

## WHALING PRODUCTS AS AN ELEMENT OF INDIGENOUS DIET IN CHUKOTKA

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### Introduction

Nutritional traditions are an area where biology and culture are closest. In combination with specific environmental resources, nutrient requirements are responsible for habits and traditions that are fixed for centuries.

An Italian inviting someone to partake of a meal would propose to share "carbohydrates"; for him the word "pasta" does not only mean "spaghetti", or floury dishes, but rather food in general. An invitation by the Russian reflects the ecological specificity of the Middle-Russian Plain, poor in mineral substances. The Russian would invite his guest to partake of "bread and salt", i.e., "carbohydrates and microelements". For Inuit (Eskimo), food was originally considered the same as meat, "neri". The Inuit terms for eating are derived from this: To eat is "nerivoq. When dinner is ready one calls "nerisassat," often shortened to "neri..." A banquet is understood as a feast with large quantities of meat, "nerersuarneq" (Larsen and Oldenburg, 2000).

The present communication addresses some aspects of human nutritional ecology as determined by biological and cultural adaptation to life in high latitudes.

The indigenous populations of the Chukotka Peninsula are the Chukchi and Siberian Eskimos – Yupik. According to the population census of 1989, the Yupik population is 1,704, and that of the Chukchi, 15,107 (Funk and Sillanpaa, eds., 1999). At the beginning of the first millennium A.D., some Chukchi tribes moved from the regions of the Chukotka Peninsula to the shores of the ambient seas. There, the coastal Chukchi came in contact with the Eskimos, and partly assumed the cultural elements of the marine hunters. As a result, the coastal Chukchi and Eskimos developed almost identical systems of nature management and nutritional ecology. On this basis, we address the situation in the communities of marine hunters of Chukotka as a whole, without dividing them into Chukchi and Yupik.

At the same time, the traditional Inuit (Eskimo) strategy of nature management and

lifestyle are virtually identical in all coastal regions of the Arctic. The effect of present-day changes in the lifestyle and nutrition on the health of the Arctic marine hunters is also similar throughout their entire distribution range (Shephard and Rode, 1996; Kozlov and Vershubsky, 1999). The above makes it possible to compare the large body of data obtained in the area of the United States, Canada and Greenland.

### Nutritional Diversity of "Traditional" Food

Present-day researchers are aware that one cannot underestimate the role of vegetative food in the traditional indigenous diets of the high latitudes (Kozlov and Vershubsky, 1999; Berezovikova and Mamleeva, 2001). For the indigenous peoples of the North, such foods are of particular value in providing fiber tissue and vitamins rather than carbohydrates, the main source of energy in the diet of the majority of temperate zone residents. The readily-assimilated carbohydrate food is hard to find in the Arctic, and absorption of carbohydrates in the intestine appears to be difficult in the high latitudes (Kozlov, 2002).

Despite the low species diversity of the high latitude marine and terrestrial fauna, the animal protein food is available in the Arctic in sufficient amounts. In addition, the northern marine fauna makes it possible to obtain large amounts of fats, the most concentrated foods (fats exceed proteins and carbohydrates in calorific value per unit mass, containing less water). The relative species paucity of the flora and fauna of the high latitudes naturally restricts the range of diet of representatives of the groups of traditional lifestyle. Marine hunters are characterized by exploitation of marine, littoral and terrestrial biotas. This provides notable expansion of the range of food compared with those consumed by tundra reindeer herders. But in this case, too, diet diversity is not great (Damas, 1984; Larsen and Oldenburg, 2000).

Terrestrial hunting and gathering have been serving for Yupik and coastal Chukchi mostly as auxiliary diets. Eskimos believe that those foods, no matter how "prestigious" they may be, are not nutritious enough. Birds, fish, plants

and eggs "all leave you feeling hungry" (Robert-Lamblin, 1986). Due to ecological reasons, the diet has traditionally been based on marine hunting products – meat and fat of marine mammals. To date, they alone are thought to be "true" food. Marine hunting products acquire the significance of "cultural super-food", regarded as the gift of God(s) to become a symbol of ethnic identity (Garine, 1994; Freeman et al., 1998).

Siberian Yupik consume the meat of various marine mammals: the gray whale and bowhead whale, walrus, bearded seal, ringed seal, ribbon seal and harbor seal. However, the Yupik treat whaling products as "cultural super-food".

The traditional diet of marine hunters of Chukotka comprises about 20 various dishes of meat, fat, skin, flippers, tongue, and entrails of cetaceans (Bogoslovskaya et al., 1986). The Yupik and coastal Chukchi clearly distinguish between the products obtained in the course of marine hunting. The gray whale is regarded traditionally as seasonal, summer food, since its meat cannot be stored for a long time. By contrast, the meat of the bowhead whale can be stored for a long time. Generally, the coastal Chukchi and Siberian Eskimos regard whale meat as "heavy" food, which is not to be consumed by sick people (Bogoslovskaya, 2001, personal communication).

### Traditional Norms of Consumption

In the early 20th century, an adult Eskimo consumed 1.8 – 2.2 kg of the meat of marine mammals (Foote, 1970). A wide distribution of imported foods and an increasing tendency to consume "market food" bring about reduction in the proportion of meat in northerners' diet. In the early 1960s the central Alaskan Inuit of Anaktuvuk Pass provided up to 65% energy requirements (Rennie et al., 1962). In the early 1970s, the consumption of whale and seal meat by Greenland Inuit averaged 0.387 kg/day (Bang and Dyerberg, 1981). The MacKenzie Delta Inuit consume mammal meat (primarily of the caribou and beluga whale) on average, 310 times a year, and various fish species another 210 times (Wein and Freeman, 1992).

Meat is not a single essential component of the northern diet. Another vital element of the traditional Arctic kitchen is animal fat. This is reflected in the saying by Canadian Arctic Indians: "Died of hunger, consuming rabbits". The lack of fats in the indigenous diet of high latitudes may prove disastrous. Hence, numerous elements of the nutritional culture of Arctic people involve

inclusion of the maximum possible amounts of animal fats (lipids) in the diet.

The greatest fat consumption is characteristic of marine hunters (review: Kozlov, 2002). When the Inuit of Canada assess the advantages of different types of traditional food, they constantly emphasize fat content (Wein and Freeman, 1992): "can't live without it (fat)" (about the beluga); "gives us fat" (about the bowhead); "makes you get fat" (about the seal). The traditional diet of an adult male Eskimo included about 100 grams of animal fat from meat and another 60 g of natural fat of marine mammals (Krupnik, 1989). With such a diet, animal fats alone could provide daily intake of up to 1280 kCal (5363 kJ) of energy, meeting 35-50% of energy requirements.

### Adaptation To Protein-Lipid Diet

Consumption of such a considerable quantity of proteins and lipids is impossible without considerable adaptive changes. They are manifested at different levels: physiological (gastric digestion), cultural (gastronomy), biochemical (development of "polar metabolism").

Various versions of gastric digestion have been described for mammal meat consumers. They also occur in humans at different frequencies (Kozlov, 2002). The so-called "wild-boar nutritional type" characterizes most humans. This type is the most pronounced in omnivorous mammals, which consume meat along with vegetative food (like bear and wild-boar). In them, digestion of the food ball in the stomach occurs mostly at the walls of the organ in close contact with gastric glands. The acidity of gastric juice is fairly low. An increase in acidity brings about irritation of the organ's walls, which may cause development of gastritis and ulcer.

Indigenous residents of the Arctic, whose diet includes, by European standards, an exceptionally high amount of protein and fats are characterized by the "wolf type" gastric digestion, similar to that of carnivores. In that case, chemical treatment of the food occurs in the central portion of the stomach, with high acidity of the gastric juice. The highly acid medium creates optimal conditions for the activity of the proteolytic enzyme pepsin, resistant only under pH within 1.0-1.5. In order to protect the organ walls from the impact of acid, its cells excrete great amounts of mucus.

By the method of target endoscopic pH-metry, we have revealed that indigenous northerners have different hydrochloric acid levels in different portions of the stomachs. Near the stomach walls, acidity is lower due to the development of great quantity of mucus, which serves as a protective interlayer between the gastric juice and the stomach walls (Chernenkov, Grozdova, Kozlov and Vershubsky, 1992, unpublished data). Our studies have supported the reports to the effect that the above functional activity of stomach glands is manifested in indigenous northerners as early as they are children (Orekhov, 1987). As a result, even under hyperacidity of the gastric contents Eskimos and Chukchi rarely develop peptic ulcer, although hyperacid gastritis is characteristic of the indigenous people of the Arctic (Pogorazdov, 1990; Kozlov and Vershubsky, 1999).

In addition to the morpho-functional adaptation, cultural adaptation was also of great significance, brought about the development of the specific features of traditional "northern kitchen".

The food that arrives in the stomach serves as a peculiar buffer, preventing an increase in acidity of the gastric content. Assimilation of proteins can be facilitated in two ways: by additional increase in the concentration of the hydrochloric acid in the gastric juice, or by gastronomic pre-treatment of the foods. The former type appears to have been implemented by indigenous residents of the North to biological capacity.

As to gastronomy, residents of the middle latitudes are more used to heat treatment of the foods containing animal proteins (frying, boiling). The above involves destruction of the quaternary and tertiary protein structures, which renders proteins more readily assimilable. However, partial denaturation of proteins (involving the secondary, and even the primary structures of the molecule) can be attained in a different way: via increasing the acidity of the product itself and exposing it to the impact of proteases. The above process provides the biochemical basis of cooking "fermented" food, widespread in the kitchen of the Chukchi and Eskimos. Whaling products vary in terms of their suitability for the cooking of fermented food. Yupik believe that only the meat of the bowhead whale can be fermented – gray whaling fails to yield the product suitable for this method of cooking (Bogoslovskaya, 2001, personal communication).

The consumption of large quantities of fermented food is a method of adaptation to environmental conditions characteristic of the indigenous people of the Arctic. The advantage of fermentation as a gastronomic method, sparing scarce Arctic fuel, is self-evident.

Consumption of large quantities of fat and their utilization as the main energy substrate as determined by the ecological features of the environment required some specific re-arrangement of the biochemical system of indigenous northerners. They are characterized by the high activity of lipolytic enzymes. Upon breaking down in the small intestine and absorption, lipids form complexes with lipoproteins, some specific proteins ensuring transport of fats. The augmented activity of lipolytic enzymes permits the breaking down of enzymes arriving with food most economically.

In addition, the fractions of transport lipoproteins with very low density (beta-lipoproteins and chylomicrons) are utilized by indigenous northerners more completely with the lipoprotein lipase of the vessel endothelium of the peripheral tissues (Panin, 1987). The above reduces the risk of accumulation of fat substances in the walls of the vessels, and, hence, the hazard of atherosclerosis. However, the main consequence is the possibility of rapid utilization of fats, i.e., switching of metabolism from the carbohydrate type to the lipid type.

#### **Lipids in the Traditional "Arctic Diet"**

In the course of evolution of the "high latitude" type of adaptation there has developed a specific type of "polar metabolism". This type of metabolism is characterized by an augmented energy role of lipids and proteins with a less important role of the carbohydrates arriving from the ambient environment. Accordingly, medical specialists define this type of nutrition as "protein-lipid".

The lack of exogenous carbohydrates (those arriving with food) in the indigenous people of the Arctic is partially compensated by increasing intensity of the formation of carbohydrates from non-carbohydrate products in the organism (Panin, 1987). Those endogenous carbohydrates ensure some of the body requirements for "rapid" energy.

Nevertheless, the basic human energy equilibrium in the high latitudes is provided by the metabolism of lipids, and the proportion of the

energy obtained as a result of carbohydrate oxidation remains relatively small (Krylov, 1980; Kushnerova et al., 1990). In the residents of the temperate climate zone this type of metabolism is periodically used as a reserve type of metabolism; it is switched on when the body needs intake of augmented amounts of energy.

In addition to the energy value, the fat of marine mammals, fish and waterfowl in the diet of the high latitudes performs some other important functions. According to the data of biochemical studies, the requirements of indigenous northerners for fat-soluble vitamins (A, D, E, K) is somewhat higher compared with that in the residents of the temperate climate. Northerners, who stick to the traditional mode of nutrition, use the "marine type" fats as the main source of fat-soluble vitamins, including vitamin D, ensuring protection from rickets in children and osteomalacia in adults.

For ecological reasons, the availability of animal fats in residents of the mainland tundra and the seacoast differs.

The usual food of Reindeer Chukchi is reindeer meat, whereas Coastal Chukchi consume "sea meat," i.e., the meat of marine mammals. It should be noted that the latter is the favorite food of the entire Chukchi people, probably, because it contains more fat. Reindeer Chukchi, who for a long time do not see whale fat, are very avaricious of it and ready to pay any price for it. In spring, when Reindeer Chukchi are visited by coastal traders, traditional treatment begins and whale fat is served. Similarly, "the meat of marine mammals is offered to anyone as the best delicacy," testified W.G. Bogoras in the early 20th century (1904). Acquisition of the products of marine hunting by the communities of tundra reindeer-herders, trading of meat and fat of marine mammals remain to date an important element of traditional subsistence of the indigenous population of Chukotka (Korf and Khotimchenko, 1990; Bogoslovskaya, 2001, personal communication).

Apparently, the input in the organism of vast amounts of fat, characteristic of the traditional "Arctic kitchen" should bring about an increase in the concentration of lipids in the blood serum. An increase in cholesterol level in the blood is particularly hazardous. That lipid does is not involved in metabolic processes in the arterial wall and directly damages it, which causes atherosclerosis.

It has been found, however, that in Arctic marine hunters consuming the greatest quantities of animal fats, the level of blood serum cholesterol is not higher, and frequently even lower, than that in other Arctic dwellers: taiga hunters and reindeer-herders (review: Kozlov and Vershubsky, 1999). The level of cholesterol, beta-lipoprotein, and triglycerides in the blood serum of marine hunters is also substantially lower compared with that of urban residents (Bang and Dyerberg, 1981). Accordingly, the incidence of atherosclerosis in northerners leading a traditional mode of life proves much lower than that in the "modernized" urban population.

The studies performed in the last third of the 20th century explained the fact of the paradoxically low level of lipids in the blood serum of northern indigenous people despite their traditionally fat-rich diet.

A major factor to prevent excessive increase in the concentration of lipids in the blood is input in the body of sufficient amount of polyunsaturated fat acids (PUFA). Similar to any animal, the human body cannot synthesize PUFA and has to obtain them from the outside. The equilibrium of food-contained saturated (SFA) and unsaturated fatty acids is responsible for the assimilation of the fat by the body and its nutritional properties. Livestock products contain 3-11 times more SFA compared with those of whaling (Bogoslovskaya et al., 1997).

The polyunsaturated fatty acids are heterogeneous. Particularly important for the functioning of biological systems are omega-6 and omega-3 polyunsaturated fat acids. Omega-6-PUFA is contained in the majority of food vegetative oils and is also concentrated in domestic animal's meat and fat, primarily, in the pork. Omega-3-PUFA (mainly produced by marine algae) belongs to the so-called "marine type fats". Their content is particularly high in the cod-liver oil and is considerable in the meat of marine mammals: seals, walruses, and whales.

Omega-6 and omega-3-PUFA are involved in the synthesis of prostaglandins (Jorgensen et al., 1986; Salem, 1989). Generally, prostaglandins associated with omega-6-PUFA stimulate cell growth, initiate inflammatory responses, and also promote augmented blood viscosity. Respectively, the consumption of large quantities of fats and oils containing omega-6-PUFA increases the risk of development of heart ischemic disease, and presumably promotes development of carcinogenic diseases.

Prostaglandins, whose formation involves omega-3-PUFA, essentially reduce the risk of development of cardiovascular diseases, and presumably provide extra protection against malignant tumors.

In the case of their traditional lifestyle, marine hunters are ecologically on the upper floor of the food pyramid. Accordingly, the Siberian Yupik and Chukchi accumulate the basic nutrients provided by algal producers and animal consumers of lower orders. Due to the large quantities of meat and fat of marine mammals consumed, the composition of blood serum lipids in Greenland Inuit, Siberian Yupik and coastal Chukchi is close to the respective indices of their food – meat and food of marine mammals (Dyerberg et al., 1975; Gerasimova et al., 1991). In fact, the content of omega-6-PUFA and the ratio of omega-6-PUFA to omega-3-PUFA in Yupik are significantly lower compared to that in the “white” residents of the same built-up areas (Young et al., 1999). Surprisingly, in a certain sense, the belief of Canadian Inuit is supported, according to which the blood of the consumed marine mammal becomes component of the human blood, lending the necessary properties to the individual (Borre, 1991). It should be noted that the milk of Inuit females that stick to the traditional type of diet also contains large amounts of omega-3-PUFA (Innis and Kuhnlein, 1988). Thus, immediately upon birth the infant organism starts receiving polyunsaturated fatty acids, “preparing itself” for transition to the “adult” diet.

The consumption of “marine type fats” leads to a change in the balance of blood serum cholesterol fractions in favor of high-density lipoproteins (HDL). HDL shows less damaging effect on the vessel wall compared with low-density lipoproteins – LDL. The low level of blood serum cholesterol in Inuit, Aleuts, and coastal Chukchi is associated with prevalence in their diet of omega-3-PUFA (Dyerberg et al., 1977; Young et al., 1995; Young et al., 1999).

#### **Changes in Food Composition Due to “Modernization”**

Modernization of the Inuit life style brings about natural change in nutrition. At the first stages, involvement of the “European” kitchen elements depended on the intensity of contacts with representatives of “Western” culture primarily determined by geographical availability (Mikkelsen and Sveistrup, 1941). With expansion of the communication network and increasing “westernization” of the lifestyle of indigenous

northerners, the proportion of “market food” in the diet of Eskimos and Chukchi increased. In 1952 54% of daily intake of energy in the Eskimos of NW Greenland was provided by traditional subsistence food, and by 1991 that proportion decreased to 25% (Pars et al., 2001).

The food composition changed accordingly. Table 1 presents the results of studies of the basic nutrients by the Inuit of North-Western Greenland in 1908 and 1972, and Chukotka Yupik in 1989, in comparison with Danish population (Krogh and Krogh, 1913; Helms, 1972; Bang and Dyerberg, 1981; Klochkova et al., 1990). The average amounts of protein, fat and carbohydrate (caloric %) in the diet of NW Greenland Inuit in 1908 can be regarded as the baseline nutrition type characteristic of the traditional diet of the marine hunters of the Arctic. In 65 or 70 years the Inuit nutrition structure has undergone considerable changes. The ratio of basic nutrients clearly approached that characteristic of the Danish urban population of early 1970s.

For a number of reasons, the “westernization” of the lifestyle and nutrition changes in the indigenous people of Chukotka have been proceeding slower than those in the Inuit of Alaska, Canada and Greenland. The analysis of the diet composition of Siberian Inuit performed in the second half of 1980s (Klochkova et al., 1990) revealed that the ratio of proteins, fats and carbohydrates in the diet of Siberian Inuit differs from that in the traditional diet, but has not yet reached the values specific for the “modernized” natives of Greenland (Table 1).

Inclusion of the “market food” into the daily diet of indigenous northerners and utilization of the dishes of the ethnic kitchen varies with occupation, age and gender. The diets of representatives of different age categories of coastal Chukchi and Siberian Yupik differ significantly. The members of the category comprising indigenous people aged 10-30-years mostly stick to the “European” diet, whereas the Chukchi and Yupik older than 30 years of age prefer the traditional diet (Fomenko, 1990). The available data are also indicative of gender and social differences in the diet of modern Inuit. Judging from indirect evidence, male hunters of Greenland consume more whale than female Inuit (Bang and Dyerberg, 1981; Robert-Lamblin, 1986).

However, it will be remembered that age roles of the traditional food are differently manifested in the indigenous people of the taiga

and tundra, on the one hand, and marine hunters, on the other. Due to their team activity pattern and specific traditions of prey distribution between the members of the community, marine hunters show less differentiation in nutrition within the group compared with reindeer-herders and taiga hunters and fishermen. Accordingly, the administrative restriction of marine hunting or its economical impossibility is harmful to the entire community.

### **The Health Consequences of Transition to "Market Food"**

Urbanization and "westernization" of the lifestyle of indigenous northerners are combined with an increasing proportion of the market food in the diet (Shephard and Rode, 1996; Kozlov and Vershubsky, 1999; Kozlov, 2002). Accordingly, residents of big built-up areas of Alaska and Chukotka show higher levels of total cholesterol and cholesterol of HDL lipoproteins compared with those in indigenous northerners dwelling in remote isolated northern villages of the same regions (Maynard, 1976; Voevoda et al., 1987). More "westernized" Inuit of Canada show significantly higher cholesterol level compared with that of the population of Chukotka (Young et al., 1995).

The type of nutrition characteristic of modern urban residents and increasingly common in the communities of Eskimos and Chukchi brings about substantial lack of equilibrium between fats with different fractions of polyunsaturated fatty acids. The ratio of omega-6 to omega-3-PUFA to the diet of modern urban residents ranges from 15:1 to 10:1, whereas that in gatherers has been found to range from 4:1 to 2:1 (Weil, 2000).

With reduction of the proportion of meat and fat of marine mammals in the diet, the favorable ratio of fatty acids in the lipids of blood serum in the Chukchi and Yupik is disturbed (Korf and Khotimchenko, 1990). The consumption of fats and proteins in the diet of "modernized" indigenous northerners remains high by the European standards, but the traditional "marine type" fats containing omega-3-PUFA are substituted by fats with a predominant content of omega-6 fatty acids. In fact, in 1997-98 female Inuit of the Buffin Island used about 86 g of fat daily, 56 g out of which amount was accounted for by purchased fat, largely vegetative oil and margarine (Kuhnlein, 1991). It raises the levels of cholesterol and triglycerides of blood serum and causes subsequent development of atherosclerosis.

In addition to prostaglandins associated with omega-6-PUFA, which increase the risk of heart ischemia, they seem to develop a favorable background for the distribution of oncologic diseases. During the last two decades an increase in the incidence of cancer has been recorded in indigenous residents of the north, including Chukotka natives (Gaudette et al., 1991; Kustov et al., 1991; Shephard and Rode, 1996). The relationship between the growth of oncologic diseases and lack of equilibrium between omega-3 and omega-6 fatty acids in northern populations lacks thorough study.

Transition to the "European" nutritional style exerts a detrimental effect on the fitness of Chukchi and Eskimo children (Prachin, 1982). Due to lower input of fats they develop disturbances of vitamin equilibrium associated with lack of fat-soluble vitamins and a decrease in the development of D vitamin. In that case hypovitaminoses are not always compensated for by an increase in the intake of daily doses of synthetic vitamins.

The hazard of development of hypovitaminoses remains in those cases where consumption of animal proteins and fats by indigenous northerners remains high (by "European" standards), but the products of marine hunting are replaced by beef, pork, chicken. For instance, the content of vitamin A in the beef is 5.5 times lower than that in the meat of the white whale, (Freeman et al., 1998). Accordingly, only 14.5% of the examined Inuit women on a "mixed", partly "westernized" diet receive the recommended quantity of vitamin A with food (Kuhnlein, 1989).

### **"Traditional" and "Market" Food Consumption by Marine Hunters of Chukotka Today**

As revealed by our surveys of 2000-2002, today the pattern of nutrition of the indigenous people of the Russian North is determined by two major factors. The first is the traditional kitchen of northern natives and its present-day natural evolution bringing it closer to the "westernized" type of nutrition. The second factor is economic, which impels many of the indigenous northerners to return to traditional food, since a market is not available. The above factors are directed differently, and differences in types of nutrition have been increasing even within a single community. Better well-off northerners have increasingly preferred the "European" diet (in "Russian" version). For the poor members of indigenous communities, hunting, fishing and

gathering of wild plants again become an important element of life support.

As shown by our studies of 2000-2002, the diet of indigenous people of the Russian North today is determined by two major factors. The first is the evolution of traditional kitchen of northern aborigines in the modern world, which leads to similarity with the "westernized" diet patterns. The second factor is economic, which forces a large proportion of northerners to "classic" traditional diet due to the fact that "market" food can hardly be afforded. These vectors are directed differently, and the differences in diet types increase even within a single community. The northerners who are better off financially, and particularly urban residents, increasingly prefer the "European" diet (in Russian version). For poor members of indigenous communities, who account for the bulk of the indigenous population of the Russian North, hunting, fishery and gathering becomes a vital element of their life support.

The political and economic development in Russia in the late 1980s – early 1990s resulted in a dramatic decline in marine hunting for the needs of indigenous people. Unfortunately, the present communication can only provide official statistic data, and indirect evidence available suggests that these data are largely distorted. Today, under the project "Nutrition and Health of Northern Indigenous Peoples – Interactions with Ethnicity, Social Status and Environment" (NUHIP), we have been conducting research aimed to provide some more objective information.

According to the Department of Agriculture, Food and Trade of the Chukchi Autonomous Region, the year 1996 became critical, when the amount of food meat of the harvested cetaceans and pinnipeds accounted for only 58.5% of the indices of 1985: 964.0 against 1647.7 tons. By the year 1998, the harvest of marine mammals increased to stay at a virtually stable level ever since (Podgainy, Zdor, 2001). In 2000 the harvest volume in terms of live mass was 2145, which yielded 1026.2 tons of food meat (Table 2).

The increase in marine hunting in the late 1990s-2000s was essentially accounted for by intensification of the harvest of small pinnipeds, primarily ringed seal, and to a less extent, larger seals: (large and the bearded seal), which was conducted by local people both in teams and on an individual basis. Accordingly, some dramatic structural changes in the consumption of the

products of marine hunting occurred. In fact, replacement of the meat and fat of the walrus by respective products of seal hunting results in decline of the resources of "fermented" food, whose importance for the health of indigenous people has already been mentioned.

Judging from the surveys conducted by other authors (Ainana et al.2002) and one of the authors of the present paper (E.Z.), the indigenous people of the coastal regions of Chukotka would like the harvest of marine mammals to be considerably increased. They believe that such an increase would permit them to substantially augment the food situation in the communities, and there are grounds for that.

During the recent years, the quotas for the harvest of marine mammals in the Chukchi Autonomous Region have not been completely utilized, judging from the number of harvested seals, walrus and cetaceans: in 1998 the quotas were utilized by 37.5%; in 2000, by 60.9% (Podgainy, Zdor, 2001). The attempts of some stakeholders of the International Whaling Commission (IWC) to ban or to sharply reduce the harvest of the gray and bowhead whales by the indigenous people of Chukotka and Alaska were neutralized partly because for the first time in the last decades IWC was offered medico-biological substantiation of the need of whaling products for the health of the indigenous people (Kozlov, 2002). For the period between 2003 and 2007 the quotas remained the same (for Chukotka, 135 gray and 5 bowhead whales per year). Thus, today, coastal Chukchi and Siberian Eskimos are authorized to almost double their production of marine hunting. Unfortunately, this opportunity has some negative aspects.

When the environment is polluted industrially, the meat and fat of marine mammals become peculiar "accumulators" of stable toxic pollutants. In particular, northerners receive polychlorbiphenyls (PCB) with the fat of cetaceans and walrus, which may cause barrenness, congenital development defects, neoplasms and other serious diseases (Revich, 2001). Even in the case of a modern, partly "westernized" diet, about 10% of women and 15% of male marine hunters among Canadian Inuit receive PCBs in quantities exceeding the maximum admissible level (1 microgram per Kg of the body mass per day). In a number of cases, the entry of PCBs with food is four times higher than the maximum allowable level (Kuhnlein, 1989).

In such conditions, an increase in the consumption of meat and fat of marine mammals may lead to an increase in toxic effects in the communities of marine hunters. The PCB is only an example. Heavy metals and chlororganic compounds are no less hazardous to the indigenous people of the Arctic (Revich, 2001; Kuhnlein et al., 2000). During the recent years the marine hunters of Chukotka frequently recorded walrus and seals with various defects of development and "ill odor and texture" of meat and fat (Bogoslovskaya, 2001, personal communication). The local people associate such deviations with possible impact of industrial pollutants, but according to Danish researchers, only 1% of Greenland marine hunters believe marine hunting products containing chemical pollutants may be hazardous to humans (Pars et al., 2001).

An increase in the harvest of marine mammals should be combined with measures on the hygienic control of the quality of the products obtained by each community. These hygienic measures are to be accompanied by adequate information support: the indigenous people should be fully aware of the possible risks.

### Conclusion

Today, traditional types of feeding characteristic of the indigenous population of the North are exposed to substantial transformation. The causes of that are both the complex changes associated with modernization and natural factors (environmental pollution, reduction in the areas of traditional nature management and depletion of resources). Modernization effects include social, economic and ethnic heterogeneity of traditional communities. Their consequences are formation of professional, age, and gender differences in nutrition in the communities of the indigenous people of the North.

Some specific consequences of modernization are the weakening and even destruction of the ancient medico-biological and cultural adaptations. Such maladaptation involves various aspects of the life of indigenous northerners, but it is the most pronounced with respect to nutrition.

The economic collapse of the infrastructure of the northern regions of Russia has resulted in numerous indigenous northerners again addressing the traditional subsistence methods. Over the last 3-4 generations they have been increasingly adapted to a modernized diet and lost

numerous traditions, knowledge and skills as well as natural resources. No complete return to traditional subsistence is possible today, but it is necessary to seek equilibrium between traditionalism and modernism.

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**Table 1**

Average amounts of protein, fat and carbohydrate (caloric %) in the diet of NW Greenland Inuit in 1908 and 1974 in comparison with Siberian Yupik in 1989, and Danish population in 1972

Ethnic group and year of investigation	Protein	Fat	Carbohydrate
Inuit, NW Greenland, 1908	44	47	8
Inuit, NW Greenland, 1974	26	37	37
Yupik, Chukotka, 1989	32	42	26
Denmark, 1972	11	42	47

**Table 2**

Consumption of the products of marine hunting by indigenous people of Chukotka, in the year 2000, in tons (source: Ainana et al., 2002)

Marine mammals	Food meat	Entrails	Fat	Large bones
Cetaceans	293.3	139.6	160.8	419.5
Pinnipeds (total)	583.0	179.9	138.7	79.9
out of which number:				
Ringed seal	97.3	--	--	--
Bearded seal	72.2	--	--	--
Walrus	413.5	--	--	--