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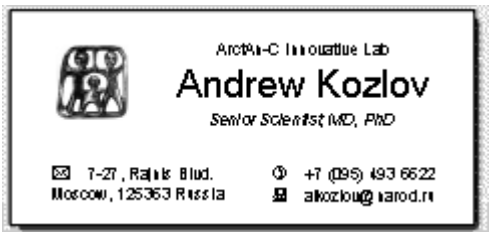

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Hypolactasia in Saami subpopulations of Russia and Finland

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Summary: Primary hypolactasia is a gene attributed condition of the inability of adult individuals to consume whole milk. Subpopulations of the Russia (Kildin) and Finland Saami are characterized by a large variability of the LAC*R (lactase restriction) gene frequencies (0.5–0.77). The distribution of primary hypolactasia among the Saami is ranging from 25% to 60%. The intensive reindeer breeding was developed by the Saami only 300–400 years ago. Reindeer milk is poor in lactose (2.4%) and is consumed by the Saami in small amounts. Thus, “milk behaviour“ connected with reindeer breeding could not have influenced the trait evolution too much. The large between-group differences of the LAC*R gene frequencies in the Saami seem to reflect the level of genetic influence of neighbouring non-Saami populations. The role of gene inflow in reducing the level of primary hypolactasia in various Saami subpopulations is confirmed by historic data of various ethnoterritorial groups as well as by the reduction of the number of traditional family name bearers and the change of the ABO blood gene frequences among the Kildin Saami in the last 30 years.

Introduction

Different reactions to whole milk developed by human organism have been actively researched by physicians and anthropologists. All healthy children below 3–5 years of age have a highly active digestion lactase enzyme which splits the “milk sugar“ lactose — the disaccharide contained in milk. Lactose provides about 30% of milk calorie value.

As children grow the enzyme usually becomes less active due to the interference of the LAC*R gene (lactase restriction — Bayless et al. 1969). This phenomenon, which is usually called primary hypolactasia, occurs with different frequency among various ethnic groups (Flatz 1987). Between the ages of 10 and 18 an individual‘s level of lactase activity is established for the whole of his or her future life. Some people preserve high lactase activity utill the end of their life (we will not discuss the cases of acquired or “secondary“ hypolactasia in this article).

There are several explanations for the evolutionary success of the LAC*P (lactase persistence) allele. The main hypotheses take into account to interaction between the biological evolution of LAC*P gene and cultural evolution of “milk behavior“ in various populations (McCracken 1971, Nei & Saitou 1986), as well as autocatalytic processes connected with this interaction (Kozlov et al. 1994).

Insufficient attention has been devoted to the effects of the mixing of population groups, such as those who retain a tradition of dairy animal husbandry (and who, accordingly, have high percent of the LAC*P allele carriers) combining with groups who have started to include milk products in their diet comparatively recently (Sahi 1974, Kozlov 1995). One of the most elegant studies of this aspect of the problem was performed by Kretchmer (1972). Still, his work considered only historical evidence of migrations and interactions among populations of Nigeria.

The purpose of our research is to compare the frequencies of LAC*P and LAC*R alleles in the Saami (Lapp) subpopulations including the group of Kildin Saami of the Kola peninsula which has not been previously researched. We have planned to study the influence of cultural-genetic and metisation factors upon the occurrence of primary hypolactasia in various groups of indigenous populations of Northwestern Europe. In order to evaluate the extent of mixing of the Saami population with the neighboring peoples we have used cultural-anthropological data.

Materials and methods

This study uses the data on the distribution of primary hypolactasia and LAC*R gene distribution in the population of Saami of the Lovozero settlement. The persons studied were self-identified as “Kildin Saami“ — the main Saami dialect group of the Kola peninsula. The examined persons were unrelated, between ages 18 and 55, with no diagnosed or suspected genetic or chronic diseases. The legal basis of the investigation was the “Research Recording List“ of the Regional Interdepartment Committee on the medical-biological researches of Northern peoples (Russian Academy of Medical Sciences).

The examined person received 50 g of lactose in 400 ml of water after an overnight fast. The capillary blood glucose was tested at the beginning and at 40 minutes. Glucose level was tested by “Glucometer-II“ device with “Dextrostix“ diagnostic stripes produced by “Miles International“. If the glucose level increased less than 1.1 mmol/l as compared with background level it was considered to be a proof of lactose intolerance. Clinical symptoms during the first 24 hours after the lactose load were taken into consideration for diagnosing hypolactasia.

Data on ABO blood group system in Kildin Saami were obtained while analysing documentation on childbirth cases in Lovozero District Hospital in 1970–77 (n=85) and 1981–89 (n=72). Based upon the same materials and also upon the results of an examination of the students of Lovozero boarding school performed in 1995 (n=83), we have developed a listing of family names of people self-identified as “Saami“. We compared this family-name list with the list of the most typical last names among the Saami in 1920-ies (Kiselyev & Kiselyeva 1979).

Results

The data on the distribution of primary hypolactasia and frequencies of LAC*R gene among the Kildin Saami and various Finland Saami subpopulations (Sahi 1994) can be seen in the Table 1.

Table 1. Hypolactasia and frequencies of LAC*R gene in various Saami subpopulations

Saami subpopulation	N	Hypolactasia, % freq.	LAC*R gene freq.
Skolt Saami	176	60	0.77
Kildin Saami (Lovozero)	50	48	0.69
Mountain Saami (Inari)	75	37	0.61
Mountain Saami (Utsijoki)	158	34	0.58
Inari (Fisher) Saami	110	25	0.50

The results of last-name analysis showed that the percent of the bearers of the traditional Saami family names among the inhabitants of Lovozero village who identify themselves as Saami was 55% in 1970–77, 48% — in the 1980‘s and 37% in 1995.

In the same way — by decades — we studied the blood group (ABO system) gene frequencies in the Kildin Saami subpopulation. According to the data for 1970–77 the frequencies of p gene equaled 0.2776, of q gene 0.1739, of r gene 0.4848. In 1980–89 they were, accordingly, 0.1597, 0.5432 and 0.2881.

Discussion

Anthropologically the Saami (Lapps) differ both from the neighboring peoples and from their "language relatives", the Uralic peoples (Hajdu 1985). Their cultural traditions are distinct and to a great extent unique. The Saami reindeer breeding is also of a special type; it bears a certain resemblance to dairy animal husbandry (Vasilevich & Levin 1951). In accordance with the cultural genetic hypothesis the tradition of using reindeer milk should lead to a decrease in the number of LAC*R gene bearers in the Saami population. But the research among various subpopulations of Finland Saami showed a great variety of hypolactasia frequencies: from 25 to 60% (Sahi 1994).

In general the LAC*R gene frequencies vary greatly among the Uralic peoples (Tamm 1991, Kozlov 1995). Only 17% of the Finns develop hypolactasia, and among the Khanty this figure goes up to 82–94%. The characteristics of various Saami groups are somewhere in the middle of this spectrum (see Table 1). As for other representatives of subarctic reindeer-breeding groups of such Uralic peoples as Mansi, Khanty and Nenets, they develop hypolactasia much more often than the Saami, in the range of 71–94% (Kozlov 1995).

How can we explain this shift of hypolactasia level among the Saami from the practically absolute nonabsorption of milk characteristic for reindeer-breeding peoples, to the mid-level which is characteristic for groups with relatively old traditions of dairy animal husbandry?

It is known that before the beginning of the 20th century there was no cow milk in the Saami household. But ethnographic sources describe the Saami using reindeer milk and it is believed that the Saami "reindeer" milk breeding developed comparatively recently. In the opinion of some researchers it happened only in the 18th century under the influence of Scandinavian milk cattle-breeding (Nickul 1970).

Here we should keep in mind that such habits were traced just in a few Saami groups. For instance, the researches stated that the Kola Saami, including the Kildin group, and the Skolt Saami of Finland never milked she-deer and never used reindeer milk (Zolotaryev 1927; Vuorela 1964).

Reindeer milk was regularly included only in the diet of the Mountain Saami. Only they used to tend grazing reindeer, which means they had an opportunity to milk she-deer. One milking produced no more than a cup of milk.

The Mountain Saami usually drank milk diluted with water in proportion 1:1. In this mixture they also added some cut sorrel (Rumex sp.) leaves. For preserving milk they added boiled Angelica sp. sprouts or roots (Nickul 1970). Both sorrel and Angelica contain a great amount of free acids. Adding them to fresh milk would lead to its quick souring and splitting of lactose.

Milk was also used for soups, in coffee and for processing cheeses and butter (Vuorela 1964). In processing of sour-milk products lactose also gets partly split. Also, the reindeer milk is poor in lactose, containing only 2.4%, which is one-third the amount in human milk (7%) and half as much as cow milk (4–5%) (Corbin & Whittier 1965).

These data on Saami "milk behavior" leads us to the conclusion that intensive reindeer breeding which enables people to widely get and use milk is evident only among the Mountain Saami and only for a few last centuries. Both the amount of consumed whole reindeer milk and the amount of lactose contained in it were very small.

That is why the traditional Saami "milk behavior" could not influence the evolution of this trait as it did with other European peoples connected with dairy neat cattle-breeding.

We would agree with Sahi's (1991) opinion that the relatively low frequency of primary hypolactasia in various Saami groups is mainly caused by the inflow of LAC*P (lactase persistence) gene from neighboring populations. To confirm this we can offer the following evidence.

Among the researched Saami groups the most "polar" ones — as far as LAC*P gene frequency is concerned — are the Skolt and the Inari (Fisher) Saami (see Table 1). By ethnographic evidence, both these groups never used reindeer milk (Zolotaryev 1927; Vuorela 1964). The Skolts can also be considered the least genetically mixed population. They inhabited isolated Northwestern regions of the Kola peninsula from as far back as the 16th century and up to the 1940's of the 20th century. By 1949 the Skolt were concentrated to the North of the Inari lake in Sevettijarvi region of Finland (Linkola & Sammallahti 1995). Here they now neighbour the Mountain Saami, but dialectical and confessional differences prevent them from mingling actively.

The Inari (Fisher) Saami, unlike other groups of Finland Saami, started small cattle-breeding and orchard-gardening in the 19th century, since they lived close enough to Finnish settlers and were influenced by them. Undoubtedly there was quite a number of intermarriages as the Inari Saami were not numerous.

Intermediate hypolactasia frequencies (48%) are found among the Kildin Saami. The example of this group provides additional data on the process of mixing with surrounding populations. In the last 30 years the number of bearers of traditional Saami family names has been declining at the rate of 10% decade. The reason for it can only be the increase of interethnic marriages, which means the inflow of genes from other populations.

This genetic assimilation is also confirmed by the data on blood groups distribution among the women self-identified as “Saami“.

The Scandinavian Saami (the Inari and the Mountain groups) are characterized by a high frequency of p gene and an extremely low frequency of q gene. Among the Kildin and Skolt Saami q gene frequency is quite high, judged by “European scale“ (Mourant et al. 1976; Khazanova Shamlyan 1970). Comparing our data with the results of hematological research of the Kola Saami done in 1960‘s we found substantial evidence of intensive gene inflow from other groups. By the beginning of 1990‘s the concentration of p gene had reduced by 2.6 times (from 0.4108 to 0.1597) while the q gene concentration had increased from 0.1145 to 0.5432 (by 4.7 times). All differences in gene concentration by decade are statistically significant ($P<0.001$).

Conclusion

Subpopulations of the Finland and Kola Saami are characterized by large variability in LAC*R gene concentrations (0.50...0.77), but compared with other reindeer-breeding peoples LAC*R gene concentration among them is relatively low. Distribution of primary hypolactasia among the Saami (25–60%) remains within intermediate figures characteristic of the Uralic peoples.

This situation can hardly be explained by the influence of selection. Cow milk appeared in the Saami diet only in the last 100 years. Intensive reindeer breeding, necessary for producing considerable amounts of milk, was developed by the Saami also comparatively recently, some 300–400 years ago. Reindeer milk is consumed in small amounts, mostly as flavoring or in sour-milk products. Even in fresh reindeer milk there is half as much lactose as in cow milk. When sour-milk products are processed milk sugar splits. Thus, “milk behavior“ connected with reindeer breeding and, moreover, with dairy cattle-breeding could not have influenced the evolution of the index too much.

The large between-group differences in the trait are also an indirect confirmation of small effect of selection. It rather reflects the level of genetic influence of neighboring, non-Saami, populations.

The role of gene inflow in reducing the level of hypolactasia in various Saami populations is confirmed by historic data on various ethnoterritorial groups as well as by the reduction of the number of the traditional family name bearers and the change of the ABO system gene frequencies among the Kildin Saami in the last 30 years traced by us.

The research conducted here shows the necessity of thorough consideration of the factor of interpopulation mixing while examining the distribution of primary (genetically attributed) hypolactasia.

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