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The international biological program/ human adaptability studies among the Skolt Sami in Finland (1966–1970)

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***Background*:** The population is increasingly lighter pigmented moving in a northward direction in Europe until reaching the Arctic Circle, where the Samis (Lapps) are clearly more pigmented.
***Methods*:** In 1966–1970, we investigated a total of 689 subjects in the villages of Sevettijärvi and Nellim, including persons with mixed Sami and Finnish heritage; of these, 487 (242 males, 245 females) had both parents classified as Skolt Sami. For estimation of the colour of the iris and hair, international scales were used. For translucency of the iris, pigmentation of the fundus was estimated in 3 different shades. The length and type of eyelashes were classified into 3 categories. To our knowledge, a simultaneous study of the pigmentation of eyebrows, eyelashes and eye fundus at different ages has not previously been published.
***Results*:** The age differences of iris colour were highly significant. Iris colour in children varied markedly, and they generally had lighter colours than later in life. Age and sex effects on the translucency of irises were found. Male irises were more translucent. Fundus pigmentation was scanty in the youngest age groups, with full pigmentation being reached at 20 years. Among young individuals hair colour darkens with increasing age. Eyebrow colour was slightly lighter for both sexes in the youngest age groups that in older cohorts. Women had longer eyelashes than males.
***Conclusions*:** The main factor of the lighter skin is a higher ability to synthesize vitamin D, providing superior protection against rickets. The Skolt Samis are more pigmented than other Nordic people. In earlier times they had problems with rickets but our studies did not show any essential symptoms of rickets today. Visual acuity among Skolt Samis was good. They had lower prevalence of myopia compared to Finns. The stronger pigmentation of Skolt Samis is probably due to their origin from darker Eastern populations. Since our investigations were made, the Skolt Samis have been to a great part mixed with neighbouring populations and scattered throughout Finland. Even their old language is nowadays used mainly for traditional purposes. Therefore similar studies could not be performed anymore.

Keywords: *Sami*; *iris*; *fundus*; *translucency*; *hair*; *eyebrows*; *eyelashes*; *age effect on pigmentation*; *photosensitivity*

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In 1965, the Scandinavian Human Adaptability Section of the International Biological Programme (IBP/HA) began studies on genetic adaptation to the Arctic climate among the Skolt Sami, part of a global collaborative research program on populations living in extreme climates (1,2). This paper reviews results of studies on pigmentation of the eyes in this isolated community. Today, this type of research is no longer conducted and is thus of historical interest. The study of physical traits such as pigmentation to discover genetic relationships or distances among different ethnic groups has largely been superseded by molecular biological studies of DNA polymorphism. However, our primary objective was to determine if darker pigmentation offered an advantage to inhabitants in the Arctic.

The authors were the promoters of this project in Finland and were responsible for the organization of the expeditions, arranging transportation, food and housing for the investigators, whose number varied in different years, but in total, were nearly 100. They represented such diverse fields as physiology (K. Lange-Andersen, Oslo, Norway), anthropology (T. Lewin, Gothenburg, Sweden), odontology (B. Hedegård, Gothenburg, Sweden), child psychiatry (Harriet Forsius, Finland), education (L. Seitamo, Finland) and nutrition (K. Hasunen, Finland). Our area of interest was genetics, including

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pigmentation of the eyes and other parts of the body because it so clearly differed from that of the surrounding populations. The cooperation with D. H. Hughes from Canada, F. A. Milan from Alaska and J. B. Jörgensen from Denmark resulted in H. Forsius and A. Eriksson's invitation to join their equivalent expeditions among the Inuit.

Populations in north-western Europe have the lightest skin pigmentation in the world. The more northerly the population, the less pigmented it is. However, this is not the case among the Sami, who reside mainly in the arctic areas of Norway, Sweden, Finland and Russia. Their pigmentation in many respects is comparable to that of populations living in Central Europe.

More than 100 years ago, family studies showed that genetically, dark pigmentation factors are dominant over less-pigmented characteristics (3). Furthermore, pigmentation of the iris and hair changes with age (4). By examining the translucency of light-coloured irises with a hammer lamp, Steltzer (5) observed that the iris was more translucent in men than in women. However, Hoffman (6) found no gender difference in fundus pigmentation.

Literature on the pigmentation of eyebrows and eyelashes is sparse. Most of the interest has been directed at twins. The strong correlation for eye pigmentation in monozygotic twins, in contrast to dizygotic twins, has also recently been shown at the molecular level (7).

Rozprym (8) investigated the heredity of the colour and form of eyebrows and eyelashes in a Czechoslovakian population and compared their pigmentation with pigmentation of the iris, hair and skin. Na et al. (9) compared the eyelashes of 20 young Caucasian and Asian females. Asian girls had significantly fewer and thicker eyelashes than Caucasian girls, but both ethnic groups had similar growth rate and length of their eyelashes. Kunjur et al. (10) compared eyebrow thickness between Caucasian, Chinese and Asian Indian populations. The only significant differences emerged between male Asian Indians and Chinese men.

There is a substantial literature on the pigmentation of the iris and hair of the Sami and other Nordic populations (for review, see 11). However, little interest has been shown in pigmentation of the eyelashes, eyebrows and fundus or translucency of the iris.

Historical background

About 2000 years ago, the Sami populated most of Finland, but they were increasingly pushed northwards by the Finns. Today, the Sami form the majority of the population only in Utsjoki, the northernmost parish of Finland (12). Comparative studies of Sami and other populations indicate that the Sami are an autochthonous European population with a unique genetic constitution (12–15).

Jacob Fellman (1793–1875) was a parish priest in Utsjoki, northern Lapland, between 1820 and 1831. He noted the dark eyes of the Sami and that the Fisher Sami were more lightly pigmented than the Mountain Sami. He also noted that the Sami had darker pigmentation than migrant Finns in the region. His memoirs were posthumously published in 1906 (16).

The Skolt Sami are different from other regional groups in many respects. The Skolt Sami, formerly the most isolated and easterly situated Sami, had lived on the Russian side of the present Finnish/Russian border. During the Second World War, they were relocated to the southeast (Nellim) and northeast (Sevettijärvi) areas of Lake Inari in northernmost Finland. The stature of the Skolts was among the shortest in Europe (11,17). In contrast to the coarse, straight hair of the Mongolian ethnic groups, the Sami have soft and often wavy hair. Microscopic studies reveal that the hair texture and hair pigmentation of the Skolt Sami should be classified as European (Caucasian), not as Mongoloid (18).

Our field studies

In 1966–1970, we investigated a total of 689 subjects in the villages of Sevettijärvi and Nellim, including persons with mixed Sami and Finnish heritage; of these, 487 (242 males, 245 females) had both parents classified as Skolt Sami. We restricted some of our analyses to those aged 20–59 years, numbering 201 subjects (100 males, 101 females). Although pigmentation is age dependent, a person's final pigmentation is achieved by the age of 20 years. Beyond the age of 60 years, a reduction in pigmentation occurs due to atrophy.

For estimation of the colour of the iris and hair, international scales (Martin-Saller for iris and Fisher-Saller for hair) were used. For translucency of the iris, pigmentation of the fundus was estimated in 3 different shades. The length and type of eyelashes were classified into 3 categories. All eye pigmentation studies were performed by the same investigator.

Results of our eye investigations among the Sami have previously been reported by Forsius et al. (12,19,20); genetic studies by Eriksson et al. (14) and pigmentation data by Eriksson and Forsius (11) and Pálsson et al. (21).

Iris colour was studied in 427 individuals. The age differences were highly significant. Iris colour in children varied markedly, and they generally had lighter colours than later in life. For persons aged 20–59 years, no age effect was detected.

Translucency of the iris was studied in 403 persons. Only subjects aged over 5 years (n = 391) were included in the analyses. Age and sex effects on the translucency of irises were found. Male irises were more translucent. In addition, with increasing age, irises were more translucent

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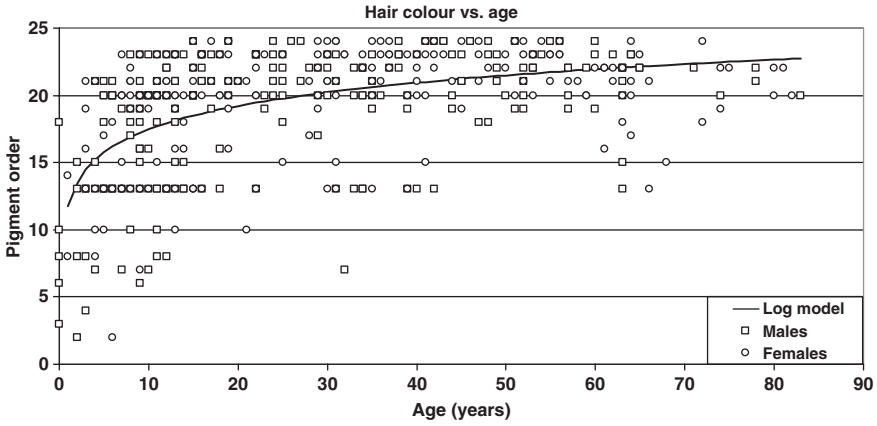

Fig. 1. Association between hair colour and age. The association is explained with a logarithmic model and is similar for males and females.

than for younger age groups, probably because of atrophy of the iris. The lighter irises in the aged probably arose for the same reason.

Fundus pigmentation was scanty in the youngest age groups, with full pigmentation being reached at 20 years. No differences between the sexes were found. In elderly subjects, the pigmentation level again decreased. For the hair colour, the Fisher-Saller scale was used. In this scale, the hair colours are classified with increasing darkness into the codes A to Y. The classes are commonly grouped into larger groups A–E, F–L, M–O, P–T and U–Y. Figure 1 presents data on how hair colour darkens with increasing age among young individuals. The colour distribution of hair among Skolt Sami aged 20–59 years is shown in Fig. 2.

The proportions of dark hair (U–Y) among Skolt Sami compared to neighbouring populations are shown in Fig. 3. Note that the proportion of dark hair is highest among Sami populations, slightly lower among north-eastern Finns and lowest among western Finns.

Eyebrow colour was slightly lighter for both sexes in the youngest age groups than in older cohorts. No sex differences in eyebrow colour were detected. Similarly, no significant age difference was obtained for the colour of eyelashes, but a difference was found for the thickness and length of eyelashes. Women had longer eyelashes than males. A strong association was also observed between the thickness and length of eyelashes.

Implications of our study

Good vision is critical for persons living traditional lifestyles in non-industrial societies. Visual acuity was studied in about 30 populations, among them Inuit in Greenland, Canada and Alaska, nomads in Tunisia and

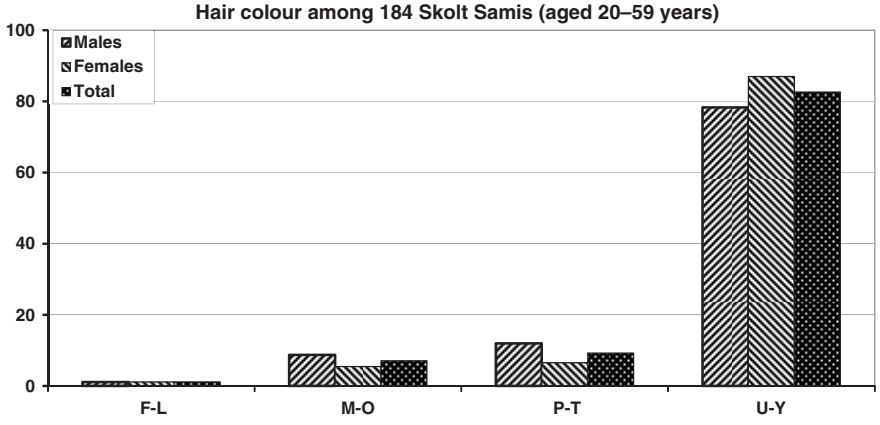

Fig. 2. Colour distribution of hair among Skolt Sami of aged 20–59 years. The colour groups defined in the Fisher-Saller scale are used. In this scale, the hair colours are classified with increasing darkness into the codes A to Y. The classes are commonly grouped in larger groups A–E, F–L, M–O, P–T and U–Y. Note that the combined colour group U–Y is dominant and that the darkest colour, Y, is missing.

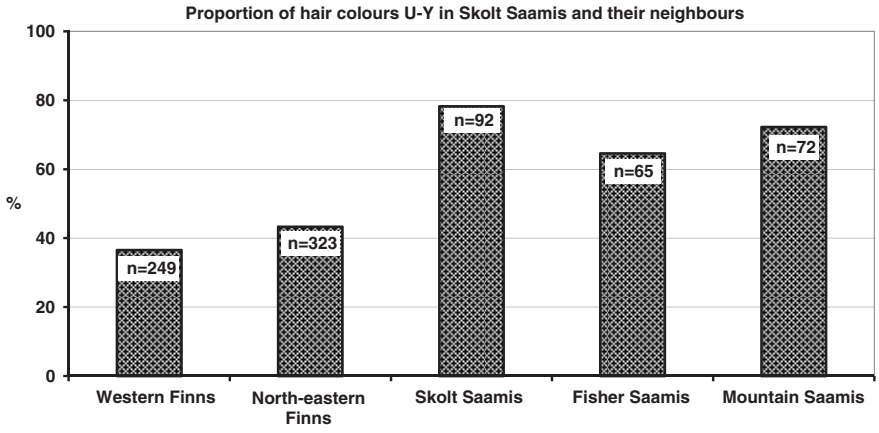

Fig. 3. Proportion of darkest hair colours (U–Y) among Skolt Sami and their neighbouring populations.

Chileans living in high altitudes. The Skolt Sami had the lowest prevalence of myopia (short-sightedness), under 10%, compared to 20% among Finns (22).

The genetic basis underlying normal variation in pigmentation traits of the skin, head hair and eye has been the subject of intensive research. The OCA2 region of 15q accounts for 74% of the variation in human eye colour (23). Eiberg et al. (24) reported finding one haplotype that covered half of the 3′ end of the *HerzC2* gene to be common in all lightly pigmented people. The mutation must have been increasingly important the more northwards the population migrated through Europe because pigmentation in people decreased until reaching the Arctic Circle, the inhabitants of which were clearly more pigmented. The main factor underlying the success of the new mutation was probably that the lighter skin of Caucasians was better able to synthesize vitamin D, providing superior protection against rickets. Rickets was in earlier times a particular problem in childbirth, a consequence of the deformed pelvises of ricket-affected mothers (11,13,15,25). It is interesting that the Inuit, who have much darker pigmentation than the Sami, appeared to be protected from rickets because of their meat-based diet.

To our knowledge, a simultaneous study of the pigmentation of eyebrows, eyelashes and eye fundus at different ages has not previously been published. With the exception of the youngest age group, which had comparatively lighter eyebrows, eyebrow pigmentation among the Skolt Sami was almost black. Eyelashes remained black throughout life. No differences in pigmentation of the eyebrows or eyelashes were observed between the sexes. Rozprym (8) investigated the association between pigmentation of eyebrows, eyelashes, iris, head hair and skin in a population in Czechoslovakia. Our results for the most part confirm his findings (12). To our knowledge, investigations into the translucency of the iris in different age groups have not been conducted. A high translucency means that the pigment layer in the iris is light and the risk for blinding increases.

The age dependency of the pigmentation of the fundus is very similar to that for hair. Pigmentation increases with age, until atrophy of the iris and fundus begins. The pigmentation of the fundus of Sami has been discussed earlier in a report on arctic populations (26). Thus, we return to our original question: has the Sami's stronger pigmentation provided an advantage for living in the Arctic? The hardest time of the year to hunt game to feed your family has traditionally been during the spring, when the snow is dazzling. However, no significant correlation existed between photosensitivity and the extent of pigmentation or translucency of the iris.

Data by Sajantila et al. (26) show that the Sami's mitochondrial gene pool differs substantially from that of the other populations studied. Their data suggest that the Sami have a history distinct from that of other groups in Europe. Based on our investigations of the pigmentation of Skolt Sami, we conclude that the pigmentation may have formerly offered an advantage, but the benefit today appears negligible.

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Conflict of interest and funding

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