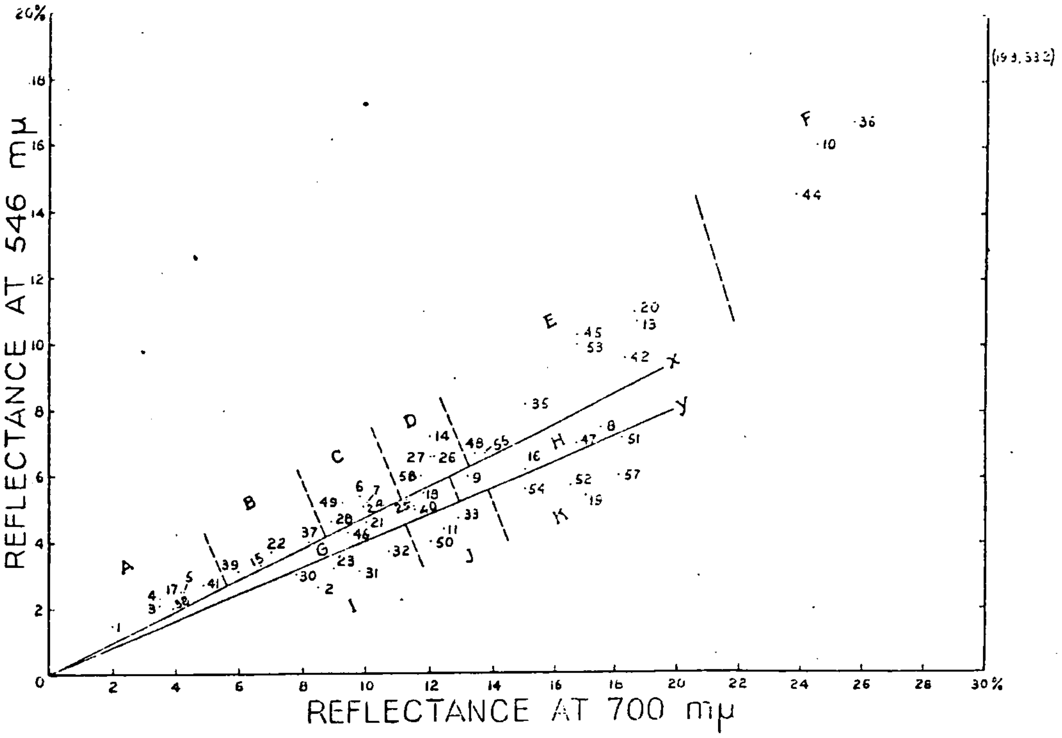


Fig. VII.2-1. Gardner's three series for colour of the hair. (After Gardner, 1934).

He found out that a cluster of points representing the reflectances at 700 nm (abscisses) and at 546 nm (ordinates) of 53 widely different hair samples, could be divided into three spaces by two straight lines (slopes 0.47 and 0.40), and that these three spaces would define the chromatic series leading from black to blond (the upper one, without any red) and the series of the pure reds (the lower one) with a reddish-brown series in between. Any observed hair colour could, thus, be referred to this diagram by finding out whether R_{546}/R_{700} (quotient between reflectances) was greater than 0.47, lower than 0.40, or intermediate. Subgroup F (blonds), within the black-to-blond series, has no counterpart within the others at 700 nm. Even the darkest blond within the series is lighter than the lightest red at both wavelengths. The nature of the relationship between the series seems to suggest that pure red hair owes little if anything to melanin content, which in turn suggests a very low melanin content for the skin as well. Figures VII.2-1 and VII.2-2 illustrate the relationships between reflectances for different hair colours as seen from two different angles. Unfortunately, the number of red-haired individuals is everywhere in our samples extremely low, insufficient for constituting a valid subgroup (5 Swedes, no British, no Spaniards), for which reason no attempt was made to study their reflectance values independently from the rest.

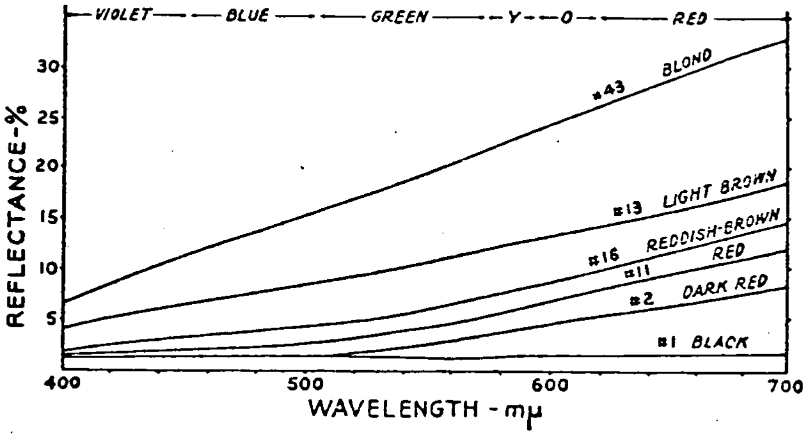


Fig. VII.2-2. Reflectance curves for different kinds of hair. (After Gardner, 1934).

The distributions of hair colour and eye colour in the three countries are summarized in figures VI.2-1, VI.2-2 and VI.2-3.

Significant association between pigmentation of the skin and colour of the iris (tables VII.2-1, VII.2-2 and VII.2-3) was only detected among Spaniards (p=0.040), where those with mixed irises were found to be lightest, followed by persons with green, grey or blue eyes. Difference between those two groups is not significant. Difference between any of those two and the darkest one is, however, significant. Exactly the same order, but without significance, is observed among Swedish. Among the British, however, pigmentation of the iris and hair change in a completely parallel way.

Significant variability of skin pigmentation with hair colour (tables VII.2-4, VII.2-5 and VII.2-6) was neatly found among Swedes (p=0.024, all possible comparisons), Spaniards (p=0.011) and nearly among British (0.060). This quasisignificant result among the British is, however, just category four's effect (with only two cases). As a whole, pigmentation of the skin diminishes with decreasing pigmentation of the hair in the three samples, but the darkest complexion belongs - among Swedes - to those in rank 3 (light brown to darker hues of bond and red). Whether this oddity is a genuine characteristic or the remnant effect of some unremoved behavioural dimension is difficult to tell. In the last case, it might be the outcome of overcompensation, of which we may already have found some signs while examining the behavioural variables' impact on pigmentation of the skin. Namely, that those naturally possessing lighter complexions - which among whites is mentally attached to hair as often at least as to skin - would tend to care more for outbalancing their 'handicap' than those already endowed with fashionable darker complexions. According to the author's personal observations, blond Swedes (although not likely the most extreme types) do often seem to have a quite acceptable capacity to tan. That may well result in overdoing for pale people in category 3, more unlikely for those in category 4.

```
SUBFILE   SVE          ASVE

* * * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * * *
                    UIA9
                 BY SEX
                    EYE
               WITH DULG
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                                           SUM OF                      MEAN              SIGNIF
SOURCE OF VARIATION                       SQUARES      DF            SQUARE        F       OF F

COVARIATES                                215.849       1           215.849   12.666    0.000
   DULG                                   215.849       1           215.849   12.666    0.000

MAIN EFFECTS                              116.468       3            38.823    2.278    0.078
   SEX                                     47.267       1            47.267    2.774    0.096
   EYE                                     64.154       2            32.077    1.882    0.153

2-WAY INTERACTIONS                         30.447       2            15.223    0.893    0.410
   SEX        EYE                          30.447       2            15.223    0.893    0.410

EXPLAINED                                 362.766       6            60.461    3.548    0.002

RESIDUAL                                11895.184     698            17.042

TOTAL                                   12257.949     704            17.412


COVARIATE    RAW REGRESSION COEFFICIENT

DULG              1.539

    751 CASES WERE PROCESSED.
     46 CASES (  6.1 PCT) WERE MISSING.

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
* * *    M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S    * * *
                    UIA9
            BY      SEX
                    EYE
            WITH DULG
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

GRAND MEAN =     65.23
                                                                         ADJUSTED FOR
                                                        ADJUSTED FOR     INDEPENDENTS
                                          UNADJUSTED    INDEPENDENTS     + COVARIATES
VARIABLE + CATEGORY                  N    DEV'N   ETA   DEV'N    BETA    DEV'N    BETA

SEX
     1                             287     0.35                            0.31
     2                             416    -0.24                           -0.21
                                                  0.07                             0.06

EYE
     2                              76    -0.64                           -0.67
     3                              23     1.28                            1.13
     4                             606     0.03                            0.04
                                                  0.08                             0.07

MULTIPLE R SQUARED                                                                 0.027
MULTIPLE R                                                                         0.165
```

Table VII.2-1. The association between skin colour and eye colour in Sweden.

Legend.

1. Eye colour:
   1 = dark, 2 = medium and light brown, 3 = mixed,
   4 = green, grey, blue.
2. Sex:
   1 = male, 2 = female.

```
SUBFILE   SPA        ASPA
* * * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * * *
                 UIA9
              BY SEX
                 EYE
            WITH A1
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                                          SUM OF                     MEAN             SIGNIF
SOURCE OF VARIATION                       SQUARES      DF            SQUARE       F      OF F

COVARIATES                                175.401       1           175.401  11.600     0.001
   A1                                     175.401       1           175.401  11.600     0.001

MAIN EFFECTS                              188.974       3            62.991   4.166     0.007
   SEX                                     94.726       1            94.726   6.264     0.013
   EYE                                     98.650       2            49.325   3.262     0.040

2-WAY INTERACTIONS                         45.010       2            22.505   1.488     0.228
   SEX       EYE                           45.010       2            22.505   1.488     0.228

EXPLAINED                                 516.115       6            86.019   5.689     0.000

RESIDUAL                                 3024.253     200            15.121

TOTAL                                    3540.368     206            17.186


COVARIATE    RAW REGRESSION COEFFICIENT

A1                0.132

    242 CASES WERE PROCESSED.
     35 CASES ( 14.5 PCT) WERE MISSING.

 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 * *    M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S    * * *
               UIA9
         BY    SEX
               EYE
         WITH  A1
 * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

GRAND MEAN =     61.89                                                       ADJUSTED FOR
                                                               ADJUSTED FOR   INDEPENDENTS
                                                 UNADJUSTED    INDEPENDENTS   + COVARIATES
VARIABLE + CATEGORY                      N      DEV'N   ETA    DEV'N   BETA   DEV'N   BETA

SEX
    1                                   99      -0.99                         -0.99
    2                                  108       0.91                          0.91
                                                        0.23                          0.23

EYE
    2                                  120      -0.68                         -0.66
    3                                   29       0.91                          1.12
    4                                   58       0.94                          0.51
                                                        0.19                          0.19

MULTIPLE R SQUARED                                                                    0.090
MULTIPLE R                                                                            0.299
```

Table VII.2-2. The association between skin colour and eye colour in Spain.

Legend.

1. Eye colour:
   1 = dark, 2 = medium and light brown, 3 = mixed,
   4 = green, grey, blue.
2. Sex:
   1 = male, 2 = female.

```
SUBFILE   GB          AG3

* * * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * * *
                    UIA9
                BY  SEX
                    EYE
              WITH  DUS
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                                        SUM OF                     MEAN              SIGNIF
SOURCE OF VARIATION                    SQUARES        DF          SQUARE        F      OF F

COVARIATES                               0.000         1           0.000     0.000    0.996
   DUS                                   0.000         1           0.000     0.000    0.996

MAIN EFFECTS                             5.657         3           1.886     0.169    0.917
   SEX                                   0.079         1           0.079     0.007    0.933
   EYE                                   5.539         2           2.770     0.249    0.780

2-WAY INTERACTIONS                       1.125         2           0.563     0.051    0.951
   SEX      EYE                          1.125         2           0.563     0.051    0.951

EXPLAINED                                6.896         6           1.149     0.103    0.996

RESIDUAL                               868.353        78          11.133

TOTAL                                  875.249        84          10.420


COVARIATE    RAW REGRESSION COEFFICIENT

DUS             -0.000

      89 CASES WERE PROCESSED.
       4 CASES (  4.5 PCT) WERE MISSING.

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
* * *    M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S    * * *
                    UIA9
              BY    SEX
                    EYE
              WITH  DUS
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

GRAND MEAN =     64.51                                                     ADJUSTED FOR
                                                            ADJUSTED FOR   INDEPENDENTS
                                              UNADJUSTED    INDEPENDENTS   + COVARIATES
VARIABLE + CATEGORY                 N         DEV'N   ETA   DEV'N    BETA  DEV'N   BETA

SEX
   1                               39         -0.05                        -0.02
   2                               46          0.04                         0.02
                                                      0.01                         0.01

EYE
   2                               21         -0.44                        -0.48
   3                                9          0.02                         0.06
   4                               55          0.16                         0.17
                                                      0.08                         0.09

MULTIPLE R SQUARED                                                                 0.010
MULTIPLE R                                                                         0.100
```

Table VII.2-3. The association between skin colour and eye colour in Britain.

Legend.

1. Eye colour:
   1 = dark, 2 = medium and light brown, 3 = mixed, 4 = green, grey, blue.
2. Sex:
   1 = male, 2 = female.

```
SUBFILE   SVE       ASVE

* * * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * *
                   UIA9
                BY SEX
                   HAIR
              WITH DULG
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                                          SUM OF                   MEAN            SIGNIF
SOURCE OF VARIATION                      SQUARES     DF           SQUARE      F     OF F

COVARIATES                               250.809      1          250.809  14.400   0.000
   DULG                                  250.809      1          250.809  14.400   0.000

MAIN EFFECTS                             206.125      3           68.708   3.945   0.008
   SEX                                    70.070      1           70.070   4.023   0.045
   HAIR                                  140.361      2           70.180   4.029   0.018

2-WAY INTERACTIONS                        13.943      2            6.971   0.400   0.670
   SEX       HAIR                         13.943      2            6.971   0.400   0.670

EXPLAINED                                470.879      6           78.480   4.506   0.000

RESIDUAL                               12052.828    692           17.417

TOTAL                                  12523.707    698           17.942


COVARIATE    RAW REGRESSION COEFFICIENT

DULG            1.682

    751 CASES WERE PROCESSED.
     52 CASES (  6.9 PCT) WERE MISSING.

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

* * *    M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S   * * *
                UIA9
            BY  SEX
                HAIR
           WITH DULG
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

GRAND MEAN =      65.19
                                                                            ADJUSTED FOR
                                                            ADJUSTED FOR    INDEPENDENTS
                                              UNADJUSTED    INDEPENDENTS    + COVARIATES
VARIABLE + CATEGORY                  N        DEV'N  ETA    DEV'N   BETA    DEV'N   BETA

SEX
   1                               285        0.39                          0.38
   2                               414       -0.27                         -0.26
                                                     0.08                           0.06

HAIR
   2                               192        0.20                          0.24
   3                               432       -0.25                         -0.31
   4                                75        0.92                          1.06
                                                     0.09                           0.11

MULTIPLE R SQUARED                                                                  0.036
MULTIPLE R                                                                          0.191
```

Table VII.2-4. Associations between skin colour and hair colour in Sweden.

Legend.

1. Hair colour:
   1 = black, 2 = dark and medium brown (with/without a reddish tint), 3 = light brown, ash blond, blond reddish blond and dark red, 4 = light blond, platine blond, albino, medium to light red.
2. Sex:
   1 = male, 2 = female.

```
SUBFILE    SPA         ASPA
* * * * * * * * * * *  A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * *
                 UIA9
              BY SEX
                 HAIR
            WITH A1
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                                                SUM OF                  MEAN             SIGNIF
SOURCE OF VARIATION                            SQUARES      DF        SQUARE        F      OF F

COVARIATES                                     158.592       1       158.592    9.878    0.002
   A1                                          158.592       1       158.592    9.878    0.002

MAIN EFFECTS                                   214.444       2       107.222    6.678    0.002
   SEX                                         100.861       1       100.861    6.282    0.013
   HAIR                                        106.870       1       106.870    6.656    0.011

2-WAY INTERACTIONS                               0.775       1         0.775    0.048    0.826
   SEX        HAIR                               0.775       1         0.775    0.048    0.826

EXPLAINED                                      400.449       4       100.112    6.235    0.000

RESIDUAL                                      3082.649     192        16.055

TOTAL                                         3483.099     196        17.771


COVARIATE    RAW REGRESSION COEFFICIENT

A1                0.140

    242 CASES WERE PROCESSED.
     45 CASES ( 18.6 PCT) WERE MISSING.

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

* * *   M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S   * * *
                 UIA9
           BY    SEX
                 HAIR
           WITH  A1
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
GRAND MEAN =    61.98
                                                                           ADJUSTED FOR
                                                            ADJUSTED FOR   INDEPENDENTS
                                                UNADJUSTED  INDEPENDENTS   + COVARIATES
VARIABLE + CATEGORY                       N     DEV'N  ETA  DEV'N   BETA   DEV'N   BETA
SEX
     1                                   90     -0.94                      -0.95
     2                                  107      0.79                       0.80
                                                        0.20                       0.21
HAIR
     2                                  163     -0.31                      -0.31
     3                                   34      1.50                       1.51
                                                        0.16                       0.15
MULTIPLE R SQUARED                                                                 0.071
MULTIPLE R                                                                         0.267

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

Table VII.2-5. Associations between skin colour and hair colour in Spain.

Legend.
1. Hair colour:
   1 = black, 2 = dark and medium brown (with/without a reddish tint), 3 = light brown, ash blond, blond reddish blond and dark red, 4 = light blond, platine blond, albino, medium to light red.
2. Sex:
   1 = male, 2 = female.

```
SUBFILE   GB          AGB

* * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * * *
              UIA9
           BY SEX
              HAIR
         WITH DUS
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                                                SUM OF                  MEAN             SIGNIF
SOURCE OF VARIATION                            SQUARES      DF        SQUARE        F     OF F

COVARIATES                                       0.589       1         0.589    0.059    0.809
   DUS                                           0.589       1         0.589    0.059    0.809

MAIN EFFECTS                                    59.139       3        19.713    1.959    0.126
   SEX                                           0.128       1         0.128    0.013    0.910
   HAIR                                         58.684       2        29.342    2.916    0.060

EXPLAINED                                       59.140       4        14.785    1.469    0.219

RESIDUAL                                       845.381      84        10.064

TOTAL                                          904.521      88        10.279


COVARIATE   RAW REGRESSION COEFFICIENT

DUS              0.000

     89 CASES WERE PROCESSED.
      0 CASES (  0.0 PCT) WERE MISSING.

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

* * *   M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S   * * *
             UIA9
        BY   SEX
             HAIR
        WITH DUS
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
GRAND MEAN =     64.54
                                                                                ADJUSTED FOR
                                                             ADJUSTED FOR      INDEPENDENTS
                                                UNADJUSTED   INDEPENDENTS      + COVARIATES
VARIABLE + CATEGORY                      N      DEV'N  ETA   DEV'N   BETA      DEV'N   BETA
SEX
    1                                   39      -0.08                           0.08
    2                                   50       0.06                          -0.06
                                                       0.02                             0.02
HAIR
    2                                   61      -0.49                          -0.49
    3                                   26       0.89                           0.88
    4                                    2       3.41                           3.42
                                                       0.25                             0.25
MULTIPLE R SQUARED                                                                     0.065
MULTIPLE R                                                                             0.256
```

Table VII.2-6. Associations between skin colour and hair colour in Britain.

Legend.

1. **Hair colour:**
   1 = black, 2 = dark and medium brown (with/without a reddish tint), 3 = light brown, ash blond, blond reddish blond and dark red, 4 = light blond, platine blond, albino, medium to light red.
2. **Sex:**
   1 = male, 2 = female.

VII.3. Skin colour and blood groups.

Certain anthropological facts seem to give support to the suggestion that, of the three kinds of allelic genes of the ABO system, gene O may be the oldest in Europe, as possibly in other parts of the world as well. B being a relatively recent Asian acquisition while A's origins are still totally unknown, although some connection with the broad-headed central European types has been alleged (Mourant et al., 1976). It has also been suggested that the ancient inhabitants of western Europe, before the coming of agriculture and matallurgy, must have had very high frequencies of O and Rh-negative and very low or no B, and that - although the Basques are their most unmixed descendants - traces of them are to be found in every refuge area of western Europe and, perhaps, even in the western mountains of the Caucasus. It is intriguing to speculate whether the high frequencies of gene A (above 0.30) in the western part of central Europe (between roughly the western Alps, the Rhineland and the French Massif Central) are not to be linked with the rise of Alpine types all through the area, and whether its presumably late arrival in northwestern Iberia and eastern Britain and also Scandinavia is not to be connected somehow with the Celtic migrations (1) and the roaming of the Teutonic tribes,

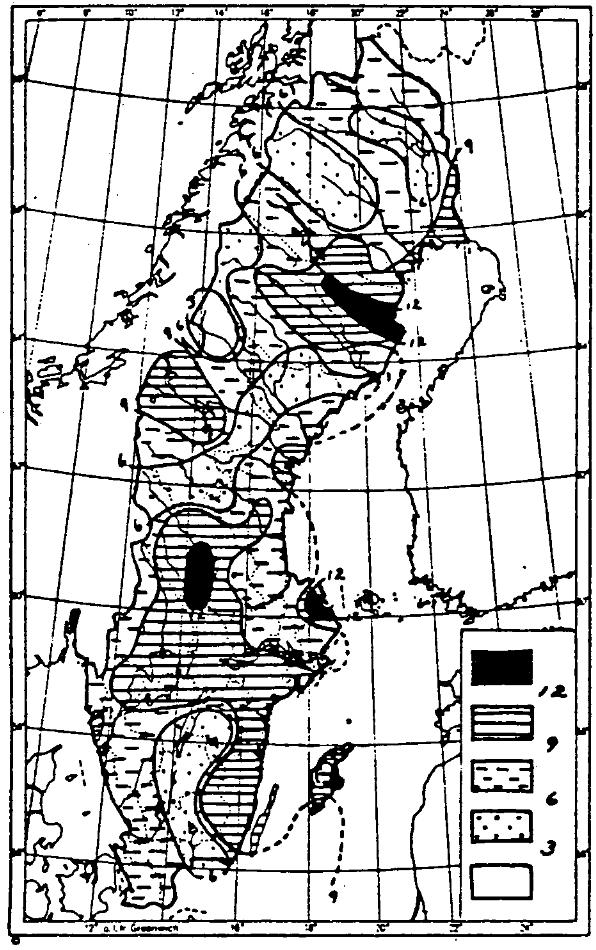
---

(1) It is highly doubtful that what to many scholars seem to represent the purest modern focus of celtism in Britain and Ireland, are biologically 'Celtic' to a significant extent, their many Celtic cultural traits notwithstanding. These two countries contained, by the time of the Celtic arrival, a comparatively dense population of farmers, in the best lowland areas, and hunters. Very likely, the most marginal areas were celticized more culturally than biologically. It is no longer accepted either that most Celts were either slain by Germanic invaders or fled to the west and to the north. Accepting a Celtic identity for those areas would put us in an extremely difficult position in trying to explain what became of the Celtic 'racial' traits in Gaul and central Europe, the original focus of celtism.

selective pressures against 00 phenotypes (Sunderlands, 1973) and diffusion without migration not withstanding.

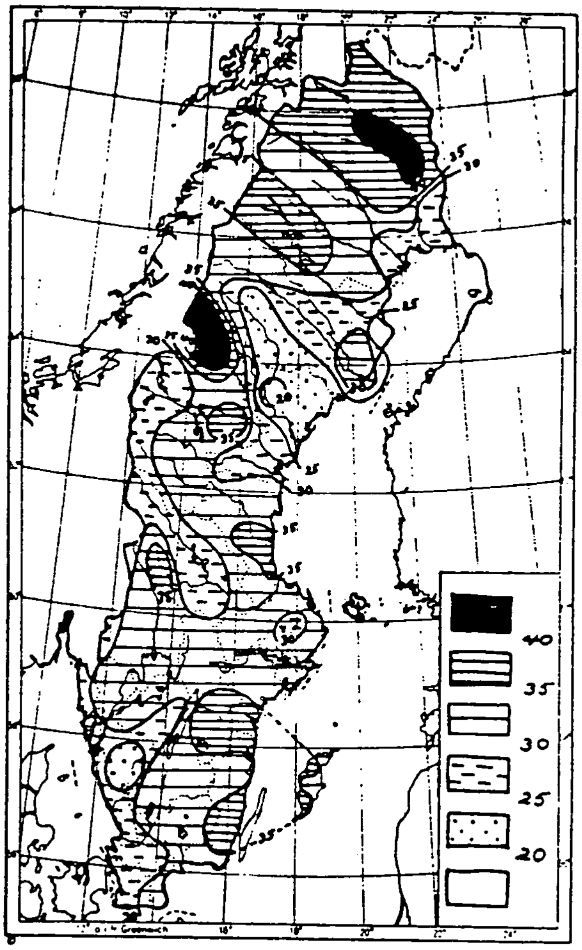
Figures VII.3-1, VII.3-2 and VII.3-3 illustrate the distribution of the ABO blood group system in the three countries.

The skin pigmentation of the Germanic and Celtic newcomers can only be guessed by reference to their assumed modern descendants. Celts and Germans must have been lighter than most inhabitants of Spain and Britain, at the time of their arrival with the possible exception in the British case of the population of mesolithic derivation (rich in 0 and Rh-negative, very poor in, perhaps even absence of A and B). These types were in Iberia represented by the ancestors of the modern Basques, which still today are among the lightest people in the area, but who - in their southern habitat - were presumably somewhat darker than the newcomers. To the extent that this outline may be correct, scarcity of A might in Britain be associated both with lighter skins (the mesolithic contribution) and possibly darker skins (the neolithic contribution), which is indeed a complication, and uniformly to darker skins in Spain. In Sweden, increasing A frequencies from the central areas towards both the Lapp and the southeastern poles of high A, plus the contribution of B-enrichened Finnish blood (rich in A and M in the east, poorer westwards) to certain districts of eastern Sweden (fig. VI.1-10), also tends to obscure the situation somewhat. This section of the work should thus rather be conducted on intra-provincial (at least intra-regional) basis, so that some control could be exerted on the nature and amount of ethnic elements intervening in the picture. The nature and size of our samples, however, render that kind of analysis impossible. Consequently, a simpler analysis of variance with sex and blood

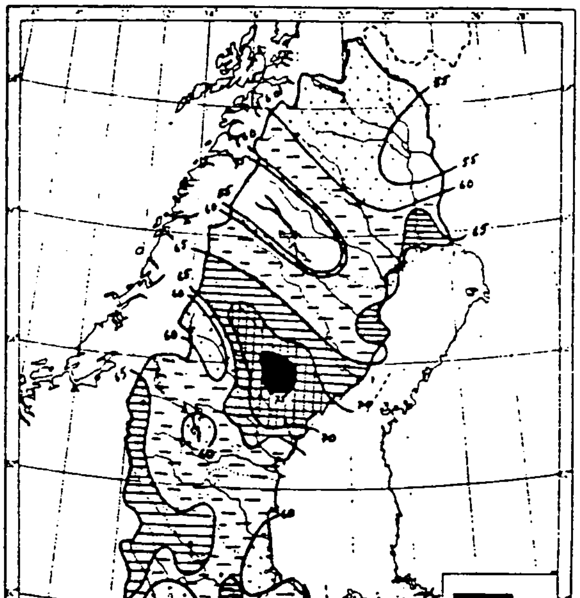


Distribution of the B gene in Sweden.

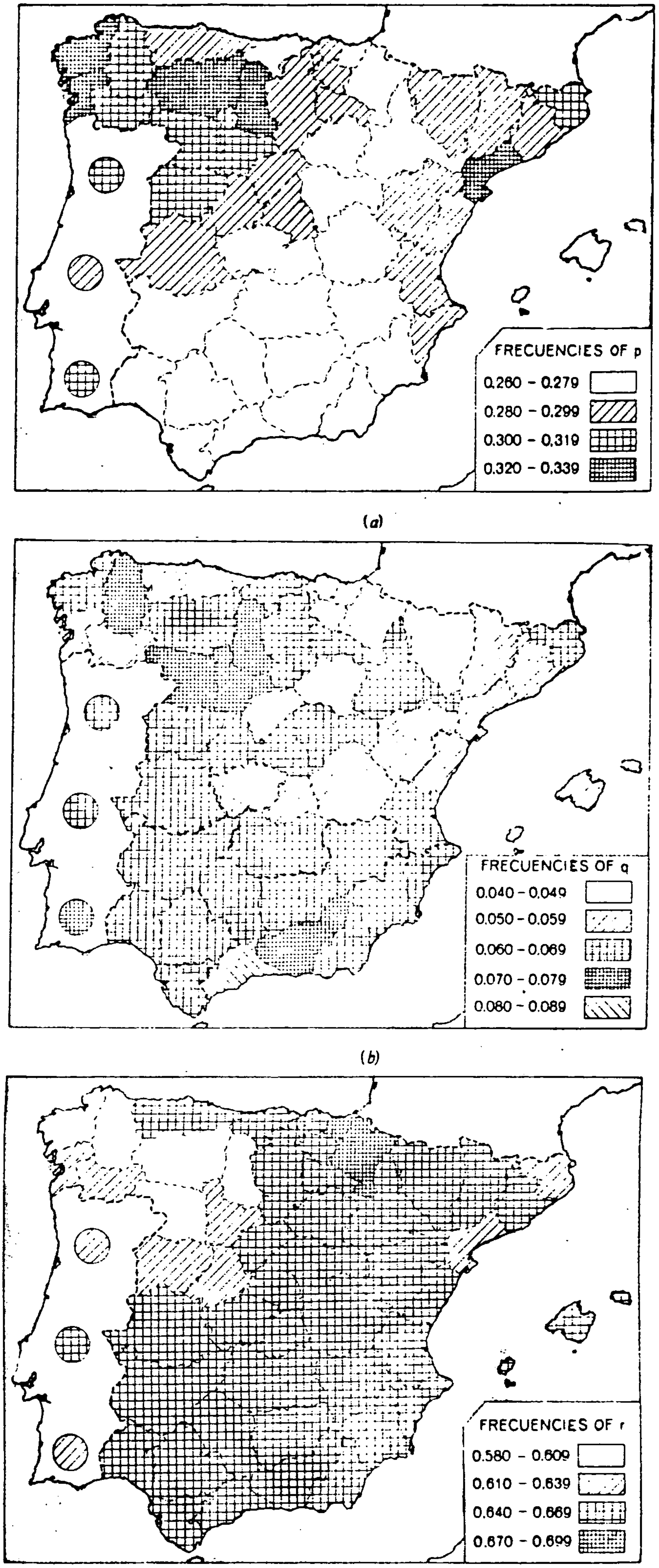
Fig. VII.3-1. Distribution of the ABO blood groups in Sweden. (After Beckman 1959).



Distribution of the A gene in Sweden.

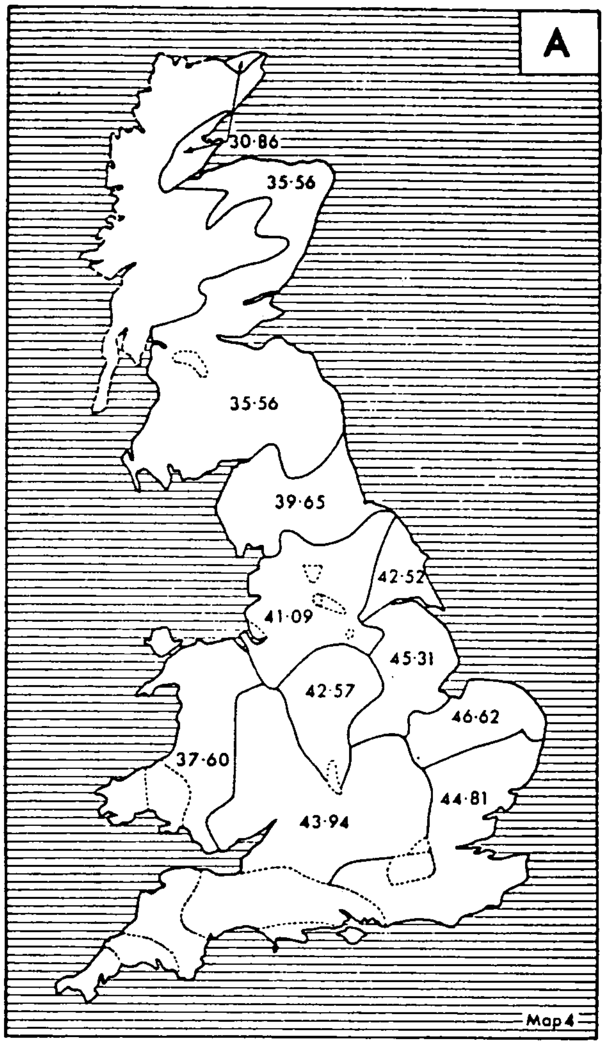


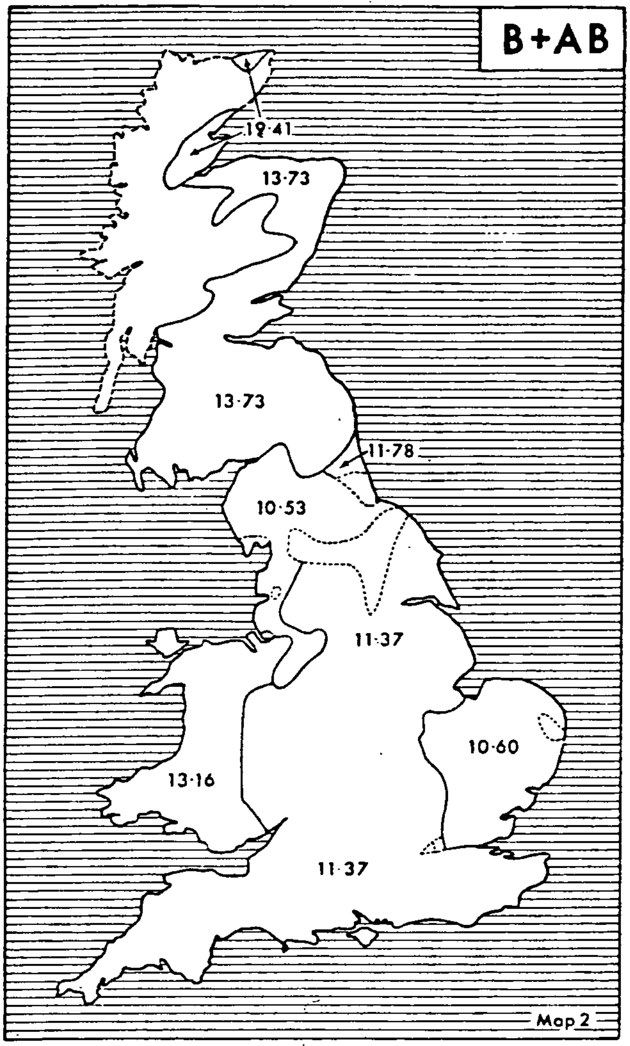
Distribution of the O gene in Sweden.



(c)

Fig. VII.3-2. Distribution of the ABO blood groups in Spain. (After Valls, 1975).





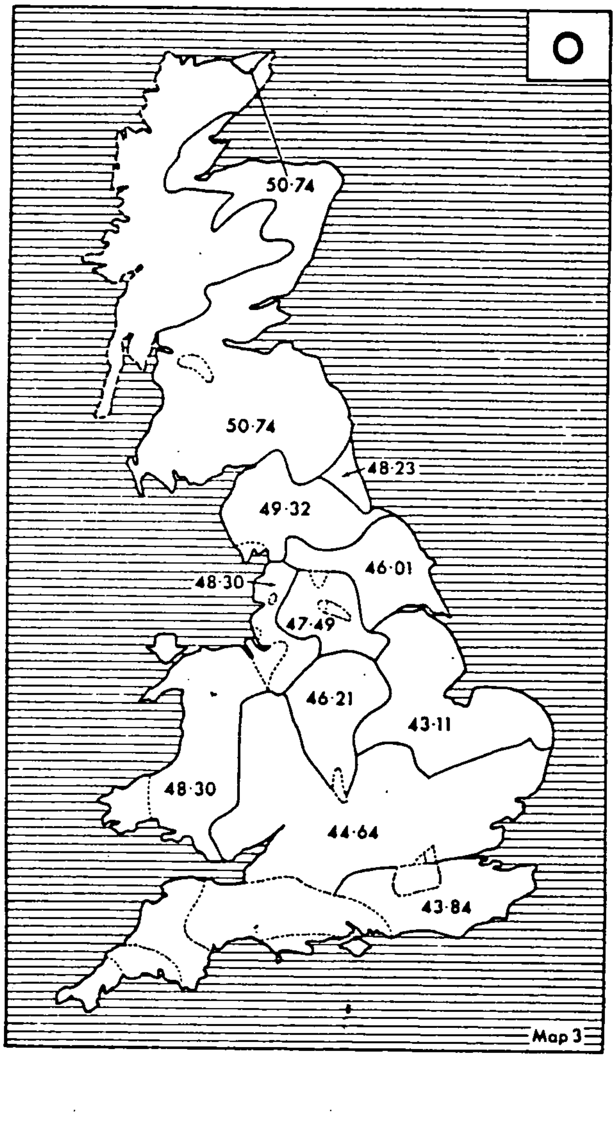


Fig. VII.3-3. Distribution of the ABO blood groups in Britain. (After Kopeć, 1970).

as only factors will be performed on the data.

Leaving aside the smaller groups, the results are as follows for the three samples (tables VII.3-1, VII.3-2 and VII.3-3). Among Swedes, possessors of phenotype 0 (84) are lighter than possessors of A (107). Since around 3/4 of the regionally classified specimens come from Götaland (and probably a very high percentage of the unclassified's ancestry is from there) we are not in fact too far away from an intra-regional analysis. Götaland is also practically free from recent non-Scandinavian admixture. All this would make the results indicated above highly interesting if they were significant. They are, however, not. Nor are they for Spaniards either (the best figure, p=0.073) or for the British. Also among Spaniards, 0-phenotypes possess lighter skins than A-phenotypes (69 vs. 75 cases). Among the British, with rather too small subgroups, the situation is reversed.

Since none of the results were significant, the situation does not deserve any further comment.

```
SUBFILE    SVE          ASVE
* * * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * * *
                  UIA9
               BY SEX
                  BLOOD
             WITH DULG
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                                       SUM OF                       MEAN            SIGNIF
SOURCE OF VARIATION                   SQUARES        DF           SQUARE       F      OF F

COVARIATES                              5.014         1            5.014    0.206    0.651
   DULG                                 5.014         1            5.014    0.206    0.651

MAIN EFFECTS                          205.348         4           51.337    2.104    0.081
   SEX                                122.169         1          122.169    5.008    0.026
   BLOOD                               85.487         3           28.496    1.168    0.323

2-WAY INTERACTIONS                     14.867         3            4.956    0.203    0.894
   SEX       BLOOD                     14.867         3            4.956    0.203    0.894

EXPLAINED                             225.230         8           28.154    1.154    0.329

RESIDUAL                             5220.680       214           24.396

TOTAL                                5445.910       222           24.531


COVARIATE   RAW REGRESSION COEFFICIENT

DULG              0.353

   751 CASES WERE PROCESSED.
   528 CASES ( 70.3 PCT) WERE MISSING.
SUBFILE    SVE          ASVE
* * *   M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S   * * *
                  UIA9
             BY   SEX
                  BLOOD
             WITH DULG
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

GRAND MEAN =      63.88                                                 ADJUSTED FOR
                                                         ADJUSTED FOR   INDEPENDENTS
                                           UNADJUSTED    INDEPENDENTS   + COVARIATES
VARIABLE + CATEGORY                  N     DEV'N  ETA    DEV'N   BETA   DEV'N   BETA

SEX
    1                               93      0.88                         0.88
    2                              130     -0.63                        -0.63
                                                  0.15                          0.15

BLOOD
    1                              107     -0.39                        -0.41
    2                               22      0.35                         0.35
    3                               10     -1.78                        -1.77
    4                               84      0.61                         0.64
                                                  0.12                          0.13

MULTIPLE R SQUARED                                                              0.039
MULTIPLE R                                                                      0.197
```

Table VII.3-1. Associations between skin colour and the ABO blood groups in Sweden.

Legend.

1. **Blood groups:**
   1 = A, 2 = B, 3 = AB, 4 = O.
2. **Sex:**
   1 = male, 2 = female.

```
SUBFILE   SPA        ASPA
* * * * * * * * * * *A N A L Y S I S   O F   V A R I A N C E* * * * * * * * * * *
              UIA9
          BY  SEX
              BLOOD
        WITH  A1
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                                            SUM OF                     MEAN           SIGNIF
SOURCE OF VARIATION                        SQUARES      DF           SQUARE       F      OF F

COVARIATES                                   6.957       1            6.957   0.469    0.494
   A1                                        6.957       1            6.957   0.469    0.494

MAIN EFFECTS                               261.666       4           65.417   4.411    0.002
   SEX                                     150.805       1          150.805  10.168    0.002
   BLOOD                                    98.267       3           32.756   2.208    0.089

2-WAY INTERACTIONS                          10.150       3            3.383   0.228    0.877
   SEX        BLOOD                         10.150       3            3.383   0.228    0.877

EXPLAINED                                  278.774       8           34.847   2.349    0.021

RESIDUAL                                  2343.413     158           14.832

TOTAL                                     2622.186     166           15.796


COVARIATE    RAW REGRESSION COEFFICIENT

A1               -0.689

    242 CASES WERE PROCESSED.
     75 CASES ( 31.0 PCT) WERE MISSING.

SUBFILE   SPA        ASPA
* * *    M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S    * * *
              UIA9
        BY    SEX
              BLOOD
        WITH  A1
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

GRAND MEAN =     61.78                                                       ADJUSTED FOR
                                                            ADJUSTED FOR    INDEPENDENTS
                                                UNADJUSTED  INDEPENDENTS    + COVARIATES
VARIABLE + CATEGORY                     N       DEV'N   ETA DEV'N    EETA   DEV'N    BETA

SEX
     1                                 76       -1.07                        -1.05
     2                                 91        0.89                         0.87
                                                       0.25                          0.24

BLOOD
     1                                 75       -0.76                        -0.68
     2                                 16        1.32                         1.37
     3                                  7       -1.42                        -1.39
     4                                 69        0.66                         0.56
                                                       0.21                          0.19

MULTIPLE R SQUARED                                                                   0.102
MULTIPLE R                                                                           0.320

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

Table VII.3-2. Associations between skin colour and the ABO blood groups in Spain.

Legend.

1. Blood groups:
   1 = A, 2 = B, 3 = AB, 4 = O.
2. Sex:
   1 = male, 2 = female.

```
SUBFILE   GB          AGB
* * * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * * *
                   UIA9
              BY   SEX
                   BLOOD
           WITH    DU5
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                                          SUM OF                  MEAN           SIGNIF
SOURCE OF VARIATION                      SQUARES      DF         SQUARE       F    OF F

COVARIATES                                 7.142       1          7.142   0.746   0.392
   DU5                                     7.142       1          7.142   0.746   0.392

MAIN EFFECTS                               6.685       4          1.671   0.175   0.950
   SEX                                     3.823       1          3.823   0.399   0.531
   BLOOD                                   3.507       3          1.169   0.122   0.947

2-WAY INTERACTIONS                         7.170       3          2.390   0.250   0.861
   SEX        BLOOD                        7.170       3          2.390   0.250   0.861

EXPLAINED                                 20.998       8          2.625   0.274   0.971

RESIDUAL                                 430.964      45          9.577

TOTAL                                    451.961      53          8.528


COVARIATE    RAW REGRESSION COEFFICIENT

DU5                 1.452

     89 CASES WERE PROCESSED.
     35 CASES ( 39.3 PCT) WERE MISSING.
SUBFILE   GB         AGB
* * *    M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S   * * *
                   UIA9
              BY   SEX
                   BLOOD
           WITH    DU5
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
                                                                          ADJUSTED FOR
GRAND MEAN =     63.87                                     ADJUSTED FOR   INDEPENDENTS
                                              UNADJUSTED   INDEPENDENTS   + COVARIATES
VARIABLE + CATEGORY                     N     DEV'N  ETA   DEV'N   BETA   DEV'N   BETA

SEX
     1                                 20     -0.20                       -0.36
     2                                 34      0.12                        0.21
                                                     0.05                         0.09

BLOOD
     1                                 21      0.24                        0.25
     2                                  7     -0.37                       -0.46
     3                                  3      0.19                        0.36
     4                                 23     -0.13                       -0.13
                                                     0.08                         0.09

MULTIPLE R SQUARED                                                               0.031
MULTIPLE R                                                                       0.175
```

Table VII.3-2. Associations between skin colour and the ABO blood groups in Britain.

Legend.

1. Blood groups:
   1 = A, 2 = B, 3 = AB, 4 = O.
2. Sex:
   1 = male, 2 = female.

VII.4. Correlations between stature and eye colour, hair colour and ABO phenotypes.

This is a twin section to VII.2 and VII.3. The principal elements in the picture have already been identified. As everywhere else, similar pigmentation for different anthropological types, as infered from studies of both the living and the dead, are often associated with different manifestations of one and the same gene system. In a country such as Spain, for instance, the association of very tall stature and blondism of hair and eyes in the same individual may well be due to chance recombination of alleles long ago dissociated and uniformly spread through the population, but an eventual repeated appearance of the phenomenon beyond expectation would demand another explanation. That most readily available, although not necessarily the only one, would be that some specific strain is as yet not totally diluted in the population. The situation is in practice, however, less simple than that, because stature is one of the most plastic of human traits and because of the presence of more than two racial elements in the picture. In addition there exists the problem of the small samples. For the standard deviation inferred for Swedes, for instance, from the first MCA (multiple classification analysis) for variable tall by eye and sex (table VII.4-4), for a difference between group means equal to 0.03 being detected as significant at the 0.05 level, group sizes should be in the relationship $1/n_1+1/n_2=2/717$, and $1/n_1+1/n_2=2/403$ if the difference is 0.04 - assuming bidirectionality and homogeneity of variance across the groups. Two of the infinite solutions admitted by each equation are $n_1=n_2=717$ and $n_1=n_2=403$ respectively, greater than most of the group sizes at our disposal.

For height's correlation with hair colour (tables

VII.4-1, VII.4-2 and VII.4-3), the Spanish and British samples are internally remarkably homogeneous, especially when disregarding the small groups. Among Swedes, the tallest are those in category 3 (medium light) (n=397), and the shortest (disregarding two black-haired individuals) are those in category 4. Differences are, everywhere, non-significant.

For variable eye, (tables VII.4-4, VII.4-5 and VII.4-6), internal homogeneity is also great among Spaniards and British and differences are not significant. Tallest among Swedes are those with light eyes (n=553). Significance is, however, not attained.

Also for blood (fig. VII.4-7, VII.4-8 and VII.4-9) the results are not significantly different. Tallest among Swedes are those with blood group A (n=112). Group sizes and relative differences are even smaller among Spaniards and British.

Thus, although no significant differences in stature were elicited between categories of eye colour, hair colour and blood group phenotypes, it must be borne in mind that some of the differences observed among Swedes would have been significant if detected between bigger-sized groups.

```
SUBFILE   SVE          ANOVA

* * * * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * * *
                      TAL
              BY HAIR
                      SEX
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                                         SUM OF                   MEAN             SIGNIF
SOURCE OF VARIATION                      SQUARES      DF        SQUARE       F      OF F

MAIN EFFECTS                              4.245        4         1.061   13.262    0.000
   HAIR                                   0.087        3         0.029    0.361    0.782
   SEX                                    4.010        1         4.010   50.104    0.000

2-WAY INTERACTIONS                        0.042        2         0.021    0.265    0.768
   HAIR      SEX                          0.042        2         0.021    0.265    0.768

EXPLAINED                                 4.288        6         0.715    8.930    0.000

RESIDUAL                                 49.455      618         0.080

TOTAL                                    53.742      624         0.086

    751 CASES WERE PROCESSED.
    126 CASES ( 16.8 PCT) WERE MISSING.

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

* * *    M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S    * * *
                        TAL
           BY           HAIR
                        SEX
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

GRAND MEAN =        1.73
                                                                          ADJUSTED FOR
                                                          ADJUSTED FOR    INDEPENDENTS
                                              UNADJUSTED  INDEPENDENTS    + COVARIATES
VARIABLE + CATEGORY                   N       DEV'N  ETA  DEV'N   BETA    DEV'N   BETA

HAIR
     1                                 2       0.06       -0.04
     2                               175      -0.02       -0.01
     3                               397       0.01        0.01
     4                                51      -0.03       -0.03
                                                    0.07         0.04

SEX
     1                               241       0.10        0.10
     2                               384      -0.06       -0.06
                                                    0.28         0.28

MULTIPLE R SQUARED                                               0.079
MULTIPLE R                                                       0.281
```

Table VII.4-1. Correlation between height and hair colour in Sweden.

```
SUBFILE   SPA          ASPA
* * * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * * *
                 TALL
              BY HAIR
                 SEX
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                                        SUM OF                   MEAN             SIGNIF
SOURCE OF VARIATION                    SQUARES      DF          SQUARE       F     OF F

MAIN EFFECTS                            0.901        3           0.300   70.264   0.000
   HAIR                                 0.001        2           0.000    0.115   0.892
   SEX                                  0.886        1           0.886  206.717   0.000

2-WAY INTERACTIONS                      0.000        2           0.000    0.052   0.949
   HAIR      SEX                        0.000        2           0.000    0.052   0.949

EXPLAINED                               0.901        5           0.180   42.059   0.000

RESIDUAL                                0.973      227           0.004

TOTAL                                   1.874      232           0.008

     242 CASES WERE PROCESSED.
       9 CASES (  3.7 PCT) WERE MISSING.

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

* * *   M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S   * * *
                 TALL
           BY    HAIR
                 SEX
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

GRAND MEAN =      1.68                                                  ADJUSTED FOR
                                                           ADJUSTED FOR  INDEPENDENTS
                                             UNADJUSTED    INDEPENDENTS  + COVARIATES
VARIABLE + CATEGORY                   N     DEV'N   ETA    DEV'N   BETA   DEV'N   BETA

HAIR
     1                               42      0.02           0.00
     2                              157     -0.00          -0.00
     3                               34      0.00           0.00
                                                    0.09           0.02

SEX
     1                              112      0.06           0.06
     2                              121     -0.06          -0.05
                                                    0.69           0.69

MULTIPLE R SQUARED                                                 0.481
MULTIPLE R                                                         0.693
```

Table VII.4-2. Correlation between height and hair colour in Spain.

```
SUBFILE   GB           AGB
* * * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * * *
                 TALL
              BY HAIR
                 SEX
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                                        SUM OF                   MEAN             SIGNIF
SOURCE OF VARIATION                    SQUARES      DF          SQUARE       F     OF F

MAIN EFFECTS                            0.375        3           0.125   33.230   0.000
   HAIR                                 0.001        2           0.000    0.111   0.895
   SEX                                  0.370        1           0.370   98.333   0.0

2-WAY INTERACTIONS                      0.002        1           0.002    0.615   0.435
   HAIR      SEX                        0.002        1           0.002    0.615   0.435

EXPLAINED                               0.377        4           0.094   25.069   0.000

RESIDUAL                                0.286       76           0.004

TOTAL                                   0.663       80           0.008

     83 CASES WERE PROCESSED.
      2 CASES (  2.4 PCT) WERE MISSING.

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

* * *   M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S   * * *
                 TALL
           BY    HAIR
                 SEX
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

GRAND MEAN =      1.68                                                  ADJUSTED FOR
                                                           ADJUSTED FOR  INDEPENDENTS
                                             UNADJUSTED    INDEPENDENTS  + COVARIATES
VARIABLE + CATEGORY                   N     DEV'N   ETA    DEV'N   BETA   DEV'N   BETA

HAIR
     2                               57      0.00          -0.00
     3                               23     -0.01           0.00
     4                                1     -0.03           0.03
                                                    0.08           0.04

SEX
     1                               35      0.09           0.08
     2                               46     -0.06          -0.06
                                                    0.75           0.76

MULTIPLE R SQUARED                                                 0.565
MULTIPLE R                                                         0.752
```

Table VII.4-3. Correlation between height and hair colour in the United Kingdom.

```
SUBFILE   SVE          ASVE

* * * * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * * *
                  TALL
               BY EYE
                  SEX
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                                               SUM OF                      MEAN               SIGNIF
SOURCE OF VARIATION                            SQUARES      DF             SQUARE       F      OF F

MAIN EFFECTS                                     4.357       4              1.089   13.964    0.000
   EYE                                           0.028       3              0.009    0.118    0.950
   SEX                                           4.303       1              4.303   54.826    0.000

2-WAY INTERACTIONS                               0.015       3              0.005    0.064    0.979
   EYE          SEX                              0.015       3              0.005    0.064    0.979

EXPLAINED                                        4.368       7              0.624    7.950    0.000

RESIDUAL                                        49.604     632              0.078

TOTAL                                           53.972     639              0.084

    751 CASES WERE PROCESSED.
    111 CASES ( 14.8 PCT) WERE MISSING.

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

* * *   M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S   * * *
                  TALL
            BY    EYE
                  SEX
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

GRAND MEAN =      1.73                                                       ADJUSTED FOR
                                                         ADJUSTED FOR        INDEPENDENTS
                                           UNADJUSTED    INDEPENDENTS        + COVARIATES
VARIABLE + CATEGORY                 N      DEV'N  ETA    DEV'N    BETA       DEV'N    BETA

EYE
    1                              10      -0.02         -0.03
    2                              63      -0.02         -0.00
    3                              14      -0.03         -0.04
    4                             553       0.00          0.00
                                                  0.03             0.02

SEX
    1                             246       0.10          0.10
    2                             394      -0.06         -0.06
                                                  0.28             0.28

MULTIPLE R SQUARED                                                 0.081
MULTIPLE R                                                         0.284
```

Table VII.4-4. Correlation between height and eye colour in Sweden.

```
SUBFILE   SPA          ASPA

* * * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * * *
                  TALL
               BY EYE
                  SEX
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                                           SUM OF                     MEAN             SIGNIF
SOURCE OF VARIATION                       SQUARES      DF            SQUARE       F      OF F

MAIN EFFECTS                                0.912       4             0.228   54.787   0.000
   EYE                                      0.012       3             0.004    0.995   0.396
   SEX                                      0.875       1             0.875  210.162   0.000

2-WAY INTERACTIONS                          0.025       3             0.008    2.020   0.112
   EYE        SEX                           0.025       3             0.008    2.020   0.112

EXPLAINED                                   0.938       7             0.134   32.173   0.000

RESIDUAL                                    0.937     225             0.004

TOTAL                                       1.874     232             0.008

    242 CASES WERE PROCESSED.
      9 CASES (  3.7 PCT) WERE MISSING.

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
* * *   M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S   * * *
                  TALL
         BY       EYE
                  SEX
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
GRAND MEAN =      1.68
                                                                            ADJUSTED FOR
                                                            ADJUSTED FOR    INDEPENDENTS
                                               UNADJUSTED   INDEPENDENTS    + COVARIATES
VARIABLE + CATEGORY                     N      DEV'N  ETA   DEV'N   BETA    DEV'N   BETA

EYE
    1                                  33       0.02         0.01
    2                                 117      -0.00        -0.00
    3                                  28       0.03         0.01
    4                                  55      -0.02        -0.01
                                                      0.14           0.08

SEX
    1                                 112       0.06         0.06
    2                                 121      -0.06        -0.06
                                                      0.69           0.69

MULTIPLE R SQUARED                                                   0.487
MULTIPLE R                                                           0.695
```

Table VII.4-5. Correlation between height and eye colour in Spain.

```
SUBFILE   GB           AGB

* * * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * * *
                  TALL
               BY EYE
                  SEX
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                                           SUM OF                     MEAN             SIGNIF
SOURCE OF VARIATION                       SQUARES      DF            SQUARE       F      OF F

MAIN EFFECTS                                0.380       4             0.095   25.149   0.000
   EYE                                      0.006       3             0.002    0.553   0.655
   SEX                                      0.342       1             0.342   93.404   0.0

2-WAY INTERACTIONS                          0.004       2             0.002    0.476   0.623
   EYE        SEX                           0.004       2             0.002    0.476   0.623

EXPLAINED                                   0.384       6             0.064   16.925   0.000

RESIDUAL                                    0.290      74             0.004

TOTAL                                       0.663      80             0.008

    89 CASES WERE PROCESSED.
     8 CASES (  9.0 PCT) WERE MISSING.

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

* * *   M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S   * * *
                  TALL
         BY       EYE
                  SEX
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
GRAND MEAN =      1.68
                                                                            ADJUSTED FOR
                                                            ADJUSTED FOR    INDEPENDENTS
                                               UNADJUSTED   INDEPENDENTS    + COVARIATES
VARIABLE + CATEGORY                     N      DEV'N  ETA   DEV'N   BETA    DEV'N   BETA

EYE
    1                                   3      -0.10        -0.04
    2                                  21      -0.00         0.00
    3                                   8      -0.02         0.00
    4                                  49       0.01         0.00
                                                      0.24           0.10

SEX
    1                                  35       0.08         0.08
    2                                  46      -0.06        -0.06
                                                      0.75           0.74

MULTIPLE R SQUARED                                                   0.573
MULTIPLE R                                                           0.757
```

Table VII.4-6. Correlation between height and eye colour in the United Kingdom.

```
SUBFILE   SVE        ASVE
* * * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * * *
             TALL
          BY ELBOD
             SEX
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                                        SUM OF                      MEAN              SIGNIF
SOURCE OF VARIATION                     SQUARES      DF             SQUARE        F     OF F

MAIN EFFECTS                             1.253        4              0.313   80.086    0.000
   BLOOD                                 0.021        3              0.007    1.753    0.157
   SEX                                   1.243        1              1.243  317.703    0.0

2-WAY INTERACTIONS                       0.004        3              0.001    0.380    0.768
   BLOOD     SEX                         0.004        3              0.001    0.380    0.768

EXPLAINED                                1.258        7              0.180   45.926    0.000

RESIDUAL                                 0.888      227              0.004

TOTAL                                    2.146      234              0.009

    751 CASES WERE PROCESSED.
    516 CASES ( 68.7 PCT) WERE MISSING.

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

* * *   M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S   * * *
             TALL
        BY   BLOOD
             SEX
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

GRAND MEAN =      1.73                                                  ADJUSTED FOR
                                                        ADJUSTED FOR   INDEPENDENTS
                                          UNADJUSTED    INDEPENDENTS   + COVARIATES
VARIABLE + CATEGORY                 N     DEV'N  ETA    DEV'N   BETA   DEV'N   BETA

BLOOD
    1                             112     0.00          0.01
    2                              22     0.00          0.00
    3                              12    -0.03         -0.04
    4                              89    -0.00         -0.00
                                                0.07           0.10

SEX


    1                              98     0.09          0.09
    2                             137    -0.06         -0.06
                                                0.76           0.76

MULTIPLE R SQUARED                                             0.584
MULTIPLE R                                                     0.764
```

Table VII.4-7. Correlation between height and the ABO blood groups in Sweden.

```
SUBFILE   SPA          ASPA

* * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * *
               TALL
            BY BLOOD
               SEX
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *


                                              SUM OF                 MEAN              SIGNIF
SOURCE OF VARIATION                          SQUARES      DF        SQUARE       F      OF F

MAIN EFFECTS                                   0.773       4         0.193   45.792   0.000
   BLOOD                                       0.002       3         0.001    0.167   0.919
   SEX                                         0.769       1         0.769  182.257   0.0

2-WAY INTERACTIONS                             0.012       3         0.004    0.981   0.403
   BLOOD     SEX                               0.012       3         0.004    0.981   0.403

EXPLAINED                                      0.785       7         0.112   26.586   0.000

RESIDUAL                                       0.658     156         0.004

TOTAL                                          1.443     163         0.009

    242 CASES WERE PROCESSED.
     78 CASES ( 32.2 PCT) WERE MISSING.

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

* * *   M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S   * * *
               TALL
          BY   BLOOD
               SEX
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

GRAND MEAN =      1.66
                                                                                ADJUSTED FOR
                                                                 ADJUSTED FOR   INDEPENDENTS
                                                  UNADJUSTED     INDEPENDENTS   + COVARIATES
VARIABLE + CATEGORY                         N     DEV'N  ETA     DEV'N   BETA   DEV'N   BETA

BLOOD
     1                                     73      0.00          -0.00
     2                                     14      0.01           0.01
     3                                      7     -0.00          -0.00
     4                                     70     -0.00           0.00
                                                         0.05             0.04

SEX
     1                                     74      0.08           0.08
     2                                     90     -0.06          -0.06
                                                         0.73             0.73

MULTIPLE R SQUARED                                                        0.535
MULTIPLE R                                                                0.732
```

Table VII.4-8. Correlation between height and the ABO blood groups in Spain.

```
SUBFILE   GE           AGE

* * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * *
               TALL
            BY BLOOD
               SEX
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *


                                              SUM OF                 MEAN              SIGNIF
SOURCE OF VARIATION                          SQUARES      DF        SQUARE       F      OF F

MAIN EFFECTS                                   0.242       4         0.061   15.579   0.000
   BLOOD                                       0.009       3         0.003    0.794   0.506
   SEX                                         0.235       1         0.235   60.557   0.000

2-WAY INTERACTIONS                             0.009       3         0.003    0.792   0.505
   BLOOD     SEX                               0.009       3         0.003    0.792   0.505

EXPLAINED                                      0.251       7         0.036    9.241   0.000

RESIDUAL                                       0.163      42         0.004

TOTAL                                          0.415      49         0.008

    89 CASES WERE PROCESSED.
    39 CASES ( 43.8 PCT) WERE MISSING.

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

* * *   M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S   * * *
               TALL
          BY   BLOOD
               SEX
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

GRAND MEAN =      1.66
                                                                                ADJUSTED FOR
                                                                 ADJUSTED FOR   INDEPENDENTS
                                                  UNADJUSTED     INDEPENDENTS   + COVARIATES
VARIABLE + CATEGORY                         N     DEV'N  ETA     DEV'N   BETA   DEV'N   BETA

BLOOD
     1                                     20      0.01          -0.01
     2                                      6     -0.03          -0.03
     3                                      3      0.00           0.01
     4                                     21      0.00           0.01
                                                         0.13             0.15

SEX
     1                                     18      0.09           0.09
     2                                     32     -0.05          -0.05
                                                         0.75             0.76

MULTIPLE R SQUARED                                                        0.584
MULTIPLE R                                                                0.764
```

Table VII.4-9. Correlation between height and the ABO blood groups in the United Kingdom.

VII.5. Hair colour, eye colour and blood types.

In table VII.5-1 the results from different cross-tabulations, with hair or eye versus blood as variables, are shown. Among Swedes, and occasionally among Spaniards and the British as well, there are signs of association between eye's and hair's lightest categories with blood group A, while their darkest categories would tend to associate with group O. Significance is not, however, attained. Suspecting this may be partly due to small sample sizes and perhaps to the of blood groups B and AB, new cross-tabulations were tried joining together males and females and suppressing groups B and AB. In addition, the colours of hair and eyes were re-grouped as dark versus light, for hair, and dark plus mixed versus light, for eyes.

After that, the trends (table VII.5-2) appear more clearly and attain significance among Swedes for hair-blood (p=0.040). Eye-blood shows the same extreme kind of polarity, but cell frequencies for dark and mixed eyes were too low (only 23 cases). For significance (if existing) to be detected when relative frequencies for one category are low in the population, extra high frequencies in the sample are required. This is especially true for Sweden and Spain, due to their extremely polar positions in a scale of pigmentation, but even the global size of the British sample is definitively too low. It is interesting to speculate whether greater sample sizes would, as for blood-hair in Sweden, have revealed any significant associations. In our samples (with one only exception: British, hair-blood), light hues of eyes and hair are more often than not aligned together with blood group A, while dark hues are aligned preferentially with blood group O. Excepting the alignment A-light hair, however, it is not justified to speak of any other associations at the population level.

(df)
/Fisher's exact probability
(Sign. at 5 %: +/-)
Symmetric lambda
Symmetric uncertainty coefficient
(N)

	♂ SWE + ASWE (3/4)	♂ SPA + ASPA (3/4)	♂ GB + AGB (3/4)	♀ SWE + ASWE (3/4)	♀ SPA + ASPA (3/4)	♀ GB + AGB (3/4)
hair - blood	(6) - 0.037 0.049 98	(6) - 0.000 0.027 76	(3) />0.10 - 0.250 0.305 20	(6) - 0.039 0.016 137	(6) - 0.026 0.032 92	(3) - 0.000 0.022 34
eye - blood	(9) - 0.000 0.024 98	(9) - 0.000 0.029 76	(3) - 0.000 0.044 20	(9) - 0.078 0.049 137	(9) - 0.021 0.034 92	(9) />0.10* - 0.06 0.141 34

Fig. VII.5-1. Associations between variables eye, hair and blood.

Legend.

1. Since the distribution of frequencies failed to fulfil Cochran's recommendations (Siegel, 1956), the x^2 test has not been used. Instead, the Fisher test has been utilized with all cases producing greater lambda and uncertainty coefficients. As the researcher was content to use significance levels rather than exact p-values, the procedure outlined in Siegel's book (pp. 99-100) was followed.
2. Whenever the Fisher test was used the number of cells had to be reduced to four. That involved re-arranging categories 1 and 2 of variable eye in one (dark) and categories 3 and 4 into another (light). No new arrangement was found necessary for variable hair. For variable blood, phenotype O constituted a class. For the other, two alternative subdivisions were tried : A and AB (B excluded) vs. A, AB and B. The level of significance was in each case higher than 0.10. Only in one case was the second alternative found unpractical, since the Fisher test demands that N shall be $\leqslant 30$. (Marked as *).
3. All levels of significance are two-tailed.

SWB+ASWP
(3/4)

hair	blood	1	4	
	1+2	22 42.308	30 57.692	52
	3+4	89 59.732	60 40.269	149
		111	90	201

$x^2 = 4.166$
$p = 0.040$ +

eye	blood	1	4	
	1+2+3	9 39.130	14 60.870	23
	4	103 57.865	75 42.135	178
		112	89	201

$x^2 = 2.188$
$p = 0.138$

SPA+ASPA
(3/4)

hair	blood	1	4	
	1+2	62 50.407	61 49.593	123
	3+4	13 59.091	9 40.909	22
		75	70	145

$x^2 = 0.270$
$p = 0.584$

eye	blood	1	4	
	1+2+3	57 50.893	55 49.107	112
	4	18 54.546	15 45.454	33
		75	70	145

$x^2 = 0.029$
$p = 0.863$

GB+AGB
(3/4)

hair	blood	1	4	
	1+2	17 51.515	16 48.485	33
	3+4	4 36.364	7 63.636	11
		21	23	44

$x^2 = 0.273$
$p = 0.584$

eye	blood	1	4	
	1+2+3	6 37.500	10 62.5	16
	4	15 53.571	13 46.429	28
		21	23	44

$x^2 = 0.508$
$p = 0.479$

Table VII.5-2. Associations between variables eye, hair and blood. (Categories re-arranged, blood groups AB and B excluded).

Legend.

1. Eye colour:
   1 = dark, 2 = medium and light brown, 3 = mixed, 4 = green, grey, blue.
2. Hair colour:
   1 = black, 2 = dark and medium brown (with/without a reddish tint), 3 = light brown, ash blond, blond reddish blond and dark red, 4 = light blond, platine blond, albino, medium to light red.
3. Blood groups:
   1 = A; 2 = B; 3 = AB; 4 = O.
4. Although not in the table, even the alignment of categories 3 and 4 - for eyes - was tried, without significant results.

VII.6. Comment

In the preceding sections some significant correlations between pigmentation of the eyes, hair and skin, on the one hand, and blood groups, on the other, have been detected. This chapter could be finished there, as everything else to be said must, necessarily, be speculative, but since, in addition to the significant associations, some trends observed within the samples bear what could be called a consistent or expected character, perhaps a minor amount of speculation should be in order. Let us summarize the situation, pulling together all significant associations, as a basis for further elaboration. This leaves us only with the Spanish and the Swedish samples to work on, since the British did not show any significant associations.

Among Swedes, three groups have been produced: one with very fair hair (4) and the lightest skin (I), another with dark hair (1,2) and intermediate skin (II) and a third with fair hair (3) and the darkest skin of all three (III). In addition a positive correlation was elicited for uia9 with tall (generally decreasing pigmentation with increasing stature), and an association between blood groups 0 and A with respectively dark and light hair colours.

Extracting support from Lundborg and Linders' survey among 47,000 young Swedish males, Coon (1939) suggested an association between tallest statures, brown hair, light eyes, slightly lowered cephalic index and slightly augmented facial index, whilst among other flaxen hair aligned together with more moderate stature, mesocephalic head index and convexity of nasal profile would betray a submerged non-Finish brachycephalic element. Furthermore from the study of skeletal material and of the living, he tentatively associated the first type with the bearers of the Corded Ware culture (or Battle Axe culture) into Scandinavia, while the second one would reveal the influence of the old brachycephalic pre-Corded people, established around the southwestern corner of the Baltic. The first type is a rugged sort of oriental Mediterranean, close to the type found in the British 'long barrows'. This may be so, but the existence of an underlying paleo-mesolithic component in the population of central and - presumably - southern Sweden, rather suggests that this is the element responsible for the associations observed by Coon(1). The available evidence - as presented by Coon (1939), Lundman (1946, 1952) and Beckman (1959) - seems to indicate that the Paleo-Mesolithic Scandinavian hunters became submerged by the spread northwards of the Neolithic farmers, leaving only a few pockets of mixed descendants in isolated refuge areas. Such diluted element (with or without components of Mediterranean extraction) is ideal for filling up our dark-haired, 0-phenotyped class. Indeed, 0-phenotypes seem to be endemic within Mediterranean populations whenever they are left in relative isolation. The existence in central Scandinavia of the so-called Tydal type - (Bryn, 1921). dark, tall and very heavy, dolichocephalic, broad faced, laterally built, strongly suggesting Cromagnon affinities - exemplifies what those Mesolithic populations must have looked like. Although the differences do not attain significance, individuals with dark hair are among the tallest in the Swedish sample (175 cases), and the same goes for individuals with dark eyes (only 63 cases).

A more complicated task is that of suggesting an identity for our two light-haired classes. An imme-

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(1) The existence of the Tydal type seems to have been unknown to Coon at the time of his writing "The races of Europe".

diate thought is that Nordic elements of the Göta variety (Coon's Österdal type) and A phenotypes are over-represented within class I, but in the absence of more substantial associations it is useless to speculate any further.

In no more than three generations, Scandinavia has evolved from being one of the most retarded areas in Europe to one of the most uniformly prosperous in the world. Under those circumstances, it is no wonder that incompletely absorbed remains of very ancient human groups would have persisted in what was during Mesolithic times a gigantic refuge area. The average facial outlook of Scandinavians today must be owed in no small extent to intensive miscegenation during prehistoric times with more modern looking populations of a mediterranoid skeletal type, which presumably outnumbered them in the long run. Apart from the Tydal group, another type of broad-faced, extremely heavy built individual has been reported as predominant in certain localities along the southwestern coast of Norway (Arbo, 1906). This is a blond, extremely brachycephalic and, for Scandinavian standards, moderately tall type (the Jaeren type) which Coon suggests is to be related to the southwestern Baltic focus of round-headedness.

What can the pigmentation of these populations have been like?

The Tydal type, although strikingly darker than its neighbours (which in Norway resemble in some respects the southwestern brachycephals), has 57.5 per cent of dark hair and 25.6 per cent of dark eyes, and the blond brachycephals from southwestern Norway (Jaeren type) are only slightly less fair than the few dolichocephals from the same region. In Ireland, Coon found that, towards the west and southwest, where the maximum concentrations of Cromagnoid-like traits exist in the population, a whole series of metric indices and frequencies augment: cephalic index, breadth of face and lower jaw, heavy browridges, laterality and heaviness of body built, stature, paleness and freckling of skin, slightly darker hair and eyes. Sunderland et al. (1973) found for skin colour in western, southwestern and southeastern Ireland a situation rather similar to that exposed by Coon. The evidence for blood groups shows good agreement with the suggested Paleo-Mesolithic descent of these types for phenotype 0, less so for others (Rh^-, B) (Sunderland et al., 1973). Frequencies of up to 60 per cent for 0-phenotypes ($r \simeq 0.775$) have been reported for the highland natives ("old Norse" farmers) from southern Norway (Casey et al, 1966), where several investigators have felt there was a submerged Palaeolithic strain, and Beckman and Mårtensson (1958) have detected increased genotypic frequencies of up to 69 per cent in certain parishes of Dalarna (Dalecarlia), where extensive concentration of Tydal types occur. In Ireland, where frequency of 0 increases westwards and southwestwards, proportions of 0-phenotypes bordering on 70 per cent ($r \simeq 0,83$) have been observed at different parts in Slieve Lougher, (among "old Irish" farmers) perhaps the most isolated area of the southwest (Casey et al., 1963). Rh^+ and B also increase westwards, which does not fit very well in the general picture. No detailed explanation has been advanced for it.

In north central Norway, and, especially, the mountains of the south, where the paleo-mesolithic cultural tradition made its most long lasting stand, metrically archaic traits are also uniformly distributed throughout the two regions. At the same time light pigmentation reaches some of its highest peaks in Scandinavia. Coon, after comparing the data on 11,800 Norwegian men with those from Lundborg and

Linders on 47,000 Swedish men, concluded that Norwegians are lighter haired than Swedes. Lundman (1940) is of the same oppinion for hair colour, although not for eye colour (where the reverse should be valid). In the light of all this, it would seem that blondism of iris and even hair may be a very ancient condition in Scandinavia, probably antedating the appearance of the Nordic type, which is hardly unexpected. With them one would expect an equally considerable antiquity, at least, for very light skins, when considering its adaptive role under conditions of poor UV-radiation. No role of any kind is known for the colour of the hair, however, which, to a great extent seems merely to follow genetically with pigmentation of the skin. For eye colour there is evidence of increased sensitivity of vision at the long wagelength end of the spectrum with decreasing fundus pigmentation (Dodt et al., 1959). Glacial conditions must have provided a superabundance of stimulus for evolution to act on pigmentation of skin and eyes. Selective pressures must then have been much stronger than now, and the alleles for blondism and rufosity are very likely to have become common during the Würm glaciation. They may, indeed, be even older, and have partially or totally disappeared during some of the warmer interglacials before, but since only during the last glaciation did man really penetrated deeply and persistently the glacial environment, it seems most likely that blondism is not older than the beginning of Würm I (around 80,000 years ago). Once it appeared its attaining of the level we know today must have taken a very long time and have proceeded very differently for separate populations, independently of their mutual degree of relationship.

Genetic exchange, but also inbreeding, founder effect and genetic drift together with differential survival, operating on small bands and familial groups must have been at its prime, giving evolution for a long period a predominantly erratic character. That and latitude would explain the apparently much less efficiency of the British Isles and Ireland as depigmentation foci when compared with the north European focus at least in terms of pigmentation of the hair. Through interbreeding and proximity to glaciated areas with similar climatic pressures, depigmentation and alleles for blondism and rufosity must have been relatively common by the end of the glacial in many areas of Europe and even outside. One of those areas may very well have been the plain stretching between southern Russia and the Caspian Sea, from where the Corded people seems to have come, but in the light of our present knowledge on the links between climatology and pigmentation it is unlikely that this has been a more important centre than the Scandinavian one. One would rather expect the pre-Nordic inhabitants of Scandinavia to be lighter than those coming afterwards. The Tydal type, however, lends inconvenient support for the opposite hypothesis. Since blond and blue-eyed individuals are far from missing in Tydal and the district has remained relative isolated during possibly most of its millenium of life, perhaps some demogenetic agents could be invoked to explain some of the anomalous characteristics there. Unfortunately, information on any demographic factors is rather poor in the articles reporting on this type in either Sweden or Norway (in 1921 the Tydal district contained some 800 persons). In addition, there are more than one Tydal-like villages. Until more extensive research is conducted on the possible connections between primitive metrical traits, selected serological markers and pigmentation of skin, hair and eyes, preferentially combined with interdisciplinary studies on other fields related to the subject, two temptative explanations can be offered:

1) Among the kin of the oldest Scandinavians, whose hunter-gatherer economy forced them into smaller demographic units, spread of new alleles must have proceeded in a most erratic way: some groups would retain most of the original dark pigmentation, while in others depigmentation would proceed at astonishing speed. Among the newcomers, on the other hand, whose food-producing economies allowed them to be much more gregarious, depigmentation (probably already under way in their Eurasiatic homeland) would be accelerated in their new habitat, and proceed at an intermediate speed but in a more steady fashion. More frequent gene flow between the groups would prevent them from forming isolates in the same extent as their less privileged neighbours, and helped them to evolve more synchronously. With time they may have caught up with most of the fairest groups among the old strain and, with that as well as by interbreeding with them, differences with respect to the oldest inhabitants must have evened out in many places. By then, different completed fertility rates must have given them numerical advantage with respect to all mesolithic and sub-neolithic groups, but not with respect to the bearers of the Early Neolithic culture with whom, owing to geographical and cultural proximity, they extensively intermingled. By the late Neolithic there are no separate remains from any of the two Neolithic cultures and the most distinctive trait of the Corded Ware culture, the battle axe, has disappeared. In the long run, only some residual enclaves (like Tydal) witness today the ancient original diversity. Perhaps other Tydal-like enclaves, but with fair pigmentation, have vanished without notice in the not-too-distant past. Indeed, then as now, prejudices against the 'deviants'

and positive assortative mating may have played a role in deciding the fate of more than one isolate. The existence in the inland valleys of southwestern Norway of an extremely depigmented population (Coon, 1939), which metrically resembles the central European Cromagnoid forms, with very high frequencies of blood group 0 genes (Casey, 1966) speaks for this possibility.

2) There may be some unnoticed ecological factor for the optimum depigmentation centre to lie in the past further away from the glacial border than the north central European home, from where Scandinavia's (and Britain's) first inhabitants must have come. Indeed, the Lapps - who have lived in the northernmost part of the region since at least 2,000 years (perhaps much longer) - are still today after centuries of miscegenation with their southern neighbours, according to older surveys, darker haired, eyed and skinned than them (Coon, 1939). Presumably, however, a population of light-eyed hunters would evolve more favourably under damp-cold conditions (maritime, cloudy, less abundant snowfall) than under dry-cold conditions (continental, sunnier, longer lasting snow cover), as the reflection of light on snow and ice is particularly a strain to depigmented eyes, especially in northern latitudes where, owing to the low angular elevation of the sun, reflected light is frontally incidental to the eye. This might explain the recurrence of predominantly dark-eyed populations all along the Arctic circle and immediately south of it. The periglacial territories inhabited by late Paleolithic man in central Europe had mean July temperatures between 5 and 10°C (33 to 50°F)

(Waterbolk, 1972) fully within the range of variation found nowadays in the northern Norwegian tundra for the same month. Thus, radially away from the glacial border there may have been one or several depigmentation centres, which progressively shifted northwards with the recession of glacial conditions. Among the populations that did not migrate with them, through miscegenation with darker elements and relaxation of selective pressures, genes for darker pigmentations became increasingly more frequent, at the same time as depigmentation was maintained or even progressed in more northerly latitudes. Those centres may have been at a distance from the glacial border comparable with that existing between southern Scandinavia and the northern modern Scandinavian tundra, which would take us to the Mediterranean and, again, the area around the northern part of the Caspian and adjacent territories. Although these regions are not specifically blond and light eyed nowadays (fig. VII.6-1), historical references and indirect evidence suggests that at least the second one may have been that in the distant past, while there are also suggestions that by the dawn of Egyptian history, blondism in the African shores of the Mediterranean was widely spread outside its modern boundaries, as probably witnessed by Egyptian paintings.

It is likely that fair pigmentation was more extensive among Caucasoids in the past, Scythians, Slavs, Germans and even Celts appeared fair to the eyes of Greeks and Romans. The old Chinese chroniclers described the Hiungnu and other barbarians tribes inhabiting the western marches of their Empire, as Europoids with frequent yellowish

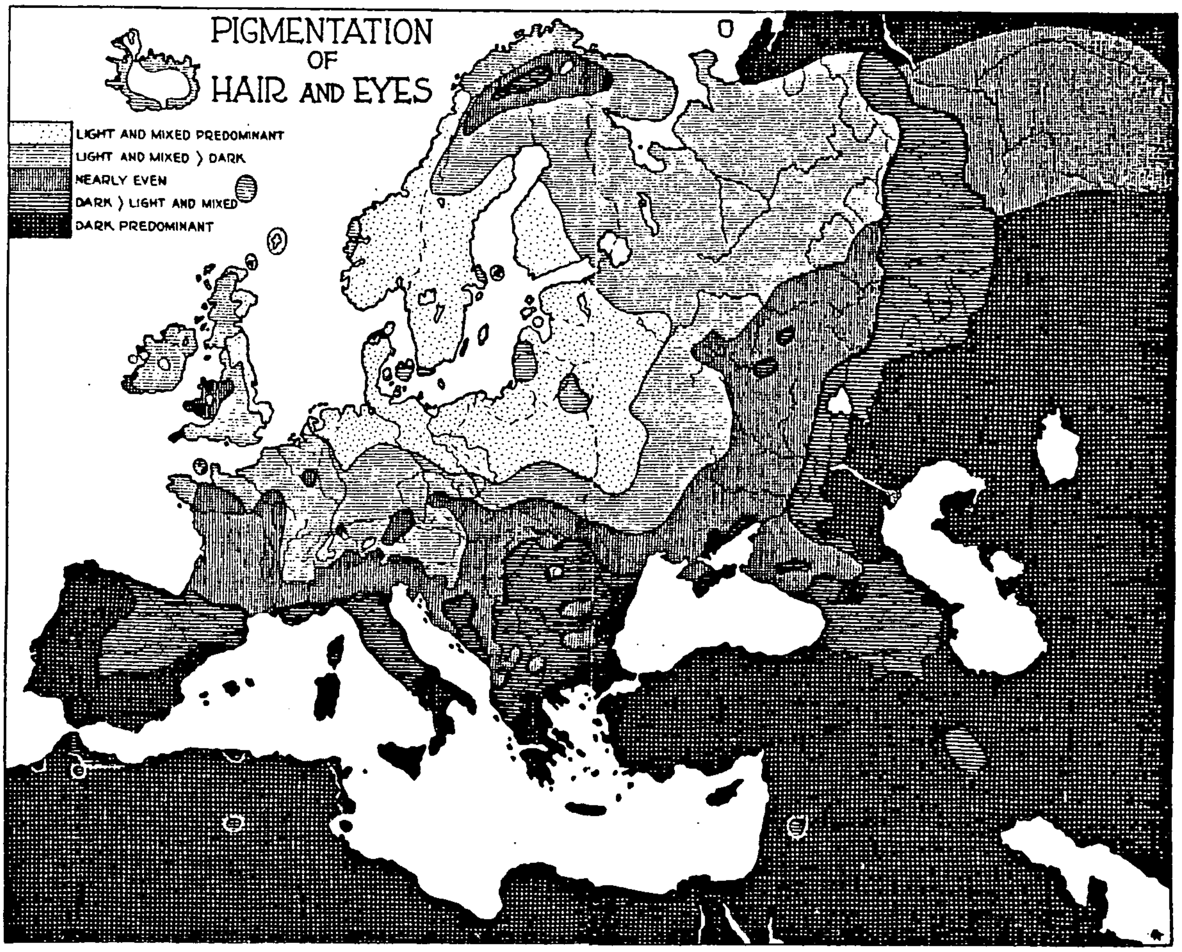


Fig. VII.6-1. Pigmentation of hair and eyes in Europe and surrounding areas. (After Coon, 1939).

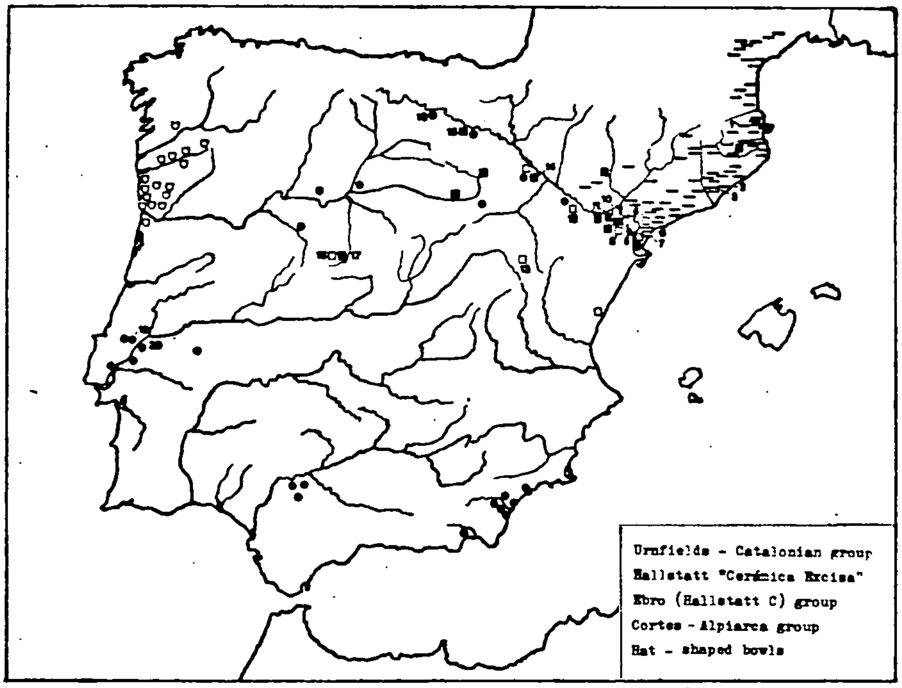
hair. Non-Mongoloid Siberian populations still contain a slight proportion of blondism as do the Ugro-Finnic speakers of Russia. But for the most part, blondism (especially of the hair) seems to have receded towards the north and west, from a territory extending from Eastern Turkestan and the Upper Ienisei - across middle-latitude Europe - possibly as far as the Atlantic. The explosive expansion of mongoloid mounted nomads is usually the accepted explanation, but steady retreat of the ecologic conditions associated to the spread of depigmentation, and relaxation of selective pressures owing to cultural advancement, may have played a significant role. Wherever the ecologic optimum for depigmentation may have been located in the past, Scandinavia - and to a lesser extent, Finland - seem to be its present centre. Presumably, the glacial moraines correspond spatially to the successive stages in the evolution of the ancient centre.

For Spain, it was found that those with the lightest hair also have the lightest skins. Category 4 (light blond and medium red upwards) is, however, missing. Mixed and light eyes are also significantly associated with lighter skins, with possessors of mixed eyes lighter than those with light eyes (although not significantly so). No more significant associations could be discovered. It is, however, likely that a more extensive survey would produce some interesting results on a regional basis.

In a country such as Spain, with such marked climatic contrasts between seasons and between districts, the aforementioned associations are likely to be dramatically upset within more than one geographic area. Two such areas become apparent from the data collected by Sánchez Fernández (1912). One extends between the central Pyrenees and the Guadarrama Sierra, across hill country and the northern part of the Ebro Depression. The other includes the narrow coastal plains of Almeria and Malaga plus the Betic mountains stretching behind them into the province of Granada. The lowest mountains are in the southern part of the northern zone (average 5,000 ft) and, excluding the highest tops, annual rainfall averages vary within both regions between 12 and 40 inches, with roughly one fourth of the Andalusian region having under 12 inches. These are, according to Sánchez's survey, two of the darkest skinned areas in Spain. At the same time, they run through two areas with a relative abundance of lighter hues of hair and iris (specially the northern one). When considering the limited resources at the disposal of the anthropologist at the beginning of the century, it is to be hoped that these observations are re-made with the aid of more sophisticated technical means.

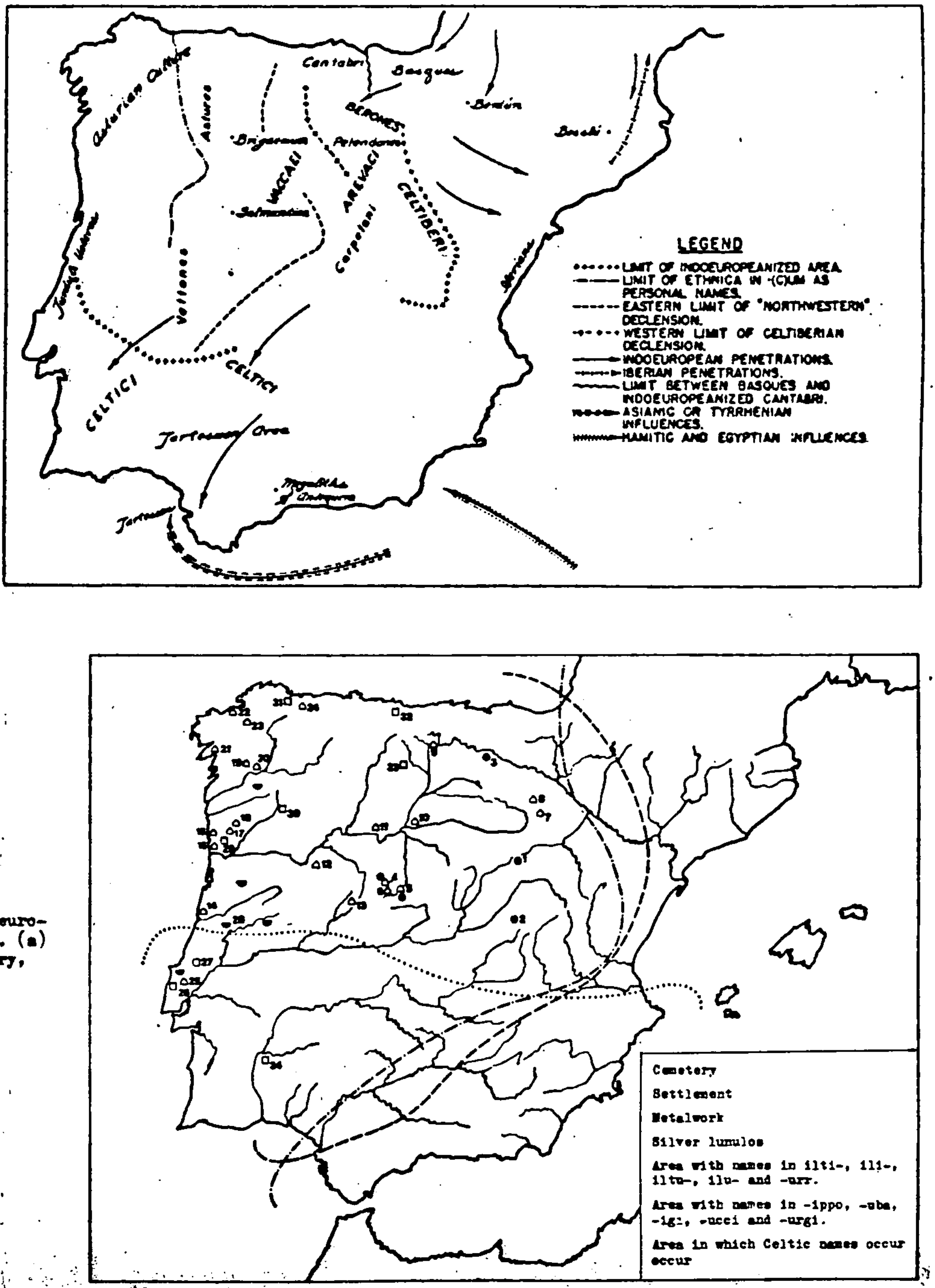
Although the invasions of Indo-European speakers after 750 B.C., and perhaps even earlier (Arribas, 1965), must have contributed to increasing light pigmentations in the country, it is extremely difficult to evaluate their importance. To a great extent, however, many of the areas most intensively settled by them fall outside the areas with a maximum of lightly pigmented hair and eyes: such is the case of the Meseta. If not, they often settled in a region which was already densely populated: that is the case of the Galaic northwest and the districts

Fig. VII.6-1. Late Bronze Age to Early Iron Age migration period.



Late Bronze Age to Early Iron Age migration period

Fig. VII.6-2. The expansion of Indoeuropean languages and peoples in Iberia. (a) (After Tovar, 1949). (b) (After Savory, 1968).



Celtic Early Iron Age

within western and southern Iberia which the Celts penetrated. The east and the northeast were left mainly untouched, except for the routes leading from the Pyrenean passes into the country. This locally affected eastern Catalunya, the Ebro valley and the south of Vasconia (fig. VII.6-1). Of the Urnfielders, Hallstatt and Celtic people who entered Spain, only those in the northwest and the Meseta managed to retain a relatively Indo-European cultural facies, as much in debt with the native substratum and the cultures of the Mediterranean litoral as with their trans-Pyreneean homelands (Savory, 1968). All this speaks of cultural as well as of numerical inferiority in most places(1) The conclusion to be extracted is that the Meseta (specially the northern half), the Cantabrian area (possibly) and Galicia were the areas most extensively affected - genetically - by the invasions. In most of the north, the northeast and the east - regions with a maximum of depigmentation - their impact, when not totally absent, must have been very slight and localized.

The most numerous of the V. and VI. century Germanic invaders - the Visigoths - counted about 200,000 people when they entered Iberia, a country with between six and eight millions inhabitants (Tarradell, 1974). After driving out the Vandals from Andalucia (into northern Africa) and almost completely exterminating the Alans from western Iberia, theysettled in the upper Ebro valley and in the region between Palencia, Segovia

(1) The picture is indeed in agreement with the limits given by Tovar (1949) to the effective extension of Celtic speech in the Peninsula (fig. VII.6-2a) sporadic penetration into other areas notwithstanding (fig. VII.6-2b).

and Burgos - side by side with the Suebian kingdom of northwestern Spain and northern Portugal. At the beginning of the sixth century, roughly 1 out of every 20 or 25 persons must have been Germanic.

On its turn, the demographic aftermath of the Muslim invasion was specially felt in the Meseta and the Ebro Depression, leading to depopulation of extensive areas. The old Visigothic and Celtiberic enclaves in the Douro valley, between Cantabria and the Central Sierra, were totally deserted by the mid VIIIth century. The region, together with the upper Ebro valley, was later repopulated between the VIIIth and XIIth centuries (Font Rius, 1974) by people from the northern mountain ranges (Galicians, Asturians, Cantabrians, Vasconians, Aragonese and Catalonians) together with mixed Germanic and Hispano-Romanic groups from other areas who had sought refuge among them. In the romanised south and east of the Peninsula, there was little depopulation by Christians. Important even was the replacement of Muslims in those two regions by Christians groups from respectively the north and centre and the northeast, to settle among the mass of the population of old native stock, now tinged also with Berber and Arabian genes.

As a whole, for the northern half and the eastern area of Spain, the serological data (Valls, 1975) and the craniological evidence (Hoyos Sainz, 1952) agree reasonably well with each other and with the picture of colonisation offered by the Reconquista period. It also suggests that the Aragonese played a role of some importance in the settlement of the eastern part of the northern Meseta, and that northern Portuguese possibly played the same role in the western region. It also helps to explain the partial deviation of northeast Catalunya from the Aragonese-Valencian norm as influence from the French Languedoc, already detectable at the beginning of the Reconquista period and, presumably, at the time of the Celtic invasions. The situation in the southern half of Spain is typologically much more complex, presumably owing to the uninterrupted history of settlement in the region and to its greater geographical openness as compared with the selfcontained area beyond the Cantabrian and the Iberian mountains.

Explaining the distribution of pigmentation in Spain is no easy task. The distribution for light eyes and that for light hair show important discrepancies, and both show discrepancies with that for skin pigmentation, as observed by Sanchez (1912) and by Aranzadi and Hoyos (1892). According to Sánchez, the darkest skinned regions are all but one totally or partially included in the Meseta (section VI.1). In general the provinces along the Portuguese frontier are darkest and the Cantabrian and Mediterranean ones (except the southeast) are lighter. Fair hair is more abundant along the northern and eastern coast, the Atlantic Andalusian coast and Aragón, which belongs partially to one of the areas with darker skins. Here, Zaragoza, extending between the Pyrenees and the Ebro Depression has 30.18 per cent of light hair (presumably including light brown), while the average for the whole country is 14.5 per cent. Rufosity is rare in Spain except in Asturias and Galicia. Light eyes (blue, grey, green and light mixed) are commoner along the Cantabrian mountains, Vasconia, Aragón, the northeastern part of Catalunya, Old Castile and Eastern Andalusia. In the Basque country the highest frequencies for light eyes (light mixed included) are reached: above 40 per cent, according to Hoyos (1952). Zaragoza has 24.96 per cent, while the average for Spain is 17.6 per cent. Blue-grey eyes become less frequent away from the Pyrenees and the Basque country. In the northern Meseta frequencies decrease towards the Portuguese border, while in the southern Meseta they broadly diminish eastwards. In Levante and Andalucía they broadly seem to decrease in north-south and east-west directions respectively.

The first fact that strikes us is that harmonic blondism (light eyes and hair with preferentially light skin) is rare outside the area enclosed to the east by the Pyrenees and the hill country bordering the southern fringes of the Ebro Depression, and to the west by the Cantabrian mountains and the sea. Outside that wide area, one of the three ingredients at least is missing (particularly light skin) and often the three of them. Another striking feature is the high degree of pigmentation of the hinterland, which constitutes a massiwe core of highly pigmented individuals, only partially broken in the north by the relatively frequent occurrence of light eyes (more frequently than not without accompanying light hair). As a whole, Andalucía is lighter haired than the Meseta, although the trait is very unevenly distributed. One more peculiarity is the light pigmentation of the Spanish Levante, with more blonds than the northern coast and with the lightest skinned province in Spain (Alicante).

Neither Levantines nor Basques can owe their blondism to Indoeuropean speakers because none inhabited the region. The Levante was intensively Berberised, but neither the number of Berbers nor their hair colour (average of 14 per cent for individuals in categories 3 and 4, among the Riffians, lightest of all Berber groups) could be enough to bring a whole region to the present level of hair blondism, not to mention that the Levante is very far away from the average 57 per cent of light and mixed eyes which characterize the Riffian Berbers (Coon, 1969). Their blondism is perhaps an attenuated version of the Aragonian blondism, and the same is probably valid for Catalunya since the three populations stand typologically very close together (Hoyos, 1952). It is extremely unsafe to talk about the Visigothic contribution to Spanish blondism, since their only important settlements, in Old Castile, were extensively and intensively affected by the dislodgement of populations accompanying the Muslim invasion, which probably hindered the intensive fixation of Gothic genes on any particular area. A more effective impact was probably that of the Suebians in north-western Iberia. Assuming for the region a demographic importance comparable with today's and two alternative figures for the number of invaders (100,000 vs. 150,000), and assuming further two alternative figures for the proportions of hair in categories 3 and 4 among the natives (10 vs. 5 per cent) and that the corresponding proportion for the invaders was 60 per cent (intermediate between modern Scandinavians and modern north Germans), a rough calculation (unsophisticated in the absence of knowledge about the genetics of hair colour) shows that the proportions of lighter hair in the region should never exceed the figures of 21 and 17 per cent (for 100,000) versus 23 and 19 per cent (for 150,000). These results, although tentative, look reasonable enough when considering the accretions of darker individuals absorbed by the region since the early days of the Reconquista and the dominant character of dark pigmentation. A similar phenomenon could have taken place somewhere else as well (although not necessarily on the same scale), notably in the Cantabrian region between the territories of Basques and Galicians (fig. VII.6-2). The identity of those populations is still debated. On an ethnographical basis Caro Baroja (1975) has connected Asturians and Cantabrians, the most numerous among them, to the Celtic world, while on a linquistic basis Tovar (1949) makes them Indoeuropean but pre-Celtic, presumably related to the Urnfield people. At any rate, they can hardly have entered a vacuum, as the area has sheltered a relatively dense population since Paleolithic times. Thus, Cantabrian blondism may well be mainly antochthonous.

Even more there must have been the case with the Catalonian and the Ebro valley regions, which, in spite of the remains of Urnfield occupation, many in the eastern Catalonian area, never lost its proto-Iberian character (Savory, 1968). Unfortunately, the prehistory of the Spanish regions has been very unevenly studied; that, together with the nature of the evidence, renders extremely unsafe most conclusions worked out on demographic assumptions. On the basis of existing knowledge it seems, however, fairly accurate to rule out the Indoeuropean invasions from significantly contributing to the genesis of Aragonese blondism. On historical and prehistoric, as well as anthropological, grounds that conclusion becomes certainty in the Basque case (1).

There were few Berbers in the Ebro valley, where Arab presence was abundant, but they were numerous along the southern borders of the Aragonese region. And there was none of either kind in the Cantabro-Basque hill country and the Pyrenees.

Blondism in at least three of the Spanish regions, thus, can not be explained otherwise than as autochtonous. It is indeed, significant that all extensive foci of blondism in Iberia(2) are directly connected with mountain areas or in their immediate vicinity. Although the situation is not unusual in anthropology, the extension and modern demographic density of parts of the zone renders it uncommon. The region has the general form of a triangle, with one side along the Pyrenees and Basque mountains, another (strongly concave towards the centre of the Meseta) along the Iberian mountain system, and the third along the narrow coastal plains of Valencia and Catalunya. Hill country and mountains delimit it practically all around, since they even run parallel to the coastal plains and encroach upon

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(1) The tribes with certainty identified as Basques occupied a vast area centered in modern Navarra, and stretching eastward across the northwestern corner of Aragón and westward through the eastern parts of Logrono and the modern Basque country. Most of this last region was by then settled by three tribes (Autrigonians, Caristians and Vardulians) whose Vasconian character is still a matter of controversy.

(2) There are no extensive foci of blondism in Portugal. Compared with Spain, the country is also remarkably free of mountains. At Povoa de Varzim, a seaside town in the province of Douro, the percentage of blonds rises to 14.3 (Mendes Correa, 1919). In a country of long faces, the Povoans are distinguished by their broad faces and broad jaws (Coon, 1939).

them in many places. The region is naturally open to the Meseta tablelands on the northwest and the southeast, the two ends of the Iberian system, and to France through two difficult passes on both ends of the Pyrenees. These were in the past practically the only two negotiable routes across the northern barrier, which - because of its complex morphology - has proved to be a more formidable obstacle to man than their higher counterparts, the Alps. The southern barrier, although the largest single 'area of difficulty' within the peninsula, is broken down by river valleys into distinct units which help to provide means of communication with the Meseta. Although penetrated in different occasions, the region's relief must have contributed effectively to minimize contact with outsiders, except in the immediate vicinity of its natural passes, thus, partially isolating its geographical heart, Aragón, for very long periods in antiquity. Inaccessibility must have been at its peak during the Würm period, which glaciated the Pyrenees and the highest tops of the Iberian system, and later with the luxuriant spread of forests, subsequent to the end of the Dryas III period. In such semi-isolation, a moderate to big population can evolve reasonably free from erratic trends, steadily permeating its immediate neighbours and being slightly affected by them along its periphery. In the absence of any alternative explanation and since the optimum period for the spread of mutant alleles for bondism in Iberia is past, it is most reasonable to suggest that its relatively high ratios among the Aragonese are merely the remain of an ancient adaptation to Paleolithic environment. The trait may well be receding. Because of that, and owing to gene losses to darker populations, blondism may have been even more frequent in the past in Aragón. On craniometrical grounds, Hoyos (1947) has described the progressive 'mediterranization' of the Cromagnoid traits of the Mesolithic and Neolithic Aragonese and eastern Spaniards. The presence to the north of the Basque people, also with relative high ratios of blondism, also attached to their mountains, which, in spite of relative isolation, have permeated the populations around them with their unusual blood group frequencies and their craniometrical peculiarities, may serve as an illustration of how a population of Mesolithic (presumably older) ancestry can evolve into a new one while retaining some of its oldest characteristics.

In north Africa and the Canary Islands the occurrence of blondism is normally associated with either a type which has been called 'nordic'(1) or a second one reminiscent of the north African Cromagnon variety (Coon, 1939). No traits specifically cromagnoid are frequent nowadays among Aragonese, Levantines or Catalonians, although isolated individuals resembling Cromagnon types have been reported in Vasconia (Fusté, 1957) and the Central Sierra (Hoyos, 1947). Yet, bone remains resembling the Cromagnon and Combe-Capelle Upper Paleolithic types are common in the whole Mediterranean area of Spain, from the Paleolithic until at least the end of the Neolithic, while in the Cantabrian area the Combe-Capelle element seems so far to be absent. These types can not simply have disappeared. Basically, alone or in combination with latter popula-

(1) Presumably nothing else than a recombination of local 'Mediterranean' and 'Cromagnon' genes - reappearing whenever and wherever the basic material is available - perhaps with some Vandal accretions.

tions, they must have evolved into the modern inhabitants of the area. Common incipient eye blondism among eastern Andalusians (Aranzadi & Hoyos, 1892) - or even among Andalusians in general (Hulse, 1934, cited in Coon, 1939) - can, on these bases, be explained in the same way as the Aragonese, or as a result of post-Reconquista plantation, or both. Indeed, two different mountain systems enclose the region, converging eastward and leaving place for the Guadalquivir depression on the west. Of the general abruptness of the Andalusian region - including some of the highest peaks in the peninsula (Mulhacén, 11,420 ft) - can witness the ample success of brigandage, endemic in Andalucia from pre-Roman times until well into the last century, and the insurmountable difficulties experienced by local authorities in their attempts to draw the outlaws out of their refuges in the sierra. Contrary to Coon's suggestion, Berbers can not be held responsible for eye blondism in, at least, eastern Andalucía since they were very few in number there. They may, however, have made a genetic impact on some particular districts of western Andalucía, since clan units tended to settle together and some came from the Atlas and the Riff districts.

Generally speaking, it is extremely difficult to evaluate the genetic effect of the Muslim occupation in Iberia, owing to the scarcity of information as to their numbers. In the long run Arabs became a minority and Berbers a discriminated - against majority. Guichard (1976) has calculated a minimum of 150,000 or 200,000 Muslims for the VIIIth century, with three more important invasions to come. However, owing to the much higher living standards and to the massive conversions to Islam among the Christians (most of whom had stayed in the occupied zone) the numbers of Muslims augmented prodigiously. Most of them must have been either converted Crhistians or hybrids - as anthropological studies among their modern descendants in northern Africa also seem to suggest (Coon, 1939). During the three first hundred years of the Reconquista no Muslims were allowed to remain in the regained territories, which suggests an indigenous origin for the darkly pigmented inhabitants of the the northwestern corner of the Meseta - presumably connected to the brunette type of southern Galicia and neighbouring areas of northern Portugal (Coon, 1939). This agrees well with the aforementioned patterns of repopulation during the Reconquista. (Font Rius, 1974). The repopulation of the southern Meseta went along new lines, and the defeated were allowed to stay as free subjects of the Christian kings. Many of them converted to Christianity and became assimilated by the native population. Their impact, thus, should be masimal in the Levante and the southern half of the Peninsula. But the distribution of Arabs and Berbers agrees badly with present differences in blondism, as Arabs were generally predominant in Andalucía while Berbers were more abundant in extensive areas of New Castile. The darker zone along the Portuguese border is presumably owing to gene flow across it.

VIII. Assortative mating and pigmentation.

Seventeen years after the publication of his most famous work, "On the origin of species', Darwin, in recognition of the seeming failure of his theory of natural selection to explain the appearance of certain sexual differences within the species, suggested that those traits must have evolved because they helped their possessors to more frequent mates or to sexual access to the most prolific members of the species (Darwin, 1889). The question is as valid in the terrain of characters common to both sexes as in that in which Darwin originally formulated it and, in a more general form, can be phrased in the following way: along with sexually dimorphic characters, are there any other traits which, by increasing their bearers' possibilities for sexual success, can lead to a shift in associated population frequencies when the trend persists for long enough? An issue of the utmost relevance in this context concerns the way in which selection of mate, whether bilateral or not, operates.

Among animals, a male's success in finding a sexual partner may depend on his physical capacity to drive away competitors and dominate the female or allow in the picture a certain amount, extremely variable, of female undertaking. The last modality implies that the female's willingness has to be gained. That requires either vigeur or sexappeal or both. Strength, positively correlated with weight, and weapon's size (horns, fangs,..), along with sexually attractive attributes, seem to procure for their male possessors the ability to build up a harem of females, within polygamic species, consequently endowing them with a better chance for propagating the genetic component of those traits. That seems to be the system at work among many Primate and Artiodactyla species, where males are normally bigger, better armed and more brilliantly coloured than females. But within monogamic species, with sex ratios close to one, even the sexually less successful individuals do have a chance of finding a mate. Under those circumstances, sexual success would not seem to be such a clear advantage from a natural selection standpoint, unless the sexually most successful individuals also managed either to 1) engage themselves in more prolific unions than the rest, or 2) be better fitted than others to keep their offspring alive or 3) it was found that, favourable sex ratio notwithstanding, a considerable proportion of individuals never managed to mate. Darwin, himself, believed one of these to be the mechanism at work within monogamic species and that some of those qualities which allowed their possessors the access to the most alluring females also enabled them to be more efficient fathers.

Among humans, whether it is matter of a socially sanctioned union or of a casual one, each of the involved partners has to gain the other's acceptance. Very often, especially among simple-technique societies the responsibility for granting acceptance is not with the bride herself but with her custodians, and this may drastically affect the contract's foundations. When the female's custodians do the selection it is on the basis of social position, which implies means to compensate them for the loss of labour force which the female's departure represents. Decision by the female is likely to introduce new factors into the picture (character, handsomeness) and even let them take priority. Women in their turn, are selected for their functional aptitudes (domestic readiness, assumed fertility) and personal attributes (beauty, character). Thus, those physical attributes which are instrumental in seizing the other sex's favours are still important. What is new about humans is the relevance of intelligence in determining sexual success. It may be directly selected by or indirectly, as one of the foundations for social position. However, as soon as the economic pressure is alleviated sexual appeal emerges, at least for men, as the most influential factor. The importance of beauty in our society is everyday empasized in art, literature, film, advertisements and the like. In people's minds attractive individuals in real life are often endowed with all kinds of good qualities (Dion et al., 1972). Prejudices in favour of handsome people have been elicited by sociological research among widely different sorts of people: children (Dion et al., 1972), school teachers (Berscheid & Walster, 1975), university students (Dion, 1972; Landy & Sigall, 1974; Sigall & Ostrove, 1975). Ethnographic material from other parts of the world seem to point in the same direction.

When compared with other human attributes, beauty has a selective advantage over them all: it is most visible. Beauty signals out a person's physical presence and attracts others' attention. Because of it we may take steps towards contacting a person, who may or may not prove interesting, whose acquaintance we might otherwise never have made. An overwhelming amount of research material suggests that this is in fact what often happens. When people are asked what kind of qualities they would prefer in a partner of the opposite sex, they often name traits such as honesty, character strength and the like, taking up physical appearance only secondarily. On the contrary, a well documented body of information shows that an attractive physique is enormously important in the evaluation of a presumptive partner's suitability. In practice, it may even happen that other factors become irrelevant (Berscheid et al., 1971), especially in connection with the first impression. Another experiment conducted among university students (Centers, 1972) produced a somewhat different scoring for men than women (table VIII-1). It may be argued whether Center's planning of his experiment did not leave full room for his female students to display the 'choose-sophisticated' syndrome disclosed by Walster and others. It is also doubtful whether a less educated female group would come out with a list in which nine out of ten traits have to do with character and intelligence, altogether suggesting a strong element of social ranking. But even allowing for the existence of class and culture differences it seems that, at least in western societies, good looks are somewhat more in demand among men than among women.

Abilities and attributes considered by both male and female raters to be more desirable for males	Abilities and attributes considered by both male and female raters to be more desirable for females
1. Achievement	1. Physical Attractiveness
2. Leadership	2. Erotic Ability
3. Occupational Ability	3. Affectional Ability
4. Economic Ability	4. Social Ability
5. Entertaining Ability	5. Domestic Ability
6. Intellectual Ability	6. Sartorial Ability
7. Observational Ability	7. Interpersonal Understanding
8. Common Sense	8. Art Appreciation
9. Athletic Ability	9. Moral-Spiritual Understanding
10. Theoretical Ability	10. Art-Creative Ability
11. Scientific Understanding	
12. Mechanical Ability[a]	

[a] Mechanical is an exception in that it was considered by both sexes to be below average in desirability as an ability for a female.

Table VIII-1. Abilities and attributes considered by university students of both sexes as socially desirable for persons of either sex, but as somewhat more desirable for persons of a given sex. (After Centers, 1972).

The existence of such a differentiation, great or small, may not be as odd as it looks. Millions of years of natural selection for manual dexterity and abstract thinking might well have brought about such a development in reproductive behaviour, introducing within the most passive sex a preference for those factors inciting the weakest responses (intelligence, character) as selective agents, while keeping sexual appeal's old role within the sex normally starting the sexual approach. It has not even to be a great innovation since even among other Primates there are traces of it: De Vore (1965) found among male baboons a general correlation between sexual activity and rank, and Jay (1965) reported that female langurs at the height of receptivity solicited most higher ranking males. Among humans, such a step would be in agreement with the main evolutionary trend but, as long as sexual appeal retains its procreative role, it would hardly be biologically recommended thoroughly and bilaterally to 'intellectualize' attraction between sexes, contrarily to what some extreme feministic elements seem to long for. To express it bluntly, being sexually alluring is adaptive only when there is someone around capable of being allured.

Beauty being so overwhelmingly important in the choice of partner, it may be questioned which are the traits that define it? Although some present day conceptions of what is attractive about men and women may still owe much to our pre-human past, the emphasis is not as overtly put today on sexually dimorphic areas. Although few men or women would object to a certain amount of forms or a vigorous physique, certain serveys (Wilson & Nias, 1976) seem to indicate that neither powerful shoulders nor muscular arms are specially attractive for women in our society, while small buttocks, lean-waist and belly, eyes, long legs, hair and tallness attained the highest scores in that order. Men's interest, on the other hand, focused on more openly sexual characters (size and shape of breasts, buttocks and legs) in widely varying combinations.

Darwin believed that there was not in the mind of man a universal prototype of beauty and that each population tends to admire its own racial traits that differentiate it from others. On this basis, sexual selection would tend to increase genetic distances between populations (Darwin, 1889). He estimated sexual selection to be the most effective amongst all processes which have contributed to create the physical differences between human groups. He was undoubtedly right about the lack of universality on beauty ideals. Not only in space but also in time, human ideals on physical perfection are subject to change. While ecologically and biologically rooted emphasis on some widespread activities and roles (hunter, warrior; mother) can lead to a certain degree of universal convergence on certain functional attributes (leanness, vigour; fecund forms), there are wide disagreements in many other areas. The diversity in human aesthetic taste becomes fully evident when comparing figurative representations of the human body through time and space. Differences are specially marked between the main racial stocks, particularly in terms of colour. At this level at least, Darwin's belief on populations preferentially admiring their own racial traits seems to be generally correct, but acculturation can easily upset any traditional norms. Hulse (1967) has reported on positive selection for light skin colour among Japanese. Also in Japan, not long ago, surgical operations on female noses for obtaining a more European-like profile had become a relatively common practice within westernised circles. In Nigeria today, commercials advertise creams which make skin lighter, bringing - reputedly - happiness and selfassurance to their possessors (Engberg, 1983). Thus, while cultural contact (often leading to cultural colonialism) brings uniformity, isolation and cultural assurance tend to work on the opposite direction, thereby making possible the fulfilment of the diversifying role postulated by Darwin, provided the following requirements are satisfied:

1. The trait for which individuals are selected as sex partners must be either genetic itself - or non-genetic, but associated to one which is gen-

etic and will be drawn in the process.

2. With respect to the bearers of the trait selected for, the population is

a. either polygenic or polyandric (with or without differential fertility and survival per union), or both, or

b. the population is monogamic, but 1) the bearers of the trait become normally engaged in unions of greater than average fertility and/or 2) are better fitted than most to keep their offspring alive, and/or 3) a non-neligible proportion of the population is left outside the reproductive stream, their phenotypes not being randomly represented.

With regard to pigmentation - the character with which this work is concerned - fulfilment of the first condition is fully met. In addition, by modifying environmental conditions, the individual is capable of dramatically altering the pigmentation of his hair and skin, nails, teeth and - lately - even eyes. The regular dying of hairs and tanning of skins may become instrumentally important in modifying selective pressures. The three countries concerning us have sex ratios close to unity(1), but in all three the proportions of adults of each sex engaged in building up families are far from 100 per cent. Concerning 2.a , all three societies are 'western' and theoretically monogamic, but it may be wondered whether the long established existence of divorce in two of them does not in practice amount to a certain degree of polygamy. During 1978 and 1977 respectively, for instance, the ratios of divorce/marriage were in Sweden 0.51 and in Britain 0.34. In Sweden, among those divorced in 1978, two years later were 44 per cent of the men and 34 per cent of the women either re-married or living with a new partner. These individuals can then be expected to leave a significantly greater contri-

(1) 1.011 for Sweden; 1.049 for Spain; 1.059 for Great Britain.

bution to the population's gene pool. In order to prove that this could affect the physical outlook of the population, it should have to be shown that there exists a correlation between divorce and physical appearance. In this respect, Kirkpatrick and Cotton (1951) have found a positive association between marital adjustment and physical attractiveness, with the greatest weight on the female good looks. Such an association, provided with the necessary steps (divorce and new partnership), would seem to lead to the spread of less attractive phenotypes in the population, unless some counterbalancing mechanisms were also involved. 2.b.1 and 2.b.2 must be rejected as long as no statistical support is presented in their favour. On the other hand, 2.b.3 may well represent part of the situation but there is again no experimental proof for it. Provided, however, that requirement 2.b.3 was satisfied, the drift in frequencies to which such situation would lead, can easily be foreseen.

But even if it is extremely involved to establish the demographic implications of any eventual selective trends in mating, the existence of such trends combined with non-random distribution of phenotypes among the selectors, other factors being neutral, may lead to a re-distribution of phenotypes (if not gene frequencies): increasing the proportions of homozygotes for the genes involved (positive assortative mating), or that of heterozygotes (negative assortative mating). For instance, with perfect assortative mating (correlation between phenotypes of mated individuals, r_{pp}, equal +1), no dominance and complete heritability, equilibrium is not reached until heterozygotes entirely disappear. In practice, however, phenotypic correlations above $r_{pp}=0.5$ are rare in human populations and the practical effects of positive assortative mating are greatly attenuated (Spuhler, 1972). With an $r_{pp}=0.5$ and one pair of genes involved, after an infinite number of generations, heterozygosis is only reduced from 0.500 to 0.333, and with ten pairs, heterozygosis is reduced to 0.476. Positive assortative mating leads to increased variability of the population as a whole, while negative assortative mating reduces it.

In an attempt to explore the eventual existence of selective mating trends, individuals of British, Spanish and Swedish extraction were asked, in combination with the reflectance test, to fill in a form where one of the sections referred to their preferences in terms of pigmentation of the eyes, hair and skin in the other sex (question 63). The intermediate category corresponds to mixed to light brown and dark blond, for eyes and hair. For the skin, it was explained as a natural medium to light brunette complexion, or - for light-haired people - a medium tanned skin. Some individuals would tick two alternatives, for instance, dark eyes and light eyes. In such a case, 0.5 would be scored in each of those categories - instead of 1. For the reasons indicated in section III.1.b, the 2/4-criterion has also been employed here. The frequency distributions for the 2/4-samples follow those for the 'pure' samples so closely that, even to the naked eye, they could be judged identical. However, only in the Swedish case were the requirements necessary for application of the x^2-test fulfiled (table VIII-2, column I). Column II shows also the frequencies for the combined samples.

The Swedish sample had the greatest proportion of persons without preferences (indifferentists) in both sexes. Next come Spanish males, followed by British females, and last come British males and Spanish females. Differences in proportions of indifferentists are significant when comparing nationalities, at each character under consideration, and non-significant when comparing characters within each sample. Within each sample and for each character, discrepancies in fre-

I

		0	1	2	3	4	5	6	
mateye	♂	41	63	22	7	80	1	0	1.286
		13	12	3	2	14	0	0	0.522
	♀	60	121	24	21	102	6	0	3.138
		12	33	4	5	16	1	0	0.210
mathair	♂	38	63	35	5	71	3	1	1.286
		12	8	7	1	16	0	0	0.522
	♀	59	109	48	14	94	6	3	4.476
		10	30	4	3	22	1	0	0.210
matskin	♂	32	17	93	9	49	0	6	2.738
		12	5	16	1	9	0	0	0.260
	♀	54	31	166	19	47	0	4	1.333
		12	7	28	4	13	0	0	0.729
mateye	♂	14	15	26	3	40	2	0	
		1	2	3	0	11	1	1	
	♀	10	29	14	0	55	2	0	
		0	4	3	0	7	0	0	
mathair	♂	17	28	37	3	13	2	0	
		2	3	5	0	6	1	2	
	♀	13	49	35	1	12	0	0	
		0	8	4	0	2	0	0	
matskin	♂	12	16	34	2	14	0	1	
		1	1	11	1	3	0	2	
	♀	9	25	68	0	8	0	0	
		0	4	8	0	2	0	0	
mateye	♂	3	9	9	0	10	1	1	
		1	5	5	0	1	0	0	
	♀	5	23	8	1	6	0	0	
		0	4	0	2	0	0	0	
mathair	♂	3	12	5	1	12	0	0	
		1	7	2	0	2	0	0	
	♀	4	24	8	0	4	2	0	
		1	3	1	0	0	1	0	
matskin	♂	3	5	18	1	6	0	0	
		1	1	7	1	2	0	0	
	♀	5	4	28	0	4	0	0	
		0	1	4	1	0	0	0	

II, III

mateye
1.04 .317
22.38 .000

0	1	2	4			III	
54 20.950	80 31.008	29.5 11.434	94.5 36.628	258	x^2=38.380 p = 0.000 +	x^2= 6.828 p = 0.009 +	SWE-ASWE
72 17.778	170.5 42.099	41 10.124	121.5 30.000	405	x^2=95.716 p = 0.000 +		

38.89 .000
7.89 .005

mathair
0.95 .330
6.95 .009

0	1	2	4			III
50 19.231	75.5 29.039	45.5 17.500	89 34.231	260	x^2=19.869 p = 0.000 +	x^2= 4.174 p = 0.040 +
69 17.122	151 37.469	62 15.385	121 30.025	403	x^2=54.042 p = 0.000 +	

18.38 .000
3.09 .075

matskin
12.38 .000
16.99 .000

0	1	2	4			III
44 16.988	27 10.425	117 45.174	61 23.552	249	x^2=73.490 p = 0.000 +	x^2= 6.836 p = 0.009 +
66 16.837	49.5 12.628	207.5 52.934	62 15.816	385	x^2=172.990 p = 0.000 +	

77.48 .000
1.19 .273

mateye
1.96 .157 5.25 .021

0	1	2	4			III	
15 12.605	20 16.807	31 26.050	53 44.538	119	x^2=28.731 p = 0.000 +	x^2= 2.732 p < 0.100	SPA-ASPA
10 8.065	34 27.419	17 13.710	63 50.807	124	x^2=53.871 p = 0.000 +		

5.02 .025
8.08 .004

mathair
2.36 .129
1.15 .284 7.33 .007

0	1	2	4			III
19 15.966	34 28.572	44.5 37.395	21.5 18.067	119	x^2=14.092 p = 0.003 +	x^2= 6.083 p = 0.014 +
13 10.484	57.5 46.371	39.5 31.855	14 11.290	124	x^2=44.758 p = 0.000 +	

2.98 .088 1.22 .001

matskin
27.19 .000 27.19 .000

0	1	2	4			III
13 11.017	18.5 15.678	68 57.627	18.5 15.678	118	x^2=67.678 p = 0.000 +	x^2= 2.837 p = 0.094
9 7.20	29 23.200	76.5 61.200	10.5 8.400	125	x^2=95.304 p = 0.000 +	

20.50 .000
7.75 .005

mateye
0.12 .700

0	1	2	4			III	
4 8.889	14.5 32.222	14.5 32.222	12 26.667	45	x^2= 5.400 p = 0.145	x^2= 6.213 p = 0.013 +	GB-AGE
5 10.204	28.5 58.163	9.5 19.388	6 12.245	49	x^2=27.082 p = 0.000 +		

9.53 .004 0.86 .355

mathair
0.61 .438
4.48 .034 1.41 .236

0	1	2	4			III
4 8.889	19.5 43.333	7.5 16.667	14 31.111	45	x^2=10.778 p = 0.012 +	x^2= 2.287 p = 0.130
5 10.417	28.5 59.375	9 18.750	5.5 11.458	48	x^2=26.375 p = 0.000 +	

9.13 .002 0.43 .500

matskin
9.82 .002 9.56 .002

0	1	2	4			III
4 8.889	7 15.556	26 57.778	8 17.778	45	x^2=24.022 p = 0.000 +	x^2= 0.550 p = 0.459
5 10.204	5.5 11.225	33.5 68.367	5 10.204	49	x^2=46.792 p = 0.000 +	

18.69 .000 19.64 .000

Table VIII-2. Mating preferences in Sweden, Spain and Britain, and their significance.
In column I, comparisons between 'pure' (first row) and '2/4' samples (second row): x^2 (upper row) and p (lower row).
In column II, significance of the preferences - among males (upper rows) and females (lower rows): x^2 (first figure) and p (second figure). On the right hand side, heterogeneity of the sample (x^2, p).
In column III, between-sex comparison of mating preferences - categories 2 and 4 pooled together for mateye and mathair, categories 1 and 2 pooled together for matskin.

Legend.

1. Mateye, mathair and matskin:
   0 = no preferences; 3 = both 1 and 2; 5 = both 1 and 4;
   6 = both 2 and 4; 1, 2 and 4 as in table VIII-3.
   1, 2 and 4 as in table VIII-3.

quencies for indifferentists and non-indifferentists are significant in all cases, except for British males with variable mateye. In all cases, except among the British, the proportions of indifferentists fall when considering preferences for skin colour.

In the Swedish and British samples, men are more conservative than women in their tastes for all three characters; to a greater extent than women they tend to like the light eyed, light haired and light complexioned individuals. Among Spaniards the reverse situation predominates (table VIII-2, column III). Differencies between sexes are significant in all cases, except among the British - mathair (p=0.130), matskin (p=0.459) - and among Spaniards - mateye (0.100), matskin (0.094).

As for the trends themselves, although Swedish males - for eyes and hair - tend to favour the national type, they also feel very attracted by the opposite pigmentation - dark eyes, dark hair. Differences between preferences (col. II) are, in fact, non-significant (p=0.317, eyes; p=0.330. hair). Swedish females show a clearly significant predilection for dark-eyed individuals (p=0.005), and close-to-significant preference for dark-haired individuals (p=0.075). Both sexes, clearly favour medium pigmented skins (p=0.000) and, after, light skins before dark. This last discrepancy (light vs. dark) is only significant among males (p=0.000).

Spanish males and females significantly favour light eyes before dark (p=0.000, males; p=0.004, females). Significantly after light, males prefer medium-coloured eyes (p=0.021) while females prefer dark. Men favour medium hair first and then dark hair (the order does not attain significance, though). After that comes light (n.s. with respect to dark, s. with respect to medium). Spanish females, on the other hand, prefer dark hair, then medium and then light. The order is significant all along. Both sexes show a predilection for medium pigmented skins, followed by dark and then light skins among females (order significant all along), and by dark and light together (n.s. order) among males.

British males prefer dark and medium eyes equally and then light, but differences are not significant. Females prefer dark eyes first, then medium, then light; differences in order are only significant among the first two (p=0.004). Males in our sample favour dark hair before light, and light before medium, but only the difference dark vs. medium is significant (p= 0.034). Females fancy first dark and then medium, followed by light. Order is only significant between the two first choices. Like Swedes and Spaniards, males and females tend to like best medium coloured skins (p=0.002, males; p=0.000, females) followed by light and dark in the males and by dark and light in the females. The order, between the two last options, is not significant.

The most favoured phenotypes, obtained by combining the answers as given by those tested, correspond to what could be expected on the basis of probabilities (table VIII-3, a to c). The samples are, indeed, too small to detect any extremely unusual preferences. (Here the 3/4-criterion has been followed.) After the 'harmonic' combinations (light eyes and light hair, dark eyes and dark hair), Swedish males favour females with light eyes and light brown hair, while females prefer the 'disharmonic' types (light hair with dark eyes, dark hair with light eyes) in approximately equal proportions. Among Spaniards, owing to recombination dynamics, the most popular type for males seems to be a female with light brown hair and light brown or mixed eyes, closely followed by light brown hair with light eyes; whereas among females, men with light eyes and dark hair, very closely followed by types mathair [illegible] (3/4)

mateye	matskin	0		1		2		4		total	
0	0	86.1	31	2.8	1	2.8	1		0	91.7	33
	1				0		0	5.6	1	5.6	1
	2	1.1	1	1.1	1		0	1.1	1	3.3	3
	4	2.0	1		0		0	2.0	1	3.9	2
	total		33		2		1		3		39
1	0		0	2.8	1		0		0	2.8	1
	1			27.8	5	11.1	2	5.6	1	44.4	8
	2		0	24.2	22	5.5	5	12.1	11	41.8	38
	4		0	11.8	6	11.8	6	5.9	3	29.4	15
	total		0		34		13		15		62
2	0		0		0		0		0		0
	1		0	16.7	3		0		0		3
	2		0	5.5	5	3.3	3	2.2	2	11.9	10
	4		0	5.9	3	3.9	2	7.8	4	17.6	9
	total		0		11		5		6		22
4	0		0		0	2.8	1	2.8	1	5.6	2
	1		0	5.6	1		0	27.8	5	33.3	6
	2	1.1	1	9.9	9	14.3	13	18.7	17	44.0	40
	4	2.0	1		0	11.8	6	35.3	18	49.0	25
	total		2		10		20		41		73
	Total	17.86	35	29.08	57	19.90	39	33.16	65	100.0	196
mateye	matskin										
0	0	90.9	50	1.8	1		0		0	92.7	51
	1		0		0		0		0		0
	2	0.6	1	1.2	2		0		0	1.9	3
	4	4.3	2		0		0		0	4.3	2
	total		53		16		2		3		74
1	0	5.5	3		0		0		0	5.5	3
	1		0	46.4	13	7.1	2	10.7	3	64.3	18
	2		0	25.9	42	9.9	16	15.4	25	51.2	83
	4		0		0	4.3	2		0	4.3	2
	total		3		55		20		28		106
2	0		0		0		0		0		0
	1		0	3.6	1	3.6	1	3.6	1	10.7	3
	2		0	3.7	6	4.9	8	3.7	6	12.3	20
	4		0		0	4.3	2		0	4.3	2
	total		0		7		11		7		25
4	0		0		0		0	1.8	1	1.8	1
	1		0	21.4	6		0	3.6	1	25.0	7
	2	0.6	1	11.7	19	7.4	12	14.8	24	34.6	56
	4		0	8.5	4	4.3	2	36.2	17	48.9	23
	total		1		29		14		42		87
	Total	19.52	57	36.64	107	16.10	47	27.74	81	100.0	292

(a)

Table VIII-3a. Mating preferences in Sweden (phenotypes).

Legend.

1. Mateye, mathair and matskin:
   0 = no preferences.
2. Mateye:
   1 = darker than category 2, 4 = lighter than category 2,
   2 = light brown to mixed eyes.
3. Mathair:
   1 = darker than category 2, 4 = lighter than category 2,
   2 = light brown (or dark blond).
4. Matskin:
   1 = darker than category 2, 4 = lighter than category 2,
   2 = medium to light brunette, medium tanned skin (for light-haired people).

mathair SPA ASPA (3/4)

			0		1		2		4		total	
mateye matskin	0	0	92.3	12		0		0		0		0
		1		0		0		0		0		0
		2	3.5	2		0		0		0	3.5	2
		4	7.1	1		0		0		0	7.1	1
	total			15		0		0		0		15
	1	0		0		0		0		0		0
		1		0	13.3	2	6.7	1		0	20.0	3
		2		0	12.3	7	7.0	4	1.8	1	21.1	12
		4		0		0	7.1	1		0	7.1	1
	total			0		9		6		1		16
	2	0		0		0		0		0		0
		1		0	6.7	1	13.3	2		0	20.0	3
		2		0	8.8	5	21.1	12	5.3	3	35.1	20
		4		0		0	28.6	4		0	28.6	4
	total			0		6		18		3		27
	4	0	7.7	1		0		0		0	7.7	1
		1	6.7	1	26.7	4	20.0	3	6.7	1	60.0	9
		2	1.8	1	12.3	7	17.5	10	8.8	5	40.4	23
		4		0	7.1	1	21.4	3	28.6	4	57.1	8
	total			3		12		16		10		41
	Total		18.18	18	27.27	27	40.41	40	14.15	14	100.0	99
mateye matskin	0	0		0		0		0		0		0
		1		0		0		0		0		0
		2	1.4	1		0		0		0	1.4	1
		4		0		0		0		0		0
	total			1		0		0		0		1
	1	0		0		0		0		0		0
		1	4.0	1	52.0	13	4.0	1		0	60.0	15
		2	1.4	1	12.7	9	5.6	4		0	19.7	14
		4		0	10.0	1		0		0	10.0	1
	total			2		23		5		0		30
	2	0		0		0		0		0		0
		1		0		0		0		0		0
		2		0	4.2	3	14.1	10	1.4	1	19.7	14
		4		0	10.0	1	10.0	1		0	20.0	2
	total			0		4		11		1		16
	4	0		0		0		0		0		0
		1		0	36.0	9	4.0	1		0	40.0	10
		2		0	21.1	15	26.8	19	11.3	8	59.2	42
		4		0	20.0	2	20.0	2	30.0	3	70.0	7
	total			0		26		22		11		59
	Total		2.83	3	50.00	53	35.85	38	11.32	12	100.0	106

(b)

Table VIII-3b. Mating preferences in Spain (phenotypes).

Legend.

1. Mateye, mathair and matskin:
   0 = no preferences.
2. Mateye:
   1 = darker than category 2, 4 = lighter than category 2,
   2 = light brown to mixed eyes.
3. Mathair:
   1 = darker than category 2, 4 = lighter than category 2,
   2 = light brown (or dark blond).
4. Matskin:
   1 = darker than category 2, 4 = lighter than category 2,
   2 = medium to light brunette, medium tanned skin (for light-haired people).

mathair GB ABS (3/4)

			0		1		2		4		total	
mateye matskin	0	0	100.0	3		0		0		0	100.0	0
		1		0		0		0		0		0
		2		0	21.1	4	5.3	1		0	26.3	5
		4		0	25.0	2		0		0	25.0	2
		total		3		6		1		0		10
	1	0		0		0		0		0		0
		1		0	50.0	2	25.0	1		0	75.0	3
		2		0	21.1	4	5.3	1		0	26.3	5
		4		0	25.0	2		0		0	25.0	2
		total		0		8		2		0		10
	2	0		0		0		0		0		0
		1		0		0		0		0		0
		2		0	10.5	2	10.5	2	15.8	3	36.8	7
		4		0		0	12.5	1	37.5	3	50.0	4
		total		0		2		3		6		11
	4	0		0		0		0		0		0
		1		0	25.0	1		0		0	25.0	1
		2		0	15.8	3	5.3	1	15.8	3	36.8	7
		4		0		0		0	25.0	2	25.0	2
		total		0		4		1		5		10
	Total		7.32	3	48.78	20	17.07	7	26.83	11	100.0	41
mateye matskin	0	0	80.0	4		0		0		0	80.0	4
		1		0		0		0		0		0
		2		0		0		0		0		0
		4		0		0		0		0		0
		total		4		0		0		0		4
	1	0		0	20.0	1		0		0	20.0	1
		1		0	20.0	1	20.0	1		0	40.0	2
		2		0	51.7	15	6.9	2	10.3	3	69.0	20
		4		0	50.0	2		0		0	50.0	2
		total		0		19		3		3		25
	2	0		0		0		0		0		0
		1		0	40.0	2		0		0	40.0	2
		2		0	10.3	3	10.3	3		0	20.7	6
		4		0		0		0		0		0
		total		0		5		3		0		8
	4	0		0		0		0		0		0
		1		0	20.0	1		0		0	20.0	1
		2		0	3.4	1	3.4	1	3.4	1	10.3	3
		4		0		0	50.0	2		0	50.0	2
		total		0		2		3		1		6
	Total		9.30	4	60.47	26	20.93	9	9.30	4	100.0	43

(c)

Table VIII-3c. Mating preferences in Great Britain (phenotypes).

Legend.

1. Mateye, mathair and matskin:
   0 = no preferences.
2. Mateye:
   1 = darker than category 2, 4 = lighter than category 2,
   2 = light brown to mixed eyes.
3. Mathair:
   1 = darker than category 2, 4 = lighter than category 2,
   2 = light brown (or dark blond).
4. Matskin:
   1 = darker than category 2, 4 = lighter than category 2,
   2 = medium to light brunette, medium tanned skin (for light-haired people).

```
SUBFILE    SVE          ASVE
* * * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * * *
                    UIA9
                 BY MATSKIN
                    SEX
               WITH DULG
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                                      SUM OF                    MEAN             SIGNIF
SOURCE OF VARIATION                   SQUARES       DF          SQUARE      F      OF F

COVARIATES                            137.031        1         137.031   6.843   0.009
   DULG                               137.031        1         137.031   6.843   0.009

MAIN EFFECTS                           87.563        3          29.188   1.458   0.226
   MATSKIN                             66.391        2          33.195   1.658   0.192
   SEX                                 14.405        1          14.405   0.719   0.397

2-WAY INTERACTIONS                     50.150        2          25.075   1.252   0.287
   MATSKIN   SEX                       50.150        2          25.075   1.252   0.287

EXPLAINED                             274.746        6          45.791   2.287   0.035

RESIDUAL                             8290.629      414          20.026

TOTAL                                8565.375      420          20.394


COVARIATE    RAW REGRESSION COEFFICIENT

DULG              1.502

    751 CASES WERE PROCESSED.
    330 CASES ( 43.9 PCT) WERE MISSING.

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

* * *   M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S   * * *
                    UIA9
               BY   MATSKIN
                    SEX
               WITH DULG
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
GRAND MEAN =    65.04                                              ADJUSTED FOR
                                                  ADJUSTED FOR     INDEPENDENTS


                                           UNADJUSTED    INDEPENDENTS    + COVARIATES
VARIABLE + CATEGORY               N        DEV'N  ETA    DEV'N   BETA    DEV'N  BETA

MATSKIN
   1                              49        0.60                          0.57
   2                             270       -0.33                         -0.30
   4                             102        0.58                          0.51
                                                  0.10                          0.09

SEX
   1                             168        0.28                          0.23
   2                             253       -0.19                         -0.15
                                                  0.05                          0.04

MULTIPLE R SQUARED                                                            0.026
MULTIPLE R                                                                    0.162
```

Table VIII-4. Associations between skin (uia9) and matskin.

```
SUBFILE   SPA        ASPA
* * * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * * *
                    UIA9
                 BY MATSKIN
                    SEX
               WITH A1
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                                             SUM OF                      MEAN             SIGNIF
SOURCE OF VARIATION                          SQUARES      DF            SQUARE       F      OF F

COVARIATES                                   161.534       1           161.534   10.146    0.002
   A1                                        161.534       1           161.534   10.146    0.002

MAIN EFFECTS                                  97.012       3            32.337    2.031    0.111
   MATSKIN                                    11.017       2             5.508    0.346    0.708
   SEX                                        86.956       1            86.956    5.462    0.020

2-WAY INTERACTIONS                             5.046       2             2.523    0.158    0.854
   MATSKIN  SEX                                5.046       2             2.523    0.158    0.854

EXPLAINED                                    351.214       6            58.536    3.677    0.002

RESIDUAL                                    3120.549     196            15.921

TOTAL                                       3471.763     202            17.187


COVARIATE   RAW REGRESSION COEFFICIENT

A1                0.147

    242 CASES WERE PROCESSED.
     39 CASES ( 16.1 PCT) WERE MISSING.

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

* * *   M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S   * * *
                UIA9
          BY    MATSKIN
                SEX
          WITH  A1
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

GRAND MEAN =     61.73                                                  ADJUSTED FOR
                                                       ADJUSTED FOR     INDEPENDENTS
                                         UNADJUSTED    INDEPENDENTS     + COVARIATES
VARIABLE + CATEGORY               N      DEV'N  ETA    DEV'N   BETA     DEV'N   BETA

MATSKIN
     1                           42      -0.47                          -0.54
     2                          135       0.20                           0.16
     4                           26      -0.28                           0.06
                                                0.07                            0.07

SEX
     1                           93      -0.97                          -1.00
     2                          110       0.82                           0.84
                                                0.22                            0.22

MULTIPLE R SQUARED                                                              0.059
MULTIPLE R                                                                      0.243
```

Table VIII-4. Associations between skin (uia9) and matskin.

```
SUBFILE   6B          AGB

* * * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * * *
                  UIA9
               BY MATSKIN
                  SEX
             WITH DU5
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                                       SUM OF                 MEAN           SIGNIF
SOURCE OF VARIATION                   SQUARES     DF         SQUARE       F    OF F

COVARIATES                              1.439      1          1.439   0.136   0.714
   DULG                                 1.439      1          1.439   0.136   0.714

MAIN EFFECTS                           41.653      3         13.884   1.311   0.278
   MATSKIN                             39.689      2         19.845   1.873   0.162
   SEX                                  3.661      1          3.661   0.346   0.559

2-WAY INTERACTIONS                     23.205      2         11.603   1.095   0.340
   MATSKIN   SEX                       23.205      2         11.603   1.095   0.340

EXPLAINED                              66.297      6         11.049   1.043   0.406

RESIDUAL                              699.152     66         10.593

TOTAL                                 765.449     72         10.631


COVARIATE   RAW REGRESSION COEFFICIENT

DULG             -0.585

     89 CASES WERE PROCESSED.
     16 CASES ( 18.0 PCT) WERE MISSING.

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

* * *   M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S   * * *
                  UIA9
             BY   MATSKIN
                  SEX
             WITH DU5
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

GRAND MEAN =     64.21                                                ADJUSTED FOR
                                                      ADJUSTED FOR   INDEPENDENTS
                                          UNADJUSTED  INDEPENDENTS   + COVARIATES
VARIABLE + CATEGORY                 N     DEV'N  ETA  DEV'N   BETA   DEV'N   BETA

MATSKIN
   1                               10     -1.71                      -1.73
   2                               51      0.40                       0.42
   4                               12     -0.29                      -0.32
                                                0.22                          0.23

SEX
   1                               34      0.12                       0.25
   2                               39     -0.11                      -0.22
                                                0.04                          0.07

MULTIPLE R SQUARED                                                            0.056
MULTIPLE R                                                                    0.237

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

Table VIII-4. Associations between skin (uia9) and matskin.

with dark eyes and dark hair, and even light eyes combined with medium hair, seem to be most fancied. British males and females mostly favour 'harmonic' specimens of the other sex - with dark eyes and hair - closely followed in the case of men by types combining medium eyes and light hair or light eyes with light hair.

So far for the trends and their proportions. Is there any evidence for the existence of non-random distribution of phenotypes among the selectors? In other words, is there any sort of assortative mating in the populations under study? Table VIII-5 shows the rank and biserial r_b correlation coefficients between the phenotypic variables (eye, hair, skin) and the mating variables. Category 0(indifferentists) has been excluded from the mating variables and 'skin' is represented by the reflectance readings (at the ninth filter) corrected for their predictors. The r_b coefficient was obtained from the MCA of an analysis of variance (table VIII-4, a to c) between uia9 (corrected), as dependent variable, and matskin plus uia9's predictors as factors and covariates.

In table VIII-4, neither matskin's nor the interaction effects were significant. In order to obtain more proper correlation coefficients than the beta regressions offered by the analysis of variance subprogram, its out-put has been rearranged into a dichotomy (1+2 vs. 4) and the biserial coefficient has been calculated instead (table VIII-4). r_b is positive for Swedes and negative for Spaniards and the British. All values are small (highest r_b=0.110, Swedes) and non-significant.

For eyes and hair, correlations with mateye and mathair, are all positive, with the following exceptions: Swedish males --eyes (r_s= -0.004), Spanish females --hair (r_s= -0.098), British males --eyes (r_s= -0.218) and British females --hair (r_s= -0.196). All coefficients are weak (strongest is -0.218, British ♂ --eyes) and no correlation is significant, except that for hair-mathair among Spanish males (r_s=0.211). All in all, it must be concluded that - with the aforementioned exception - there is no evidence of any significantly important assortative mating trends in the three populations under consideration. The existence of well defined mating preferences seems to be broadly independent on their possessors' pigmentation. Indeed, it must be borne in mind that, with greater sample sizes, some cases might attain significance - namely Spanish females (eyes), British males (eyes, hair) and females (hair) - but that must remain for the moment as an uncertain possibility. For all other cases, especially among Swedes, the non-existence of assortative mating seems difficult to refute. In fact, the numerical value of the coefficients seems to decrease with increasing size of the sample, a phenomenon occasionally found before when the British sample was involved (which might or might not be due to sampling hazards).

Thus, the existence of a liking for a southern European type of pigmentation seems to be a well established fact in the populations under study, often - especially among females - with absolute preference over other types. A strong element of attraction for the exotic or uncommon is probably implied in the picture, and the fact that Spaniards have - to a minor extent - also included an infrequent element in their mating preferences would rather confirm than deny this conjecture. Whether these preferences are somehow restrained by mentally 'housing' them in a national mate or not it must remain a matter of conjecture, since no information on that subject was collected, but that might well be the case with a considerable proportion of informants. Are these trends very old? Although literature and travelling, and to a lesser extent art, may have helped in making south European outlooks physically attractive in countries like Sweden, where they - until the recent massive influx of immigrants - were extremely scarce, ordinary people had to wait for the advent of more powerful media - namely TV and film - before having a chance to become acquainted with them. In lands like Spain, or even Britain, that should not have been necessary, but in Sweden the pigmentary preferences elicited by the questionnaire may well not be older than the century.

The Swedish sample is representative of the social stratification of a country where most of the population is middle class, but the Spanish and British samples are mainly constituted by students. To what extent this may have affected the results is difficult to tell, but it should presumably be expected that the mass of the population is more conservative in taste. This might significantly affect the outcome of the experiment in the case of the Spaniards, perhaps attenuating that preference for light eyes, but not necessarily so in the case of the British, where hair colour under the light brown variety is in many areas almost as abundant as all the rest together. Indeed Spanish folksongs and popular poetry almost without exception witness a seemingly very old preference for the national type.

There is more clear evidence of a change in fashion in the field of skin colour preferences. During the nineteenth century and up to the first decade of our century, many Europeans would go through physical pain in order to keep their epidermis hidden from the sun, not seldom as a token of class affinity. Sunburn was mentally connected with lower class and heavy physical work outdoors. The phenomenom was especially intensive in non-Mediterrenean Europe, where pale complexions were already endemic. The way to a change in fashion was paved at the turn of the century by the confirmation in science of the folk belief in the therapeutic power of sunlight, the rapid spread over Europe of places intended to extract medical benefits of the new knowledge - in which the Icelandian N.R. Finsen was a pioneer - and the new winds in art and literature (Waldetoft, 1983). The new ideas were effectively diffused by newspapers and books. Healthy, handsome young men and women bathing in summer landscapes became popular motifs in painting, while naturist movements tried to put the new ideas into systematic practice. In 1896 Finsen opened in Denmark his famous institute for medical therapy with artificially produced UV-rays, and in 1903 Dr. Rollier founded in Switzerland the first anti-tuberculosis sanatorium. By the 20's the firms which had been manufacturing creams for keeping pale skins white, had gone over to the production of tanning lotions.

It is too soon to predict what can become of these trends and their chances for significantly to affect the genotype frequencies for pigmentation. A global shift in gene frequencies would require as shown, apart from the existing selective mating trends, a series of requirements whose fulfilment, although suspected in certain cases, is difficult to prove and evaluate, plus the existence, of course, of adequate amounts of the requested genetic material. For a mere redistribution of genotype frequencies the existence of assortative mating is necessary. Its probabilities for success are, however, heavily reduced by decreasing size of the phenotypic correlation and increasing size of the number of gene pairs involved. It seems then - even without being able to evaluate all the different parameters involved in the calculations (Spuhler, 1972) - that little can be expected from the assortative mating process. A more realistic possibility might lie with selective mating trends. Here, for all preferences involving less common appearances, the three countries are rather badly served by the national

stock. Thus, supposing the most 'deviant' aspects of these trends do not disappear too soon, their main possibility for significantly to influence the gene pool may lie in the differential absorption of foreign elements. Britain and Sweden have the best expectancy in that respect, since they have now for several decades been open to massive immigration, but the phenomenon is little known in our time in Spain. Here, however, subsequent to the increasing opening of the country and the rising standard of economic and social conditions, a certain amount of miscegenation - probably a token of more to come - has been taking place, mainly along the coasts and in the great cities.
The impact of immigration should be especially strong in Sweden and Spain, where most incomers would likely turn out to be respectively darker and lighter. Sweden is already experiencing its effects. Immigrant workers and political refugees, amounting(1) to between one eighth and one ninth of the country's total population, some of them - as in Britain - coloured (table VIII-6), most of them in full procreative age(2), come to the country alone or with their families and many stay(3), Their unions with other foreigners are on average much more fertile than those between Swedes (table VIII-7), producing many darkly pigmented Swedes. Many more engage in unions with the local population(4). According to a rough calculation, these foreigners and their offspring may be expected to provide about one third of the exotic partners prefered by many Swedes.

(1) Together with second-generation immigrants and hybrids.

(2) According to a census from 1979, for instance, around 60 per cent of the population of foreign extraction was between ages 20 and 44.

(3) Among those immigrated between the years 1968 and 1978, around 50 per cent were still in the country by the end of the period.

(4) Among all matrimonies celebrated during 1979 where at least one of the contracting parties had non-Swedish citizenship, mixed marriages constituted 71 per dent of the total.

		eye	hair	skin
mateye	♂	-0.004 194 -		
	♀	0.029 300 -		
mathair	♂		0.068 200 -	
	♀		0.045 307 -	
matskin			Swe+Aswe	0.110 421 - (♂ + ♀)

		eye	hair	skin
mateye	♂	0.067 97 -		
	♀	0.145 112 -		
mathair	♂		0.211 92 0.031 +	
	♀		-0.098 115 -	
matskin			Spa+Aspa	-0.043 203 - (♂ + ♀)

		eye	hair	skin
mateye	♂	-0.218 39 -		
	♀	0.061 41 -		
mathair	♂		0.151 40 -	
	♀		-0.196 40 -	
matskin			Gb+Agb	-0.058 73 - (♂ + ♀)

Table VIII-5. Correlations between pigmentation and mating preferences.
Two first rows: rank correlations. Third row: biserial coefficient, calculated according to McNemar (1955, p. 193).

Origin	1969	1972	1975	1979
		Percentages		
Iceland, Finland, Scandinavia	69.6	48.7	60.8	47.2
Other European countries	22.6	30.7	20.8	21.9
(Mediterranean Europe)				20.1
(Europe: Total)				69.1
Africa	1.0	3.0	2.5	3.4
South	0.5	1.3	3.4	7.6
North America	3.4	7.0	4.2	4.0
Asia	2.2	7.5	7.2	14.3
Oceania, Soviet Union	0.7	1.7	1.1	1.6
Absolute figures	65,000	30,000	44,000	37,000

Table VIII-6. Immigration to Sweden under 1969-1979.

	1970	1972	1974	1976	1978	1979
Immigrants . 1000						961
Total						8333
Immigration (+)		25600	31900	39700	31700	32400
Emigration		33100	20700	18900	15900	16400
Live births (++) per thousand women	1903.5	1899.0	1865.0	1650.5	1563.5	1621.5
	2441.5	2321.0	2250.0	2240.5	2117.0	2156.0
Females						18029
Males						18996

Table VIII-7. Some statistical facts about Sweden.
(+). Non-Swedish nationalities considered only.
(++). Swedish females/Non-Swedish females.

In agreement with the results from a number of investigations, well defined preferences for certain physical traits have been demonstrated in the field of pigmentation. Thus, a clear predilection for a rather pigmented phenotype has been elicited among females in the three countries under study, while the males are either in favor of the local modal type (Swedes) or tend slightly to depart from it (British and Spaniards), in the direction of what in each case constitutes the most exotic phenotype. No traces, however, of assortative mating could be demonstrated, except for one trait among Spanish males. Yet, the phenotypic correlation is small and, presumably, no significant drift in either gene or phenotype frequencies can be expected, at least in a foreseeable future, even after fulfilment of all other requirements. Exact prediction is, however, impossible since the assortment coefficients employed here are not directly comparable with Spuhler's, owing to their different statistical nature, and since the exact number of genes involved in the manifestation of the traits under consideration is still unknown. On the other hand, clear preferences for exotic pigmentations may lead, provided the adequate sort of partners is made available by continued immigration or whatever, in the course of time to a shift in gene frequencies.

CHAPTER IX

IX.1. SAMPLES AND METHODS

The populations examined in this section range across a wide geographical area, from Northern Europe to the Mediterranean and from the British Isles to North Central Europe. Unfortunately no data from Eastern Europe were available to the author at the time of writing. Thus, this densely populated part of Europe is unrepresented. In addition, South Western and Central Europe are scarcely covered. A list of the populations under consideration (with references) is given in appendix E. Some of them are not European but have been included for purposes of comparison.

Since most data come from articles by different authors, the philosophy behind each is entirely individual and so are the methods and the instruments utilized. In a work of this kind the complications raised by this diversity of methodology fall into one of the following groups: 1) technical problems and 2) statistical problems. Under the first heading are included those derived from the use of different filters and spectrophotometers, different standard surfaces and by taking the measurements on non-comparable sites of the skin. Under the second heading are considered the problems deriving from sample size, fulfilment of statistical requirements and others.

The data to be analysed were all taken by means of E.E.L., instruments using two different sets of filters: the 425-545-685 set and the 430-550-685 set, although minor variations and wavelengths of filters one to nine also take place within the second series. The problems raised by the diversity of spectrophotometers, filters and standard surfaces have been commented upon in more detail elsewhere (Fernández, in print). This and other irregularities have, within reason, been ignored in order to avoid excessive reduction of the amount of available data. It must be borne in mind, however, that some mis-positioning of populations can in consequence arise and that, even if this would not be expected to be major, there is enough ground here to question the whole idea of interpopulation comparisons as long as this source of spurious variation is not brought under control. No Photovolt spectrophotometers have been used in studies of European populations included in this work. Magnesium carbonate has probably been used in all cases as standard 'white' for calibration with an exception - Wassermann's South Africans, where magnesium oxide served. This is however no more than a guess since some authors do not mention the matter at all.

Some data, potentially interesting in this context, were not inter-comparable with the rest due to the diversity of the skin areas selected for measurement. Because of this, all of Correnti's and Barnicot's data and part of Rijn-Tournel's data were of no relevance at all for the aims of this section. Perhaps it should be mentioned here that Barnicot's results (1958) - measurements taken at the forearm - have been negligently compared by a number of investigators with their own sample means - readings taken at the upper arm.

There is no generally accepted methodology for dealing with the analysis of data. Several treatments have been proposed. Harrison & Owen (1956/7; 1964) found that: 1) in vitro the reciprocal of the reflectance values at long wavelengths (specially at 655 nm and 685 nm) is linearly proportional to the concentration of melanin and, according to the same authors, is not significantly altered by variations in the presence of blood or bile underneath. For the other filters this relationship holds only at lower concentrations of melanin. 2) The relationship between reflectance readings at 425, 545 and 685 nm, which is curvilinear, turns out to be linear when plotted under the form $\log_{10}R_{425}$, R_{545} and $\text{antilog}_{10} R_{685}$. One more advantage was claimed by Harrison & Owen for their method: that additiveness of genic effects is more clearly revealed that way. One limitation, however, according to the author's own experience, linked to - at least - the logarithmic transformation, is that it totally distorts the shape of the distribution curves, so that parametric statistics can no longer be applied. In support of Harrison & Owen's observations about the relationship between melanin concentrations and reflectances at filters 608 and 609 are the experiments of Harmse (1964), Walsh (1963), Lee et al. (1959) and Jansen (1953).

Other methodologies (Tobias, 1961; Huizinga, 1968; Kalla, 1970) have also been proposed, to be applied to the evaluation of tanning. They are of no relevance in this context.

A few authors have employed the tri-stimulus filters and the three I.C.I. specifications (dominant wavelength, purity and luminance), (Weiner, 1951; Das & Mukherjee, 1963), which should physically be the most informative and accurate procedure to characterize the actual average colour of a population. The arguments for and against this methodology have been outlined in section I.5. More recently, Leguebe (1976 a,b; 1977 a; 1979 a,b) has examined several populations by means of factor analysis and principal component analysis reaching some interesting results (Leguebe, 1979 b). Leguebe (1979 a) has shown that limiting the measurements to filter 609 - or even to filters 601, 605 and 609 - leads to ignoring a non-negligible source of variability and to misspending its discrimination power. In fact a discriminant analysis applied to five widely different groups - Whites, North Africans, Vietnamese, Bushmen and Negroes - accepted first filters 604, 608 and 607 (in that order) while looking for the optimum discriminant combination. This casts doubt on the convenience of using 601, 605 and 609 as a simplified substitute for the nine filters.

Part of the methodological discrepancies is no doubt generated by the diversity of pursued objects, but a great deal derives from our deficiencies in knowledge of whatever underlies the diversity of colour. When for instance populations are collated by their means and standard deviations at filter 609 - or should it be at 608? - the comparison is really between the reciprocals of their melanin concentrations; while if the C.I.E. specifications are used in the comparison, the actual colours, as we see them, are compared. To what extent both approaches produce comparable results should solely depend on the extent to which colour of the skin is determined by melanin alone to the exclusion of other factors. Principal component analysis with nine variables (filters) seems to be a better tool for characterizing populations by colour, but its accuracy rests on whether or not those nine reflectance readings provide the best physical 'image' of colour. Since physicians have unanimously agreed that the best 'image' is given by the C.I.E. specifications, it would seem that the nine-filters methodology is not entirely satisfactory.

An additional source of insecurity is the fact that few investigators give any information at all about the fulfilment or violation of the assumptions. It is known that when comparing several samples with each other, if they are not big enough, the distribution of scores in the population should be normal and that in any case homogeneity of variance should be satisfied if inferences extracted from the use of the t-test and the oneway anovar are to be considered fully reliable. In practice, however, under certain conditions, both assumptions can be violated without the reliability of the conclusions being significantly diminished, (Hays, 1974; Mc Nemar, 1959). In order to minimize the effects of such an eventual transgression, Hays' recommendations on corrections of the degrees of freedom when applying the t-test have been followed.

A diagram illustrating the relative positions of the populations under study has been included as figure IX.2-1. Indeed, the picture might be somewhat distorted as a result of three types of error: 1) operational errors, due to unnoticed malfunctioning of the spectrophotometer (too high/low readings caused by non-calibration, instability, ..) 2) statistical errors (mainly inadequate use of parametric statisties with distributions erroneously assumed to fulfil the appropriate requirements, 3) interobserver error, caused by the multiplicity of measurement procedures introduced by different investigators. Whilst Lees et al. (1978) have proved that the third source of error can be brought under control, it is not equally easy to discard the others.

Summary

Diversity of spectrophotometers, filter sets and standard surfaces are problems which have afflicted the use of spectrophotometry in human biology since the beginning.

The different methodologies which have been proposed for the analysis of reflectance data are summarily reviewed.

Author	Population	Filter 601 x	s	N	Filter 605 x	s	N	Filter 609(xx) x	s	N
Fernández	York ♀				45.690	3.743	29	70.517	2.861	29
Hulse. 1973	N. Northumberland ♀	37.12	4.46	67	45.30	4.45	67	69.33	3.17	67
Hulse, 1973	N. Northumberland ♂	34.26	5.06	58	44.09	3.94	58	68.97	3.89	58
Rigters-Aris, 1972/3	Dutch ♂	39.7	4.04	99	44.7	3.85	99	68.9	2.51	99
Hulse. 1973	SE Northumberland ♀	36.55	3.82	40	44.40	3.57	40	68.70	3.39	40
Hayez, 1965	Brussels ♀	41.375	4.139	100	47.085	4.615	10	68.005	4.745	100
Robins, 1973 (x)	Blue-eyed Whites ♀	36.9	1.18	15	41.7	0.99	15	67.3	0.73	15
Hulse, 1973	SE Northumberland ♂	33.46	4.43	37	42.27	3.64	37	66.95	3.93	37
Ojikutu, 1965	Mainz ♂	40.3	1.20	74	45.2	3.46	74	66.9	3.02	74
Smith & Mitchell. 1973	Cumberland ♂ + ♀	36.48	4.57	252	42.13	3.92	252	66.77	2.99	252
Rigters-Aris, 1972/3	Dutch ♀	37.7	4.30	100	43.2	4.02	100	66.7	2.34	100
Robins, 1973 (x)	Blue-eyed Whites ♂	36.3	0.78	38	39.1	0.73	38	66.7	0.41	38
	Brown-eyed Whites ♂	35.3	0.64	46	39.4	0.59	46	66.5	0.51	46
Smith & Mitchell. 1973	I. of Man ♂ + ♀	36.68	4.09	163	41.88	3.65	163	66.41	2.84	163
Leguebe, 1964	Belgians ♂	38.940	3.733	50	43.250	3.282	50	65.980	3.126	50
Leguebe, 1961	Bruxelles ♂	37.713	4.831	143	44.773	3.959	143	65.727	3.145	143
Fernández	Malmö ♂	34.630	4.894	255	41.068	4.892	254	65.615	3.945	249
	York ♂				41.258	5.036	318	65.511	5.011	318

Table IX.2-1. Populations arranged by decreasing order of reflectance at filter no. 9.

		Filter 601			Filter 605			Filter 609(xx)		
Author	Population	x	s	N	x	s	N	x	s	N
Sunderland et al., 1973	Ballinlough ♂ + ♀	35.833	4.024	232	41.466	3.868	232	65.212	2.928	232
Hayez, 1965	Brussels ♂	33.175	5.696	103	39.820	5.612	103	65.019	5.286	103
Fernández	Malmö ♀	35.221	5.084	382	42.129	4.925	382	64.939	4.321	380
	Durham ♂	35.579	5.040	33	41.109	4.746	33	64.845	3.358	33
	Durham ♀	38.170	4.908	46	42.893	4.038	46	64.815	2.772	46
Sunderland et al., 1973	Rossmore ♂ + ♀	35.091	4.094	201	41.208	4.211	201	64.717	3.203	201
Robins, 1973 (x)	Brown-eyed Whites ♀	33.2	0.63	35	37.7	0.48	35	64.7	0.38	35
Sunderland et al., 1973	Carnew ♀	37.23	4.17	162	42.12	4.01	162	64.64	2.85	162
Leguebe, 1964	Belgians ♀	35.389	3.647	45	42.400	3.096	45	64.589	2.971	45
Sunderland et al., 1973	Carnew ♂	34.86	4.36	105	39.37	4.36	105	64.40	3.52	105
Leguebe, 1961	Bruxelles ♀	36.500	3.978	177	44.568	3.618	177	64.285	2.925	177
Büchi, 1957/8	Calcutta o	28.50		10	38.75		10	64.25		10
Wassermann & Heyl, 1968	South Africans ♂ + ♀	30.826	5.628	217	38.792	6.735	217	63.952	10.914	217
Smith & Mitchell, 1973	Merthyr Tydfil ♂ + ♀	33.01	4.31	182	38.68	4.36	182	63,16	4.85	182
Tiwari, 1963	European mothers	34.93	3.09	23	38.58	3.97	23	62.97	3.17	23
Pijn-Tournel, 1966	Belgians ♂ + ♀	38.746	5.442	113	43.540	4.195	115	62.752	3.786	115
Fernández	Madrid ♀	32.574	4.956	116	39.210	5.179	115	62.535	4.062	115
Harrison & Owen, 1964 (x)	Liverpool ♂ + ♀	36.1	0.453	104	41.0	0.453	103	62.3	0.342	105

Author	Population	Filter 601			Filter 605			Filter 609(xx)		
		x	s	N	x	s	N	x	s	N
Fernández	Madrid ♂	30.386	4.706	104	36.742	4.318	104	60.967	4.217	104
Verhulpen, 1973	Belgians ♂ + ♀	32.329	4.082	82	37.561	3.695	82	60.866	2.730	82
Fernández	Århus ♂ + ♀	31.015	5.073	34	38.044	4.337	34	60.456	2.947	34
Sunderland. 1979	Iraq-Syria ♀	31.2	5.779	19	39.1	4.472	19	60.2	2.345	19
Harrison & Owen. 1967	Porto Alegre ♀	28.150		268	35.530		268	59.250		268
Sunderland, 1979	Turkey ♂ + ♀	29.192	5.078	55	37.058	3.970	55	59.202	2.767	55
	Palestine ♀	29.6	4.561	19	37.3	3.782	19	58.8	2.324	19
	Lebanon ♀	28.7	3.950	41	36.6	4.111	41	58.4	2.302	41
Tiwari, 1963	Indo-European children ♂ + ♀	26.637	3.394	35	34.148	3.910	35	58.261	2.549	35
Sunderland, 1979	Lebanon ♂	27.0	4.889	142	34.4	4.765	142	58.0	2.916	142
Harrison & Owen, 1967	Porto Alegre ♂	25.500		216	33.610		216	57.920		216
Harrison & Owen, 1964 (x)	B_E hybrids ♂ + ♀	27.2	1.320	30	34.7	1.122	30	57.9	0.926	30
Sunderland, 1979	Palestine ♂	26.4	5.040	40	33.6	4.743	40	57.6	3.082	40
	Iraq-Syria ♂	27.4	4.506	35	34.1	4.405	35	57.4	3.098	35

IX.2. Results and discussion

The populations to be examined are all included in table E . Some are non-European - although Caucasoid - and will be considered for purposes of general comparison. Fig. IX.2-1 is a graphical representation of their relative positions. The reflectance figures employed here are all 'raw', without any of the corrections due to the exposure variables. In all three cases they have been arranged in decreasing order of reflectance at filter 609 (table IX.2-1). Such a bewildering variety of coordinates (geographical, genetical and cultural) may be expected to produce highly significant differences between many of the groups. An analysis of variance (one-way) shows the overall F to be significant at a level lower than 0.001. For the calculations all groups with fewer than ninety-nine cases have been disregarded, in order to secure fulfilment of the central theorem (Hays, 1981) and the South African sample with its widely diverging standard deviation has also been omitted.

Source	S.S.	df	variance estimate	F	Significance
Between groups	15324.892	20	766.245	55.083	0.001
Within groups	49049.139	3526	13.911		

Table IX.2-2. Oneway anova between populations. N > 99.

For several reasons I have decided to compare these populations on the basis of their melanin concentrations alone. The inverse of melanin concentration has been repeatedly shown (Harrison & Owen, 1956/7; Harmse, 1964) to be linearly related to measurements at filters 608 and 609. 1) It is mela-

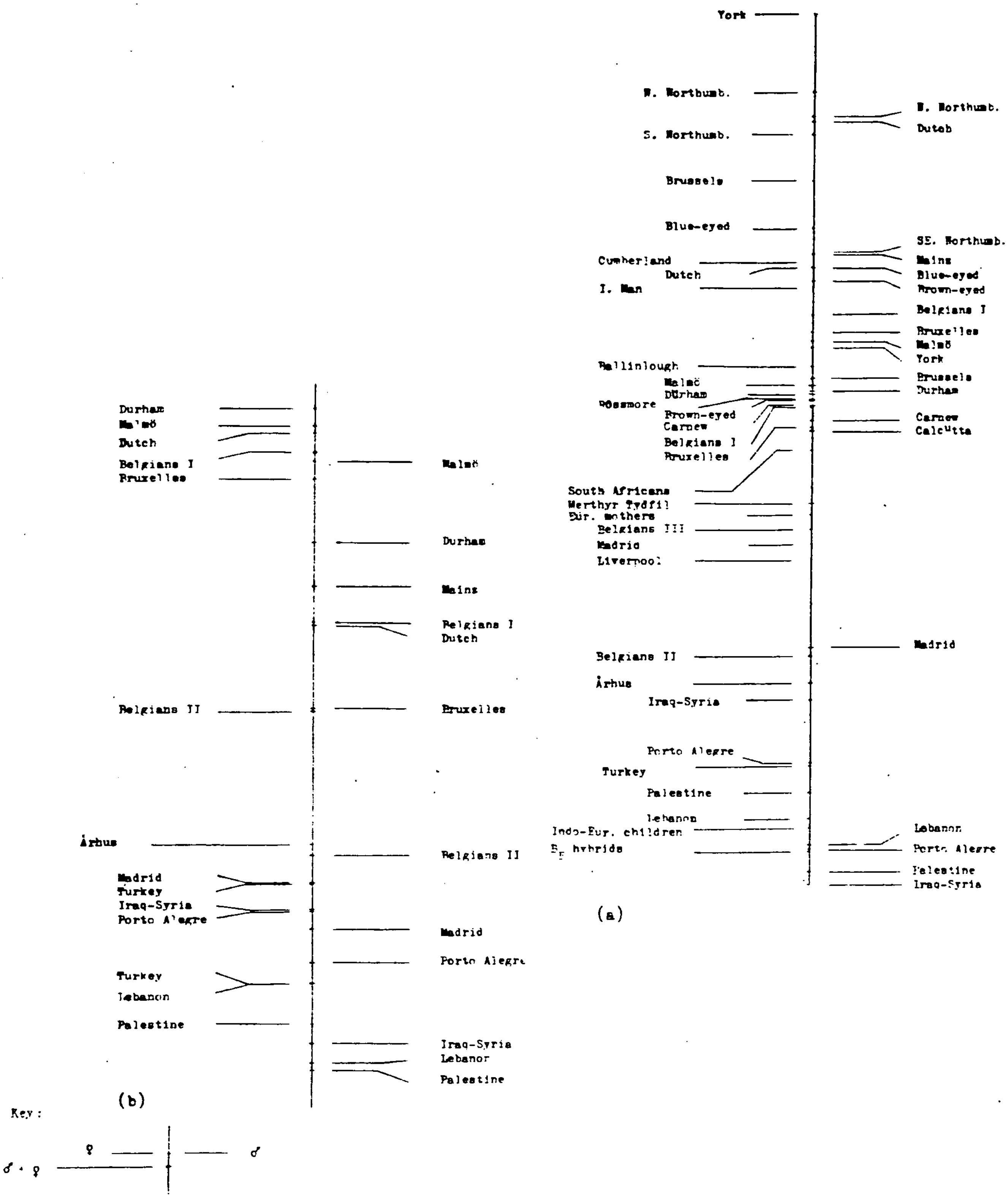

Fig. IX.2-1. Inter-population comparisons: (a) upper inner arm, (b) forehead.

nin, and probably thickness of the stratum corneum, which seems to have a protective function subject to selective pressures; melanoid, carotene and blood - although adding to colour - do not seem to have any such a role. Ergo, the variability added by them rather obscures the meaning of the picture in evolutionary and selective terms. 2) An analysis based on the X-Y-Z or even all nine filters is utterly impossible due to the character of the available data. Under these circumstances calculations based on filters 601, 605 and 609 - although more informative in terms of colour variability - do not provide any 'definitive' information on either colour or melanin, whilst 609 (readings at 608 being normally missing) is the best in this latter respect. 3) Filter 609 is in addition the only one which practically always corresponds to the same wavelength - 685 nm.

No planned comparisons between groups have been attempted since any relatively clear picture of their differences would require t-tests in numbers such as to highly increase the chances of spurious significance levels showing up. The probability of at least one out of a group of m independent t-tests carried out, spuriously showing significance at the level is: $1 - (1 - \alpha)^m$, which if α is small tends to the value $m\alpha$. Instead a battery of post hoc comparisons, the Sheffé method, have been employed. Here the probability of over-looking a true difference is greater (type II error), but the probability of commiting a type I error in one or more cases is only α. Moreover this method is known to be relatively insensitive to departures from normality and homogeneity of variance (Hays, 1981).

As proper material for calculations, all groups have been selected, with the exception of the South Africans because of their extremely deviant variance. The following clusters resulted: 1) the females from

York and from SE. Northumberland, with all populations in between, define the lightest block, 2) populations between the females from Brussels and the males from York, 3) from Ballinlough to Belgians III, 4) all populations between the Madrid women and the Palestinean women, 5) from the Lebanese females to the Iraq-Syria males.

At least within the main racial stocks concentration of melanin can be safely assumed to be a continuous variable. Under these circumstances, subdividing the range of variation of this variable, within any of those stocks, and pretending that grouping to be definitive is statistical as well as biological nonsense. The clustering process can be initiated at any point along the range of the variable and many other groupings could be produced, all of them equally valid. The present partition provides only a framework which automatically answers some of the questions which the reader might like to ask about interpopulation differences. If it does not, the appropriate clustering can be produced in similar way by choosing a more adequate departure point.

Since the choice here fell upon the York males - the clustering process proceeding 'upwards' and 'downwards' from there - one can be sure that at least the Dutch males and the Belgians II differ significantly from the rest of the Netherlands and Belgium as well as from each other. Also the females from York, three of the Northumberland samples and the pooled men and women from Liverpool are significantly different from the rest of the British and Irish samples, not to mention differences from each other. Since the Scheffé method is a rather conservative one, when compared for instance with the t-test, it can be expected that the use of the latter would reveal even more significant differences.

Within Sweden, when 'raw' reflectance readings are employed, no statistically significant difference was found between different geographical areas (significance levels: 0.811 for 320 pure females and 0.441 for 205 pure males) (table IX.2-3), in spite of the fact that the country stretches across a full fourteen degrees of latitude. Even if the Swedes are traditionally in Anthropology looked upon as a comparatively homogeneous group and even if some of the sub-samples are rather small, the uniformity of the sample in terms of colour - geographical diversity notwithstanding - should warn us against uncritically accepting the presence of such pronounced differences within the British block and especially within Belgium and the Netherlands. The Århus (Danish) sample is rather too detached from Swedes and other northern European populations as well as closer than was foreseeable to the Middle Eastern block. Regarding Sweden, the North European centre of blondism, it defies expectation by occupying a comparatively low position, whilst the Spaniards take a 'logical' intermediate place between other Europeans further North and the Middle Eastern groups. Again, Liverpool and Belgians II - when compared with most groups of their own kinds and to Madrid - seem to be placed lower than expected.

Were anybody reflecting upon the possibility - as an overall explanation - that whilst the lightest European groups might be in their right positions the Swedes may have been measured with a spectrophotometer which 'read' too low, it should be remarked that all Swedes and Spaniards and most of the British were tested with the same instrument. This means that a 'corrective' upward jump of the Malmö subsamples would imply a proportionate displacement upwards of Madrid and Durham, placing the Spaniards in a position extremely difficult to explain, unless we were prepared to accept that the whole of the third block and possibly part of the second were also to be shifted towards the top.

It would seem that among populations containing non-negligible and/or different percentages of 'sunbathers', with broadly similar patterns of forehead exposure (use vs. absence of fringe, hats) and living in approximately comparable environments, the forehead would be a better site for comparison than the upper arm, since - although the colour of the forehead is further away from the basal pigmentation - relative distances between populations are not likely to be as affected by different habits of exposure as when considering the upper arm. With the forehead means, (fig. IX.2-1,b), a somewhat different picture is found. Within the North European block Belgians II and Århus still lie rather low when compared respectively with their Belgian and Scandinavian counterparts, although their position with respect to Spaniards agrees better with what could be forecast. Unfortunately some populations are unrepresented at the forehead site (notably Northumberland, York and Liverpool) for which reason we are left without means of comparison. Sweden has climbed up a few 'logical' steps and only the Durham males are placed higher, whilst the Dutch females and the Belgian I females come between the females and the males from Malmö. Even if this picture comes closer to the expected, there is in the author's opinion sound ground for questioning whether not much of the unexpected ranking is to be attributed to technical error. Although this is presumably impossible to establish, it provides a further warning of the need to control all sources of spurious variation in spectrophotometry.

```
SUBFILE   SVE
- - - - - - - - - - - - - - - - - - - - - - O N E W A Y - - - - - - - - - - - - - - - - - -
```

♂

```
      VARIABLE  UIA9
                                             ANALYSIS OF VARIANCE

                   SOURCE        D.F.   SUM OF SQUARES        MEAN SQUARES    F RATIO   F PROB.
         BETWEEN GROUPS            11        173.4058              15.7642     1.008    0.4405
         WITHIN GROUPS            193       3017.6424              15.6355
         TOTAL                    204       3191.0481

SUBFILE   SVE
- - - - - - - - - - - - - - - - - - - - - - O N E W A Y - - - - - - - - - - - - - - - - - -
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♀

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      VARIABLE  UIA9
                                             ANALYSIS OF VARIANCE

                   SOURCE        D.F.   SUM OF SQUARES        MEAN SQUARES    F RATIO   F PROB.
         BETWEEN GROUPS            15        206.0685              13.7379     0.672    0.8113
         WITHIN GROUPS            304       6211.5703              20.4328
         TOTAL                    319       6417.6367
```

Table IX.2-3. Apparent uniformity of pigmentation of the skin in Sweden. (Raw figures compared. Independent variable: landskap).

Summary

A number of populations were analysed by means of the Scheffé method for post hoc comparisons. After careful consideration of the results, it is strongly suspected that some fraction of the observed interpopulational variability is just the outcome of plain operational error.

It is felt by the author that the use of spectrophotometry in the field of physical anthropology demands instruments of greater precision than those currently used until now. Deeper insight, on the experimenter's side, into the basic technical aspects of that methodology would also help.

CHAPTER X

X. Conclusion

When pondering the mathematical layout for correlation and regression analysis, a very relevant matter concerns the evaluation of the risks involved in the categorization of a basically continuous variable. They have been treated in some detail in section IV.1. They may range from the creation of inexistent linear correlations to the oversight of underlying curvilinear trends.

It may be added that, in general, the existence of profound differences in national idiosincracy - by modelling the manner of exposure to UV-radiation, the ultimate agent - will result in diversification within each of the exposure variables. In fact, each of them is not - as we have been forced to assume - a unique variable, but several related ones, as its categories will fail to be universally aprehended in the same way by everybody. The differences transcend the level of frequencies to go beyond the label itself. Two typical pictures of sunbathing behaviour - that of a well-oiled Swede, patiently lying down in the beach, his/her arms rotated outwards for a more even tan on the inner side, compared to that of a Spaniard camping in the sierra or sitting at a bar terrace in the beach - sufficiently illustrate the point. Interpopulational similarities and differences within a nominally unique exposure variable will, of necessity, be deceiving. That background inconsistency ought to account for part of the aforementioned lack of uniformity in correlation patterns, in between-sample and between-sex comparisons.

Other factors, equally contributing to diminished uniformity of correlation patterns, were pointed out in chapter V as having to do with structural inequalities between the samples, in terms of - above all - the functions of days- and age. When extrapolating to the population level, a small-sized sample will stand a poor chance of being representative. Part of the discrepancies presented by the British samples may just be the outcome of a rare sampling of cases.

The combined effect from all these factors is to diminish the reliability and, at times, the representativeness of the results. This circumstance must be borne in mind by the experimenter when planning his/ her research. There may be no practicable way out of the problem for every particular situation, but a state to strive after should be that, whenever possible, each of the variables should extend along the greatest range of values compatible with the structure of the population. That, plus stratified sampling, should take care of most problems - except those derived from the categorization of continuous variables. Unfortunately, accurate stratified sampling requires a priori knowledge of the population structure - a requirement rarely satisfied.

Sections IV.1 to IV.3 have elicited a number of interesting trends concerning the correlations between age and the behavioural variables, on the one hand, and pigmentation (nine filters, two sites), on the other. A schematic resume of the pattern of correlations is shown in table X-1. Although the existence of numerous exceptions severely restrict its applicability, certain general traits can be singled out:

1. The correlation coefficients are greater in numerical value among men than among women.
2. They are normally greater at the upper inner arm than at the forehead (except for dimension age: viceversa).
3. When the functions of age and days- are involved, the correlation coefficients are generally best among the first filters. A minimum is reached at the fifth filter or nearby.
4. The best predictors are habitu, newhat and crfhnow (cruianow among Spanish females), among the exposure variables; the logarithmic and inverse functions of days-, and the lower powers of age and days- .

	atterns of variation of the simple correlation coefficients			the signs of the coef. are normally ...	percentages of variance explained at filters 1, 5 and 9.
	along the spectrum (filters 1 to 9)	within each filter	between samples		
I. Exposure variables	1. No general trend for variation of the coef. 2. Coef. better among men than among women (except for cr-now: viceversa). 3. Coef. better at uia than at fh (except for cr-now: viceversa).	1. Coef. (leaving cr-now outside) generally decrease in the order: newhat>habitu>habitf>cr- , among men. Among women habitu>newhat. When introducing cr-now, crfhnow tends to overtake the 3rd place among males (1). Among females, crfhnow (2) tends to occupy the 1st place -with the other in a 3rd to 5th place. 2. Sign. does not norm. appear beyond the level of the 2nd variable. (1) Except for British ♂ (2) Among Sp ♀: cruianow	1. Sign. figures deteriorate with decreasing size of the sample (1). (1) The trend is not clear for cr-now (in spite of the British showing the worst figures).	1. habit-: - (1) 2. cr-: + 3. cr-now: + (2) 4. newhat: - (1) Occasional exceptions at uia between the 5th and 7th filters. (2) Many exceptions. Exceptions: habitu: Br ♂ (7) cruia: Sw ♂ ,♀ (8) crfh: Br ♂ (6), Br ♀ (4) cruianow: Sp ♂ (4), Br ♀ (all) crfhnow: Sw ♀ (all), Sp ♂ (6), Br ♂ (4), Br ♀ (6) newhat: Sp ♀ (5)	1. No general homogeneity of effects. 2. uia, fh (%): max. among Br (most often) and Sp, (♂ , ♀).
II. Functions of days-	1. Coef. norm. better (decreasingly so) among the first filters (1). A minimum is reached at the 5th filter or nearby. 2. Coef. better among men than among women 3. Coef. better at uia than at fh. (1) Br ♂ , ♀ (uia, fh): norm. better among the last filters.	1. Coef. increasingly worse with ascending order of power. d-in and d-lg usually undergo a common fate. They often are the best predictors. 2. Sign. does not norm. appear beyond the quadratic level (for polynomials). d-lg is perhaps somewhat better than d-in.	1. Sign. figures deteriorate with decreasing size of the sample.	1. powers of days-: + (1). 2. d-in: - 3. d-lg: + (1) Exceptions predominant from 4th and 3rd powers of daysfh (Sw ♀ and Sp ♀ resp.) onwards; abundant from 1st power among central filters (Br ♀). d-in and d-lg present virtually no exceptions Exceptions: uia: norm. affecting filters between 2nd and 5th. Br ♂ (uia): opposite to every general rule for signs (practically at all filters and functions of days- and age). fh: norm. affecting the 5th filter (less regularly, others as well).	1. No general homogeneity of effects. 2. uia (%): max. among Sw ♂ , ♀ - min. among Sp ♂ , ♀ . fh (%): max. among Sp ♂ , Br ♀ - min. among Sw ♂ , ♀ .
II. unctions f age	1. Coef. norm. better among the first filters (1); A minimum is reached at the 5th filter (or thereabouts), although sign. figures crop up often among the intermediate filters (leaving one of the ends outside). 2. Coef. norm. better among men than among women. 3. Coef. better at fh than at uia (opposite to II). (1) Sw ♀, Sp ♀ (uia) and Sp ♀, Br ♀ (fh): norm. better among the last filters.	1. Coef. increasingly worse (often) with ascending order of power 2. Sign. norm. appears at the three levels of power or not at all.	1. Sign. figures deteriorate with decreasing size of the sample (1). (1) fh: size does not seem as restrictive there.	1. powers of age: + (uia), - (fh) (1). (1) Sp ♂ and Br ♂ (fh): +, for the two last filters at each power of age. Br ♀ (uia): -, predominant at each power of age.	1. No general homogeneity of effects. 2. uia (%): max. among Sw ♀., Sp ♂ - min. among Sw ♂ , Br ♀. fh (%): max. among Sw ♂ , ♀ - min. among Sp ♂ , ♀.

Table I-1. General patterns of correlation (mainly bivariate) between some of the independent variables and pigmentation. (Sections IV.1 to IV.3).
All filters and samples. Males and females separate.

5. In general, the levels of significance deteriorate with decreasing size of the samples.
6. Generally speaking, the signs of the correlations are positive, except for the following variables: habit-, newhat, d-in and - at the forehead - the powers of age.

Most of these traits could be forecasted a priori in terms of, for instance, increased behavioural distance between the categories of the exposure variable concerned - producing a greater Δy in formula IV.1-1 - (men vs. women, inner arm vs. forehead), the increased absorption power of melanin at shorter wavelengths (greater coefficients among the first filters) or the asynchronism of the changes in melanin and haemoglobin content after exposure of the skin to UV-radiation (conflicting trends lowering the strength of the correlations at the central region of the spectrum). So many agents are, however, at play in every case that any safe explanation must be validated against a formula. In the case of the exposure variables, for example, the correlation coefficient is seen to depend mathematically on a few factors, which do not only have to do with the actual score values but also with the nature of their distributions. These factors are: 1) the number of cases in each category (which, together with the values assigned to the categories, determine s_x's value), 2) the values adopted by the dependent variable, and 3) their degree of dispersion (which, together with the two aforementioned, determine s_y and Δy). In the present context, however, explaining each case in terms of formula IV.1-1 is of little more than anecdotic value, as no general rule can be issued concerning the universal validity of any particular mechanism.

When considering the combined effect of all behavioural variables and functions of age, dimensions age, and days- are quantitatively and qualitatively predominant over the others as predictors. The pattern is as following:

1. The functions of age and days- are more preponderant among males than among females.
2. Their predominance is greatest among Swedes and smallest among Spaniards.
3. Their preponderance is more marked at the forehead than at the inner arm.
4. After the functions of days- and age, the most important predictors are habitu, at the inner arm, and newhat, at the forehead.

And when considering the multiple correlation coefficient itself:

1. R is generally greater among males than among females.
2. R is also greater at the forehead than at the inner arm.
3. At the inner arm, the multiple correlation coefficients normally diminish from both ends of the spectrum towards the middle.
4. R often (but not always) diminishes with decreasing sample size.

Most of these traits just reproduce at the multiple correlation level the conditions previously observed for bivariate correlations. Owing to the nature of the regression analysis method employed, each of the predictors may potentially represent more than one dimension, for which reason it would be misleading to look at the variables in any regression equation as necessarily standing for all dimensions worthy of consideration in a unequivocal manner.

Variable sex, when males and females are pooled together, turns out to be an important predictor. Males are darker than females at practically every filter and sample. The relevance of big sample sizes is probably exemplified by the general improvement in uniformity of regression patterns brought about by the pooling of sexes.

When the geographical coordinates are introduced into the picture, dimensions age, days- and - often - sex are found to be more important as predictors than geographical origin. In spite of the survey taking place during the 'dark' period of the year, behaviour proved to be more important than geography as a source of internal pigmentary variability. It becomes evident that no period of the year can a priori be held as safe. Comparing populations on the basis only of their raw reflectance figures, without taking the behavioural factors in consideration, is a very hazardous game. Thus, the need somehow to have that sort of factors included (ideally, under control) in studies of human 'skin colour' is emphasised once more.

The relevance of the issue is dramatically illustrated by the Swedish case, where the introduction of the behavioural variables allowed the experimenter to disclose previously undetected pigmentary differences between regions. There, in accordance with the expected in terms of ecological factors, southern Sweden turned out to be darker than the north - while, in an alike manner, central Spain appeared darker than the periphery. These results also agree basically with the tha rather scanty available knowledge on the subject. In those two samples pigmentation of the skin follows ecology more closely than pigmentation of either eyes or hair does.

A number of interesting associations between the three pigmentations (skin, eyes and hair), the blood groups and stature were disclosed. Others with metrical traits may perhaps be suspected. Relationships between populations established on the basis of polymorphic traits can be used to check on those based on polygenic (mainly metric) traits, a sort of anthropology which has fallen in disgrace during the last thirty years - one of the reasons for it being the lack of agreement about the importance of the multifactorial genetics' role in modelling the phenotype. Relatively recent research, like Beckman's (1959), suggests that a potentially very productive field of research lies open in that direction. The simultaneous use of both polygenic and polymorphic traits provides us with a tool of interesting possibilities to investigate the reliability of anthropometry in racial studies.

The possibility of a shift in gene frequencies in the three countries under study - as a consequence of the existence of very clear sexual preferences in the field of pigmentation - although conceivable, is very difficult to evaluate, as dependent on a series of factors of difficult quantification. The relevance of a such process is, however, easy to grasp.

In addition to the sources of error which could be labelled 'statistical', the spreading of the reflectometric techniques in the domain of human biology has been afflicted by a number of 'technical' problems. These derive from the diversity of filter sets, spectrophotometers and - at the beginning - standard surfaces in use, not to forget plain operational error - resulting from both the apparatus' shortcomings and the anthropologist's limitations as a technician. Section IX.2 bears witness of the potential importance of this last source of spurious variability, as there are - in the opinion of the author - strong arguments in favour of a technical origin for part of the differences observed between the populations analysed in that section.

Reflectophotometry must be approached with a greater insight into its technical aspects. Thoroughful information (prior and after purchasing the apparatus) and technical service (periodic maintenance) must be demanded from the technical firm, so that - ideally - the experimenter should be able to prevent or avoid the most common pitfalls accompanying the use of the technique, and to neutralize them - if necessary - by adopting the appropiate measures (either personally or vicariously). Before that new state is reached, however, the anthropologist must acquire the consciousness of the urgent need for it.

Modern studies of human 'skin colour' frequently display a surprisingly high degree of confussion concerning the adequacy of their methodologies to their nominal goals. Nine, three or one filters, the C.I.E. specifications or even the filters 604, 607 and 608 - all have been proposed as the best possible methodology; it is often overseen that being the the aims involved totally different, comparing their methodologies is of no consequence. Only an infinite number of filters can accurately represent a colour - by means either of the whole reflectance curve or of the C.I.E. specifications, to be extracted from it. Among the instruments available in the market, the automatic recording type provides the closest aproximation to that condition. A nine filter curve is just too ambiguous for such a purpose. It furnishes, however, orientative information about the concentrations of melanin and haemoglobins, but not about their absolute values. The same goes for the readings with the 608 or the 609 filters concerning melanin content. The emphasis are then in colour versus contents of diverse epidermic 'colourants' - two widely different things, since several colourants contribute to the final chromatic result. On the other hand, filters 604, 607 and 608 may constitute the best discriminant three for Leguebe's (1979 a) sampling of populations, but not necessarily for every other possible group of samples. Indeed, they do not either have to be the best triad among all those candidating to yield the best representation of any particular abridged curve.

When dealing with melanin, as with any other pigment, the distance from the melanosomes to the epidermis' surface is nearly as interesting as their number. Displacement of the melanin granules towards the surface, even without a corresponding change in the total amount of melanin, shows up as a general depletion of the reflectance curve, especially at the short wavelengths. Since readings at the red end of the spectrum are nearly insensitive to positional changes, that information would be totally lost without a knowledge of other region/s of the curve. It must be conceded, however, that, in terms of the information with biological implications which the anthropologist may as yet be able to squeeze from the curve, most of it is still superfluous to him. In spite of that, for the reason firstly exposed and in foresight of the likely demands of future research, as much as for gaining exactitude and for saving valuable time in the field, the use of an automatic recording spectrophotometer is to be warmly recommended.

Homogeneity of methods and tools must be given top priority. On this respect, it must be emphasised that calibration of alike instruments on the magnesium carbonate's surface is no guarantee for production of 'identical' reflectance readings on one and the same object. That failure is probably the most common source of operational error in skin colour studies. Reliable maintenance service and standard coloured cards should be made available by the manufacturers, and the cards should be purchased by each anthropology department in order to ensure comparability of performance. Portability is indispensable, and the incorporation of a device for automatic computation of the X-Y-Z specifications, although not essential, would be highly convenient. All those technical requirements are nowadays satisfied by many spectrophotometers, perhaps without portability. If not yet in the market, it may probably be presumed that the portable automatic spectrophotometer will soon be a reality.

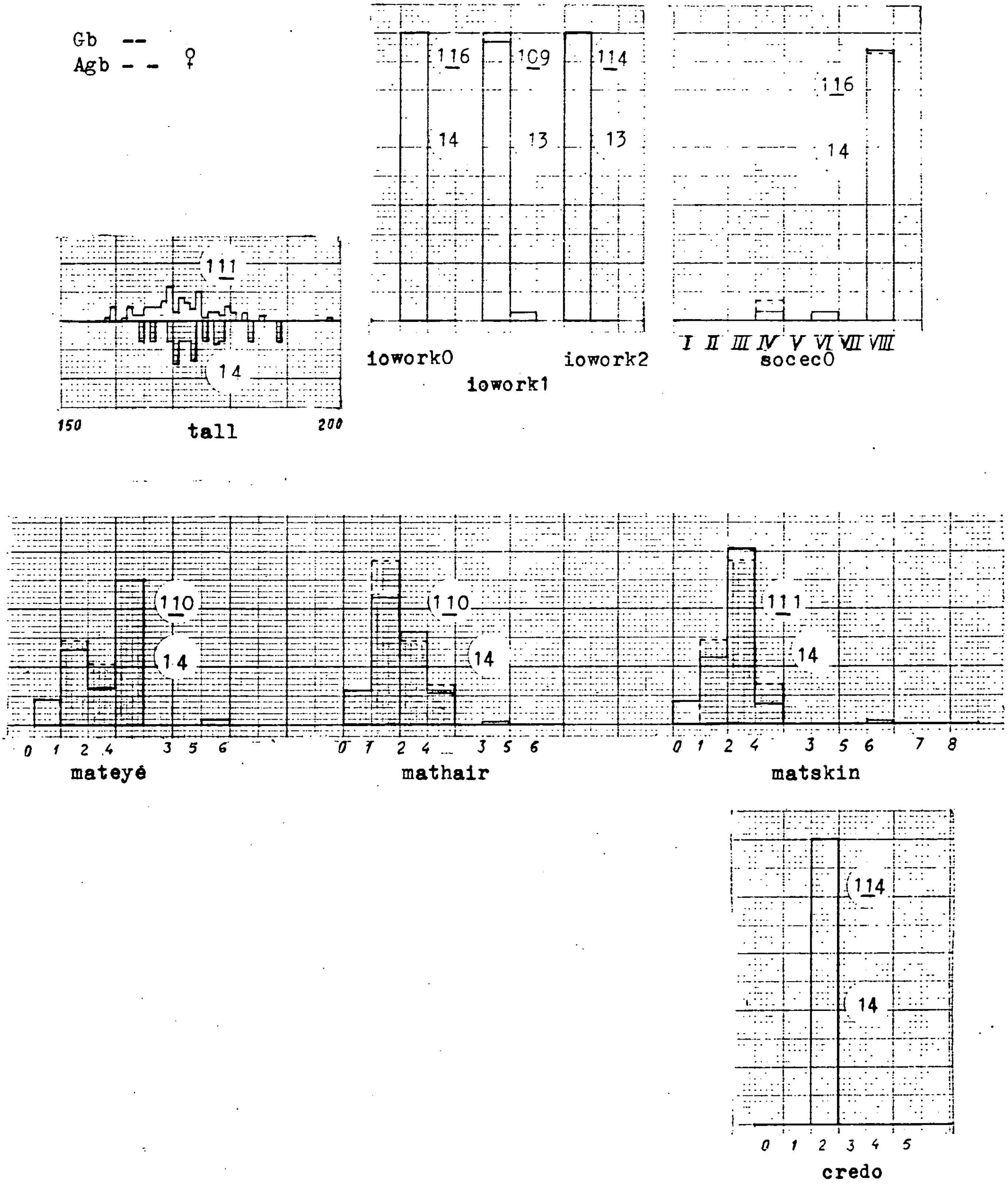

Fig. A-2 . Distribution of frequencies for the most important of the behavioural and socioeconomic variables.

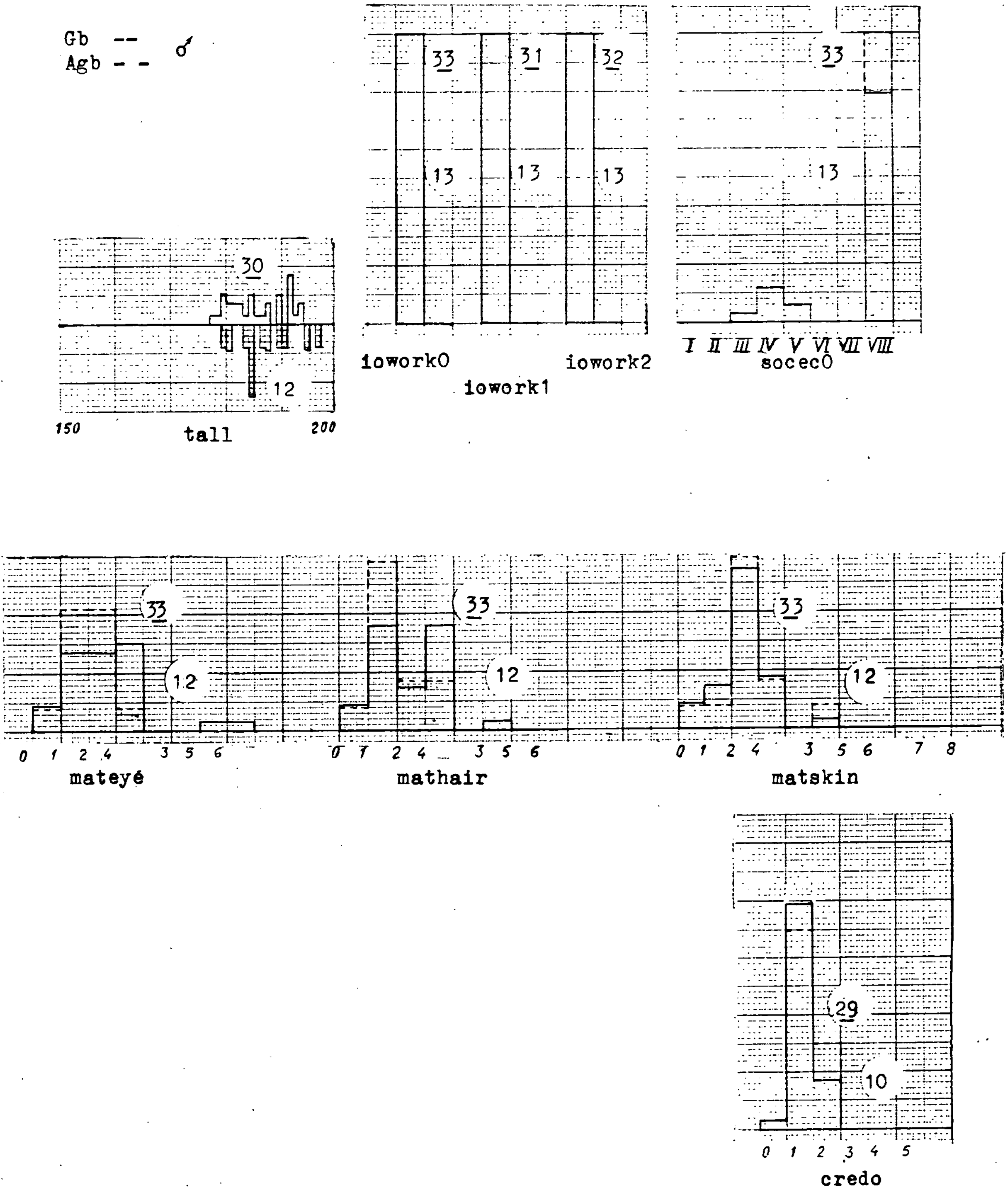

Fig. A-2. Distribution of frequencies for the most important of the behavioural and socioeconomic variables.

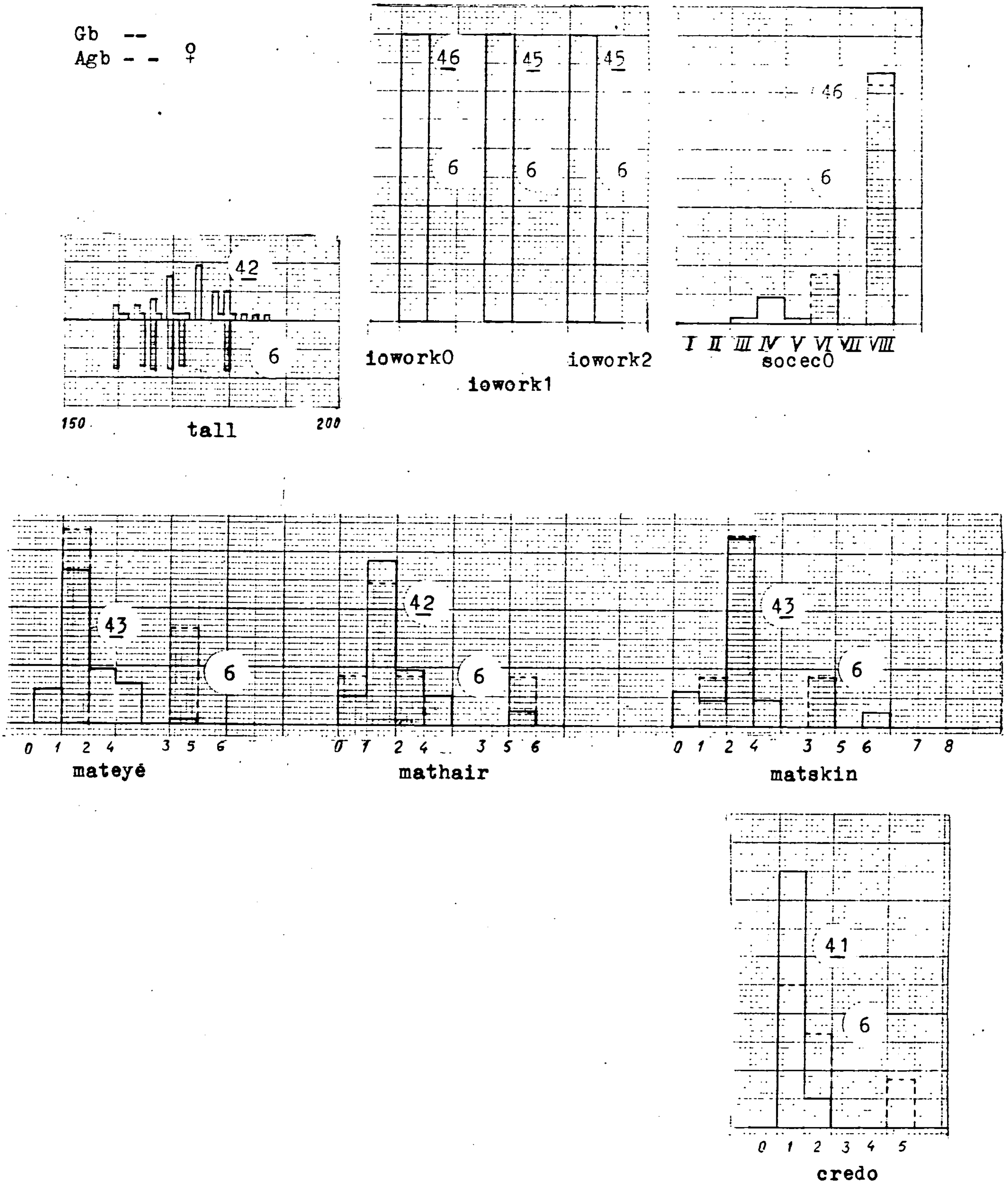

Fig. A-2 . Distribution of frequencies for the most important of the behavioural and socioeconomic variables.

Appendix B,1

♂		Swe		♀			
Mean Mode Kurt.	St. error St. dev. Skew.	N (Sig.) (Kurt.)	Total (Skew.)	Mean Mode Kurt.	St. error St. dev. Skew.	N (Sig.) (Kurt.)	Total (Skew.)
34.630 31.000 0.132	0.306 4.894 -0.052	255 –	260 –	35.221 35.000 0.354	0.260 5.084 -0.451	382 –	393 +
43.684 46.000 0.410	0.339 5.415 -0.396	255 –	260 +	43.688 44.000 0.328	0.278 5.426 -0.431	382 –	393 +
44.492 45.000 0.402	0.350 5.591 -0.236	255 –	260 –	44.011 44.000 0.196	0.288 5.635 -0.558	382 –	393 +
43.739 46.000 0.519	0.334 5.324 -0.329	254 –	260 –	43.933 43.000 0.268	0.272 5.316 -0.473	382 –	393 +
41.068 39.000 0.463	0.307 4.892 -0.203	254 –	260 –	42.129 41.000 0.018	0.252 4.925 -0.275	382 –	393 –
46.256 47.000 0.392	0.289 4.611 -0.024	254 –	260 –	47.176 50.000 0.267	0.241 4.703 -0.390	382 –	393 +
57.309 59.060 1.172	0.303 4.755 -0.522	252 +	260 +	57.498 59.000 1.117	0.250 4.874 -0.847	380 +	393 +
64.219 67.000 0.812	0.245 3.890 -2.416	252 –	260 –	63.659 66.000 2.142	0.234 4.556 -1.177	380 –	393 +
65.615 68.000 1.518	0.250 3.945 -0.563	249 +	260 +	64.939 66.000 1.111	0.226 4.409 -1.036	380 +	393 +

28.362 26.000 0.363	0.294 4.694 0.569	255 –	260 +	29.527 29.000 0.248	0.240 4.699 0.169	383 –	393 –
35.517 33.000 -0.046	0.330 5.269 0.212	255 –	260 –	36.992 35.000 0.082	0.267 5.224 0.060	383 –	393 –
36.100 36.000 0.053	0.346 5.524 0.411	255 –	260 +	37.094 40.000 -0.013	0.273 5.343 -0.071	383 –	393 –
35.510 34.000 0.136	0.331 5.267 0.367	254 –	260 +	37.499 39.000 0.231	0.266 5.215 0.152	383 –	393 –
33.513 33.000 -0.192	0.334 5.323 0.301	254 –	260 –	35.604 35.000 0.034	0.269 5.264 0.282	383 –	393 –
38.957 40.000 0.183	0.354 5.641 0.362	254 –	260 +	40.817 42.000 0.130	0.258 5.045 -0.066	383 –	395 –
52.342 53.000 0.752	0.350 5.554 -0.315	252 –	260 –	53.902 53.000 2.502	0.253 4.926 -0.832	379 –	393 +
61.433 63.000 1.152	0.301 4.780 -0.618	252 +	260 +	62.316 62.000 2.771	0.221 4.322 -0.936	381 –	393 +
63.789 64.000 0.274	0.262 4.127 -0.396	249 –	260 +	64.315 63.000 0.544	0.199 3.887 -0.382	381 –	393 +

Table B.1. Some elementary statistics for the non-composite samples. Fulfilment of the normality criteria.

♂		Spa				♀	
Mean Mode Kurt.	St. error St. dev. Skew.	N (Sig.) (Kurt.)	Total (Sig.) (Skew.)	Mean Mode Kurt.	St. error St. dev. Skew.	N (Sig.) (Kurt.)	Total (Sig.) (Skew.)
30.386 29.000 0.180	0.461 4.786 0.547	104 –	104 –	32.574 30.000 -0.321	0.460 4.956 -0.319	116 –	116 –
38.330 37.000 0.072	0.505 5.154 0.353	104 –	104 –	40.414 40.000 -0.134	0.495 5.335 -0.351	116 –	116 –
38.707 36.000 -0.254	0.520 5.301 0.470	104 –	104 –	40.281 41.000 0.166	0.505 5.416 -0.399	115 –	116 –
38.342 37.000 -0.232	0.485 4.946 0.364	104 –	104 –	40.889 40.000 -0.031	0.455 4.875 -0.074	115 –	116 –
36.742 36.000 0.196	0.423 4.318 0.337	103 –	104 –	39.210 35.000 -0.367	0.483 5.179 -0.284	115 –	116 –
41.883 39.000 -0.466	0.448 4.544 0.269	104 –	104 –	44.750 41.000 1.503	0.510 5.474 0.129	115 +	116 –
52.611 53.000 -0.085	0.444 4.530 0.119	104 –	104 –	54.398 56.000 2.650	0.463 4.934 -1.289	115 +	116 +
58.841 59.000 0.189	0.419 4.269 0.353	104 –	104 –	60.452 62.000 0.357	0.372 3.994 -0.385	115 –	116 –
60.967 58.000 -0.195	0.414 4.217 0.196	104 –	104 –	62.535 62.000 0.169	0.379 4.062 -0.337	115 –	116 –
21.825 19.000 1.003	0.354 3.615 0.724	104 –	104 ←	23.464 22.000 0.066	0.382 4.113 0.388	116 –	116 –
28.450 29.000 -0.772	0.412 4.199 0.056	104 –	104 –	30.178 30.000 -0.077	0.401 4.317 -0.106	116 –	116 –
28.474 24.000 0.506	0.411 4.188 0.340	104 –	104 –	30.092 29.000 -0.225	0.435 4.662 -0.182	115 –	116 –
28.270 25.000 -0.175	0.376 3.838 -0.022	104 –	104 –	30.330 30.000 0.643	0.413 4.427 0.393	115 –	116 –
27.473 24.000 -0.506	0.378 3.853 0.165	104 –	104 –	29.869 32.000 0.233	0.394 4.225 -0.090	115 –	116 –
32.183 33.000 -0.466	0.420 4.280 0.116	104 –	104 –	35.354 33.000 0.787	0.444 4.764 0.464	115 –	116 –
45.096 40.000 0.017	0.434 4.429 0.126	104 –	104 –	46.535 49.000 0.526	0.441 4.726 0.110	115 –	116 –
53.287 52.000 -0.381	0.460 4.692 -0.063	104 –	104 –	54.467 52.000 0.356	0.443 4.748 0.153	115 –	116 –
56.724 59.000 -0.208	0.404 4.122 -0.049	104 –	104 –	57.430 59.000 0.090	0.413 4.427 0.136	115 –	116 –

Table B.1. Some elementary statistics for the non-composite samples. Pulfilment of the normality criteria.

♂				Gb		♀	
Mean Mode Kurt.	St. error St. dev. Skew.	N (Sig.) (Kurt.)	Total (Skew.)	Mean Mode Kurt.	St. error St. dev. Skew.	N (Sig.) (Kurt.)	Total (Skew.)
35.579 29.000 -0.126	0.877 5.040 0.038	33 -	33 -	38.170 36.000 -0.826	0.724 4.908 -0.143	46 -	46 -
41.597 39.000 -0.246	0.870 4.999 -0.133	33 -	33 -	44.217 39.000 -0.720	0.724 4.908 0.071	46 -	46 -
43.858 42.000 0.425	0.772 4.433 -0.028	33 -	33 -	45.967 44.000 -0.556	0.637 4.317 -0.127	46 -	46 -
43.036 46.000 -0.281	0.728 4.184 -0.224	33 -	33 -	45.476 46.000 -0.763	0.589 3.994 0.187	46 -	46 -
41.189 39.000 -0.003	0.826 4.746 -0.154	33 -	33 -	42.893 40.000 -1.064	0.595 4.038 0.346	46 -	46 -
45.133 44.000 -0.025	0.636 3.655 -0.337	33 -	33 -	46.998 42.000 -0.792	0.568 3.855 0.351	46 -	46 -
56.594 53.000 -0.183	0.727 4.178 -0.131	33 -	33 -	57.770 57.000 -0.491	0.516 3.501 0.180	46 -	46 -
62.536 61.000 -0.158	0.564 3.238 -0.317	33 -	33 -	63.243 62.000 -0.494	0.453 3.074 0.175	46 -	46 -
64.845 65.000 -0.411	0.584 3.358 0.017	33 -	33 -	64.815 66.000 0.915	0.409 2.772 0.757	46 -	46 -
26.621 29.000 -0.485	0.537 3.083 -0.611	33 -	33 -	30.180 29.000 0.043	0.512 3.474 0.096	46 -	46 -
31.394 31.000 -0.092	0.569 3.266 -0.074	33 -	33 -	35.211 36.000 1.276	0.557 3.777 0.301	46 -	46 -
34.545 36.000 0.269	0.682 3.920 -0.366	33 -	33 -	37.054 37.000 0.894	0.649 4.402 -0.315	46 -	46 -
33.418 36.000 -0.674	0.667 3.831 -0.287	33 -	33 -	37.361 40.000 0.640	0.602 4.080 0.031	46 -	46 -
31.491 33.000 -0.740	0.662 3.804 0.043	33 -	33 -	35.250 35.000 1.381	0.641 4.346 0.859	46 -	46 +
36.636 37.000 -0.365	0.641 3.683 -0.168	33 -	33 -	40.074 36.000 -0.482	0.545 3.695 0.528	46 -	46 -
50.985 45.000 0.455	0.743 4.267 0.456	33 -	33 -	53.922 54.000 0.529	0.492 3.338 0.207	46 -	46 -
59.152 62.000 2.406	0.730 4.194 -1.252	33 -	33 +	62.389 63.000 0.628	0.525 3.560 -0.487	46 -	46 -
62.536 63.000 3.045	0.556 3.193 -1.493	33 +	33 +	64.554 65.000 0.227	0.470 3.191 -0.248	46 -	46 -

Table B.1. Some elementary statistics for the non-composite samples. Fulfilment of the normality criteria.

Appendix 8.2

SWE + ASWE (3/4)

♂

habit--or-- : 0 - 0 Mean Mode Kurt.	St. error St. dev. Skew.	N (Sig.) (Kurt.)	Total (Skew.)	1 - 0 Mean Mode Kurt.	St. error St. dev. Skew.	N (Sig.) (Kurt.)	Total (Skew.)	habit--cr-- : 1 - 1 Mean Mode Kurt.	St. error St. dev. Skew.	N (Sig.) (Kurt.)	Total (Skew.)
35.858 36.000 -0.168	0.544 4.894 -0.027	81 –	81 –	33.772 33.000 0.211	0.406 4.416 -0.111	118 –	118 –	33.287 30.000 -0.033	0.853 5.259 -0.165	38 –	38 –
45.152 43.000 -0.147	0.602 5.415 -0.320	81 –	81 –	42.816 41.000 -0.001	0.435 4.723 -0.390	118 –	118 –	42.424 39.000 0.214	0.909 5.604 -0.629	38 –	38 –
45.810 48.000 0.527	0.603 5.431 -0.600	81 –	81 –	43.548 42.000 0.784	0.492 5.339 0.113	118 –	118 –	42.618 41.000 -0.213	1.001 6.170 -0.513	38 –	38 –
44.844 46.000 0.078	0.634 5.708 -0.306	81 –	81 –	42.904 41.000 0.190	0.432 4.696 -0.369	118 –	118 –	42.757 44.000 0.378	0.812 4.938 -0.478	37 –	38 –
41.735 39.000 -0.076	0.559 5.032 -0.367	81 –	81 –	40.817 39.000 0.424	0.416 4.517 0.127	118 –	118 –	39.719 39.000 0.178	0.835 5.081 -0.408	37 –	38 –
47.259 47.000 -0.146	0.562 5.054 0.367	81 –	81 –	45.687 43.000 -0.894	0.390 4.235 0.070	118 –	118 –	45.454 41.000 0.403	0.759 4.615 -0.523	37 –	38 –
58.186 60.000 -0.437	0.548 4.936 -0.058	81 –	81 –	56.867 59.000 0.896	0.409 4.421 -0.284	117 –	118 –	55.742 62.000 1.633	0.998 5.987 -1.295	36 –	38 +
64.632 67.000 0.104	0.459 4.131 -0.434	81 –	81 –	63.959 65.000 0.152	0.359 3.885 0.595	117 –	118 +	62.789 64.000 0.209	0.700 4.201 -0.804	36 –	38 –
65.878 69.000 0.534	0.462 4.103 -0.286	79 –	81 –	65.650 66.000 0.055	0.293 3.143 0.021	115 –	118 –	64.311 65.000 0.459	0.844 5.065 -0.777	36 –	38 –
28.145 26.000 1.830	0.524 4.683 1.046	80 +	80 +	28.231 27.000 -0.149	0.409 4.648 0.392	129 –	129 –	28.085 26.000 0.857	0.901 4.682 0.725	27 –	27 –
35.909 33.000 0.900	0.541 4.843 0.910	80 –	80 +	35.490 35.000 -0.321	0.446 5.071 -0.072	129 –	129 –	35.070 30.000 0.799	0.955 4.965 0.970	27 –	27 –
36.209 36.000 1.064	0.619 5.540 1.002	80 –	80 +	35.813 36.000 -0.433	0.475 5.390 0.013	129 –	129 –	36.163 39.000 0.719	1.063 5.522 0.661	27 –	27 –
35.350 32.000 0.341	0.515 4.605 0.724	80 –	80 +	35.084 36.000 -0.213	0.464 5.248 0.161	128 –	129 –	35.968 40.000 2.042	1.096 5.693 1.146	27 –	27 +
33.854 33.000 0.083	0.555 4.966 0.580	80 –	80 –	33.316 31.000 -0.322	0.464 5.248 0.327	128 –	129 –	32.600 31.000 0.890	1.081 5.618 0.614	27 –	27 –
39.457 40.000 1.498	0.618 5.530 1.025	80 –	80 +	38.764 36.000 -0.149	0.482 5.453 0.130	128 –	129 –	38.207 35.000 0.144	1.126 5.853 0.493	27 –	27 –
52.312 53.000 -0.170	0.655 5.860 0.012	80 –	80 –	51.803 51.000 1.129	0.529 5.966 -0.315	127 –	129 –	52.711 50.000 1.360	0.827 4.298 0.871	27 –	27 –
61.555 61.000 1.489	0.570 5.094 -0.405	80 –	80 –	61.161 63.000 0.454	0.426 4.802 -0.662	127 –	129 +	61.426 60.000 2.566	0.967 5.026 -1.174	27 –	27 +
63.645 64.000 0.720	0.474 4.190 -0.264	78 –	80 –	63.354 66.000 0.346	0.379 4.236 -0.509	125 –	129 +	64.019 68.000 0.025	0.714 3.709 -0.330	27 –	27 –

SWE + ASWE (3/4)

habitu-cruia: 0 - 0 ♀ 0 - 1

Mean Mode Kurt.	St. error St. dev. Skew.	N (Sig.) (Kurt.)	Total (Sig.) (Skew.)	Mean Mode Kurt.	St. error St. dev. Skew.	N (Sig.) (Kurt.)	Total (Sig.) (Skew.)
36.389	0.673	35	35	37.522	1.494	9	9
37.000	4.038			36.000	4.482		
0.788	-0.776	–	–	2.634	1.490	–?	–?
45.700	0.766	35	35	45.889	1.510	9	9
44.000	4.534			36.000	4.529		
0.680	0.167	–	–	0.799	-1.150	–	–?
46.674	0.820	35	35	46.633	0.893	9	9
49.000	4.850			44.000	2.680		
0.318	-0.569	–	–	-0.974	-0.684	–	–
45.871	0.775	35	35	47.311	1.374	9	9
47.000	4.587			49.000	4.121		
0.804	-0.287	–	–	-0.093	-0.711	–	–
43.674	0.811	35	35	45.278	0.925	9	9
46.000	4.798			47.000	2.774		
-0.011	0.596	+	–	2.847	-1.216	–?	–?
48.234	0.665	35	35	48.944	0.988	9	9
50.000	3.936			50.000	2.963		
-0.301	-0.040	–	–	0.024	-1.189	–	–?
59.403	0.738	35	35	59.344	0.666	9	9
60.000	4.366			56.000	1.999		
-0.397	-0.131	–	–	-0.891	-0.508	–	–
65.363	0.706	35	35	65.589	0.967	9	9
67.000	4.175			64.000	2.902		
0.126	-0.621	–	–	0.760	-0.521	–	–
66.157	0.696	35	35	65.944	1.054	9	9
63.000	4.117			61.400	3.161		
0.733	-0.545	–	–	-0.803	-0.022	–	–

SWE + ASWE (3/4)

habitu-cruia: 1 - 0 ♀ 1 - 1

Mean Mode Kurt.	St. error St. dev. Skew.	N (Sig.) (Kurt.)	Total (Sig.) (Skew.)	Mean Mode Kurt.	St. error St. dev. Skew.	N (Sig.) (Kurt.)	Total (Sig.) (Skew.)
35.611	0.366	178	185	34.472	0.441	141	144
35.000	4.889			37.000	5.242		
0.185	-0.499	–	+	0.088	-0.115	–	–
43.879	0.370	178	185	42.940	0.478	141	144
44.000	4.930			41.000	5.682		
0.135	-0.393	–	–	-0.389	-0.080	–	–
44.468	0.387	178	185	43.891	0.480	141	144
46.000	5.165			44.000	5.700		
-0.012	-0.324	–	–	-0.363	-0.323	–	–
44.029	0.371	178	185	43.316	0.440	141	144
40.000	4.946			46.000	5.223		
-0.288	-0.145	–	–	-0.400	-0.364	–	–
42.190	0.350	178	185	41.653	0.410	141	144
45.000	4.669			41.000	4.869		
-0.139	-0.105	–	–	-0.341	-0.385	–	–
47.377	0.363	178	185	46.543	0.430	141	144
51.000	4.705			50.000	5.108		
0.361	0.331	–	–	0.276	-0.462	–	–
57.494	0.367	178	185	56.941	0.419	140	144
61.000	4.893			59.000	4.963		
0.857	-0.663	–	+	1.206	-0.867	+	+
63.675	0.337	178	185	63.220	0.361	140	144
67.000	4.491			64.000	4.274		
0.510	-0.857	–	+	2.184	-2.755	+	+
64.863	0.327	176	185	64.801	0.347	140	144
66.000	4.326			64.000	4.104		
0.813	-0.993	–	+	2.185	-1.231	+	+

SPA + ASPA (3/4)

♂

habit--cr- 0 - 0				1 - 0				habit--cr- 1 - 1			
Mean Mode Kurt.	St. error St. dev. Skew.	N (Sig.) (Kurt.)	Total (Skew.)	Mean Mode Kurt.	St. error St. dev. Skew.	N (Sig.) (Kurt.)	Total (Skew.)	Mean Mode Kurt.	St. error St. dev. Skew.	N (Sig.) (Kurt.)	Total (Skew.)
31.959 24.000 -0.764	0.967 5.024 0.042	27 –	27 –	29.722 29.000 0.867	0.523 4.593 0.712	77 –	77 +	30.214 31.000 -0.743	1.011 2.675 -0.891	7 –	7 –
40.574 32.000 -1.209	0.975 5.067 -0.087	27 –	27 –	37.147 37.000 1.072	0.576 5.054 0.629	77 –	77 –	39.429 40.000 1.189	0.948 2.507 -0.593	7 –	7 –
41.630 36.000 -1.329	1.019 5.297 0.206	27 –	27 –	37.493 32.000 0.432	0.574 5.040 0.516	77 –	77 –	38.143 33.000 -2.083	1.467 3.881 -0.483	7 –	7 –
40.626 37.000 -0.535	0.884 4.593 0.105	27 –	27 –	37.314 32.000 0.204	0.561 4.921 0.482	77 –	77 –	37.929 34.000 0.559	1.482 3.920 0.918	7 –	7 –
38.315 37.000 -0.059	0.791 4.109 -0.034	27 –	27 –	36.152 36.000 0.495	0.520 4.566 0.627	77 –	77 –	36.071 37.000 1.007	1.082 2.864 -0.737	7 –	7 –
43.333 40.000 -1.125	0.861 4.472 -0.210	27 –	27 –	41.461 39.000 0.130	0.556 4.846 0.505	76 –	77 –	42.000 43.000 -0.643	1.577 4.173 -0.799	7 –	7 –
54.652 63.000 0.091	0.821 4.266 -0.310	27 –	27 –	51.792 53.000 0.082	0.532 4.668 0.157	77 –	77 –	52.143 54.000 -0.917	1.434 3.794 -0.990	7 –	7 –
60.733 59.000 0.298	0.922 4.791 -0.248	27 –	27 –	58.061 58.000 0.473	0.465 4.076 0.291	77 –	77 –	59.429 54.000 -0.522	1.307 3.457 -0.473	7 –	7 –
62.507 60.000 -0.477	0.855 4.445 -0.037	27 –	27 –	60.278 58.000 0.456	0.424 3.718 0.257	77 –	77 –	61.114 53.000 -1.288	2.279 6.028 -0.608	7 –	7 –
22.286 25.000 1.505	0.568 3.004 0.534	28 –	28 –	21.686 19.000 1.217	0.444 3.898 0.973	77 –	77 +	21.929 18.000 -0.721	1.141 3.020 0.035	7 –	7 –
29.296 27.000 -0.409	0.789 4.175 0.316	28 –	28 –	27.877 29.000 -0.828	0.451 3.958 0.032	77 –	77 –	28.214 33.000 -1.961	1.766 4.671 -0.273	7 –	7 –
29.089 26.000 -0.408	0.707 3.742 0.217	28 –	28 –	28.186 24.000 0.826	0.491 4.308 0.428	77 –	77 –	28.714 24.000 -1.663	1.475 3.904 0.206	7 –	7 –
28.357 29.000 0.531	0.714 3.781 -0.055	28 –	28 –	28.177 25.000 -0.319	0.442 3.881 0.033	77 –	77 –	27.429 23.000 -1.319	1.197 3.168 -0.506	7 –	7 –
26.936 28.000 -1.178	0.758 4.009 1.678	28 –	28 +	27.441 24.000 -0.396	0.444 3.893 0.196	77 –	77 –	29.000 28.000 4.338	2.330 6.164 1.901	7 –	7 – ?
31.875 29.000 -0.370	0.791 4.185 0.426	28 –	28 –	32.169 33.000 -0.419	0.492 4.319 0.088	77 –	77 –	34.429 32.000 2.416	2.518 6.661 0.890	7 –	7 –
45.400 43.000 -0.492	0.764 4.045 0.184	28 –	28 –	44.738 40.000 -0.044	0.534 4.686 0.211	77 –	77 –	46.429 42.000 -1.744	1.474 3.899 0.307	7 –	7 –
54.375 54.000 0.102	1.011 5.352 -0.305	28 –	28 –	52.695 53.000 -0.450	0.511 4.486 -0.016	77 –	77 –	53.829 48.000 -0.959	1.401 3.707 -0.637	7 –	7 –
57.486 60.000 -0.499	0.714 3.768 0.131	28 –	28 –	58.339 59.000 -0.077	0.472 4.143 -0.009	77 –	77 –	56.357 50.000 -1.536	1.721 4.553 0.059	7 –	7 –

SPA + ASPA (3/4)

habitu-eruia: 0 – 0

Mean Mode Kurt.	St. error St. dev. Skew.	N (Sig.) (Kurt.)	Total (Skew.)
34.278 30.000 -0.490	1.066 4.522 -0.693	18 —	18 —
42.194 40.000 -1.027	0.836 3.549 -0.429	18 —	18 —
42.350 43.000 -0.591	0.954 4.048 -0.589	18 —	18 —
42.083 39.000 -0.921	0.847 3.594 0.056	18 —	18 —
40.356 43.000 -1.183	0.960 4.072 -0.285	18 —	18 —
46.194 49.000 1.132	1.203 5.102 1.005	18 —	18 —
56.500 56.000 -0.036	0.639 2.712 -0.030	18 —	18 —
61.300 59.000 -0.714	0.514 2.179 0.577	18 —	18 —
63.500 63.000 -0.035	0.570 2.419 -0.526	18 —	18 —

1 – 0

Mean Mode Kurt.	St. error	N (Sig.) (Kurt.)	Total (Skew.)
31.952 33.000 -0.195	0.509 4.581 -0.125	81 —	81 —
39.673 36.000 -0.287	0.584 5.252 -0.084	81 —	81 —
39.759 41.000 0.165	0.598 5.378 -0.168	81 —	81 —
40.247 38.000 -0.853	0.538 4.841 0.347	81 —	81 —
38.855 35.000 -0.105	0.566 5.094 -0.183	81 —	81 —
44.041 41.000 0.604	0.570 5.129 -0.234	81 —	81 —
53.528 53.000 1.997	0.563 5.071 -1.009	81 +	81 +
60.026 62.000 0.340	0.461 4.146 -0.150	81 —	81 —
61.988 62.000 0.427	0.442 3.980 -0.288	81 —	81 —

habitu-eruia: 1 – 1

Mean Mode Kurt.	St. error St. dev. Skew.	N (Sig.) (Kurt.)	Total (Skew.)
33.583 37.000 -0.774	1.683 7.142 -0.614	18 —	18 —
42.028 40.000 -0.021	1.695 7.190 -0.767	18 —	18 —
41.528 40.000 0.386	1.627 6.902 -0.947	18 —	18 —
42.111 41.000 -0.032	1.600 6.788 -0.593	18 —	18 —
40.083 44.000 -0.659	1.689 7.167 -0.439	18 —	18 —
47.056 50.000 0.834	1.817 7.710 0.129	18 —	18 —
56.556 54.000 -0.676	0.990 4.201 0.851	18 —	18 —
61.267 63.000 -0.559	1.153 4.892 -0.614	18 —	18 —
63.556 60.000 -0.936	1.213 5.147 -0.411	18 —	18 —

GB + AGB (3/4)
♂

habit- -cr- : 0 - 0				1 - 0				habit- -cr- : 1 - 1			
Mean Mode Kurt.	St. error St. dev. Skew.	N (Sig.) (Kurt.)	Total (Skew.)	Mean Mode Kurt.	St. error St. dev. Skew.	N (Sig.) (Kurt.)	Total (Skew.)	Mean Mode Kurt.	St. error St. dev. Skew.	N (Sig.) (Kurt.)	Total (Skew.)
35.250 36.000 0.418	1.309 5.238 0.363	16 —	16 —	35.194 29.000 -0.373	1.201 4.804 0.147	16 —	16 —	36.000 34.000 1.500	1.242 2.483 1.371	4 —	4 — ?
41.219 36.000 0.017	1.019 4.074 0.759	16 —	16 —	41.231 39.000 -0.646	1.458 5.832 -0.100	16 —	16 —	42.000 39.000 1.500	1.080 2.160 -1.190	4 —	4 — ?
43.681 43.000 0.078	0.963 3.852 0.760	16 —	16 —	43.000 42.000 0.233	1.102 4.408 0.464	16 —	16 —	43.750 46.000 -1.289	1.436 2.872 -0.855	4 — ?	4 —
42.906 46.000 -0.056	0.926 3.703 -0.185	16 —	16 —	42.656 42.000 0.355	1.021 4.085 0.507	16 —	16 —	43.250 46.000 -0.518	1.601 3.202 -0.084	4 — ?	4 —
40.475 39.000 -0.510	0.831 3.323 -0.117	16 —	16 —	41.792 39.000 -0.800	0.848 4.152 0.617	16 —	16 —	42.125 39.000 -5.348	1.533 3.065 -0.068	4 — ?	4 —
44.225 45.000 -0.009	0.806 3.224 -0.071	16 —	16 —	45.481 44.000 0.101	0.910 3.639 -0.082	16 —	16 —	45.050 43.000 -2.998	0.950 1.900 0.099	4 — ?	4 —
55.825 53.000 -1.244	1.137 4.547 0.047	16 —	16 —	57.094 53.000 0.028	0.953 3.814 0.493	16 —	16 —	58.250 56.500 -2.433	0.777 1.555 0.0	4 — ?	4 —
61.387 60.000 -1.043	0.838 3.351 -0.315	16 —	16 —	62.487 61.000 -0.118	0.639 2.555 0.689	16 —	16 —	64.175 63.000 2.367	0.643 1.287 1.359	4 — ?	4 — ?
63.775 61.500 -0.495	0.802 3.207 0.294	16 —	16 —	64.931 63.000 0.300	0.891 3.563 0.077	16 —	16 —	65.375 63.000 -5.027	1.248 2.496 0.103	4 — ?	4 —
28.247 29.000 0.091	0.732 2.833 0.229	15 —	15 —	26.536 24.000 -0.128	0.846 3.165 -0.338	14 —	14 —	25.667 21.000 -1.723	1.365 3.344 -0.916	6 — ?	6 —
33.333 33.000 0.476	0.647 2.505 1.018	15 —	15 —	29.614 31.000 -0.984	0.885 3.312 -0.044	14 —	14 —	30.833 26.500 -0.793	1.464 3.587 0.042	6 —	6 —
36.047 36.000 1.348	0.723 2.799 0.009	15 —	15 —	33.686 36.000 -0.904	0.982 3.675 -0.405	14 —	14 —	33.917 27.000 0.597	2.505 6.135 0.640	6 —	6 —
35.500 36.000 -0.941	0.735 2.847 -0.064	15 —	15 —	31.643 33.000 -0.597	0.782 2.925 -0.471	14 —	14 —	33.667 33.500 -1.570	2.259 5.534 -0.550	6 — ?	6 —
33.367 32.000 -0.764	0.945 3.662 0.237	15 —	15 —	30.464 29.000 -2.070	0.672 2.515 -0.016	14 —	14 —	30.533 24.000 -1.509	1.891 4.633 -0.537	6 — ?	6 —
37.693 36.000 -1.072	0.973 3.767 -0.025	15 —	15 —	35.857 37.000 -0.032	0.762 2.852 -0.993	14 —	14 —	35.833 30.000 -1.363	2.120 5.193 0.027	6 — ?	6 —
51.800 50.000 1.300	1.036 4.013 -0.870	15 —	15 —	50.286 45.000 2.352	1.311 4.906 1.245	14 —	14 — ?	49.667 45.000 -0.945	1.498 3.670 0.252	6 —	6 —
60.547 61.000 0.430	0.868 3.360 0.204	15 —	15 —	57.714 60.000 1.380	1.308 4.894 -1.510	14 —	14 — ?	58.617 53.500 -1.173	1.809 4.432 0.547	6 — ?	6 —
63.167 63.000 0.665	0.751 2.907 -0.302	15 —	15 —	61.429 62.000 2.498	0.953 3.567 -1.806	14 —	14 — ?	63.617 65.000 -3.211	0.622 1.524 -0.044	6 — ?	6 —

GB + AGB (3/4)

habitu-oruia: 0 - 0				1 - 0				habitu-oruia: 1 - 1			
Mean Mode Kurt.	St. error St. dev. Skew.	N (Sig.) (Kurt.)	Total (Sig.) (Skew.)	Mean Mode Kurt.	St. error St. dev. Skew.	N (Sig.) (Kurt.)	Total (Sig.) (Skew.)	Mean Mode Kurt.	St. error St. dev. Skew.	N (Sig.) (Kurt.)	Total (Sig.) (Skew.)
40.538 41.000 0.922	1.228 4.427 -1.052	13 —	13 —	36.167 32.000 -0.271	1.223 5.990 -0.309	24 —	24 —	38.391 36.000 1.216	1.157 3.837 1.186	11 —	11 —?
45.800 47.000 1.208	1.349 4.863 -0.734	13 —	13 —	41.837 30.000 1.859	1.234 6.045 -0.777	24 —	24 —	45.564 46.000 0.687	1.363 4.519 0.689	11 —	11 —
47.731 48.500 1.725	1.260 4.542 -1.202	13 —	13 —?	44.171 40.000 2.697	1.201 5.884 -1.060	24 —	24 —	45.964 44.000 2.456	0.884 2.933 1.577	11 —	11 —?
46.462 46.000 0.105	1.190 4.289 -0.424	13 —	13 —	43.996 41.000 2.782	1.155 5.659 -0.909	24 —	24 —	45.918 44.000 0.336	0.761 2.525 0.550	11 —	11 —
43.769 43.000 -0.719	1.178 4.246 -0.104	13 —	13 —	41.375 39.000 2.450	1.050 5.142 -0.671	24 —	24 —	43.618 40.000 -0.977	1.101 3.652 0.417	11 —	11 —
48.000 46.000 -0.152	1.092 3.937 -0.380	13 —	13 —	45.737 42.000 -0.229	0.936 4.583 0.309	24 —	24 —	47.382 47.000 1.599	0.893 2.964 1.033	11 —	11 —
58.000 58.000 0.606	1.134 4.088 -0.597	13 —	13 —	56.375 54.000 3.604	0.977 4.788 -1.078	24 —	24 —?	57.773 57.000 0.858	0.724 2.402 0.978	11 —	11 —
64.038 62.000 0.694	0.921 3.322 -0.776	13 —	13 —	62.133 62.000 3.435	0.792 3.878 -0.885	24 —	24 —	62.636 64.000 -0.711	0.709 2.350 0.299	11 —	11 —
65.246 66.000 1.186	0.887 3.198 0.097	13 —	13 —	63.921 64.000 4.013	0.700 3.430 -0.432	24 —	24 —	64.627 64.000 3.137	0.650 2.156 1.472	11 +	11 —?

Appendix C.1

SWE + ASWE (3/4) ♂ N = 207

	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.
	Du1	Du2	Du3	Du4	Du5	A1	A2	A3	Duin	Dulg
habitu	-0.171 0.014	-0.192 0.006	-0.183 0.008	-0.170 0.014	-0.159 0.023	0.048 -	0.061 -	0.065 -	0.071 -	-0.107 -
orule	-0.030 -	-0.049 -	-0.052 -	-0.051 -	-0.048 -	-0.105 -	-0.099 -	-0.095 -	0.078 -	-0.021 -
cr-now										
ex-bath										
newhat										
Du1	1.000 0.000	0.909 0.001	0.811 0.001	0.754 0.001	0.717 0.001	-0.023 -	-0.034 -	-0.037 -	-0.561 0.001	0.659 0.001
Du2		1.000 0.000	0.978 0.001	0.948 0.001	0.920 0.001	-0.035 -	-0.045 -	-0.047 -	-0.289 0.001	0.587 0.001
Du3			1.000 0.000	0.993 0.001	0.978 0.001	-0.035 -	-0.043 -	-0.044 -	-0.174 0.012	0.443 0.001
Du4				1.000 0.000	0.996 0.001	-0.033 -	-0.039 -	-0.040 -	-0.135 0.054	0.383 0.001
Du5					1.000 0.000	-0.031 -	-0.037 -	-0.037 -	-0.120 0.084	0.353 0.001
A1						1.000 0.000	0.982 0.001	0.947 0.001	-0.024 -	0.005 -
A2							1.000 0.000	0.989 0.001	-0.025 -	-0.001 -
A3								1.000 0.000	-0.023 -	-0.005 -
Duin									1.000 0.000	-0.856 0.001
Dulg										1.000 0.000

Table C.1. Zero-order correlations and significance coefficients: behavioural variables and age. Significance level: 0.05. Males and females separate.

SPA + ASFA (3/4) ♂ N = 78

	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.
	Du1	Du2	Du3	Du4	Du5	A1	A2	A3	Duin	Dulg
habitu	-0.489 0.001	-0.481 0.001	-0.470 0.001	-0.460 0.001	-0.451 0.001	-0.203 0.076	-0.238 0.036	-0.261 0.022	0.457 0.001	-0.485 0.001
ornia	-0.103 -	-0.087 -	-0.078 -	-0.073 -	-0.069 -	-0.046 -	-0.043 -	-0.042 -	0.168 -	-0.130 -
ex-habitor-now	-0.027 -	-0.031 -	-0.031 -	-0.031 -	-0.030 -	-0.054 -	-0.044 -	-0.036 -	0.003 -	-0.017 -
newhat										
Du1	1.000 0.000	0.991 0.001	0.972 0.001	0.951 0.001	0.934 0.001	0.419 0.001	0.467 0.001	0.496 0.001	-0.923 0.001	0.984 0.001
Du2		1.000 0.000	0.995 0.001	0.984 0.001	0.972 0.001	0.411 0.001	0.458 0.001	0.488 0.001	-0.870 0.001	0.953 0.001
Du3			1.000 0.000	0.997 0.001	0.991 0.001	0.387 0.001	0.434 0.001	0.465 0.001	-0.825 0.001	0.919 0.001
Du4				1.000 0.000	0.998 0.001	0.360 0.001	0.407 0.001	0.438 0.001	-0.790 0.001	0.890 0.001
Du5					1.000 0.000	0.335 0.002	0.382 0.001	0.413 0.001	-0.765 0.001	0.867 0.001
A1						1.000 0.000	0.982 0.001	0.940 0.001	-0.313 0.006	0.391 0.001
A2							1.000 0.000	0.987 0.001	-0.368 0.001	0.441 0.001
A3								1.000 0.000	-0.406 0.001	0.473 0.001
Duin									1.000 0.000	-0.975 0.001
Dulg										1.000 0.000

GB + AGB	(3/4)	♂							N = 31	
	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.
	Du1	Du2	Du3	Du4	Du5	A1	A2	A3	Duin	Dulg
habitu	-0.305 0.097	-0.295 -	-0.284 -	-0.277 -	-0.274 -	0.050 -	0.050 -	0.051 -	0.297 -	-0.307 0.094
cruis	-0.180 -	-0.162 -	-0.146 -	-0.134 -	-0.125 -	0.084 -	0.067 -	0.050 -	0.198 -	-0.194 -
ex-hebdcr-now										
newhat										
Du1	1.000 0.000	0.985 0.001	0.956 0.001	0.927 0.001	0.900 0.001	-0.180 -	-0.175 -	-0.167 -	-0.909 0.001	0.977 0.001
Du2		1.000 0.000	0.992 0.001	0.976 0.001	0.958 0.001	-0.158 -	-0.153 -	-0.147 -	-0.827 0.001	0.927 0.001
Du3			1.000 0.000	0.996 0.001	0.986 0.001	-0.142 -	-0.139 -	-0.134 -	-0.757 0.001	0.875 0.001
Du4				1.000 0.000	0.997 0.001	-0.132 -	-0.130 -	-0.127 -	-0.706 0.001	0.833 0.001
Du5					1.000 0.000	-0.124 -	-0.124 -	-0.121 -	-0.669 0.001	0.800 0.001
A1						1.000 0.000	0.996 0.001	0.985 0.001	0.238 -	-0.209 -
A2							1.000 0.000	0.996 0.001	0.232 -	-0.203 -
A3								1.000 0.000	0.224 -	-0.195 -
Duin									1.000 0.000	-0.976 0.001
Dulg										1.000 0.000

BWE + ASWE (3/4) ♀ N = 319

	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.
	Du1	Du2	Du3	Du4	Du5	A1	A2	A3	Duin	Dulg
habitu	-0.061 -	-0.133 0.018	-0.157 0.006	-0.163 0.003	-0.165 0.003	-0.013 -	-0.030 -	-0.044 -	0.029 -	-0.019 -
ornia	-0.164 0.003	-0.111 0.050	-0.067 -	-0.053 -	-0.049 -	-0.016 -	-0.024 -	-0.037 -	-0.010 -	-0.122 0.030
or-now	0.079 -	0.028 -	-0.000 -	-0.008 -	-0.010 -	-0.000 -	0.001 -	0.002 -	-0.049 -	0.090 -
ex-hab										
nwhat										
Du1	1.000 0.000	0.830 0.001	0.659 0.001	0.606 0.001	0.593 0.001	0.203 0.001	0.236 0.001	0.263 0.001	-0.461 0.001	0.865 0.001
Du2		1.000 0.000	0.966 0.001	0.945 0.001	0.939 0.001	0.183 0.001	0.224 0.001	0.264 0.001	-0.193 0.001	0.490 0.001
Du3			1.000 0.000	0.998 0.001	0.996 0.001	0.161 0.004	0.201 0.001	0.242 0.001	-0.076 -	0.277 0.001
Du4				1.000 0.000	1.000+ 0.001	0.155 0.006	0.194 0.001	0.235 0.001	-0.047 -	0.219 0.001
Du5					1.000 0.000	0.154 0.006	0.193 0.001	0.233 0.001	-0.040 -	0.205 0.001
A1						1.000 0.000	0.984 0.001	0.948 0.001	-0.100 0.074	0.182 0.001
A2							1.000 0.000	0.988 0.001	-0.111 0.050	0.202 0.001
A3								1.000 0.000	-0.113 0.046	0.211 0.001
Duin									1.000 0.000	-0.767 0.001
Dulg										1.000 0.000

SPA + ASPA (3/4) ♀ N = 78

	r sig. Du1	r sig. Du2	r sig. Du3	r sig. Du4	r sig. Du5	r sig. A1	r sig. A2	r sig. A3	r sig. Duin	r sig. Dulg
habitu	-0.473 0.001	-0.463 0.001	-0.449 0.001	-0.436 0.001	-0.426 0.001	-0.462 0.001	-0.474 0.001	-0.479 0.001	0.454 0.001	-0.472 0.001
cruis	-0.070 -	-0.080 -	-0.083 -	-0.084 -	-0.083 -	-0.082 -	-0.091 -	-0.096 -	0.035 -	-0.054 -
or-now	-0.046 -	-0.041 -	-0.038 -	-0.036 -	-0.035 -	-0.073 -	-0.060 -	-0.051 -	0.054 -	-0.050 -
ex-hab										
nowhat										
Du1	1.000 0.000	0.993 0.001	0.978 0.001	0.963 0.001	0.951 0.001	0.691 0.001	0.699 0.001	0.696 0.001	-0.947 0.001	0.988 0.001
Du2		1.000 0.000	0.996 0.001	0.988 0.001	0.980 0.001	0.717 0.001	0.728 0.001	0.725 0.001	-0.905 0.001	0.963 0.001
Du3			1.000 0.000	0.998 0.001	0.994 0.001	0.731 0.001	0.743 0.001	0.742 0.001	-0.868 0.001	0.936 0.001
Du4				1.000 0.000	0.999 0.001	0.738 0.001	0.751 0.001	0.751 0.001	-0.841 0.001	0.915 0.001
Du5					1.000 0.000	0.741 0.001	0.755 0.001	0.755 0.001	-0.822 0.001	0.898 0.001
A1						1.000 0.000	0.993 0.001	0.979 0.001	-0.592 0.001	0.650 0.001
A2							1.000 0.000	0.996 0.001	-0.593 0.001	0.654 0.001
A3								1.000 0.000	-0.586 0.001	0.649 0.001
Duin									1.000 0.000	-0.985 0.001
Dulg										1.000 0.000

GB + AGB (3/4) ♀ N = 45

	r sig. Du1	r sig. Du2	r sig. Du3	r sig. Du4	r sig. Du5	r sig. A1	r sig. A2	r sig. A3	r sig. Duin	r sig. Dulg
habitu	-0.252 -	-0.266 0.076	-0.263 0.082	-0.257 0.090	-0.254 -	-0.301 0.045	-0.288 0.055	-0.272 0.070	0.132 -	-0.202 -
cruis	-0.199 -	-0.156 -	-0.124 -	-0.105 -	-0.095 -	-0.039 -	-0.051 -	-0.063 -	0.238 -	-0.231 -
or-now	-0.067 -	-0.061 -	-0.051 -	-0.043 -	-0.038 -	0.276 0.066	0.309 0.039	0.340 0.022	0.031 -	-0.056 -
ex-huth										
newhat										
Du1	1.000 0.000	0.964 0.001	0.907 0.001	0.866 0.001	0.843 0.001	-0.056 -	-0.072 -	-0.088 -	-0.812 0.001	0.946 0.001
Du2		1.000 0.000	0.986 0.001	0.967 0.001	0.954 0.001	0.062 -	0.043 -	0.022 -	-0.640 0.001	0.829 0.001
Du3			1.000 0.000	0.996 0.001	0.993 0.001	0.125 -	0.103 -	0.080 -	-0.516 0.001	0.728 0.001
Du4				1.000 0.000	0.999 0.001	0.152 -	0.130 -	0.106 -	-0.449 0.002	0.668 0.001
Du5					1.000 0.000	0.164 -	0.141 -	0.116 -	-0.415 0.004	0.637 0.004
A1						1.000 0.000	0.996 0.001	0.984 0.001	0.349 0.018	-0.214 -
A2							1.000 0.000	0.996 0.001	0.356 0.016	-0.225 -
A3								1.000 0.000	0.359 0.015	-0.234 -
Duin									1.000	-0.955 0.001
Dulg										1.000 0.000

SWE + ASWE (3/4) ♂ N = 211

	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.
	Df1	Df2	Df3	Df4	Df5	A1	A2	A3	Dfin	Dflg
habitf	-0.198 0.004	-0.205 0.03	-0.189 0.006	-0.173 0.012	-0.161 0.020	0.079 -	0.091 -	0.093 -	0.051 -	-0.136 0.048
crfh	-0.114 0.099	-0.073 -	-0.055 -	-0.047 -	-0.043 -	0.028 -	0.034 -	0.028 -	0.074 -	-0.136 0.048
cr-now	0.030 -	0.005 -	-0.005 -	-0.007 -	-0.007 -	-0.024 -	-0.026 -	-0.025 -	-0.022 -	0.043 -
ex-hath										
newhat	-0.039 -	-0.073 -	-0.085 -	-0.088 -	-0.088 -	0.359 0.001	0.318 0.001	0.286 0.001	-0.006 -	-0.005 -
Df1	1.000 0.000	0.891 0.001	0.779 0.001	0.719 0.001	0.683 0.001	-0.048 -	-0.060 -	-0.067 -	-0.402 0.001	0.803 0.001
Df2		1.000 0.000	0.975 0.001	0.944 0.001	0.916 0.001	-0.044 -	-0.055 -	-0.059 -	-0.168 0.014	0.498 0.001
Df3			1.000 0.000	0.992 0.001	0.978 0.001	-0.038 -	-0.046 -	-0.047 -	-0.087 -	0.352 0.001
Df4				1.000 0.000	0.996 0.001	-0.034 -	-0.040 -	-0.041 -	-0.063 -	0.297 0.001
Df5					1.000 0.000	-0.031 -	-0.037 -	-0.037 -	-0.055 -	0.271 0.001
A1						1.000 0.000	0.985 0.001	0.951 0.001	-0.021 -	-0.024 -
A2							1.000 0.000	0.991 0.001	-0.023 -	-0.030 -
A3								1.000 0.000	-0.020 -	-0.037 -
Dfin									1.000 0.000	-0.796 0.001
Dflg										1.000 0.000

SPA + ASPA (3/4) ♂ N = 104

	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.
	Df1	Df2	Df3	Df4	Df5	A1	A2	A3	Dfin	Dflg
habitf	-0.440 0.001	-0.459 0.001	-0.440 0.001	-0.426 0.001	-0.415 0.001	-0.261 0.008	-0.28 0.003	-0.302 0.002	0.150 -	-0.269 0.006
crfh	-0.095 -	-0.076 -	-0.067 -	-0.062 -	-0.060 -	-0.103 -	-0.089 -	-0.075 -	0.059 -	-0.094 -
cr-now	0.024 -	-0.034 -	-0.048 -	-0.050 -	-0.050 -	-0.055 -	-0.055 -	-0.052 -	-0.117 -	0.110 -
ex-hath										
newhat	0.001 -	0.041 -	0.043 -	0.038 -	0.033 -	0.091 -	0.096 -	0.099 -	0.129 -	-0.090 -
Df1	1.000 0.000	0.925 0.001	0.866 0.001	0.836 0.001	0.819 0.001	0.360 0.001	0.385 0.001	0.401 0.001	-0.569 0.001	0.822 0.001
Df2		1.000 0.000	0.989 0.001	0.977 0.001	0.966 0.001	0.384 0.001	0.422 0.001	0.448 0.001	-0.293 0.002	0.555 0.001
Df3			1.000 0.000	0.997 0.001	0.992 0.001	0.358 0.001	0.399 0.001	0.428 0.001	-0.199 0.044	0.451 0.001
Df4				1.000 0.000	0.999 0.001	0.331 0.001	0.372 0.001	0.403 0.001	-0.170 0.084	0.414 0.001
Df5					1.000 0.000	0.308 0.001	0.349 0.001	0.379 0.001	-0.159 -	0.398 0.001
A1						1.000 0.000	0.983 0.001	0.945 0.001	-0.090 -	0.195 0.048
A2							1.000 0.000	0.989 0.001	-0.085 -	0.197 0.046
A3								1.000 0.000	-0.078 -	0.195 0.048
Dfin									1.000 0.000	-0.885 0.001
Dflg										1.000 0.000

GB + AGB (3/4) ♂ N = 32

	r sig. Df1	r sig. Df2	r sig. Df3	r sig. Df4	r sig. Df5	r sig. A1	r sig. A2	r sig. A3	r sig. Dfin	r sig. Dfig
habitf	-0.329 0.066	-0.309 0.086	-0.293 -	-0.284 -	-0.279 -	0.036 -	0.037 -	0.038 -	0.282 -	-0.332 0.064
crfh	-0.213 -	-0.201 -	-0.194 -	-0.187 -	-0.179 -	0.156 -	0.157 -	0.162 -	0.275 -	-0.241 -
cr-now	-0.085 -	-0.090 -	-0.088 -	-0.084 -	-0.081 -	0.028 -	0.007 -	-0.012 -	0.017 -	-0.061 -
ex-hath										
newhat	-0.043 -	-0.050 -	-0.046 -	-0.042 -	-0.040 -	0.172 -	0.169 -	0.168 -	-0.067 -	-0.002 -
Df1	1.000 0.000	0.977 0.001	0.942 0.001	0.909 0.001	0.882 0.001	-0.147 -	-0.143 -	-0.137 -	-0.721 0.001	0.942 0.001
Df2		1.000 0.000	0.991 0.001	0.974 0.001	0.955 0.001	-0.141 -	-0.138 -	-0.133 -	-0.585 0.001	0.856 0.001
Df3			1.000 0.000	0.995 0.001	0.985 0.001	-0.132 -	-0.130 -	-0.126 -	-0.506 0.002	0.790 0.001
Df4				1.000 0.000	0.997 0.001	-0.124 -	-0.123 -	-0.120 -	-0.460 0.008	0.744 0.001
Df5					1.000 0.000	-0.117 -	-0.117 -	-0.115 -	-0.432 0.013	0.711 0.001
A1						1.000 0.000	0.996 0.001	0.985 0.001	0.055 -	-0.126 -
A2							1.000 0.000	0.996 0.001	0.056 -	-0.123 -
A3								1.000 0.000	0.057 -	-0.120 -
Dfin									1.000 0.000	-0.906 0.001
Dfig										1.000 0.000

SWE + ASWE (3/4) ♀ N = 327

	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.
	Df1	Df2	Df3	Df4	Df5	A1	A2	A3	Dfin	Dflg
habitf	-0.110 0.047	-0.154 0.005	-0.163 0.003	-0.165 0.003	-0.165 0.003	-0.019 -	-0.037 -	-0.050 -	0.066 -	-0.079 -
orfh	-0.046 -	-0.041 -	-0.041 -	-0.041 -	-0.041 -	-0.027 -	-0.030 -	-0.030 -	0.104 0.060	-0.073 -
or-now	0.016 -	-0.019 -	-0.028 -	-0.029 -	-0.029 -	0.289 0.001	0.243 0.001	0.196 0.001	-0.038 -	0.041 -
ex-hath										
newhat	0.026 -	-0.024 -	-0.047 -	-0.052 -	-0.053 -	0.237 0.001	0.235 0.001	0.226 0.001	0.004 -	0.023 -
Df1	1.000 0.000	0.801 0.001	0.609 0.001	0.552 0.001	0.539 0.001	0.245 0.001	0.274 0.001	0.294 0.001	-0.512 0.001	0.847 0.001
Df2		1.000 0.000	0.961 0.001	0.938 0.001	0.932 0.001	0.208 0.001	0.247 0.001	0.285 0.001	-0.198 0.001	0.438 0.001
Df3			1.000 0.000	0.997 0.001	0.996 0.001	0.169 0.001	0.208 0.001	0.248 0.001	-0.068 -	0.220 0.001
Df4				1.000 0.000	• 0.001	0.159 0.004	0.197 0.001	0.236 0.001	-0.038 -	0.164 0.003
Df5					1.000 0.000	0.156 0.005	0.194 0.001	0.234 0.001	-0.031 -	0.151 0.007
A1						1.000 0.000	0.984 0.001	0.949 0.001	-0.107 0.056	0.197 0.001
A2							1.000 0.000	0.989 0.001	-0.119 0.033	0.213 0.001
A3								1.000 0.000	-0.121 0.030	0.217 0.001
Dfin									1.000 0.000	-0.831 0.001
Dflg										1.000 0.000

SPA + ASPA (3/4) ♀ N = 105

	r sig. Df1	r sig. Df2	r sig. Df3	r sig. Df4	r sig. Df5	r sig. A1	r sig. A2	r sig. A3	r sig. Dfin	r sig. Dflg
habitf	-0.439 0.001	-0.467 0.001	-0.442 0.001	-0.424 0.001	-0.413 0.001	-0.447 0.001	-0.460 0.001	-0.465 0.001	0.122 -	-0.266 0.006
orfh	-0.204 0.037	-0.148 -	-0.121 -	-0.112 -	-0.107 -	-0.037 -	-0.023 -	-0.012 -	0.153 -	-0.218 0.026
cr-now	-0.141 -	-0.118 -	-0.104 -	-0.099 -	-0.096 -	-0.061 -	-0.075 -	-0.086 -	0.260 0.007	-0.192 0.050
ex-bath										
newhat	0.154 -	0.087 -	0.059 -	0.050 -	0.046 -	0.125 -	0.093 -	0.074 -	-0.146 -	0.189 0.054
Df1	1.000 0.000	0.874 0.001	0.771 0.001	0.730 0.001	0.712 0.001	0.567 0.001	0.566 0.001	0.557 0.001	-0.422 0.001	0.802 0.001
Df2		1.000 0.000	0.982 0.001	0.965 0.001	0.955 0.001	0.708 0.001	0.721 0.001	0.719 0.001	-0.178 0.069	0.454 0.001
Df3			1.000 0.000	0.997 0.001	0.992 0.001	0.725 0.001	0.744 0.001	0.745 0.001	-0.092 -	0.307 0.001
Df4				1.000 0.000	0.999 0.001	0.729 0.001	0.750 0.001	0.752 0.001	-0.067 -	0.261 0.007
Df5					1.000 0.000	0.731 0.001	0.753 0.001	0.756 0.001	-0.059 -	0.246 0.011
A1						1.000 0.000	0.990 0.001	0.972 0.001	-0.102 -	0.259 0.008
A2							1.000 0.000	0.995 0.001	-0.086 -	0.241 0.014
A3								1.000 0.000	-0.076 -	0.228 0.019
Dfin									1.000 0.000	-0.786 0.001
Dflg										1.000 0.000

GB + AGB	(3/4)	♀							N = 46	
	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.
	Df1	Df2	Df3	Df4	Df5	A1	A2	A3	Dfin	Dflg
habitf	-0.261 0.081	-0.272 0.068	-0.266 0.074	-0.259 0.083	-0.255 0.088	-0.30 0.038	-0.292 0.048	-0.276 0.064	0.147 -	-0.214 -
orfh	-0.133 -	-0.133 -	-0.130 -	-0.128 -	-0.126 -	-0.010 -	-0.021 -	-0.033 -	0.115 -	-0.126 -
or-now	0.149 -	0.175 -	0.190 -	0.179 -	0.201 -	0.126 -	0.112 -	0.099 -	-0.108 -	0.122 -
ex-bath	0.070 -	0.110 -	0.133 -	0.145 -	0.151 -	-0.021 -	-0.017 -	-0.014 -	0.015 -	0.022 -
newhat	0.070 -	0.110 -	0.133 -	0.145 -	0.151 -	-0.021 -	-0.017 -	-0.014 -	0.015 -	0.022 -
Df1	1.000 0.000	0.963 0.001	0.904 0.001	0.862 0.001	0.839 0.001	-0.046 -	-0.062 -	-0.078 -	-0.816 0.001	0.947 0.001
Df2		1.000 0.000	0.985 0.001	0.966 0.001	0.953 0.001	0.068 -	0.048 -	0.028 -	-0.642 0.001	0.828 0.001
Df3			1.000 0.000	0.996 0.001	0.990 0.001	0.128 -	0.106 -	0.083 -	-0.516 0.001	0.724 0.001
Df4				1.000 0.000	0.999 0.001	0.154 -	0.132 -	0.108 -	-0.447 0.002	0.662 0.001
Df5					1.000 0.000	0.166 -	0.143 -	0.118 -	-0.412 0.004	0.630 0.001
A1						1.000 0.000	0.996 0.001	0.984 0.001	0.328 0.026	-0.197 -
A2							1.000 0.000	0.996 0.001	0.335 0.023	-0.208 -
A3								1.000 0.000	0.339 0.022	-0.218 -
Dfin									1.000 0.000	-0.957 0.001
Dflg										1.000 0.000

Appendix C.2

SWE + ASWE (3/4) ♂ N = 207

	r sig. habitu	r sig. cruis	r sig. cruisnow	r sig. exinbath	r sig.	r sig. daysuis	r sig. age (=A1)
uis1	-0.193 0.006 +	-0.018 -				0.324 0.001 +	0.085 -
uis2	-0.201 0.004 +	0.004 -				0.212 0.002 +	0.094 -
uis3	-0.189 0.007 +	-0.058 -				0.233 0.001 +	0.148 0.034
uis4	-0.173 0.014	-0.029 -				0.230 0.001 +	0.099 -
uis5	-0.064 -	-0.069 -				0.124 0.076	0.085 -
uis6	-0.104 -	-0.018 -				0.188 0.006 +	0.090 -
uis7	-0.123 0.080	-0.045 -				0.194 0.006 +	0.108 -
uis8	-0.100 -	-0.070 -				0.148 0.034	0.090 -
uis9	-0.048 -	-0.043 -				0.112 -	0.053 -
habitu	1.000 0.000 +	0.218 0.002 +				-0.171 0.014	0.048 -
cruis		1.000 0.000 +				-0.030 -	-0.105 -
cr-now							
ex-bth							
days-						1.000 0.000 +	-0.023 -
age							1.000 0.000 +

Table C.2. Zero-order correlations and significance coefficients: pigmentation, behavioural (primary) variables and age. Significance level: 0.05. Males and females separate.

SPA + ASTA (3/4) ♂ N = 78

	r sig. habitu	r sig. cruia	r sig. cruianow	r sig. exinbath	r sig.	r sig. daysuia	r sig. age (=A1)
uia1	-0.225 0.048	-0.008 -	-0.052 -			0.260 0.022	0.342 + 0.002
uia2	-0.222 0.050	0.083 -	-0.037 -			0.240 0.034	0.224 0.048
uia3	-0.318 0.004	-0.026 -	-0.063 -			0.292 0.010	0.229 0.044
uia4	-0.259 0.022	0.006 -	-0.029 -			0.197 0.086	0.264 0.018
uia5	-0.115 -	-0.042 -	0.027 -			0.093 -	0.208 0.068
uia6	-0.107 -	0.005 -	0.088 -			0.101 -	0.183 -
uia7	-0.215 0.060	0.007 -	0.060 -			0.140 -	0.162 -
uia8	-0.242 0.034	0.101 -	0.033 -			0.128 -	0.202 0.076
uia9	-0.185 -	0.117 -	0.047 -			0.126 -	0.304 0.007
habito	1.000 0.000	0.149 -	0.065 -			-0.489 0.001	-0.203 0.076
cruia		1.000	-0.030 -			-0.103 -	-0.046 -
cr-now			1.000 + 0.000			-0.027 -	-0.054 -
ex-bth							
dayu-						1.000 + 0.000	0.419 0.000
age							1.000 0.000

GB + ACP (3/4) ♂ N = 31

	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.
	habitu	cruia	cruianow	exinbath		daysuia	age (=A1)
uia1	-0.010 -	0.171 -				-0.045 -	-0.280 -
uia2	0.026 -	0.145 -				-0.257 -	-0.122 -
uia3	0.022 -	0.141 -				-0.188 -	-0.269 -
uia4	-0.011 -	0.175 -				-0.078 -	-0.222 -
uia5	0.167 -	0.124 -				-0.199 -	-0.276 -
uia6	0.151 -	0.211 -				-0.245 -	-0.068 -
uia7	0.217 -	0.310 0.090				-0.336 0.064	-0.054 -
uia8	0.195 -	0.422 0.018				-0.412 0.021	0.005 -
uia9	0.173 -	0.242 -				-0.409 0.022	-0.197 -
habitu	1.000 + 0.000	0.108 -				-0.305 0.096	0.050 -
cruia		1.000 + 0.000				-0.180 -	0.084 -
cr-now							
ex-hb							
days-						1.000 + 0.000	-0.180 -
age							1.000 + 0.000

SWB + ASWB (3/4) ♀ N = 319

	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.
	habitu	cruia	cruianow	exinbath		daysuia	age (=A1)
uia1	-0.098 0.080	-0.059 -	0.109 0.054			0.404 + 0.001	0.048 -
uia2	-0.127 0.024	-0.067 -	0.090 -			0.379 + 0.001	0.081 -
uia3	-0.137 0.015	-0.096 0.075	0.074 -			0.367 + 0.001	0.090 -
uia4	-0.138 0.014	-0.048 -	0.091 -			0.321 + 0.001	0.094 0.094
uia5	-0.120 0.032	-0.029 -	0.025 -			0.272 + 0.001	0.057 -
uia6	-0.084 -	-0.064 -	0.066 -			0.297 + 0.001	0.060 -
uia7	-0.114 0.042	-0.039 -	0.020 -			0.259 + 0.001	0.122 0.032
uia8	-0.126 0.024	-0.029 -	0.068 -			0.322 + 0.001	0.248 + 0.001
uia9	-0.084 -	0.028 -	0.106 0.058			0.325 + 0.001	0.251 + 0.001
habitu	1.000 + 0.000	0.101 0.074	0.013 -			-0.061 -	-0.013 -
cruia		1.000 + 0.000	0.166 0.004			-0.164 0.004	-0.016 -
cr-now			1.000 + 0.000			0.079 -	-0.000 -
ex-hb							
days-						1.000 + 0.000	0.203 + 0.001
age							1.000 + 0.000

SFA + ASFA (3/4) ♀ N = 78

	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.
	habitu	cruia	cruianow	exinbath		daysuia	age (=A1)
uia1	-0.084 -	0.042 -	0.221 0.052			0.024 -	0.034 -
uia2	-0.104 -	0.140 -	0.242 0.034			-0.044 -	-0.037 -
uia3	-0.111 -	0.093 -	0.094 -			0.032 -	0.026 -
uia4	0.000 -	0.073 -	0.249 0.028			-0.093 -	-0.063 -
uia5	-0.059 -	0.060 -	0.235 0.039			0.039 -	0.009 -
uia6	-0.095 -	0.199 0.082	0.173 -			0.066 -	0.072 -
uia7	-0.149 -	0.194 0.088	0.178 -			0.100 -	0.106 -
uia8	-0.027 -	0.042 -	0.138 -			0.048 -	0.066 -
uia9	-0.057 -	0.066 -	0.169 -			0.088 -	0.094 -
habitu	1.000 + 0.000	0.196 0.082	0.081 -			-0.473 + 0.001	-0.462 + 0.001
cruia		1.000 + 0.000	0.072 -			-0.070 -	-0.082 -
or-now			1.000 + 0.000			-0.046 -	-0.073 -
ex-hb							
days-						1.000 + 0.000	0.691 + 0.001
age							1.000 + 0.000

GB + AGP (3/4) ♀ N = 45

	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.
	habitu	cruia	cruianow	exinbath		daysuia	age (=A1)
uia1	-0.236 -	0.069 -	-0.026 -			0.042 -	-0.076 -
uia2	-0.154 -	0.175 -	-0.066 -			0.010 -	0.010 -
uia3	-0.193 -	0.064 -	-0.064 -			0.101 -	-0.128 -
uia4	-0.130 -	0.085 -	-0.036 -			0.155 -	-0.098 -
uia5	-0.152 -	0.038 -	-0.012 -			0.095 -	-0.005 -
uia6	-0.161 -	0.077 -	-0.085 -			0.119 -	-0.034 -
uia7	-0.180 -	0.069 -	-0.116 -			0.116 -	0.078 -
uia8	-0.231 -	0.066 -	-0.196 -			0.198 -	0.109 -
uia9	-0.163 -	0.098 -	-0.166 -			0.186 -	-0.016 -
habitu	1.000 + 0.000	0.226 -	0.130 -			-0.252 0.096	-0.301 0.044
cruia		1.000 + 0.000	0.128 -			-0.199 -	-0.039 -
cr-now			1.000 0.000			-0.067 -	0.276 0.066
ex-bth							
days-						1.000 + 0.000	-0.056 -
age							1.000 + 0.000

SWE + ASWE (3/4) ♂ N = 211

	r sig. habitf	r sig. crfh	r sig. crfhnow	r sig. exinbath	r sig. newhat	r sig. daysfh	r sig. age (=A1)
fh1	-0.017 -	0.037 -	0.108 -		-0.229 + 0.001	0.095 -	-0.420 + 0.001
fh2	-0.039 -	-0.011 -	0.057 -		-0.239 + 0.001	0.106 -	-0.403 + 0.001
fh3	-0.048 -	0.023 -	0.047 -		-0.155 0.022	0.193 0.005	-0.391 + 0.001
fh4	-0.037 -	0.072 -	0.072 -		-0.205 0.003	0.132 0.056	-0.417 + 0.001
fh5	-0.049 -	0.007 -	0.044 -		-0.246 + 0.001	0.120 0.082	-0.461 + 0.001
fh6	-0.047 -	0.021 -	0.114 0.098		-0.240 + 0.001	0.089 -	-0.428 + 0.001
fh7	0.009 -	0.094 -	0.021 -		-0.181 0.008	0.101 -	-0.348 + 0.001
fh8	-0.040 -	0.017 -	0.022 -		-0.117 0.093	0.166 0.016	-0.329 + 0.001
fh9	-0.024 -	0.065 -	0.052 -		-0.110 -	0.146 0.034	-0.361 + 0.002
habitf	1.000 + 0.000	0.266 + 0.001	0.045 -		0.089 -	-0.198 0.004	0.079 -
crfh		1.000 + 0.000	-0.028 -		-0.107 -	-0.114 0.098	0.028 -
cr-now			1.000 + 0.000		0.074 -	0.030 -	-0.024 -
ex-hth							
newhat					1.000 + 0.000	-0.039 -	0.359 + 0.001
days-						1.000 + 0.000	-0.048 -
age							1.000 + 0.000

SFA + ASFA (3/4) ♂ N = 104

	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.
	habitf	crfh	crfhnow	exinbath	newhat	daysfh	age (=A1)
fh1	-0.104 -	0.020 -	-0.088 -		-0.292 + 0.003	0.218 0.026	-0.023 -
fh2	-0.150 -	0.004 -	-0.166 0.092		-0.197 0.046	0.158 -	-0.188 0.056
fh3	-0.075 -	0.021 -	-0.053 -		-0.179 0.070	0.118 -	-0.163 -
fh4	-0.026 -	-0.047 -	-0.023 -		-0.289 + 0.002	0.153 -	-0.210 0.032
fh5	-0.042 -	0.055 -	0.083 -		-0.190 0.054	0.010 -	-0.242 0.013
fh6	0.053 -	0.134 -	0.160 -		-0.256 + 0.008	0.093 -	-0.246 0.012
fh7	-0.033 -	0.086 -	0.031 -		-0.239 0.014	0.176 0.074	-0.070 -
fh8	-0.184 0.062	0.035 -	-0.080 -		-0.067 -	0.166 0.092	0.035 -
fh9	-0.077 -	-0.014 -	-0.108 -		-0.093 -	0.164 0.096	0.056 -
habitf	1.000 + 0.000	0.143 -	0.120 -		-0.084 -	-0.440 + 0.001	-0.261 0.008
crfh		1.000 + 0.000	0.119 -		0.002 -	-0.005 -	-0.103 -
cr-now			1.000 + 0.000		-0.254 + 0.009	0.024 -	-0.055 -
ex-hth							
newhat					1.000 + 0.000	0.001 -	0.091 -
days-						1.000 + 0.000	0.360 + 0.001
age							1.000 + 0.000

GB + AGB (3/4) ♂ N = 32

	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.
	habitf	crfh	crfhnow	exinbath	newhat	daysfh	age (=A1)
fh1	-0.291 -	-0.243 -	0.154 -		-0.209 -	0.053 -	-0.346 0.052
fh2	-0.539 + 0.0014	0.007 -	0.021 -		-0.157 -	0.123 -	-0.094 -
fh3	-0.304 0.090	-0.054 -	0.054 -		-0.082 -	0.084 -	-0.274 -
fh4	-0.472 + 0.006	0.023 -	-0.022 -		-0.043 -	0.233 -	-0.283 -
fh5	-0.217 -	-0.122 -	-0.095 -		-0.243 -	0.181 -	-0.421 0.016
fh6	-0.172 -	-0.094 -	0.164 -		-0.103 -	0.159 -	-0.286 -
fh7	-0.246 -	-0.141 -	-0.116 -		-0.093 -	0.124 -	-0.044 -
fh8	-0.339 0.058	-0.036 -	-0.122 -		0.158 -	0.262 -	0.077 -
fh9	-0.133 -	0.077 -	0.007 -		0.149 -	0.097 -	0.152 -
habitf	1.000 + 0.000	0.149 -	0.200 -		0.289 -	-0.329 0.066	0.036 -
crfh		1.000 + 0.000	0.149 -		0.190 -	-0.213 -	0.156 -
cr-now			1.000 + 0.000		0.085 -	-0.085 -	0.028 -
ex-bth							
newhat					1.000 + 0.000	-0.043 -	0.172 -
days-						1.000 + 0.000	-0.147 -
age							1.000 + 0.000

SWE + ASWE (3/4) ♀ N = 327

	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.
	habitf	crfh	crfhnow	exinhath	newhat	daysfh	age (=A1)
fh1	-0.065 -	0.013 -	-0.169 + 0.002		-0.097 0.082	0.190 + <0.001	-0.344 + <0.001
fh2	-0.101 0.071	0.028 -	-0.168 + 0.002		-0.095 0.090	0.206 + <0.001	-0.290 + <0.001
fh3	-0.079 -	-0.008 -	-0.206 + <0.001		-0.110 0.047	0.178 + 0.001	-0.336 + <0.001
fh4	-0.094 0.090	0.008 -	-0.196 + <0.001		-0.034 -	0.171 + 0.002	-0.339 + <0.001
fh5	-0.051 -	0.039 -	-0.176 + 0.001		-0.084 -	0.113 0.043	-0.362 + <0.001
fh6	-0.040 -	0.076 -	-0.116 0.036		-0.052 -	0.140 0.012	-0.326 + <0.001
fh7	-0.034 -	0.091 -	-0.126 0.022		-0.002 -	0.121 0.030	-0.285 + <0.001
fh8	-0.047 -	0.027 -	-0.077 -		0.036 -	0.141 0.012	-0.220 <0.001
fh9	-0.009 -	0.020 -	-0.113 0.043		0.028 -	0.068 -	-0.254 + <0.001
habitf	1.000 + 0.000	0.144 + 0.009	0.029 -		0.078 -	-0.110 0.047	-0.019 -
crfh		1.000 0.000	0.179 + 0.001		0.036 -	-0.046 -	-0.027 -
or-now			1.000 + 0.000		0.162 + 0.003	0.016 -	0.289 + <0.001
ex-hth							
newhat					1.000 + 0.000	0.026 -	0.237 + <0.001
days-						1.000 + 0.000	0.245 + <0.001
age							1.000 + 0.000

SPA + ASPA (3/4) ♀ N = 105

	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.
	habitf	crfh	crfhnow	exintath	newhat	daysfh	age (=A1)
fh1	-0.043 -	0.077 -	0.077 -		0.050 -	0.191 0.052	0.011 -
fh2	-0.066 -	0.116 -	0.013 -		0.020 -	0.147 -	-0.006 -
fh3	-0.021 -	0.092 -	0.053 -		0.004 -	0.126 -	-0.018 -
fh4	-0.016 -	0.137 -	0.019 -		0.040 -	0.167 0.090	-0.044 -
fh5	0.057 -	0.135 -	0.046 -		-0.145 -	0.066 -	-0.067 -
fh6	0.006 -	0.138 -	0.072 -		-0.228 0.019	0.004 -	-0.133 -
fh7	-0.072 -	0.158 -	0.043 -		-0.171 0.082	0.118 -	-0.075 -
fh8	-0.000	0.144 -	0.015 -		0.011 -	0.077 -	-0.083 -
fh9	-0.092 -	0.129 -	-0.014 -		-0.078 -	0.106 -	-0.059 -
habitf	1.000 + 0.000	0.196 0.045	0.167 0.090		-0.003 -	-0.439 + 0.001	-0.447 + 0.001
crfh		1.000 + 0.000	0.324 + 0.001		0.006 -	-0.204 0.037	-0.037 -
cr-now			1.000 + 0.000		-0.100 -	-0.141 -	-0.060 -
ex-bth							
newhat					1.000 + 0.000	0.154 -	0.125 -
days-						1.000 + 0.000	0.567 + 0.001
age							1.000 + 0.000

GP + AGP (3/4) ♀ N = 46

	r sig. habitf	r sig. crfh	r sig. crfhnow	r sig. exinbath	r sig. newhat	r sig. daysfh	r sig. age (=A1)
fh1	-0.160 -	-0.072 -	-0.086 -		-0.085 -	0.170 -	-0.280 0.060
fh2	-0.051 -	-0.117 -	-0.180 -		-0.185 -	0.008 -	-0.181 -
fh3	-0.052 -	-0.046 -	-0.145 -		-0.073 -	-0.187 -	-0.288 0.052
fh4	0.105 -	0.035 -	-0.068 -		-0.063 -	-0.052 -	-0.257 0.086
fh5	-0.031 -	0.014 -	-0.069 -		-0.044 -	-0.056 -	-0.250 0.094
fh6	-0.094 -	0.059 -	-0.049 -		-0.020 -	-0.038 -	-0.296 0.045
fh7	-0.072 -	0.067 -	0.175 -		0.034 -	0.175 -	-0.316 0.032
fh8	-0.022 -	0.018 -	0.312 0.034		-0.019 -	0.270 0.070	-0.240 -
fh9	0.009 -	-0.037 -	0.129 -		0.087 -	0.273 0.068	-0.374 + 0.010
habitf	1.000 + 0.000	0.297 0.046	0.018 -		0.073 -	-0.261 0.076	-0.306 0.038
crfh		1.000 + 0.000	0.222 -		0.081 -	-0.133 -	-0.010 -
cr-now			1.000 + 0.000		-0.151 -	0.149 -	0.126 -
ex-hth							
newhat					1.000 + 0.000	0.070 -	-0.021 -
days-						1.000 + 0.000	-0.046 -
age							1.000 + 0.000

Appendix C.3.

SWE + ASWE (3/4) ♂ N = 207

	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.
	uia1	uia2	uia3	uia4	uia5	uia6	uia7	uia8	uia9	
uia1	1.000 0.000	0.808 0.001	0.793 0.001	0.730 0.001	0.695 0.001	0.654 0.001	0.636 0.001	0.533 0.001	0.519 0.001	
uia2		1.000 0.000	0.857 0.001	0.788 0.001	0.733 0.001	0.663 0.001	0.726 0.001	0.559 0.001	0.599 0.001	
uia3			1.000 0.000	0.783 0.001	0.761 0.001	0.684 0.001	0.729 0.001	0.547 0.001	0.575 0.001	
uia4				1.000 0.000	0.775 0.001	0.729 0.001	0.748 0.001	0.565 0.001	0.675 0.001	
uia5					1.000 0.000	0.752 0.001	0.752 0.001	0.571 0.001	0.606 0.001	
uia6						1.000 0.000	0.762 0.001	0.551 0.001	0.569 0.001	
uia7							1.000 0.000	0.642 0.001	0.707 0.001	
uda8								1.000 0.000	0.732 0.001	
uia9									1.000 0.000	
Du1	0.324 0.001	0.212 0.002	0.233 0.001	0.230 0.001	0.124 0.076	0.188 0.006	0.194 0.005	0.148 0.034	0.112 -	
Du2	0.193 0.006	0.109 -	0.125 0.076	0.165 0.018	0.033 -	0.116 0.096	0.126 0.070	0.109 -	0.052 -	
Du3	0.130 0.062	0.071 -	0.076 -	0.125 0.076	-0.018 -	0.083 -	0.088 -	0.081 -	0.012 -	
Du4	0.105 -	0.061 -	0.060 -	0.105 -	-0.045 -	0.070 -	0.069 -	0.062 -	-0.014 -	
Du5	0.093 -	0.056 -	0.053 -	0.091 -	-0.062 -	0.064 -	0.056 -	0.049 -	-0.034 -	
A1	0.085 -	0.094 -	0.148 0.033	0.099 -	0.085 -	0.090 -	0.108 -	0.090 -	0.053 -	
A2	0.066 -	0.096 -	0.142 0.041	0.103 -	0.089 -	0.076 -	0.105 -	0.091 -	0.057 -	
A3	0.043 -	0.089 -	0.131 0.062	0.097 -	0.084 -	0.059 -	0.098 -	0.083 -	0.054 -	
Duin	-0.389 0.001	-0.342 0.001	-0.326 0.001	-0.262 0.001	-0.216 0.002	-0.266 0.001	-0.267 0.001	-0.185 0.008	-0.168 0.015	
Dulg	0.419 0.001	0.319 0.001	0.326 0.001	0.265 0.001	0.197 0.004	0.249 0.001	0.246 0.001	0.169 0.015	0.154 0.027	

Table C.3. Zero-order correlations and significance coefficients: pigmentation, behavioural variables and age. Significance level: 0.05. Males and females separate.

SPA + ASPA (3/4) ♂ N = 78

	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.
	uia1	uia2	uia3	uia4	uia5	uia6	uia7	uia8	uia9	
uia1	1.000 0.000	0.853 0.001	0.838 0.001	0.857 0.001	0.700 0.001	0.603 0.001	0.777 0.001	0.697 0.001	0.616 0.001	
uia2		1.000 0.000	0.915 0.001	0.897 0.001	0.711 0.001	0.651 0.001	0.838 0.001	0.745 0.001	0.646 0.001	
uia3			1.000 0.000	0.907 0.001	0.739 0.001	0.709 0.001	0.830 0.001	0.746 0.001	0.653 0.001	
uia4				1.000 0.000	0.752 0.001	0.700 0.001	0.835 0.001	0.699 0.001	0.647 0.001	
uia5					1.000 0.000	0.906 0.001	0.814 0.001	0.648 0.001	0.593 0.001	
uia6						1.000 0.000	0.787 0.001	0.672 0.001	0.641 0.001	
uia7							1.000 0.000	0.800 0.001	0.760 0.001	
uia8								1.000 0.000	0.696 0.001	
uia9									1.000 0.000	
Du1	-0.260 0.022	0.240 0.034	0.292 0.010	0.197 0.086	0.093 -	0.101 -	0.140 -	0.128 -	0.126 -	
Du2	0.253 0.026	0.226 0.046	0.271 0.016	0.189 -	0.084 -	0.089 -	0.132 -	0.104 -	0.097 -	
Du3	0.244 0.031	0.212 0.062	0.255 0.024	0.178 -	0.075 -	0.076 -	0.124 -	0.087 -	0.071 -	
Du4	0.237 0.037	0.203 0.076	0.243 0.033	0.169 -	0.068 -	0.067 -	0.120 -	0.077 -	0.050 -	
Du5	0.231 0.043	0.196 0.086	0.235 0.039	0.162 -	0.064 -	0.060 -	0.118 -	0.071 -	0.036 -	
A1	0.342 0.002	0.224 0.048	0.229 0.044	0.264 0.019	0.208 0.068	0.183 -	0.162 -	0.202 0.076	0.304 0.006	
A2	0.306 0.006	0.203 0.076	0.215 0.060	0.236 0.036	0.178 -	0.163 -	0.134 -	0.184 -	0.283 0.012	
A3	0.262 0.020	0.175 -	0.192 0.092	0.200 0.080	0.139 -	0.133 -	0.098 -	0.158 -	0.252 0.026	
Duin	-0.231 0.043	-0.239 0.036	-0.305 0.006	-0.167 -	-0.082 -	-0.092 -	-0.131 -	-0.162 -	-0.140 -	
Dulg	0.256 0.024	0.248 0.028	0.308 0.006	0.194 0.088	0.095 -	0.105 -	0.144 -	0.152 -	0.146 -	

GB + AGP (3/4) ♂ N = 31

	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.
	uia1	uia2	uia3	uia4	uia5	uia6	uia7	uia8	uia9	
uia1	1.000 0.000	0.862 0.001	0.882 0.001	0.843 0.001	0.682 0.001	0.713 0.001	0.360 0.046	0.455 0.010	0.634 0.001	
uia2		1.000 0.000	0.848 0.001	0.800 0.001	0.691 0.001	0.734 0.001	0.432 0.014	0.485 0.006	0.635 0.001	
uia3			1.000 0.000	0.911 0.001	0.762 0.001	0.749 0.001	0.538 0.001	0.614 0.001	0.769 0.001	
uia4				1.000 0.000	0.804 0.001	0.729 0.001	0.530 0.002	0.581 0.001	0.684 0.001	
uia5					1.000 0.000	0.692 0.001	0.422 0.017	0.508 0.003	0.677 0.001	
uia6						1.000	0.510 0.003	0.644 0.001	0.765 0.001	
uia7							1.000 0.000	0.449 0.010	0.665 0.001	
uia8								1.000 0.000	0.751 0.001	
uia9									1.000 0.000	
Du1	-0.045 -	-0.257 -	-0.188 -	-0.078 -	-0.199 -	-0.245 -	-0.336 0.004	-0.412 0.020	-0.409 0.022	
Du2	-0.035 -	-0.226 -	-0.192 -	-0.059 -	-0.163 -	-0.190 -	-0.274 -	-0.427 0.016	-0.403 0.024	
Du3	-0.027 -	-0.196 -	-0.192 -	-0.042 -	-0.140 -	-0.148 -	-0.229 -	-0.442 0.012	-0.399 0.026	
Du4	-0.019 -	-0.167 -	-0.188 -	-0.027 -	-0.124 -	-0.118 -	-0.199 -	-0.455 0.010	-0.397 0.026	
Du5	-0.009 -	-0.140 -	-0.180 -	-0.012 -	-0.114 -	-0.096 -	-0.180 -	-0.466 0.008	-0.395 0.028	
A1	-0.280 -	-0.122 -	-0.269 -	-0.222 -	-0.276 -	-0.088 -	-0.054 -	0.005 -	-0.197 -	
A2	-0.277 -	-0.121 -	-0.265 -	-0.224 -	-0.278 -	-0.094 -	-0.046 -	-0.015 -	-0.210 -	
A3	-0.273 -	-0.119 -	-0.261 -	-0.225 -	-0.279 -	-0.098 -	-0.038 -	-0.035 -	-0.221 -	
Duin	0.090 -	0.312 0.088	0.178 -	0.129 -	0.295 -	0.358 0.047	0.454 0.010	0.373 0.019	0.413 0.020	
Dulg	-0.063 -	-0.287 -	-0.182 -	-0.102 -	-0.245 -	-0.307 0.094	-0.403 0.024	-0.393 0.028	-0.414 0.020	

SWE + ASWE (3/4) ♀ N = 319

	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.
	uia1	uia2	uia3	uia4	uia5	uia6	uia7	uia8	uia9	
uia1	1.000 0.000	0.862 0.001	0.844 0.001	0.791 0.001	0.721 0.001	0.679 0.001	0.623 0.001	0.598 0.001	0.576 0.001	
uia2		1.000 0.000	0.902 0.001	0.851 0.001	0.792 0.001	0.777 0.001	0.727 0.001	0.687 0.001	0.633 0.001	
uia3			1.000 0.000	0.874 0.001	0.788 0.001	0.781 0.001	0.736 0.001	0.703 0.001	0.643 0.001	
uia4				1.000 0.000	0.832 0.001	0.794 0.001	0.728 0.001	0.690 0.001	0.637 0.001	
uia5					1.000 0.000	0.839 0.001	0.762 0.001	0.694 0.001	0.633 0.001	
uia6						1.000 0.000	0.769 0.001	0.727 0.001	0.657 0.001	
uia7							1.000 0.000	0.842 0.001	0.788 0.001	
uia8								1.000 0.000	0.860 0.001	
uia9									1.000 0.000	
Du1	0.404 0.000	0.379 0.001	0.367 0.001	0.321 0.001	0.272 0.001	0.297 0.001	0.259 0.001	0.322 0.001	0.325 0.001	
Du2	0.187 0.001	0.168 0.002	0.148 0.008	0.128 0.022	0.102 0.068	0.132 0.018	0.126 0.024	0.174 0.002	0.164 0.003	
Du3	0.065 -	0.052 -	0.031 -	0.026 -	0.013 -	0.041 -	0.048 -	0.086 -	0.069 -	
Du4	0.031 -	0.020 -	-0.001 -	-0.002 -	-0.011 -	0.016 -	0.026 -	0.062 -	0.043 -	
Du5	0.023 -	0.012 -	-0.009 -	-0.008 -	-0.016 -	0.010 -	0.021 -	0.056 -	0.037 -	
A1	0.048 -	0.081 -	0.090 -	0.094 0.094	0.057 -	0.060 -	0.122 0.030	0.248 0.001	0.251 0.001	
A2	0.060 -	0.084 -	0.101 0.074	0.104 0.064	0.069 -	0.070 -	0.126 0.024	0.250 0.001	0.247 0.001	
A3	0.067 -	0.083 -	0.106 0.058	0.104 0.064	0.072 -	0.076 -	0.125 0.027	0.242 0.001	0.234 0.001	
Duin	-0.260 0.001	-0.251 0.001	-0.251 0.001	-0.196 0.001	-0.180 0.001	-0.181 0.001	-0.127 0.024	-0.142 0.011	-0.142 0.011	
DuJg	0.451 0.001	0.427 0.001	0.426 0.001	0.368 0.001	0.318 0.001	0.331 0.001	0.268 0.001	0.322 0.001	0.327 0.001	

SPA + ASFA (3/4) ♀ N = 78

	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.
	uia1	uia2	uia3	uia4	uia5	uia6	uia7	uia8	uia9	
uia1	1.000 0.000	0.840 0.001	0.808 0.001	0.746 0.001	0.783 0.001	0.677 0.001	0.591 0.001	0.717 0.001	0.683 0.001	
uia2		1.000 0.000	0.900 0.001	0.790 0.001	0.806 0.001	0.678 0.001	0.621 0.001	0.757 0.001	0.725 0.001	
uia3			1.000 0.000	0.767 0.001	0.822 0.001	0.675 0.001	0.684 0.001	0.796 0.001	0.765 0.001	
uia4				1.000 0.000	0.785 0.001	0.582 0.001	0.517 0.001	0.656 0.001	0.624 0.001	
uia5					1.000 0.000	0.781 0.001	0.728 0.001	0.766 0.001	0.747 0.001	
uia6						1.000 0.000	0.566 0.001	0.657 0.001	0.688 0.001	
uia7							1.000 0.000	0.681 0.001	0.581 0.001	
uia8								1.000 0.000	0.840 0.001	
uia9									1.000 0.000	
Du1	0.024 -	-0.044 -	0.032 -	-0.093 -	0.039 -	0.066 -	0.100 -	0.048 -	0.088 -	
Du2	0.007 -	-0.060 -	0.013 -	-0.109 -	0.021 -	0.057 -	0.079 -	0.038 -	0.085 -	
Du3	-0.006 -	-0.071 -	0.001 -	-0.119 -	0.009 -	0.053 -	0.063 -	0.032 -	0.080 -	
Du4	-0.015 -	-0.078 -	-0.006 -	-0.126 -	0.003 -	0.052 -	0.053 -	0.029 -	0.077 -	
Du5	-0.020 -	-0.082 -	-0.011 -	-0.131 -	-0.002 -	0.052 -	0.046 -	0.027 -	0.074 -	
A1	0.034 -	-0.037 -	0.026 -	-0.063 -	0.009 -	0.072 -	0.106 -	0.066 -	0.094 -	
A2	0.048 -	-0.021 -	0.043 -	-0.042 -	0.031 -	0.093 -	0.105 -	0.076 -	0.108 -	
A3	0.057 -	-0.009 -	0.053 -	-0.028 -	0.047 -	0.108 -	0.106 -	0.082 -	0.117 -	
Duin	-0.063 -	-0.003 -	-0.086 -	0.050 -	-0.091 -	-0.097 -	-0.154 -	-0.081 -	-0.084 -	
Du1g	0.044 -	-0.022 -	0.058 -	-0.073 -	0.064 -	0.080 -	0.127 -	0.063 -	0.088 -	

GB + AGB (3/4) ♀ N = 45

	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.
	uia1	uia2	uia3	uia4	uia5	uia6	uia7	uia8	uia9	
uia1	1.000 0.000	0.902 0.001	0.921 0.001	0.921 0.001	0.813 0.001	0.810 0.001	0.831 0.001	0.722 0.001	0.717 0.001	
uia2		1.000 0.000	0.932 0.001	0.930 0.001	0.855 0.001	0.856 0.001	0.871 0.001	0.774 0.001	0.727 0.001	
uia3			1.000 0.000	0.952 0.001	0.838 0.001	0.852 0.001	0.856 0.001	0.782 0.001	0.772 0.001	
uia4				1.000 0.000	0.901 0.001	0.887 0.001	0.895 0.001	0.809 0.001	0.792 0.001	
uia5					1.000 0.000	0.894 0.001	0.870 0.001	0.761 0.001	0.793 0.001	
uia6						1.000 0.000	0.913 0.001	0.798 0.001	0.812 0.001	
uia7							1.000 0.000	0.877 0.001	0.881 0.001	
uia8								1.000 0.000	0.892 0.001	
uia9									1.000 0.000	
Du1	0.042 -	0.010 -	0.101 -	0.155 -	0.095 -	0.119 -	0.116 -	0.198 -	0.186 -	
Du2	0.039 -	0.036 -	0.081 -	0.123 -	0.079 -	0.103 -	0.140 -	0.215 -	0.181 -	
Du3	0.029 -	0.042 -	0.059 -	0.092 -	0.057 -	0.082 -	0.142 -	0.213 -	0.167 -	
Du4	0.021 -	0.042 -	0.044 -	0.072 -	0.041 -	0.067 -	0.138 -	0.208 -	0.156 -	
Du5	0.016 -	0.041 -	0.035 -	0.061 -	0.032 -	0.058 -	0.135 -	0.203 -	0.150 -	
A1	-0.076 -	0.010 -	-0.128 -	-0.098 -	-0.005 -	-0.034 -	0.078 -	0.109 -	-0.016 -	
A2	-0.080 -	-0.001 -	-0.127 -	-0.104 -	-0.017 -	-0.042 -	0.068 -	0.090 -	-0.033 -	
A3	-0.083 -	-0.011 -	-0.123 -	-0.108 -	-0.027 -	-0.048 -	0.059 -	0.072 -	-0.047 -	
Duin	0.014 -	0.098 -	-0.068 -	-0.128 -	-0.044 -	-0.072 -	0.020 -	-0.076 -	-0.115 -	
Dulg	0.023 -	-0.040 -	0.099 -	0.160 -	0.085 -	0.108 -	0.056 -	0.145 -	0.162 -	

SWE + ASWE (3/4) ♂ N = 211

	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.
	fh1	fh2	fh3	fh4	fh5	fh6	fh7	fh8	fh9	
fh1	1.000 0.000	0.808 0.001	0.790 0.001	0.741 0.001	0.727 0.001	0.728 0.001	0.647 0.001	0.647 0.001	0.661 0.001	
fh2		1.000 0.000	0.810 0.001	0.739 0.001	0.746 0.001	0.700 0.001	0.612 0.001	0.620 0.001	0.618 0.001	
fh3			1.000 0.000	0.759 0.001	0.764 0.001	0.710 0.001	0.664 0.001	0.687 0.001	0.640 0.001	
fh4				1.000 0.000	0.804 0.001	0.787 0.001	0.702 0.001	0.662 0.001	0.658 0.001	
fh5					1.000 0.000	0.787 0.001	0.653 0.001	0.675 0.001	0.628 0.001	
fh6						1.000 0.000	0.646 0.001	0.645 0.001	0.628 0.001	
fh7							1.000 0.000	0.674 0.001	0.613 0.001	
fh8								1.000 0.000	0.772 0.001	
fh9									1.000 0.000	
Df1	0.095 -	0.106 -	0.193 0.005	0.132 0.056	0.120 0.082	0.089 -	0.101 -	0.166 0.016	0.146 0.034	
Df2	0.007 -	0.032 -	0.090 -	0.058 -	0.057 -	0.003 -	0.057 -	0.088 -	0.094 -	
Df3	-0.029 -	0.003 -	0.043 -	0.024 -	0.027 -	-0.031 -	0.029 -	0.042 -	0.054 -	
Df4	-0.039 -	-0.005 -	0.026 -	0.012 -	0.015 -	-0.040 -	0.013 -	0.018 -	0.032 -	
Df5	-0.043 -	-0.009 -	0.019 -	0.005 -	0.008 -	-0.043 -	0.002 -	0.001 -	0.018 -	
A1	-0.420 0.001	-0.403 0.001	-0.391 0.001	-0.417 0.001	-0.461 0.001	-0.428 0.001	-0.348 0.001	-0.329 0.001	-0.361 0.001	
A2	-0.369 0.001	-0.355 0.001	-0.360 0.001	-0.379 0.001	-0.413 0.001	-0.388 0.001	-0.311 0.001	-0.307 0.001	-0.341 0.001	
A3	-0.334 0.001	-0.321 0.001	-0.337 0.001	-0.353 0.001	-0.379 0.001	-0.361 0.001	-0.283 0.001	-0.291 0.001	-0.326 0.001	
Dfin	-0.100 -	-0.118 0.087	-0.136 0.048	-0.144 0.036	-0.156 0.024	-0.104 -	-0.066 -	-0.123 0.077	-0.022 -	
DSig	0.156 0.024	0.159 0.022	0.234 0.001	0.181 0.008	0.172 0.012	0.150 0.030	0.112 -	0.188 0.006	0.114 0.098	

SPA + ASPA (3/4) ♂ N = 104

	r sig. fh1	r sig. fh2	r sig. fh3	r sig. fh4	r sig. fh5	r sig. fh6	r sig. fh7	r sig. fh8	r sig. fh9	r sig.
fh1	1.000 0.000	0.707 0.001	0.707 0.001	0.739 0.001	0.419 0.001	0.577 0.001	0.696 0.001	0.634 0.001	0.574 0.001	
fh2		1.000 0.000	0.729 0.001	0.757 0.001	0.468 0.001	0.559 0.001	0.682 0.001	0.563 0.001	0.557 0.001	
fh3			1.000 0.000	0.732 0.001	0.602 0.001	0.581 0.001	0.709 0.001	0.558 0.001	0.490 0.001	
fh4				1.000 0.000	0.580 0.001	0.670 0.001	0.674 0.001	0.549 0.001	0.549 0.001	
fh5					1.000 0.000	0.589 0.001	0.512 0.001	0.378 0.001	0.297 0.002	
fh6						1.000 0.000	0.751 0.001	0.534 0.001	0.609 0.001	
fh7							1.000 0.000	0.755 0.001	0.732 0.001	
fh8								1.000 0.000	0.772 0.001	
fh9									1.000 0.000	
Df1	0.218 0.026	0.158 -	0.118 -	0.153 -	0.010 -	0.093 -	0.176 0.074	0.166 0.092	0.164 0.096	
Df2	0.168 0.088	0.119 -	0.076 -	0.082 -	-0.026 -	0.058 -	0.122 -	0.158 -	0.142 -	
Df3	0.152 -	0.112 -	0.065 -	0.069 -	-0.028 -	0.053 -	0.108 -	0.154 -	0.134 -	
Df4	0.150 -	0.116 -	0.066 -	0.073 -	-0.022 -	0.057 -	0.109 -	0.155 -	0.134 -	
Df5	0.151 -	0.121 -	0.070 -	0.082 -	-0.016 -	0.063 -	0.112 -	0.156 -	0.135 -	
A1	-0.023 -	-0.188 0.056	-0.163 -	-0.210 0.032	-0.242 0.013	-0.246 0.012	-0.070 -	0.035 -	0.056 -	
A2	-0.039 -	-0.190 0.054	-0.172 0.081	-0.230 0.018	-0.230 0.018	-0.223 0.024	-0.084 -	0.042 -	0.059 -	
A3	-0.054	-0.188 0.056	-0.181 0.068	-0.244 0.012	-0.220 0.024	-0.201 0.042	-0.099 -	0.045 -	0.055 -	
Dfln	-0.281 0.004	-0.215 0.029	-0.252 0.010	-0.324 0.001	-0.148 -	-0.214	-0.255 0.009	-0.152 -	-0.171 0.084	
Dflg	0.264 0.006	0.199 0.044	0.186 0.058	0.261 0.008	0.093 -	0.159 -	0.237 0.016	0.155 -	0.173 0.081	

GB + AGB (3/4) ♂ N = 32

	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.
	fh1	fh2	fh3	fh4	fh5	fh6	fh7	fh8	fh9	
fh1	1.000 0.000	0.582 0.001	0.648 0.001	0.649 0.001	0.313 0.082	0.497 0.003	0.649 0.001	0.410 0.019	0.444 0.010	
fh2		1.000 0.000	0.723 0.001	0.763 0.001	0.316 0.078	0.691 0.001	0.677 0.001	0.486 0.004	0.382 0.030	
fh3			1.000 0.000	0.823 0.001	0.284 -	0.729 0.001	0.656 0.001	0.513 0.002	0.374 0.034	
fh4				1.000 0.000	0.388 0.028	0.697 0.001	0.702 0.001	0.521 0.002	0.374 0.034	
fh5					1.000 0.000	0.169 -	0.182 -	0.263 -	0.257 -	
fh6						1.000 0.000	0.572 0.001	0.293 -	0.191 -	
fh7							1.000 0.000	0.696 0.001	0.643 0.001	
fh8								1.000 0.000	0.866 0.001	
fh9									1.000 0.000	
Df1	0.053 -	0.123 -	0.084 -	0.233 -	0.181 -	0.159 -	0.124 -	0.262 -	0.097 -	
Df2	0.039 -	0.132 -	0.051 -	0.245 -	0.154 -	0.176 -	0.091 -	0.181 -	0.027 -	
Df3	0.027 -	0.145 -	0.034 -	0.249 -	0.138 -	0.188 -	0.070 -	0.132 -	-0.017 -	
Df4	0.020 -	0.164 -	0.030 -	0.253 -	0.131 -	0.198 -	0.063 -	0.106 -	-0.040 -	
Df5	0.018 -	0.186 -	0.036 -	0.260 -	0.131 -	0.208 -	0.064 -	0.094 -	-0.049 -	
A1	-0.346 0.052	-0.094 -	-0.274 -	-0.283 -	-0.421 0.016	-0.286 -	-0.044 -	0.077 -	0.152 -	
A2	-0.344 0.054	-0.115 -	-0.289 -	-0.301 -	-0.403 -	-0.310 -	-0.075 -	0.054 -	0.135 -	
A3	-0.342 -	-0.136 -	-0.301 0.096	-0.317 0.078	-0.386 0.028	-0.332 0.064	-0.105 -	0.030 -	0.117 -	
Dfln	-0.010 -	-0.066 -	-0.118 -	-0.079 -	-0.171 -	-0.106 -	-0.123 -	-0.380 0.032	-0.173 -	
Dflg	0.050 -	0.107 -	0.119 -	0.184 -	0.200 -	0.136 -	0.149 -	0.356 0.044	0.169 -	

SWB + ASWB (3/4) ♀ N = 327

	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.
	fh1	fh2	fh3	fh4	fh5	fh6	fh7	fh8	fh9	
fh1	1.000 0.000	0.820 0.001	0.828 0.001	0.768 0.001	0.715 0.001	0.677 0.001	0.618 0.001	0.590 0.001	0.567 0.001	
fh2		1.000 0.000	0.846 0.001	0.810 0.001	0.740 0.001	0.736 0.001	0.683 0.001	0.647 0.001	0.583 0.001	
fh3			1.000 0.000	0.843 0.001	0.762 0.001	0.743 0.001	0.686 0.001	0.639 0.001	0.573 0.001	
fh4				1.000 0.000	0.802 0.001	0.709 0.001	0.626 0.001	0.607 0.001	0.549 0.001	
fh5					1.000 0.000	0.799 0.001	0.660 0.001	0.542 0.001	0.487 0.001	
fh6						1.000 0.000	0.692 0.001	0.620 0.001	0.541 0.001	
fh7							1.000 0.000	0.692 0.001	0.609 0.001	
fh8								1.000 0.000	0.690 0.001	
fh9									1.000 0.000	
Df1	0.190 0.001	0.206 0.001	0.178 0.001	0.171 0.002	0.113 0.044	0.140 0.012	0.121 0.030	0.141 0.012	0.068 -	
Df2	0.079 -	0.095 0.090	0.071 -	0.069 -	0.032 -	0.056 -	0.035 -	0.012 -	-0.019 -	
Df3	0.015 -	0.025 -	0.009 -	0.008 -	-0.011 -	0.006 -	-0.018 -	-0.051 -	-0.064 -	
Df4	-0.003 -	0.006 -	-0.008 -	-0.008 -	-0.022 -	-0.008 -	-0.033 -	-0.067 -	-0.075 -	
Df5	-0.007 -	0.001 -	-0.012 -	-0.012 -	-0.025 -	-0.012 -	-0.037 -	-0.070 -	-0.077 -	
A1	-0.344 0.001	-0.290 0.001	-0.336 0.001	-0.339 0.001	-0.362 0.001	-0.326 0.001	-0.285 0.001	-0.220 0.001	-0.254 0.001	
A2	-0.297 0.001	-0.247 0.001	-0.285 0.001	-0.284 0.001	-0.305 0.001	-0.279 0.001	-0.254 0.001	-0.200 0.001	-0.238 0.001	
A3	-0.255 0.001	-0.210 0.001	-0.241 0.001	-0.239 0.001	-0.258 0.001	-0.240 0.001	-0.225 0.001	-0.183 0.001	-0.219 0.001	
Dfin	-0.104 0.060	-0.083 -	-0.122 0.028	-0.093 0.096	-0.097 0.082	-0.063 -	-0.033 -	-0.077 -	-0.003 -	
Dflg	0.193 0.001	0.188 0.001	0.188 0.001	0.170 0.002	0.132 0.016	0.132 0.016	0.105 0.060	0.155 0.006	0.063 -	

SPA + ASPA (3/4) ♀ N = 105

	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.
	fh1	fh2	fh3	fh4	fh5	fh6	fh7	fh8	fh9	
fh1	1.000 0.000	0.794 0.001	0.737 0.001	0.760 0.001	0.706 0.001	0.703 0.001	0.761 0.001	0.695 0.001	0.542 0.001	
fh2		1.000 0.000	0.847 0.001	0.856 0.001	0.770 0.001	0.729 0.001	0.815 0.001	0.750 0.001	0.694 0.001	
fh3			1.000 0.000	0.851 0.001	0.770 0.001	0.720 0.001	0.823 0.001	0.711 0.001	0.738 0.001	
fh4				1.000 0.000	0.803 0.001	0.757 0.001	0.807 0.001	0.761 0.001	0.690 0.001	
fh5					1.000 0.000	0.789 0.001	0.788 0.001	0.796 0.001	0.621 0.001	
fh6						1.000 0.000	0.865 0.001	0.736 0.001	0.714 0.001	
fh7							1.000 0.000	0.849 0.001	0.809 0.001	
fh8								1.000 0.000	0.803 0.001	
fh9									1.000 0.000	
Df1	0.191 0.052	0.147 -	0.126 -	0.167 -	0.066 -	0.004 -	0.118 -	0.077 -	0.106 -	
Df2	0.090 -	0.031 -	0.014 -	0.044 -	-0.062 -	-0.070 -	0.011 -	-0.038 -	0.021 -	
Df3	0.033 -	-0.024 -	-0.037 -	-0.013 -	-0.105 -	-0.107 -	-0.042 -	-0.086 -	-0.030 -	
Df4	0.008 -	-0.046 -	-0.057 -	-0.037 -	-0.115 -	-0.123 -	-0.063 -	-0.105 -	-0.055 -	
Df5	-0.004 -	-0.056 -	-0.066 -	-0.048 -	-0.117 -	-0.132 -	-0.074 -	-0.113 -	-0.069 -	
A1	0.011 -	-0.006 -	-0.018 -	-0.044 -	-0.067 -	-0.133 -	-0.075 -	-0.083 -	-0.059 -	
A2	0.019 -	0.004 -	-0.014 -	-0.031 -	-0.046 -	-0.096 -	-0.041 -	-0.048 -	-0.025 -	
A3	0.024 -	0.012 -	-0.009 -	-0.021 -	-0.033 -	-0.072 -	-0.020 -	-0.024 -	-0.003 -	
Dfin	-0.046 -	-0.070 -	-0.040 -	-0.125 -	-0.022 -	0.060 -	-0.011 -	-0.052 -	0.041 -	
Dflg	0.182 0.063	0.181 0.066	0.164 0.094	0.218 0.026	0.142 -	0.014 -	0.136 -	0.133 -	0.088 -	

GB + AGB (3/4) ♀ N = 46

	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.	r sig.
	fh1	fh2	fh3	fh4	fh5	fh6	fh7	fh8	fh9	
fh1	1.000 0.000	0.733 0.001	0.536 0.001	0.711 0.001	0.623 0.001	0.596 0.001	0.642 0.001	0.439 0.002	0.456 0.001	
fh2		1.000 0.000	0.768 0.001	0.749 0.001	0.673 0.001	0.600 0.001	0.604 0.001	0.369 0.016	0.260 0.081	
fh3			1.000 0.000	0.677 0.001	0.683 0.001	0.605 0.001	0.586 0.001	0.334 0.023	0.274 0.066	
fh4				1.000 0.000	0.741 0.001	0.685 0.001	0.649 0.001	0.487 0.001	0.419 0.004	
fh5					1.000 0.000	0.737 0.001	0.703 0.001	0.462 0.001	0.414 0.004	
fh6						1.000 0.000	0.609 0.001	0.487 0.001	0.399 0.006	
fh7							1.000 0.000	0.767 0.001	0.755 0.001	
fh8								1.000 0.000	0.784 0.001	
fh9									1.000 0.000	
Df1	0.170 -	0.008 -	-0.187 -	-0.052 -	-0.056 -	-0.038 -	0.175 -	0.270 0.070	0.273 0.068	
Df2	0.124 -	0.003 -	-0.201 -	-0.081 -	-0.092 -	-0.093 -	0.188 -	0.186 -	0.187 -	
Df3	0.089 -	0.003 -	-0.195 -	-0.096 -	-0.107 -	-0.118 -	0.056 -	0.132 -	0.131 -	
Df4	0.069 -	0.005 -	-0.185 -	-0.103 -	-0.113 -	-0.128 -	0.035 -	0.103 -	0.102 -	
Df5	0.059 -	0.007 -	-0.178 -	-0.106 -	-0.115 -	-0.131 -	0.026 -	0.090 -	0.088 -	
A1	-0.280 0.060	-0.181 -	-0.288 0.052	-0.257 0.086	-0.250 0.094	-0.296 0.044	-0.316 0.032	-0.240 -	-0.374 0.010	
A2	-0.283 0.058	-0.185 -	-0.285 0.056	-0.254 0.088	-0.254 0.088	-0.309 0.037	-0.320 0.030	-0.247 -	-0.373 0.010	
A3	-0.284 0.056	-0.186 -	-0.279 0.061	-0.247 -	-0.256 0.086	-0.317 0.032	-0.321 0.030	-0.252 0.092	-0.370 0.013	
Dfln	-0.205 -	-0.035 -	0.058 -	-0.026 -	-0.056 -	-0.119 -	-0.330 0.024	-0.408 0.004	-0.403 0.006	
Dflg	0.203 -	0.020 -	-0.134 -	-0.011 -	-0.000 -	0.042 -	0.263 0.080	0.355 0.015	0.357 0.014	

Appendix D.1

N = 207	T = 0.99		SWE + ASWE			(3/4) ♂ (Behav. only)				N = 235
	B R	Beta ΔR^2	SE SE	F F	p p	B R	Beta ΔR^2	SE SE	F F	p p
Dulg	9.025 0.419	0.413 0.175	1.366 4.332	43.630 43.563	<0.001 0.000					
A1	0.030 0.427	0.083 0.007	0.023 4.324	1.716 22.715	- 0.000					
Habitu						-2.002 0.203	-0.198 0.041	0.672 4.731	8.873 10.019	<0.010 0.002
Cruia						-0.270 0.204	-0.021 0.000	0.859 4.740	0.099 5.039	- 0.007
Constant	13.876					35.667				
Duin	-170.598 0.216	-0.210 0.047	55.547 4.570	9.432 10.031	<0.010 0.002					
A2	432×10^{-6} 0.232	0.087 0.007	0.000 4.564	1.622 5.781	- 0.004					
Habitu	-0.546 0.238	-0.054 0.003	0.690 4.568	0.625 4.056	- 0.008	-0.703 0.093	-0.070 0.009	0.673 4.751	1.093 2.039	- 0.155
Cruia						-1.160 0.128	-0.090 0.008	0.859 4.743	1.823 1.935	- -
Du5										
Constant	42.453					41.629				
Duin	-101.661 0.168	-0.154 0.028	42.985 3.526	5.593 5.948	0.050 0.016					
A2	207×10^{-6} 0.176	0.056 0.003	0.000 3.529	0.648 3.267	- 0.040					
Habitu	-0.303 0.181	-0.039 0.002	0.534 3.535	0.323 2.278	- 0.081	-0.275 0.058	-0.035 0.003	0.533 3.766	0.266 0.777	- 0.379
Cruia						-0.919 0.105	-0.091 0.003	0.681 3.760	1.822 1.301	- 0.274
Du5										
Constant	66.583					65.927				

N = 207	T = 0.95				SWE + AS
	B R	Beta R	SE SE	F F	p p
Dulg	8.669 0.419	0.402 0.175	1.358 4.332	40.762 43.563	<0.001 0.000
A1	328×10^{-4} 0.453	0.090 0.008	0.023 4.273	2.082 17.506	- 0.000
Habitu	-1.582 0.444	-0.154 0.022	0.647 4.264	5.979 25.085	<0.050 0.000
Cruia					
Constant	15.687				
Duin	-179.177 0.216	-0.221 0.047	55.764 4.570	10.324 10.031	<0.010 0.002
A2	409×10^{-6} 0.247	0.084 0.006	0.000 4.558	1.520 4.390	- 0.005
Habitu	-0.691 0.256	-0.069 0.005	0.696 4.558	0.983 3.538	- 0.008
Cruia					
Du5	-979×10^{-17} 0.234	-0.096 0.008	0.000 4.562	1.929 5.879	- 0.003
Constant	42.678				
Duin	-105.728 0.168	-0.170 0.028	43.281 3.526	5.967 5.948	<0.050 0.016
A2	200×10^{-6} 0.184	0.054 0.003	0.000 3.533	0.605 2.363	- 0.072
Habitu	-0.372 0.190	-0.048 0.002	0.541 3.538	0.473 1.886	- 0.114
Cruia					
Du5	-464×10^{-17} 0.176	-0.060 0.003	0.000 3.529	0.720 3.277	- 0.040
Constant	66.689				

Table D.1. The regression of pigmentation on age and the behavioural variables. Filters no. 1, 5 and 9. Parameter specifications (n,F,T): (14,0.01,0.99), (80,0.01,0.001) and (14,0.01,0.95). Final steps. Males and females separate.

N = 78 T = 0.99 SPA + ASPA (3/4) ♂ N = 112
(Behav. only)

	B R	Beta R	SE SE	F F	p p	B R	Beta R	SE SE	F F	p p
A1	0.207 0.342	0.341 0.117	0.066 4.237	9.841 10.096	<0.010 0.002					
Cruianow	-1.340 0.344	-0.034 0.001	4.296 4.262	0.097 5.037	- 0.009	-0.687 0.226	-0.014 0.000	4.661 4.631	0.022 1.943	- 0.127
Habitu						-2.398 0.219	-0.223 0.048	1.015 4.596	5.579 5.528	<0.050 0.021
Cruia						1.013 0.226	0.056 0.003	1.705 4.610	0.353 2.929	- 0.058
Constant	26.207					32.085				
A1	0.122 0.208	0.208 0.043	0.067 4.274	3.344 3.425	- 0.068					
Cruianow	1.413 0.211	0.037 0.001	4.362 4.299	0.105 1.749	- 0.181	1.908 0.228	0.041 0.002	4.415 4.386	0.187 1.974	- 0.122
Cruia	-0.556 0.213	-0.032 0.001	2.003 4.326	0.077 1.177	- 0.324	0.368 0.224	0.021 0.000	1.615 4.370	0.052 2.890	- 0.060
Habitu						-2.324 0.224	-0.227 0.050	0.962 4.351	5.836 5.783	<0.050 0.018
Constant	34.139					38.415				
A1	0.173 0.304	0.313 0.092	0.061 3.907	8.155 7.726	<0.010 0.007					
Cruia	2.200 0.331	0.133 0.017	1.812 3.896	1.474 4.606	- 0.013	1.078 0.245	0.067 0.004	1.495 4.047	0.520 3.492	- 0.034
Cruianow	2.320 0.337	0.065 0.004	3.946 3.913	0.346 3.159	- 0.030	2.269 0.251	0.052 0.003	4.086 4.060	0.308 2.416	- 0.070
Habitu						-2.327 0.237	-0.245 0.056	0.890 4.038	6.834 6.515	=0.010 0.012
Constant	56.721					62.558				

N = 78 T = 0.95 SPA + ASPA

	B R	Beta R	SE SE	F F	p p
A1	0.188 0.342	0.309 0.117	0.067 4.237	7.792 10.096	<0.050 0.002
Cruianow	-0.949 0.360	-0.024 0.001	4.300 4.257	0.049 3.073	- 0.021
Habitu	-1.717 0.378	-0.166 0.025	1.161 4.203	2.188 6.238	- 0.003
Cruia	0.538 0.379	0.030 0.001	1.992 4.229	0.073 4.334	- 0.009
Constant	27.917				
A1	0.114 0.208	0.194 0.043	0.069 4.274	2.762 3.425	- 0.068
Cruianow	1.581 0.225	0.041 0.002	4.388 4.315	0.130 1.309	- 0.278
Cruia	-0.369 0.226	-0.021 0.000	2.032 4.343	0.033 0.977	- 0.425
Habitu	-0.755 0.221	-0.075 0.006	1.184 4.290	0.406 1.917	- 0.154
Constant	34.895				
A1	0.173 0.304	0.313 0.092	0.061 3.907	8.155 7.726	<0.010 0.007
Cruia	2.200 0.331	0.133 0.017	1.812 3.896	1.474 4.606	- 0.013
Cruianow	2.320 0.337	0.065 0.004	3.946 3.913	0.346 3.159	- 0.030
Habitu					
Constant	56.721				

Table D.1. The regression of pigmentation on age and the behavioural variables. Filters no. 1, 5 and 9. Parameter specifications (n,F,T): (14,0.01,0.99), (80,0.01,0.001) and (14,0.01,0.95). Final steps. Males and females separate.

N = 31 T = 0.99 GP + AGP (3/4) (Behav. only) ♂ N = 37

	B R	Beta R	SE SE	F F	p p	B R	Beta R	SE SE	F F	p p
A1	-0.371 0.280	-0.297 0.079	0.223 4.789	2.766 2.469	- 0.127					
Cruia	2.816 0.341	0.196 0.038	2.566 4.772	1.205 1.846	- 0.177	2.157 0.156	0.157 0.023	2.386 4.856	0.817 0.425	- 0.657
Habitu					-	-0.597 0.031	-0.063 0.001	1.637 4.844	0.133 0.033	- 0.856
Du2										
Constant	42.835					35.520				
Duin	960.001 0.295	0.295 0.087	576.928 4.388	2.769 2.769	- 0.107					
Habitu						0.932 0.120	0.108 0.014	1.506 4.410	0.383 0.511	- 0.480
Cruia						0.764 0.134	0.061 0.004	2.195 4.467	0.121 0.310	- 0.736
Constant	36.701					40.490				
Dulg	-8.643 0.414	-0.413 0.171	3.534 3.165	5.982 5.982	<0.050 0.021					
Habitu						0.722 0.143	0.110 0.020	1.127 3.337	0.410 0.726	- 0.400
Cruia						1.530 0.211	0.160 0.024	1.643 3.343	0.868 0.795	- 0.460
A3										
Constant	85.101					63.992				

N = 31 T = 0.95 GB + AGB

	B R	Beta R	SE SE	F F	p p
A1	-0.380 0.280	-0.304 0.079	0.229 4.789	2.753 2.469	- 0.127
Cruia	2.703 0.341	0.168 0.038	2.639 4.772	1.049 1.846	- 0.177
Habitu					
Du2	-276x10^{-6} 0.345	-0.052 0.003	0.000 4.853	0.080 1.217	- 0.323
Constant	43.265				
Duin	915.991 0.295	0.282 0.087	597.574 4.388	2.350 2.769	- 0.107
Habitu					
Cruia	0.204 0.303	0.068 0.005	2.435 4.455	0.138 1.412	- 0.260
Constant	36.784				
Dulg	-9.235 0.414	-0.442 0.171	3.508 3.165	6.929 5.982	<0.050 0.021
Habitu					
Cruia	1.722 0.542	0.172 0.028	1.653 3.027	1.085 3.749	- 0.023
A3	-143x10^{-6} 0.515	-0.316 0.095	0.000 3.032	3.668 5.065	- 0.013
Constant	87.796				

Table D.1. The regression of pigmentation on age and the behavioural variables. Filters no. 1, 5 and 9. Parameter specifications (n,F,T): (14,0.01,0.99), (80,0.01,0.001) and (14,0.01,0.95). Final steps. Males and females separate.

N = 319 SWE + ASWE (3/4) (Behav. only) ♀ N = 364

T = 0.99

	B B	Beta R	SE SE	F F	p p	B R	Beta R	SE SE	F F	p p
Dulg	9.864 0.451	0.443 0.203	1.117 4.506	77.970 80.710	<0.001 0.000					
Habitu	-1.491 0.459	-0.090 0.008	0.825 4.490	3.271 42.227	- 0.000	-1.237 0.098	-0.083 0.010	0.786 4.947	2.476 3.536	- 0.051
Cruianow	1.846 0.465	0.070 0.005	1.325 4.483	1.941 28.883	- 0.000	2.471 0.163	0.093 0.008	1.410 4.916	3.070 3.293	- 0.021
Cruia						-1.117 0.136	-0.111 0.009	0.540 4.932	4.282 3.386	<0.050 0.035
A1										
Constant	15.294					36.747				
Dulg	6.749 0.318	0.316 0.101	1.131 4.582	35.640 35.735	<0.001 0.000					
Habitu	-1.803 0.338	-0.114 0.013	0.838 4.556	4.630 20.387	0.050 0.000	-1.979 0.144	-0.137 0.021	0.761 4.748	6.769 7.703	<0.010 0.006
Cruia						-0.436 0.150	-0.045 0.002	0.522 4.750	0.698 4.174	- 0.016
Cruianow						0.325 0.151	0.013 0.000	1.364 4.756	0.057 2.794	- 0.040
Constant	29.353					44.178				
Dulg	6.020 0.327	0.318 0.107	1.005 4.048	35.899 37.902	<0.001 0.000					
Habitu	-1.110 0.336	-0.079 0.006	0.742 4.040	2.239 20.104	- 0.000	-1.356 0.106	-0.105 0.011	0.682 4.265	3.958 4.079	<0.050 0.044
Cruianow	1.760 0.345	0.079 0.006	1.192 4.033	2.182 14.180	- 0.000	1.875 0.132	0.081 0.006	1.222 4.257	2.352 3.184	- 0.043
Cruia						-0.135 0.133	-0.016 0.000	0.468 4.263	0.084 2.146	- 0.094
Constant	52.823					66.138				

N = 319 SWE + ASWE

T = 0.95

	B R	Beta R	SE SE	F F	p p
Dulg	10.008 0.451	0.449 0.203	1.137 4.506	77.447 80.710	<0.001 0.000
Habitu	-1.496 0.459	-0.091 0.008	0.825 4.490	3.288 42.227	- 0.000
Cruianow	1.831 0.465	0.069 0.005	1.326 4.493	1.905 28.883	- 0.000
Cruia					
A1	-102×10^{-4} 0.466	-0.035 0.001	0.015 4.437	0.477 21.745	- 0.000
Constant	15.271				
Dulg	6.816 0.318	0.319 0.101	1.149 4.592	35.189 35.735	<0.001 0.000
Habitu	-1.836 0.338	-0.116 0.013	0.844 4.556	4.728 20.387	0.050 0.000
Cruia	0.217 0.339	0.022 0.000	0.533 4.562	0.166 13.607	- 0.000
Cruianow	-0.161 0.339	-0.006 0.000	1.372 4.569	0.014 10.177	- 0.000
Constant	29.149				
Dulg	5.330 0.327	0.282 0.107	1.001 4.048	28.343 37.902	<0.001 0.000
Habitu	-1.085 0.397	-0.077 0.006	0.727 3.950	2.230 14.635	- 0.000
Cruianow	1.834 0.372	0.082 0.005	1.168 3.958	2.457 18.702	- 0.000
Cruia					
A1	491×10^{-4} 0.381	0.199 0.035	0.013 3.967	14.230 26.741	<0.001 0.000
Constant	52.931				

Table D.1. The regression of pigmentation on age and the behavioural variables. Filters no. 1, 5 and 9. Parameter specifications (n,F,T): (14,0.01,0.99), (80,0.01,0.001) and (14,0.01,0.95). Final steps. Males and females separate.

N = 78 SIA + ASPA (3/4) ♀ N = 117

T = 0.99 (Behav. only)

	B R	Beta R	SE SE	F F	p P	B R	Beta R	SE SE	F F	p P
Cruianow	5.576 0.221	0.229 0.049	2.732 4.620	4.165 3.902	<0.050 0.052	3.006 0.230	0.141 0.019	1.996 5.010	2.268 2.109	- 0.103
Habitu	-1.379 0.244	-0.103 0.011	1.510 4.625	0.834 2.364	- 0.101	-2.474 0.145	-0.176 0.021	1.309 5.050	3.571 2.459	- 0.120
Cruia						1.279 0.185	0.091 0.013	1.326 5.038	0.930 2.008	- 0.139
Constant	34.136					34.278				
Cruianow	6.533 0.235	0.237 0.055	3.103 5.217	4.432 4.438	<0.050 0.038	1.956 0.150	0.084 0.007	2.214 5.557	0.781 0.864	- 0.462
Duin	-897.525 0.257	-0.105 0.011	957.889 5.221	0.878 2.647	- 0.078					
Cruia	0.633 0.261	0.047 0.002	1.513 5.250	0.175 1.804	- 0.154	1.123 0.125	0.073 0.008	1.471 5.552	0.583 0.907	- 0.407
Habitu						-1.721 0.090	-0.112 0.008	1.452 5.549	1.405 0.941	- 0.334
Constant	43.087					40.356				
Cruianow	3.508 0.169	0.175 0.029	2.263 3.844	2.403 2.230	- 0.140	0.378 0.179	0.022 0.001	1.597 4.009	0.056 1.245	- 0.297
A3	124×10^{-7} 0.210	0.126 0.016	0.000 3.838	1.238 1.737	- 0.183					
Habitu						-1.531 0.111	-0.138 0.012	1.048 4.014	2.136 1.424	- 0.235
Cruia						1.524 0.178	0.137 0.019	1.061 3.992	2.061 1.856	- 0.161
Constant	62.559					63.500				

N = 78 SPA + ASPA

T = 0.95

	B R	Beta R	SE SE	F F	p P
Cruianow	5.511 0.221	0.227 0.049	2.752 4.620	4.011 3.902	<0.050 0.052
Habitu	-1.502 0.244	-0.112 0.011	1.547 4.625	0.943 2.364	- 0.101
Cruia	0.565 0.248	0.048 0.002	1.365 4.651	0.171 1.616	- 0.193
Constant	34.136				
Cruianow	6.533 0.235	0.237 0.055	3.103 5.217	4.432 4.438	<0.050 0.038
Duin	-897.525 0.257	-0.105 0.011	957.889 5.221	0.878 2.647	- 0.078
Cruia	0.633 0.261	0.047 0.002	1.513 5.250	0.175 1.804	- 0.154
Constant	43.087				
Cruianow	3.420 0.169	0.171 0.029	2.278 3.844	2.254 2.230	- 0.140
A3	130×10^{-7} 0.210	0.132 0.016	0.000 3.838	1.337 1.737	- 0.183
Habitu					
Cruie	0.644 0.220	0.066 0.004	1.115 3.856	0.333 1.259	- 0.295
Constant	62.428				

Table D.1. The regression of pigmentation on age and the behavioural variables. Filters no. 1, 5 and 9. Parameter specifications (n,F,T): (14,0.01,0.99), (80,0.01,0.001) and (14,0.01,0.95). Final steps. Males and females separate.

N = 45 T = 0.99 GB + AGP (3/4) (Behav. only) ♀ N = 48

	B R	Beta R	SE SE	F P	p p	B R	Beta R	SE SE	F F	p p
Habitu	-2.862 0.236	-0.236 0.056	1.801 5.342	2.526 2.526	- 0.119	-3.700 0.285	-0.314 0.081	1.721 5.242	4.624 4.056	<0.050 0.050
Cruia						1.561 0.309	0.123 0.014	1.851 5.259	0.704 2.367	- 0.105
Duin										
Constant	39.750					40.103				

Habitu	-1.713 0.152	-0.152 0.023	1.701 5.047	1.014 1.014	- 0.320	-2.022 0.167	-0.185 0.028	1.647 4.994	1.507 1.316	- 0.257
Cruia						0.910 0.183	0.077 0.006	1.782 5.035	0.261 0.778	- 0.465
Dulg										
Constant	43.525					43.528				

Du1	851×10^{-5} 0.186	0.175 0.034	0.007 3.215	1.362 1.533	- 0.222					
Cruianow	-2.399 0.241	-0.155 0.024	2.329 3.213	1.061 1.298	- 0.284	-2.524 0.288	-0.161 0.025	2.304 3.143	1.200 1.323	- 0.279
Habitu						-1.482 0.198	-0.214 0.039	1.034 3.146	2.053 1.874	- 0.178
Cruia						1.179 0.240	0.158 0.019	1.118 3.150	1.111 1.378	- 0.263
Constant	62.779					65.416				

N = 46 T = 0.95 GB + AGP

	B R	Beta R	SE SE	F F	p p
Habitu	-2.935 0.236	-0.242 0.056	1.836 5.342	2.555 2.526	- 0.119
Cruia					
Duin	189.604 0.240	0.046 0.002	527.996 5.400	0.091 1.282	- 0.288
Constant	39.943				

Habitu	-1.595 0.152	-0.140 0.023	1.755 5.047	0.815 1.014	- 0.320
Cruia					
Dulg	2.535 0.162	0.056 0.003	7.009 5.099	0.131 0.562	- 0.574
Constant	37.571				

Du1	851.10^{-5} 0.186	0.175 0.034	0.007 3.215	1.362 1.533	- 0.222
Cruianow	-2.399 0.241	-0.155 0.024	2.329 3.213	1.061 1.298	- 0.284
Habitu					
Cruia					
Constant	62.779				

Table D.1. The regression of pigmentation on age and the behavioural variables. Filters no. 1, 5 and 9. Parameter specifications (n,F,T): (14,0.01,0.99), (80,0.01,0.001) and (14,0.01,0.95). Final steps. Males and females separate.

N = 211	T = 0.99			SWE + ASWE		(3/4) (Behav. only)		♂		N = 223
	B R	Beta R	SE SE	F F	p p	B R	Beta R	SE SE	F F	p p
A1	-0.151 0.420	-0.414 0.176	0.023 4.393	44.626 44.662	<0.001 0.000					
Dflg	2.207 0.444	0.142 0.021	0.964 4.346	5.241 25.567	<0.050 0.000					
Crfhnow	6.417 0.454	0.092 0.008	4.350 4.334	2.176 17.867	- 0.000	8.724 0.118	0.123 0.012	4.674 4.745	3.484 1.023	- 0.383
Habitf						0.145 0.007	0.015 0.000	0.692 4.756	0.044 0.011	- 0.918
Crfh						0.281 0.043	0.020 0.002	0.959 4.762	0.086 0.207	- 0.813
Newhat						-2.055 0.244	-0.216 0.046	0.633 4.645	10.534 3.434	<0.010 0.010
Constant	27.187					29.186				
A1	-0.186 0.461	-0.465 0.212	0.024 4.726	58.185 56.264	<0.001 0.000					
Dfin	-44.574 0.489	-0.168 0.027	16.221 4.655	7.552 32.743	<0.050 0.000					
Crfh	0.492 0.490	0.032 0.001	0.927 4.663	0.281 21.847	- 0.000	-0.143 0.054	-0.009 0.000	1.054 5.241	0.018 0.323	- 0.724
Crfhnow	2.319 0.491	0.030 0.001	4.697 4.671	0.244 16.387	- 0.000	4.865 0.072	0.062 0.002	5.137 5.248	0.897 0.377	- 0.770
Df5	$169x10^{-17}$ 0.492	-0.014 0.000	0.000 4.682	0.056 13.061	- 0.000					
Habitf						-0.319 0.050	-0.029 0.003	0.761 5.231	0.176 0.556	- 0.457
Newhat						-2.548 0.251	-0.244 0.058	0.696 5.105	13.402 3.649	<0.001 0.007
Constant	38.245					35.002				
A1	-0.115 0.361	-0.354 0.130	0.021 4.046	30.310 33.255	- 0.000					
Df1	$539x10^{-5}$ 0.383	0.128 0.017	0.003 4.017	3.963 17.880	<0.050 0.000					
Crfhnow	2.508 0.385	0.040 0.002	4.036 4.023	0.386 12.014	- 0.000	4.020 0.093	0.063 0.003	4.267 4.258	0.867 0.640	- 0.590
Habitf						-0.198 0.011	-0.022 0.000	0.632 4.257	0.098 0.027	- 0.869
Crfh						0.793 0.074	0.064 0.005	0.875 4.255	0.820 0.613	- 0.543
Newhat						-0.967 0.146	-0.114 0.013	0.578 4.241	2.795 1.182	- 0.319
Constant	65.458					64.144				

N = 211		T = 0.95			SWE + ASWE
	B R	Beta R	SE SE	F F	p p
A1	-0.151 0.420	-0.416 0.176	0.023 4.393	45.043 44.662	<0.001 0.000
Dflg	2.357 0.444	0.152 0.021	0.972 4.346	5.878 25.567	<0.005 0.000
Crfhnow	6.526 0.454	0.093 0.008	4.347 4.334	2.254 17.867	- 0.000
Habitf					
Crfh	0.990 0.459	0.072 0.005	0.862 4.331	1.320 13.751	- 0.000
Constant	26.743				
A1	-0.186 0.461	-0.465 0.212	0.024 4.726	58.185 56.264	<0.001 0.000
Dfin	-44.574 0.489	-0.168 0.027	16.221 4.655	7.552 32.743	<0.010 0.000
Crfh	0.492 0.490	0.032 0.001	0.927 4.663	0.281 21.847	- 0.000
Crfhnow	2.319 0.491	0.030 0.001	4.697 4.671	0.244 16.387	- 0.000
Df5	$-169x10^{-17}$ 0.492	-0.014 0.000	0.000 4.682	0.056 13.061	- 0.000
Habitf					
Newhat					
Constant	38.245				
A1	-0.115 0.361	-0.356 0.130	0.021 4.046	30.795 31.255	<0.001 0.000
Df1	$582x10^{-5}$ 0.383	0.138 0.017	0.003 4.017	4.592 17.880	<0.050 0.000
Crfhnow	2.648 0.396	0.042 0.002	4.027 4.013	0.433 9.565	- 0.000
Habitf					
Crfh	1.137 0.394	0.092 0.008	0.797 4.007	2.038 12.644	- 0.000
Newhat					
Constant	65.240				

Table D.1. The regression of pigmentation on age and the behavioural variables. Filters no. 1, 5 and 9. Parameter specifications (n,F,T): (14,0.01,0.99), (80,0.01,0.001) and (14,0.01,0.95). Final steps. Males and females separate.

N = 104 SPA + ASPA (3/4) ♂ N = 108

T = 0.99 (Behav. only)

	B R	Beta R	SE SE	F F	p p	B R	Beta R	SE SE	F F	p p
Newhat	-2.081 0.292	-0.271 0.086	0.715 3.366	8.483 9.533	<0.010 0.003	-2.659 0.368	-0.348 0.113	0.724 3.288	13.498 4.042	<0.001 0.004
Dflg	1.868 0.377	0.243 0.057	0.716 3.276	6.801 8.374	0.010 0.000					
Crfh	0.605 0.380	0.044 0.002	1.293 3.288	0.219 5.612	- 0.001	0.809 0.127	0.058 0.001	1.308 3.474	0.382 0.858	- 0.427
Habitf						-1.102 0.122	-0.138 0.015	0.745 3.460	2.188 1.597	- 0.209
Crfhnow						-2.741 0.150	-0.167 0.006	1.574 3.480	3.031 0.794	- 0.500
Dfin										
Df5										
Constant	19.122					24.513				
A1	-0.197 0.242	-0.257 0.058	0.073 5.372	7.251 6.328	<0.050 0.013					
Dfin	-53.577 0.296	-0.171 0.029	29.910 5.314	3.209 4.837	- 0.010					
Habitf						-0.865 0.041	-0.069 0.002	1.229 5.452	0.495 0.175	- 0.676
Crfh						1.318 0.073	0.060 0.004	2.158 5.468	0.373 0.285	- 0.753
Crfhnow						1.034 0.110	0.040 0.007	2.596 5.475	0.159 0.426	- 0.735
Newhat						-2.077 0.101	-0.174 0.028	1.194 5.423	3.027 1.082	- 0.369
Constant	33.176					29.822				
Dflg	1.503 0.173	0.166 0.030	0.887 4.084	2.869 3.152	- 0.079					
Newhat	-0.704 0.190	-0.078 0.006	0.889 4.092	0.626 1.883	- 0.157	-1.045 0.190	-0.116 0.012	0.903 4.084	1.339 1.303	- 0.278
Habitf						-1.078 0.119	-0.114 0.014	0.930 4.091	1.343 1.527	- 0.219
Crfhnow						-2.489 0.154	-0.128 0.010	1.965 4.090	1.605 1.279	- 0.283
Crfh						0.202 0.191	0.012 0.000	1.633 4.103	0.015 0.972	- 0.426
A2										
Constant	53.861					58.335				

N = 104 SPA + ASPA

T = 0.095

	B R	Beta R	SE SE	F F	p p
Newhat	-2.054 0.292	-0.267 0.086	0.715 3.366	8.256 9.533	<0.010 0.003
Dflg					
Crfh	0.579 0.403	0.042 0.002	1.284 3.270	0.203 4.792	- 0.001
Habitf					
Crfhnow					
Dfin	-45.671 0.382	-0.222 0.060	18.763 3.269	5.925 8.617	<0.050 0.000
Df5	$390x10^{-17}$ 0.401	0.125 0.015	0.000 .3.257	1.797 6.372	- 0.001
Constant	23.606				
A1	-0.183 0.242	-0.238 0.059	0.074 5.372	6.112 6.329	<0.050 0.013
Dfin	-47.753 0.295	-0.152 0.029	30.153 5.314	2.509 4.837	- 0.010
Habitf					
Crfh	0.866 0.332	0.040 0.002	2.088 5.300	0.172 3.071	- 0.020
Crfhnow					
Newhat	-1.799 0.330	-0.149 0.021	1.163 5.278	2.391 4.071	- 0.009
Constnat	33.977				
Dflg	1.693 0.173	0.166 0.030	0.916 4.084	3.376 3.152	- 0.079
Newhat					
Habitf					
Crfhnow	-2.490 0.215	-0.130 0.016	1.916 4.070	1.689 2.448	- 0.092
Crfh	0.339 0.216	0.021 0.000	1.633 4.089	0.043 1.630	- 0.187
A2	$134x10^{-6}$ 0.217	0.017 0.000	0.001 4.109	0.027 1.217	- 0.308
Constant	52.993				

Table D.1. The regression of pigmentation on age and the behavioural variables. Filters no. 1, 5 and 9. Parameter specifications (n,F,T): (14,0.01,0.99), (80,0.01,0.001) and (14,0.01,0.95). Final steps. Males and females separate.

N = 32 T = 0.99 GP + AGP (3/4) ♂ N = 36 (Behav. only)

	B R	Beta R	SE SE	F F	p p	B R	Beta R	SE SE	F F	p p
A1	-0.292	-0.336	0.144	4.079	-					
	0.346	0.120	3.210	4.085	0.052					
Habitf	-1.909	-0.279	1.139	2.809	-	-1.496	-0.235	1.106	1.830	-
	0.445	0.078	3.118	3.570	0.041	0.248	0.062	3.154	2.234	0.144
Crfh						-1.528	-0.201	1.296	1.390	-
						0.307	0.033	3.146	1.717	0.195
Crfhnow						3.412	0.247	2.341	2.124	-
						0.388	0.057	3.093	1.894	0.150
Newhat						-0.795	-0.121	1.113	0.510	-
						0.406	0.014	3.117	1.526	0.219
Constant	34.367					28.246				
A1	-0.536	-0.414	0.213	6.336	<0.050					
	0.421	0.177	4.639	6.457	0.017					
Habitf	-2.071	-0.203	1.680	1.519	-	-1.332	-0.136	1.809	0.542	-
	0.467	0.041	4.599	4.044	0.028	0.186	0.035	4.938	1.217	0.278
Crfh						-0.638	-0.054	2.119	0.091	-
						0.200	0.006	4.998	0.690	0.509
Crfhnow						-0.870	-0.041	3.929	0.052	-
						0.205	0.002	5.071	0.466	0.708
Newhat						-1.487	-0.146	1.820	0.667	-
						0.249	0.020	5.098	0.512	0.727
Constant	44.924					33.764				
Dfin	-246.040	-0.182	243.943	1.017	-					
	0.173	0.030	3.227	0.929	0.343					
A1	0.134	0.162	0.150	0.802	-					
	0.237	0.026	3.238	0.863	0.433					
Habitf						-1.160	-0.183	1.164	0.994	-
						0.120	0.014	3.220	0.494	0.487
Crfh						0.552	0.073	1.364	0.164	-
						0.154	0.010	3.253	0.403	0.672
Crfhnow						0.261	0.019	2.464	0.011	-
						0.156	0.000	3.302	0.265	0.850
Newhat						1.305	0.213	1.172	1.418	-
						0.259	0.043	3.291	0.556	0.696
Constant	60.781					62.426				

N = 32 F = 0.95 GP + AGP

	B R	Beta R	SE SE	F F	p p
A1	-0.296	-0.341	0.142	4.315	<0.050
	0.346	0.120	3.210	4.085	0.052
Habitf	-2.221	-0.325	1.146	3.759	-
	0.445	0.078	3.118	3.570	0.041
Crfh					
Crfhnow	3.125	0.228	2.290	1.963	-
	0.498	0.050	3.072	3.072	0.044
Newhat					
Constant	34.451				
A1	-0.535	-0.413	0.217	6.103	<0.050
	0.421	0.177	4.639	6.457	0.017
Habitf	-1.980	-0.194	1.743	1.291	-
	0.467	0.041	4.599	4.044	0.028
Crfh					
Crfhnow	-0.916	-0.045	3.485	0.069	-
	0.459	0.002	4.675	2.533	0.070
Newhat					
Constant	44.992				
Dfin	-234.372	-0.174	247.402	0.897	-
	0.173	0.030	3.227	0.929	0.343
A1	0.115	0.142	0.154	0.566	-
	0.237	0.026	3.238	0.863	0.433
Habitf					
Crfh					
Crfhnow					
Newhat	0.751	0.115	1.241	0.367	-
	0.262	0.012	3.274	0.695	0.560
Constant	60.813				

Table D.1. The regression of pigmentation on age and the behavioural variables. Filters no. 1, 5 and 9. Parameter specifications (n,F,T): (14,0.01,0.99), (80,0.01,0.001) and (14,0.01,0.95). Final steps. Males and females separate.

N = 327 SWE + ASWE (♂♂) ♀ N = 33[illegible]

T = 0.99 (Behav. only)

	B R	Beta R	SE SE	F F	p p	B R	Beta R	SE SE	F F	p p
A1	$932\ 10^{-4}$ 0.344	-0.346 0.119	0.014 4.334	44.115 43.668	<0.001 0.000					
Habitf	-1.087 0.351	-0.071 0.005	0.795 4.328	1.870 22.827	- 0.000	-0.757 0.046	-0.053 0.002	0.780 4.714	0.942 0.706	- 0.402
Crfh					-	0.666 0.058	0.068 0.003	0.545 4.716	1.495 0.571	- 0.566
Crfhnow						-2.035 0.191	-0.178 0.033	0.631 4.646	10.411 4.231	<0.010 0.006
Newhat						-0.390 0.195	-0.041 0.002	0.512 4.549	0.579 3.314	- 0.011
Dflg										
Constant	33.214					30.809				
A1	-0.107 0.362	-0.363 0.131	0.015 4.691	49.233 48.917	<0.001 0.000					
Habitf	-0.958 0.366	-0.058 0.003	0.861 4.690	1.239 25.095	- 0.000	-0.792 0.043	-0.052 0.002	0.858 5.067	0.893 0.620	- 0.432
Crfh						0.812 0.062	0.077 0.002	0.585 5.070	1.929 0.647	- 0.524
Crfhnow						-2.194 0.194	-0.178 0.034	0.678 4.991	10.483 4.369	<0.010 0.005
Newhat						-0.513 0.200	-0.051 0.003	0.550 4.992	0.871 3.493	- 0.008
Dflg										
Constant	39.607					36.982				
A1	$-567x10^{-4}$ 0.254	-0.254 0.064	0.012 3.699	22.314 22.342	<0.001 0.000					
Habitf	-0.171 0.254	-0.014 0.060	0.680 3.704	0.063 11.170	- 0.000					
Crfh						0.401 0.029	0.050 0.001	0.439 3.836	0.834 0.281	- 0.597
Crfhnow						-1.256 0.129	-0.135 0.016	0.518 3.811	5.893 2.831	<0.050 0.060
Newhat						0.366 0.137	0.048 0.002	0.420 3.812	0.760 2.139	- 0.095
Dflg										
Df5										
Constant	66.066					64.335				

N = 327 SWE + ASWE

T = 0.95

	B R	Beta R	SE SE	F F	p p
A1	-0.107 0.344	-0.397 0.119	0.014 4.334	60.544 43.668	<0.001 0.000
Habitf	-0.844 0.438	-0.055 0.003	0.775 4.152	1.186 25.566	- 0.000
Crfh	0.299 0.439	0.030 0.001	0.487 4.167	0.353 19.225	- 0.000
Crfhnow					
Newhat					
Dflg	3.662 0.435	0.269 0.071	0.698 4.163	27.551 37.928	<0.001 0.000
Constant	25.739				
A1	-0.118 0.362	-0.403 0.131	0.015 4.691	61.103 48.917	<0.001 0.000
Habitf	-0.815 0.422	-0.049 0.002	0.852 4.583	0.914 17.444	- 0.000
Crfh	0.530 0.419	0.051 0.002	0.535 4.582	0.979 22.960	- 0.000
Crfhnow					
Newhat					
Dflg	3.133 0.417	0.211 0.043	0.767 4.591	16.663 34.092	<0.001 0.000
Constant	33.164				
A1	$-601x10^{-4}$ 0.254	-0.269 0.064	0.012 3.699	23.906 22.342	<0.001 0.000
Habitf	-0.206 0.285	-0.015 0.000	0.694 3.689	0.089 5.563	- 0.000
Crfh	0.171 0.284	0.021 0.000	0.431 3.683	0.157 7.077	- 0.000
Crfhnow					
Newhat					
Dflg	1.407 0.279	0.125 0.013	0.622 3.678	5.126 13.636	<0.050 0.000
Df5	$-655x10^{-17}$ 0.284	-0.056 0.003	0.000 3.678	1.026 9.419	- 0.000
Constant	63.248				

Table D.1. The regression of pigmentation on age and the behavioural variables. Filters no. 1, 5 and 9. Parameter specifications (n,F,T): (14,0.01,0.99), (80,0.01,0.001) and (14,0.01,0.95). Final steps. Males and females separate.

N = 105 T = 0.99 SPA + ASPA (3/4) (Behav. only) ♀ N = 111

	B	Beta	SE	F	p	B	Beta	SE	F	p
	R	R	SE	F	p	R	R	SE	F	p
Df1	$541x10^{-5}$	0.191	0.003	3.908	-					
	0.191	0.037	4.040	3.908	0.051					
Habitf						-0.966	-0.087	1.092	0.782	-
						0.061	0.004	4.027	0.404	0.526
Crfh						0.608	0.072	0.876	0.482	-
						0.114	0.009	4.027	0.712	0.493
Crfhnow						0.650	0.075	0.692	0.531	-
						0.131	0.004	4.037	0.626	0.600
Newhat						0.912	0.065	1.348	0.458	-
						0.147	0.004	4.047	0.581	0.677
	22.351					22.980				
Newhat	-2.187	-0.143	1.499	2.129	-	-2.024	-0.138	1.408	2.068	-
	0.145	0.021	4.281	2.206	0.141	0.180	0.019	4.228	0.885	0.476
Crfh	1.217	0.135	0.880	1.911	-	1.082	0.122	0.915	1.396	-
	0.198	0.018	4.261	2.088	0.129	1.115	0.012	4.230	0.722	0.488
A2	$-238x10^{-6}$	-0.030	0.001	0.091	-					
	0.201	0.001	4.281	1.410	0.244					
Habitf						0.282	0.024	1.140	0.061	-
						0.040	0.002	4.235	0.173	0.679
Crfhnow						-0.255	-0.028	0.932	0.075	-
						0.116	0.000	4.249	0.485	0.693
Dflg										
Constant	31.731					31.292				
Crfh	1.190	0.130	0.903	1.735	-	1.570	0.173	0.932	2.838	-
	0.129	0.017	4.364	1.755	0.188	0.183	0.021	4.284	1.862	0.160
Newhat	-1.210	-0.078	1.538	0.619	-	-1.061	-0.071	1.433	0.547	-
	0.152	0.006	4.371	1.201	0.305	0.205	0.005	4.305	1.156	0.334
A2	$-118x10^{-6}$	-0.014	0.001	0.021	-					
	0.152	0.000	4.392	0.800	0.497					
Habitf						-1.597	-0.134	1.161	1.891	-
						0.110	0.012	4.311	1.337	0.250
Crfhnow						-0.647	-0.069	0.949	0.466	-
						0.192	0.004	4.296	1.365	0.257
Df1										
Constant	58.149					59.365				

N = 105 SPA + ASPA T = 0.95

	B	Beta	SE	F	p
	R	R	SE	F	p
Df1	$603x10^{-5}$	0.213	0.003	4.526	<0.050
	0.191	0.037	4.040	3.908	0.051
Habitf					
Crfh	1.036	0.121	0.851	1.493	-
	0.225	0.014	4.030	2.721	0.071
Crfhnow					
Newhat	0.234	0.016	1.430	0.027	-
	0.226	0.000	4.049	1.806	0.151
Constant	21.663				
Newhat	-2.860	-0.187	1.485	3.695	-
	0.145	0.021	4.281	2.206	0.141
Crfh	1.651	0.183	0.883	3.498	-
	0.287	0.032	4.186	3.020	0.033
A2					
Habitf					
Crfhnow					
Dflg	1.757	0.217	0.808	4.733	<0.050
	0.225	0.030	4.236	2.715	0.071
Constant	28.407				
Crfh	1.485	0.162	0.913	2.645	-
	0.129	0.017	4.364	1.755	0.189
Newhat	-1.606	-0.103	1.533	1.097	-
	0.213	0.010	4.342	1.601	0.194
A2					
Habitf					
Crfhnow					
Df1	$468x10^{-5}$	0.155	0.003	2.368	-
	0.187	0.018	4.344	1.851	0.162
Constant	57.451				

Table D.1. The regression of pigmentation on age and the behavioural variables. Filters no. 1, 5 and 9. Parameter specifications (n,F,T): (14,0.01,0.99), (80,0.01,0.001) and (14,0.01,0.95). Final steps. Males and females separate.

N = 46	T = 0.99			GP + AGP		(3/4) (Behav. only)		♀		N = 48
	B R	Beta R	SE SE	F F	p p	B R	Beta R	SE SE	F F	p p
A3	-133x10^{-6} 0.284	-0.273 0.080	0.000 3.305	3.496 3.844	- 0.056					
Df1	796x10^{-5} 0.320	0.155 0.022	0.008 3.303	1.130 2.450	- 0.098					
Newhat	-0.670 0.335	-0.099 0.010	0.984 3.324	0.464 1.767	- 0.168	-0.948 0.248	-0.133 0.017	1.073 3.645	0.781 0.705	- 0.593
Habitf						-1.486 0.207	-0.190 0.043	1.228 3.559	1.463 2.053	- 0.159
Crfh						-0.115 0.210	-0.016 0.001	1.178 3.596	0.010 1.033	- 0.364
Crfhnow						-0.367 0.211	-0.049 0.001	1.167 3.636	0.099 0.683	- 0.567
Constant	29.794					31.671				
A3	-143x10^{-6} 0.256	-0.249 0.066	0.000 3.948	2.851 3.085	- 0.086					
Df3	-133x10^{-10} 0.270	-0.087 0.008	0.000 3.978	0.347 1.693	- 0.196					
Habitf						-0.674 0.070	-0.070 0.005	1.528 4.442	0.194 0.225	- 0.637
Crfhnow						-1.004 0.104	-0.109 0.006	1.453 4.478	0.478 0.244	- 0.785
Crfh						0.441 0.108	0.050 0.001	1.466 4.527	0.091 0.174	- 0.913
Newhat						-1.209 0.174	-0.139 0.019	1.335 4.536	0.821 0.335	- 0.853
Constant	36.657					36.421				
Dfin	-954.260 0.403	-0.405 0.163	327.541 2.881	8.488 8.539	<0.010 0.006					
Newhat	0.574 0.414	0.093 0.009	0.856 2.899	0.451 4.442	- 0.018	0.510 0.166	0.079 0.006	0.988 3.356	0.266 0.304	- 0.873
Habitf						-0.530 0.094	-0.075 0.009	1.131 3.275	0.220 0.410	- 0.525
Crfh						-0.628 0.111	-0.095 0.004	1.085 3.306	0.335 0.281	- 0.757
Crfhnow						0.770 0.147	0.113 0.009	1.075 3.327	0.513 0.323	- 0.809
Constant	69.022					64.759				

N = 46	T = 0.95				GP + AGP
	B R	Beta R	SE SE	F F	p p
A3	-134x10^{-6} 0.284	-0.275 0.080	0.000 3.305	3.476 3.844	- 0.056
Df1	757x10^{-5} 0.320	0.148 0.022	0.008 3.303	0.980 2.450	- 0.098
Newhat	-0.637 0.335	-0.094 0.010	0.998 3.324	0.407 1.767	- 0.168
Habitf					
Crfh	-0.370 0.339	-0.054 0.003	1.020 3.359	0.132 1.331	- 0.275
Crfhnow					
Constant	30.025				
A3	-144x10^{-6} 0.256	-0.250 0.066	0.000 3.948	2.807 3.085	- 0.086
Df3	-125x10^{-10} 0.270	-0.082 0.008	0.000 3.978	0.296 1.693	- 0.196
Habitf					
Crfhnow					
Crfh					
Newhat	-0.290 0.273	-0.036 0.001	1.198 4.022	0.058 1.124	- 0.350
Constant	36.791				
Dfin	-949.445 0.403	-0.403 0.163	338.418 2.881	7.871 8.539	<0.010 0.006
Newhat	0.541 0.414	0.104 0.009	0.882 2.899	0.528 4.442	- 0.018
Habitf	0.414 0.430	0.059 0.003	1.003 2.944	0.170 2.325	- 0.073
Crfh					
Crfhnow	0.649 0.426	0.100 0.010	0.928 2.915	0.488 3.104	- 0.037
Constant	68.435				

Table D.1. The regression of pigmentation on age and the behavioural variables. Filters no. 1, 5 and 9. Parameter specifications (n,F,T): (14,0.01,0.99), (80,0.01,0.001) and (14,0.01,0.95). Final steps. Males and females separate.

Appendix D.2

Because of its extreme length (108 pages), I decided to suppress table D.2 from the main body of the thesis. Separate copies of it will be available, however, in the Department of Anthropology at the University of Durham.

Appendix E

APPENDIX E. Populations analysed in the text.

Ballinlough	Sunderland et al. 1973
B_E (Harrison)	Harrison & Owen, 1964
Belgians I	in Leguebe, 1977
Belgians II	in Leguebe 1977
Belgians III	Rijn-Tournel, 1966
Blue-eyed	Robins, 1973
Brown-eyed	-,,-
Brussels	in Leguebe, 1977
Bruxelles	Leguebe, 1961
Carnew	Sunderland et al. 1973
Chechen	Sunderland, 1967
Durham	Fernández
Dutch	Rigters-Aris, 1972/3
Europeans from Calcutta	Büchi, 1957/8
Europeans from Liverpool	Harrison & Owen, 1964
Europeans from London	Barnicot, 1958
Europeans from Mainz	Ojikutu, 1965
European mothers	Tiwari, 1963
Indo-European children	-,,-
Iraq-Syria	Sunderland, 1979
Lebanon	-,,-
Madrid	Fernández
Malmö	-,,-
Man	Smith & Mitchell, 1973
Merthyr Tydfil	-,,-
N. Northumberland	Hulse, 1973
Palestina	Sunderland, 1979
Porto Alegre	Harrison et al. 1967
Rossmore	Sunderland et al.1973
South African Whites	Wassermann & Heyl, 1968
SE. Northumberland	Hulse, 1973
Turkey	Sunderland, 1979
York	in Fernández's
Århus	-,,-

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