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Ways of identifying lichen and plant species by the Nenets reindeer herders in Yamal

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Abstract

Yamal Nenets herders have historically developed a rich knowledge of lichens and vascular plants, which feature in the diet of their migratory reindeer herds in the tundra zone of northwest Siberia. In the Nenets language there are native names for certain species of lichens and other reindeer forage plants, including graminoids, herbs, shrubs, berries, and mushrooms. During participant fieldwork together with nomadic tundra Nenets herders, we documented names and definitions of reindeer food on herding territories during their long migration routes from the northern forest-tundra transition zone to the northern coastal tundra. Like many other Indigenous peoples of Siberia, Nenets have noticed that the Arctic is changing and some of its recent dynamics are seriously affecting their livelihood. The degradation of some lichen composition and cover on tundra pastures has also contributed to a decrease of herders' linguistic palette for describing these losses in a concrete manner. Since the Nenets language is on the list of endangered languages of the world, this has an especially negative impact on the language skills and traditional knowledge of the younger generations of Nenets people, who may not know what these lichens look like and why they are important for the Nenets reindeer herding culture.

Key words: traditional knowledge, Yamal Nenets, ethnolinguistics and ethnobotany, Indigenous peoples and languages, reindeer and reindeer herding in conditions of climate change

Introduction

The Nenets understanding of landscape, their connection to it, and their perception of their environment is based on their mobility perspective and reindeer. This supports a unique reindeer herding culture and includes an understanding of the tundra and its landscape, including knowing the traditional ethnobotanical names of different tundra lichens and plants. This means that reindeer herders observe their reindeer and their feeding habits daily and they are closely familiar with different tundra plants, since the diet of reindeer changes markedly within the reindeer herding season (Lavrilenko and Kuljugina 2002; Behnke et al. 2011; Laptander et al. 2023). Even in a changing Arctic environment, reindeer herding is still considered the main livelihood of the nomadic Nenets people.

The Nenets domestic reindeer *ty* (*Rangifer tarandus tarandus* L.) spend their lifetime grazing free in the tundra, but under human control. They are different from the wild reindeer *ilebts* (Syroechkovski and Kuprianov 1995). Unlike Sámi in the Western European Arctic, the Nenets practice close herding, which makes the animals much more "domestic" than the reindeer are, for example, in Finland, and they make annual migrations from summer to winter pastures (cf. Ingold 1980; Nyyssönen and Salmi 2013; Laptander et al. 2023). Reindeer herding nomads use different types of tundra landscapes for herding work and every season they use pastures with different combinations of lichens, grasses, and shrubs (Habeck 2007; Behnke et al. 2011; Istomin 2012; Yoshida 2018; Istomin and Dwyer 2021).

For many Indigenous cultures this ethnobotanical knowledge of plants is reflected in a deep understanding of local landscapes and traditional ethnoecology (Berlin 1992; Basso 1996; Holloway 2006; Clarke 2007; Zhdanov 2009; Brodskij 2014; Malysheva et al. 2022). Moreover, this knowledge is based on a long-term observation of nature and on experiential learning of its different conditions (Johnson and Hunn 2010).

There are only a few works about ethnogeographic studies on the Siberian ecology and the role of landscape in the life of local and Indigenous peoples (Istomin 2012; Lavrillier and Gabyshev 2017; Ksenofontov et al. 2019; Mamontova et al. 2020). However, traditional knowledge about local environment and traditional ethnoecology is essential. It is valuable for every Indigenous community around the world and is deeply connected to their cultures and languages (Cruikshank 2012; Martinez et al. 2019; Mamontova et al. 2020).

Landscape ethnoecology is based on the understanding of the landscape as it is perceived and imagined by the local community. The concepts of landscape ethnoecology (the spatial structure of different ecosystems or types of environments), cultural geography

(climate, landforms, waters, vegetation, human response, and interaction with the landscape), and landscape anthropology (cultural perception, understanding, and meaning of the landscape) are all compatible with this understanding of "landscape" (Johnson and Hunn 2010). This also includes linguistic knowledge of different names for landscapes, as well as vegetation and plants, which grow on particular landscapes. Thus, language reflects a range of cultural and cognitive issues, and linguistics has the tools and models to identify, describe, and explain representations of the landscape that are of key interest to other branches of science (Mark et al. 2011).

Our aim here is to describe the Yamal Nenets ethnobotanical names of lichens and other plants. Accordingly, in this paper, we are going to show the Nenets' knowledge of the tundra environment and landscape, as well as their linguistic knowledge of tundra plants. Our research interest has a particular focus on (1) how Nenets reindeer herders understand their home tundra and landscapes and (2) how this knowledge reveals the distribution of tundra plants and lichens, which form the majority of the reindeer diet. We emphasize that the Nenets' ethnobotanical knowledge of tundra plants is based on their historically developed strategies of herding domestic animals across a large expanse of the Arctic tundra. Due to the extremely cold temperatures and severe Arctic climate, tundra vegetation is very sparse. Without any doubt, we can say that to keep their reindeer together, the Nenets reindeer herding people became relational thinkers for developing different ways and strategies for maximizing benefits from their work.

Additionally, in this paper, we are going to describe not only the Yamal Nenets' understanding of the tundra landscape where they herd reindeer, but we will also pay special attention to their categorization of tundra vegetation with connection to the seasonality of land use and what, if any, symptoms of a warming climate they have noticed during their work with reindeer. Therefore, our hypothesis is that the most Nenets names for the reindeer lichens and plants, which are in the reindeer diet, are an integral part of reindeer herders "manual" about ways of herding reindeer in their home environment.

The Yamal reindeer herders' local knowledge of tundra plants reflects the overall vegetation characteristics of the Arctic tundra. And interestingly, in the Nenets language there are different ways of naming reindeer lichens and, simultaneously, a lack individual names for other tundra vascular plants. For lichen, this means that Nenets ways of knowing them are not related to the lichen as separate plants, but in relation to reindeer grazing traditions; to the Nenets understanding of their way of life; to the landscape, waterbodies, seasons, and all the other components of their environment. This provides an explanation that the Nenets nomads' rational way of assessing the tundra landscape is by virtue of its value to reindeer husbandry. This is reflected in the naming of vascular plants, which are of less significance as reindeer forage. This also explains, within the framework of the Nenets language, why only a few species of plants, which are especially loved by reindeer, have names in the Nenets language. Owing to the harsh climate and short-growing seasons that last only approximately one month and half, only a few vascular plants can grow. Lichens are symbiotic organisms composed of a fungus and algae/cyanobacteria that absorb water and nutrients directly from the atmosphere, which allows them to thrive in extreme environments (Ahti and Oksanen 1990). Lichens account for a large part of the biodiversity in the Arctic tundra (Lavrinenko and Kuljugina 2002; Zhdanov 2009; Beldiman et al. 2020). Reindeer are adjusted to their environment and have an evolutionary adaptation that allows them to feed on lichens and tundra plants (Richardson and Wiegand 1977). In some publications, it is actually mentioned that the Indigenous inhabitants of the Arctic used lichens for assisting in the domestication of reindeer (Syroechkovski 1987; Inga 2007; Inga and Öje 2012).

Currently, the Yamal Nenets traditional lifestyle and work with reindeer is changing due to many factors, including a warming climate, shifting weather patterns, and a transformation of the landscape due to infrastructure development (Arefiev 2000; Volkovitskiy and Terekhina 2022; Povoroznyuk et al. 2023; Spiegel et al. 2023). We also explore if some of the tundra plant names are disappearing due to social and environmental changes in the tundra. This adds urgency to our work on the documentation of the Nenets language. According to the UNESCO Atlas of the World's Languages in Danger, the Tundra Nenets language is recognized as being definitely endangered (Source: UNESCO World Atlas of the World's Languages in Danger). The tundra Nenets language belongs to the northern Samoyedic languages of the Uralic language family, spoken by the Nenets on both sides of the Polar Urals in Eurasia, and many of its dialects are still little documented.

During our work we collected around 40 Nenets words for reindeer food, among them names for reindeer lichens and descriptions of their value in the life of the Yamal Nenets people. Our research shows that the landscape of the tundra and, especially places with *njada* (the Nenets name for reindeer lichen), are also connected to the social space of the local environment and ethnoecology, and are considered to have personal agency and be spiritual custodians (Stammler 2008). It is interesting, that in Nenets folklore mythological human-like reindeer creatures, so called "strange people", called *njad/njadam' ngaworta"* (lichen (or moss) eaters) are mentioned (Zhitkov 1913; Golovnev 1995; Golovnev and Osherenko 1999; Tereshchenko 2008).

Like all other beings, lichen also have a spiritual dimension that reindeer herders ought to respect as part of their everyday being in the environment. Elders in particular have emphasized that respecting lichen includes not building nomadic camps on lichen grounds, as the human–lichen relationships are mediated through reindeer and their grazing preferences. Humans must therefore not disturb this relationship by trampling such precious grounds before reindeer graze there. Reindeer also respect lichen in such a way that they will not graze all lichen on a certain plot as sheep would graze hay. Rather, they take only a fraction of the available lichen biomass from a certain plot, before migrating onward to the next spot. Humans follow this logic when they make sure, through nomadic migration, that the land gets enough time to recover for future human–reindeer–lichen relations. Such a respectful attitude is welcomed by *njada——khe-khe* (the lichen spirit), who let lichen flourish again for the next visit.

Fig. 1. During 9 months of a snow-covered period (in the Nenets is it called "*syra yoljtsj*") the diet of reindeer consists of different lichen species from the genera Cladonia P. Browne and Cetraria Ach. together with grasses, which they dig from under the snow.

On the other hand, the lichen spirit will not honor disrespectful behavior by herders, which leads to the depletion of lichen and hence trouble for reindeer and humans in future years (Stammler 2008).

In the Yamal peninsula, the reindeer nutrition is completely dependent on the quality and seasonal specifics of pastures (Figs. 1, 2*a* and 2*b*).

Every year reindeer herders carry out their cycles of nomadic migrations, travelling huge distances with thousands of reindeer and long caravans of sledges through the tundra of the Yamal peninsula (see Fig. 3*a*). In the north of the Yamal peninsula, it is the shrub–lichen–moss northern tundra——*vy* in the Nenets; in the central part and in the south, the landscape can be described as shrub–lichen–moss tundra with some trees *khoinjangy* and forest-tundra, which is referred to as *pedara*. The permafrost, *ya serer"* is ubiquitous on the whole territory of Yamal. The Polar Ural and other tundras of the Yamal peninsula are rich in different species of lichens and other tundra plants (Walker et al. 2005; Golubkov and Tsurykau 2017; Skarin et al. 2020). During the snow-covered period, the diet of domestic reindeer consists of 70% reindeer lichen (different types of *Cladonia* P. Browne and *Cetraria* Ach.) and only 30% from grasses from under the snow, like horsetails (*Equisetum* L.) and sedges (*Festuca ovina* L. and *Carex* L.). From the end of May until September reindeer eat very little lichen but eat mostly grasses and leaves (Sambuk 1933; Syroechkovski 2000; Baskin 2021).

Since reindeer are in constant search of food, the type of which is the most valuable for them in varies the given periods: in spring, young leaves of Arctic willows and other tundra shrubs; in late spring and summer, grasses, leaves, and different sedges; and in autumn, grasses and leaves, to which reindeer add tundra berries and mushrooms. In late autumn and winter, reindeer forage is based mostly on lichen. Nenets reindeer herders use reindeer lichen and plants as an important instrument for keeping their domestic reindeer under control and for regulating the speed of the animals' movement and the general distribution of the herd over the pasturelands. Reindeer herders' respectful attitude toward lichens is reflected in their rational way of keeping reindeer on seasonal pastures. This happens in all seasons as necessary. Therefore, herders have an intimate knowledge of the different lichens that reindeer eat. This knowledge is part of the Nenets relational worldview where people know all components in the environment as living beings in relation one to another.

Materials and methods

This work was completed by a Nenets linguistic anthropologist and western researchers. Together we completed documentation work on collecting names and descriptions of culturally significant species of lichens and tundra plants, with a special focus on their significant role in Yamal Nenets reindeer herding culture. For conducting this work, we used the advantages of complex research approaches based on (1) anthropological fieldwork and (2) participatory research, including (a) participant observation; (b) interviewing, (c) ethnolinguistics, and (d) language documentation; and (3) natural science approaches.

Interviews with Nenets reindeer herders were collected during the period from 2001 and 2021 with 7 female and 14 male reindeer herders from six reindeer herding communities in the Yamalo-Nenets autonomous district: (1) in the west in Laborowskaja and in the tundra near the Polar Ural mountains, (2) Salekhard, (3) Aksarka, (4) Yarsale and Yarsalinskaja tundra in the south, (5) Tambejskaja, and (6) Syo-yakha tundra toward the north of the Yamal Peninsula (Fig. 3*b*). The interviews were collected in the Nenets and Russian languages. Moreover, interviews in Nenets were done in two poorly documented eastern dialects of the tundra Nenets language. All the people with whom we worked have reindeer herds and migrate as full-time nomads with them, according to the Nenets' traditional way of working with reindeer.

Most of the semi-structured interviews, which were done during migrations or walks in the tundra, were not recorded. Instead, we took notes on Nenets names for lichen and special Nenets words for specific lichen types and names for other plants, which are also part of the reindeer diet. However, some information about the reindeer diet we received as part of the narratives formed during the process of herding work, concerning talks with reindeer herders about their knowledge of reindeer food, lichens, tundra plants, and vegetation on pastures; there are also recordings, where reindeer herders say special names for reindeer food in the Nenets language.

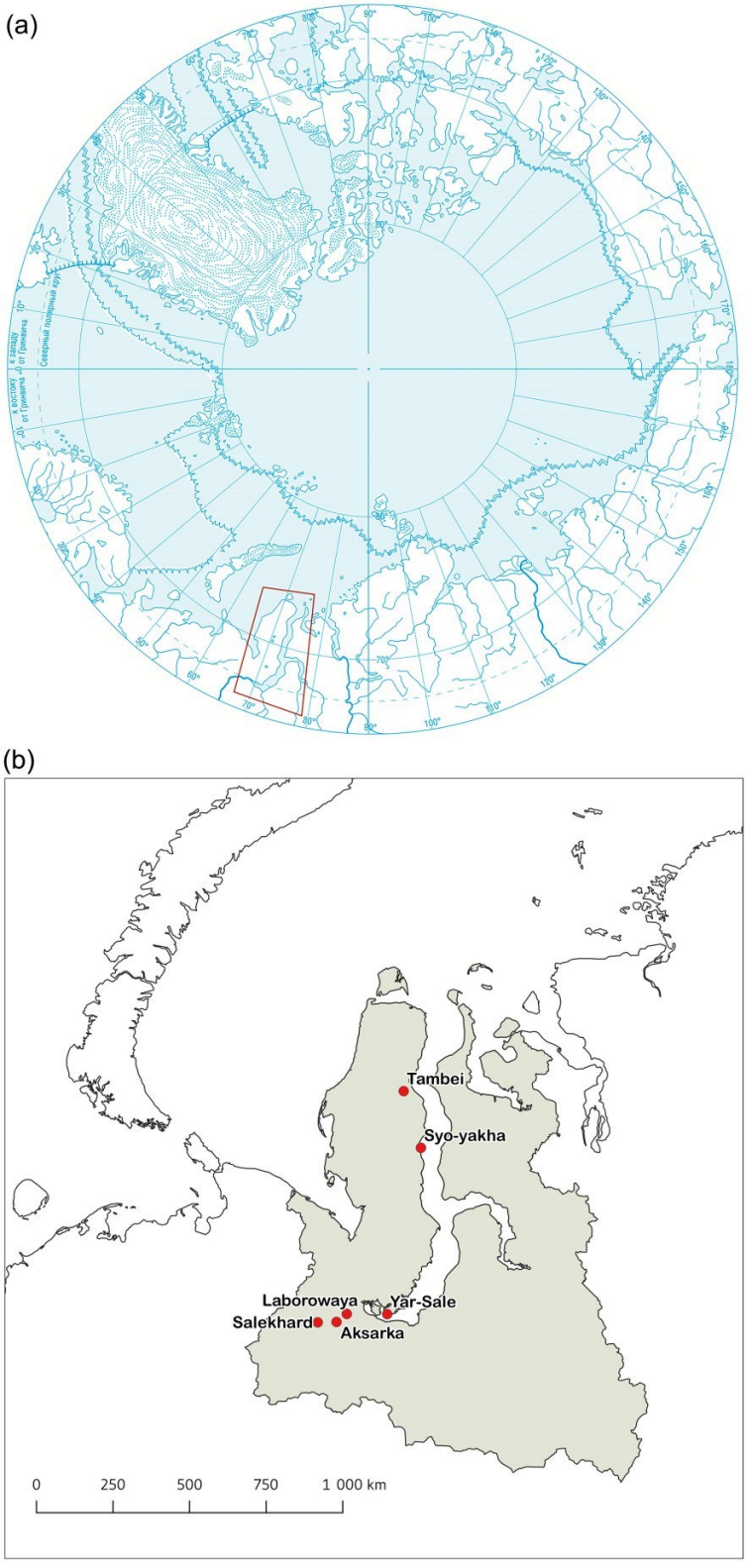
Fig. 2. (*a*) Summer in the Yamal tundra is short and lasts only 7–11 weeks. This period is called in the Nenets *ta"* or *taŋy*. (*b*) Tundra vegetation in summer is composed of lichens, mosses, grasses, and shrubs. In the list of predominant plants are aquatic plants and other aquatic sedges such as *carex aquatilis Wahlenb.*

(a)

(b)

While interviewing reindeer herders, we did not use any questionnaires, or photos or drawings of

Fig. 3. (*a*) The Yamal Peninsula in the Arctic. (*b*) Map of the Yamal peninsula with study sites of the Nenets names for reindeer food.



lichens and plants, but we made drawings and photos of terested in investigating this matter together with reindeer some tundra plants during the interviews or after. In some herders:

cases, when it was possible, we gathered some samples of plant species. To achieve the aim of our work, we were in- 1) What are the Nenets' names for lichens and plants?

2) Which lichens and plants are part of the reindeer diet?
3) Which lichens and other tundra plant/s do reindeer like to eat?
4) When do reindeer graze on it/them? 5) Where does it grow in the tundra?

The interviews that we recorded were transcribed and analyzed. The process of transformation of recorded audio data into textual form is multi-layered. The analysis of interviews includes work on transcribing texts and words. We translated the Nenets words into the target English language. As a result, we collected names for lichens and plants in two northern-eastern dialects of the tundra Nenets language across the territory of our field work areas in Priuraljskij county (*raion*) and Yamaljskij county (*raion*) of the YamaloNenets autonomous district.

Our analysis of the lichen and plant names shows that almost all names for the reindeer lichens and plants are native Nenets. Actually, they are specific reindeer herding terms, and they are usually composed of a combination of adjectives and nouns. In the largest Nenets-Russian dictionary there is only one word for lichens *няда* (*njada*) (Tereshchenko 2008:337). The same is true with other Nenets dictionaries (Lehtisalo 1932; Verbov 1937; Khomich 1954; Tereshchenko 2008; Burkova et al. 2010). However, published resources about Nenets reindeer husbandry and reindeer herding terminologies helped us to understand which lichens and tundra plants are essential in the Nenets' traditional reindeer herding work (Laptander 2010; Pyrerka 2018; Baskin 2021).

Additionally, we tried to match the Nenets names with their possible Western scientific taxonomies. Some of the words for lichen are common for individual Nenets reindeer herders and only at the local level. Thus, not all reindeer herders use the same names for reindeer lichens. When it was complicated to find equivalents for some names for lichens and plants in English, we asked our Nenets consultants additional questions. For example, our results showed that there are three different variations of the tube-like lichen names: *njaŋgdakhana-wadjodana njada* (arctic finger lichen); therefore, at first we even mixed it up with *tulisej-njada* (white tube-like lichen). There is also *mjujda-siljaŋg-parjalakha-njada* (lichenlike in the form of micro tubes). It was difficult to find their English names and find proper scientific names in Latin. However, after consultation with herders and our scientific colleagues who are working in the field of studying lichens, we managed to make a proper identification of these lichen names.

Interviews with reindeer herders were collected in the Nenets language by the first author. Interviewees did not get any special education in plant taxonomy or biology of plants; therefore, their knowledge about the tundra plants is native Nenets, and based on the knowledge they have received from their parents and grandparents and during their work with reindeer. Other interviews in the Russian language were collected by the second author in the Tambeiskaja tundra near Sabetta from one female and five male reindeer herders in June 2001 (Fig. 4). They were also not recorded, but notes were taken. The second author also collected some samples of reindeer lichens and plants with their names in the Nenets language.

The third author conducted fieldwork in different parts of the Yamal tundra from 1993 until 2019 as a natural scientist. He documented types of lichens that grow there with their Latin names. Finally, together with a fourth author, we made identifications of collected tundra lichens and plants and provided them with possible Latin names.

Since a conversion of field records into research texts is a theoretically complicated process, requiring further analysis and finding their corresponding names in English language, as well as their Western scientific taxonomies or scientific Latin names, we did this work as a team.

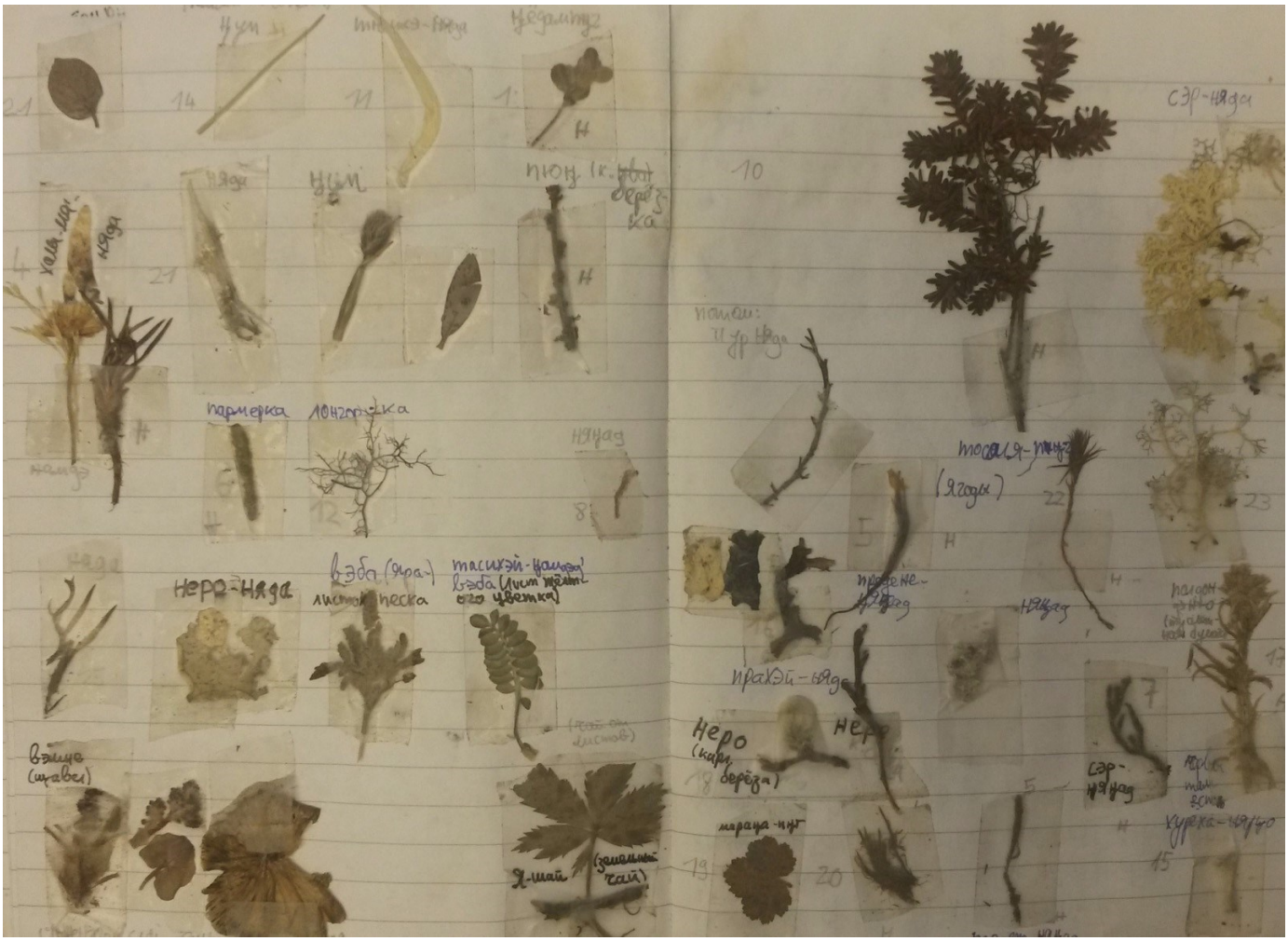
Every Nenets name for reindeer lichen, which was collected during fieldwork, was detailed and the place of lichen distribution in the tundra was determined, including the locations of growth, descriptions as to whether the lichen can be found in dry or wet places, on hills or in meadows, in forests or mountains, and in winter or summer pastures. The Nenets names for lichens also contain descriptions of appearance, color, and definition by similarity.

We wrote the Nenets words for reindeer lichens and plants in Latin letters with their translations in English. In Toivo Lehtisalo's work the Nenets word for lichen is written in a very detailed phonetical way: *n′ad¯a,¯ n′a¯ɒ, n′a¯ɛi,* and *n′ᵊātᵗᵖə* (Lehtisalo 1932:37).) However, for this work we write the Nenets word lichen as *njada.* All other Nenets plant names are also written using the International Phonetic Alphabet (IPA 2023). In the text, we write at the beginning of a word: <я> as <ya> like in *я/ya* (ground), *яра/*yara (sandy); <ю> as <yu>, for e.g., *юмбор"/yumbor" (yumburad)*. All other palatal consonants are written with <j>, like in *няда/njada (n′adej)¯* (lichen), *нерo/njero* (willow) or *тюлисей/tjulisej* (tube-like); <ё> is <jo>——like in the word *хасрё/khasrjo* (a thermokarst lake, covered with grasses and sedges, until it begins to thaw); <ы> as <y>——*мы/ty* (reindeer), *тыя/tyja* (narrow) or *сырэй/syrej* (winter). The cyrillic letter <х> is written as < kh>, like in a word *хархако/kharkhako.* Furthermore, to indicate two specialized Nenets glottal stops, we use one apostrophe <'>—— for the voiced (nasalizing) glottal stop to indicate the genitive case, and two <">——for the voiced (non-nasalizing) glottal stop, like in *сэр"/ser"* (white), *мар"лаха/tar"lakha* (hair-like). It also indicates the plural number: *ŋум"/ŋum"* (grasses) and *ŋамдэд"/ŋamded"* (flowers). Additionally, we write <j> at the end of the word to mark the short <i>, like in *ненэй/njenej* (real, pure, Nenets); <ŋ> is for the velar nasal n: *ŋувця/ŋuwtsja* (soft grass), and <aˇ> indicates extra short <a>, like in the name of a plant *наˇрцо/nartsoˇ.*

Research ethics

This research was completed with the pertinent ethical guidelines of the Frankfurt Declaration of the German Anthropological Association (DGSKA) (www.dgska.de).[1] Furthermore, our research was carried out according to the requirements of the University of Lapland using the Finnish guidelines for research integrity (www.tenk.fi)[2] and the American Anthropological Association guidelines of Anthropological Ethics of research.[3] All interviewees were informed about the objectives of this study and have agreed to sharing it publicly.

Fig. 4. Nenets names for lichens and other tundra plants from field notes.



Results

Nenets names for reindeer lichens

A Nenets general name for all types of lichens is *njada* or just *njenej-njada* (a real, ordinary lichen) or *ty njada* (a reindeer lichen). Places with different types of lichen are called in Nenets *njadej-ya"* (the ground with lichens) (Fig. 5*a*). The Nenets reindeer herders know almost all names for different species of lichens that are part of the reindeer diet. The most valuable are called cladonias and cetrarias in the western taxonomic language, among them *Cladonia rangiferina* (L.) F. H. Wigg., *Cladonia stellaris* (Opiz) Pouzar and Vezda, and *Cetrária islandica* (L.), which are part of the reindeer diet.

The lichens with the greatest nutritional value are star cladonia (*Cladonia stellaris* (Opiz) Pouzar and Vezda), rein-deer cladonia (*Cladonia rangiferina*), soft cladonia (*Cladonia mitis* Sandst.), forest cladonia (*Cladonia arbuscula* (Wallr.) Flot.), snow flavocetraria (*Flavocetraria nivalis* (L.) Kärnefelt and A. Thell), and Icelandic cetraria (*Cetraria islandica*). However, *tynjada* (a reindeer lichen), *Cladonia rangiferina,* is perceived as the most valuable type of lichen.

It has been estimated that about 30% of the lichen species growing in the Yamal Peninsula are eaten by reindeer (Lavrinenko and Kuljugina 2002). While fruticose lichens, such as *Cladonia arbuscula*, *C. rangiferina*, *C. stellaris*, *Flavocetraria nivalis*, *F. cucullata* (Bellardi) Kärnefelt and A. Thell, and some *Stereocaulon* Hoffm. species, are preferred forage species for the reindeer, foliose lichens such as *Peltigera* Willd. and *Nephroma* Ach. are not eaten; therefore, these lichens do not have names in the Nenets language.

The Nenets names of lichens indicate places where they grow in the tundra; describe the quality of the pasture ground if it is dry or wet.

Table 1 gives a description of reindeer lichen names which consist of two, three, or four elements.

The lichen names with two components. *Moŋga-njada* can be translated from Nenets as a "marsh lichen". This lichen name is formed from two nouns: *moŋga* (a dry lowland located between rivers banks) and *njada* (lichen). This describes the tundra meadows along river banks, which reindeer herders usually use for keeping reindeer during the calving period in spring, as these places are better protected from the cold wind and have a special type of lichen.

The lichen names with three elements. The lichen name *njaŋgadakhana-wadjodana-njada* (reindeer lichen growing in the moss) *Dactylina arctica* (Hook. f.) Nyl. consists of three components: noun (location) + adjective + noun. The first part describes a place——*njaŋgadakhana* (in the moss)——then the adjective *wadjodana* (a place of growing), and the noun *njada* (lichen).

Fig. 5. (*a*) *Njadej"* pasture with lichens *Flavocetraria cucullata* (Bellardi) Kärnefelt and A. Thell and *Bryocaulon divergens* (Ach.) Kärnefelt. (*b*) *Njero-njada* (reindeer lichen that grows near the willow roots or freckle pelt lichen). *Nephroma arcticum* (L.) Torss. (*c*) *Njaŋ*gdakhana-wadjodana-njada (tube-like lichen growing in the moss) *Dactylina arctica* (Hook. f.) Nyl. (*d*) *Lichens can also grow on trees. Pja-njada* (tree lichens) *Evernia mesomorpha* Nyl. In general, these lichens are called arboreal lichens to separate them from ground lichens and are a valuable source of nutrition for reindeer in winter.

Nenets name	English translation
• *mOŋga-njada*	marsh lichen
• *njaŋgdakhana-wadjodana njada*	reindeer lichen growing in moss or arctic finger lichen *Dactylina arctica* (Hook. f.) Nyl.
• *njero-njada* • *njero'-paŋgkhana-ŋeda-njada*	freckle pelt lichen, reindeer lichen growing near the willow roots *Nephroma arcticum* (L.) Torss.
• *sada-njada*	reindeer lichen growing in puddles
• *yumburad'-njada*	reindeer lichen growing near tussocks, on hummocks *yumbor"* a place with tussocks or hummocky tundra
• *pja-njada*	reindeer lichen, which grows on trees *Evernia mesomorpha* Nyl.
• *yarej-ya'-njada*	reindeer lichen growing in sandy hills
•*khasuj-yara-ninja-wadjurta-njada*	lichen growing on dry sandy ground

A term with four components. The term *njero'-paŋgkhanaŋeda-njada* (reindeer lichen growing near the willow roots) consists of noun + adverb + adjective + noun.

Table 2. Description of the appearance.

Nenets name	English translation	Latin name
• *labas-njada*	ball lichens, which grow in groups	*Sphaerophorus globosus* (Huds.) Vain.
•*ŋewakata-njada*	lichen with little heads tops	*Cladonia merochlorophaea* Asahina
• *khalbuj-njada*	oblong reindeer lichen	*Cladonia stellaris* (Opiz) Pouzar and Vezdaˇ
• *tjulisej-njada*	white tube-like lichen or whiteworm lichen	*Thamnolia vermicularis* (Ach.)
• *labtsoj-njada*	flat lichen	*Peltigera aphthosa* (L.) Willd.
• *ljartsajada-njadakotsja*	lichen with many thin branches	*Cladonia mitis* Sandst.
• *tyja-njada*	lichen with narrow branches	*Cladonia subulata* (L.) F. H. Wigg. *or Cladonia* L. *sp,*
• *mjujda-siljaŋg-parjalakha-njada*	lichen-like in the form of micro tubes (reindeer adore this plant)	*Flavocetraria cucullata* (Bellardi) Kärnefelt and A. Thell
• *nito-ninja-ŋoneda-njada*	lichen that grows together (on top of each other)	*Cladonia rangiferina* (L.) F. H. Wigg.

Table 3. Lichen colors.

Nenets name	English translation	Latin name
• *ser”-njada*	white lichen	*Cladonia rangiferina* (L.) F. H. Wigg.
• *ser”-syrej-njada*	white winter lichen	*Cladonia portentosa* (Dufour) Coem.
• *wul’tse-ser”-njada*	extremely white lichen	*Cladonia stellaris* (Opiz) Pouzar and Vezdaˇ
• *yaberenja-njada*	white shining lichen	*Flavocetraria nivalis* (L.) Kärnefelt and A. Thell
• *ser”-torik-njada*	white low lichen	*Cetraria islandica* (L.) Ach.
• *paridenja-njada*	black reindeer lichen	*Bryocaulon divergens* (Ach.) Kärnefelt
• *paridenja-ŋewa-tar”lakha-syrei-njada*	winter lichen that is like dark hair	*Alectoria nigricans* (Ach.) Nyl.
• *padjararka-njada*	greenish lichen	*Cetraria islandica* (L.) Ach.
• *njarm-njada*	red reindeer lichen	*Cladonia floerkeana* (Fr.) Flörke
• *parakhej-njada*	grey lichen that looks burnt	*Cladonia gracilis* (L.) Willd.

Table 4. Definition by similarity with something else.

Nenets name	English translation	Latin name
• *pur”-njada*	rust-like reindeer lichen	*Cladonia macrophylla* (Schaer.) Stenh. or *Stereocaulon tomentosum* Fr.
• *parjalakha-njada*	reindeer lichen that looks like *parja* [a storage for food, made from poles]	*Cladonia stygia* (Fr.) Ruoss
• *ilebtsja-njada*	wild reindeer lichen, or	
• *somboj-warawrakha-njada*	beautiful fibrous lichen, like *waraw* [fibre towels made from the birch trees]	*Cladonia amaurocraea* (Flörke) Schaer.
• *pedarakorakha-njada*	lichen that looks like trees in the forest (*pedara* [forest])	*Cladonia stellaris* (Opiz) Pouzar and Vezdaˇ
ty’-lambejrakha-njada or syrej-njada	reindeer antlers-like lichen, winter lichen	*Cladonia arbuscula.* (Wallr.) Flot.
•		

Table 5. Tundra grasses.

Nenets name	English translation
•ŋum"	graminoids, any greenery, all grasses and sedges in the tundra
•ŋuwetsja	low grass, grasses *Festuca ovina* L.
njanzjako-ŋuwetsja	soft grass

Table 6. Growing locations in the tundra.

Nenets name	English translation
• khasrjo-ŋamded"	plants growing on thermokarst lakes
sada-ŋamded"	water sedge *Carex aquatilis* Wahlenb., and other typical mire plants

The lichen names with five elements. The lichen name is connected to a place name *yara* (a sandy place), *ninja* (on), *khasuj-yara-ninja-wadjurta-njada* (lichen growing on dry sandy *wadjurta* (usually growing), and *njada* (lichen). In this way, ground) consists of five words, where the adjective *khasuj* (dry) the name relates local botanical characteristics and also a de**Fig. 6.** In summer, the reindeer diet is based on willows and grasses.

Table 7. Defenition of plants.

Nenets name	English translation	Latin name
• kharwkhako	Horsetail	*Equisetum L.*
• kharkhako	Coltsfoot	*Tussilago farfara L.*
• tarenzja	cottongrass	*Eriophorum vaginatum L.*
• nartsoˇ	bogbean or buckbean	*Menyanthes trifoliata L.*
ty-wemnja	reindeer sorrel	*Rumex arcticus Trautv.*

scription of the place that grows in puddles), is where this type of lichen is most common. In the Piuraljskaja tundra, this lichen is mostly known as the *khabarta-njada* (moose lichen), identifying it as to be a forage for forest moose.

All these names indicate a particular type of lichen habitat. For example, *njero'-paŋgkhana-ŋeda-njada* (lichen grows near the willow roots), common to the shrub tundra with willows, has as an identifier the noun *njero* willow (Fig. 5*b*) or *njaŋgdakhana-wadjodana-njada* (lichen, which grows in the moss) has as an identifier the noun *njaŋgd* (moss) (Fig. 5*c*). While *yarej ya* (the sandy hills or the sandy places) are very common at the top of tundra hills.

There is a different description of the lichens that grow on wetlands, like puddles and mires. For example, *sada-njada* (lichen formed from the noun *sada* (a puddle). Another wetland lichen is *yumburad' njada* (lichen that grows near tussocks hummocks lichen), here *yumbor"* is a name of hummocky wet tundra.

Table 1, therefore, shows the importance of naming that includes landscape information as to where herders can find these types of lichens. Such descriptive information about some lichen types also tells about reindeer herders' perception and understanding of the tundra environment. By also giving a geographic description of some places, this provides reindeer herders information about the distribution of specific lichen species in the tundra at a certain season of the year. For example, two types of lichens: *nero-njada* (lichen growing near willows or freckle pelt lichen) are more important for

reindeer in the summer, while *pja-njada* (lichen that grows on trees) (Fig. 5*d*) is an important winter food for reindeer, especially during winters with deep snow or ice on the ground.

Other Nenets names of lichens describe appearance; color; and tell about their seasonality in the reindeer diet.

The term *labas-njada* (ball lichens that grow in groups) is similar to the Nenets phrase *njanj labas* (hunk of bread). While other terms for reindeer lichens give descriptions of leaves and branches. It is composed as *ŋewakata-njada* (lichen with heads tops), with the adjective *ŋewakata* (little-headed) and the noun *njada* (lichen). The term *tyja-njada* (lichen with narrow branches) is composed of the adjective *tyja* (narrow) and the noun *njada* (lichen) (Table 2).

The whiteworm lichen has the Nenets term *tjulisej-njada,* with the adjective *tjulisej* (empty inside); therefore, it was translated from Nenets as (white tube-like lichen). There are also names of lichens with four components, like *mjujdasiljaŋg-parjalakha-njada* (lichen-like in the form of micro tubes) and *nito-ninja-ŋoneda-njada* (lichen that grows together (on top of each other)).

There are three different Nenets words for white reindeer lichen (Table 3). Since these three terms correspond to distinct lichen subspecies with descriptions of seasonal fea

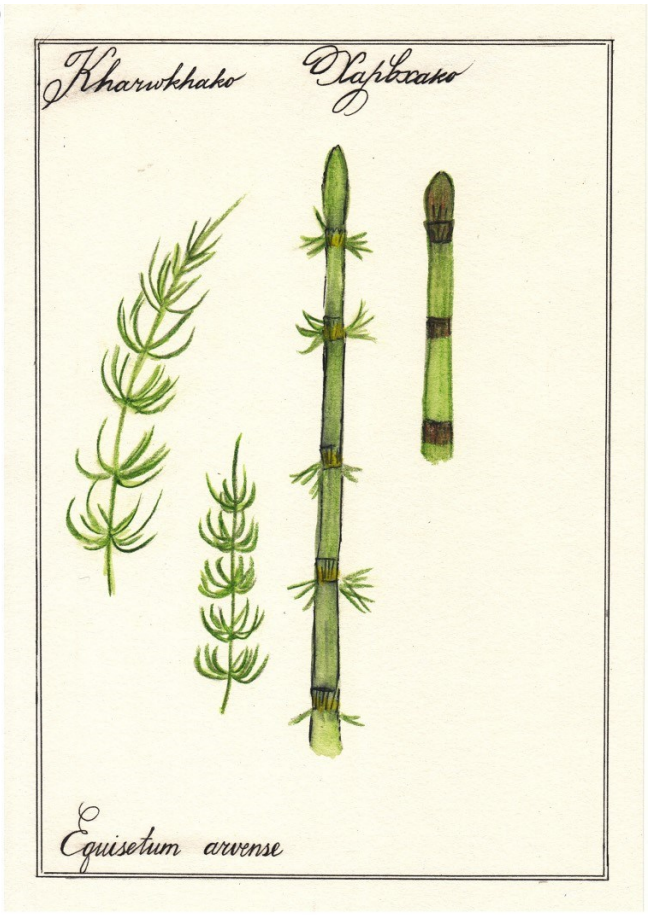


Fig. 7. (*a*) *Kharwkhako,* horsetail, *Equisetum*. (*b*) *Kharkhako,* coltsfoot, *Tussilago farfara* L.

tures. White colored lichens are divided into: (1) *ser"-njada* (white lichen), (2) *ser"-syrei-njada* (white winter lichen), (3) *wul'tse-ser" njada* (extremely white lichen), (4) *ser"-torik-njada* (white low lichen). This table shows that *wul'tse-ser" njada* and *pedarakorakha-njada* can be simply different phenotypes of the same species, i.e., (*C. stellaris*). This explains how Nenets'

Fig. 8. *Nartso,˘* buckbean*, Menyanthes trifoliata.*

Table 8. The nenets names for berries.

Nenets name	English translation	Latin name
•*ŋodja*	berry	
• *lamduj*	Arctic blueberry	*Vaccinium uliginosum* L.
• *tosalja*	black crowberry	*Empetrum L. sp.*
• *yensdej*	lingonberry	*Vaccinium vitis-idaea* L.
• *le"mor'-ŋodja*	arctic raspberry	*Rubus arcticus* L.
maraŋga	cloudberry	*Rubus chamaemorus* L.

language captures variations in appearance within the same species.

The necessity for Nenets reindeer herders to identify different colors is based mostly on the importance of identifying their growing locations, describing the quality of the reindeer pastures, and for calculating how long the reindeer herd can stay there.

Black color is in the names of *paridenja-njada* (black reindeer lichen) and *paridenja-ŋewa-tar"lakha-syrej-njada* (winter lichen that is like dark hair).

The term for *padjararka-njada* (greenish lichen) is composed of the adjective *padjarakha* (the color of bile or green) and the noun *njada* (lichen). The same is with the term *njarm-njada*: it is also composed of the adjective *njarm* (redness, reddish (color)) and the noun *njada* (lichen). So, we can translate it as "red reindeer lichen". There is also *parakhej-njada* (grey lichen that looks burnt), it is composed in the same way: the adjective *parakhej* (burned) and the noun *njada* (lichen). Definition of the lichen by similarity with something else (Table 4).

1) Reindeer lichen which has a similarity with reindeer antlers *ty'-lambejrakha-njada* (reindeer antlers-like lichen) has another name *syrej-njada* (winter-lichen) (*Cladonia arbuscula*), which identifies the seasonal use of this reindeer lichen in winter, when reindeer mostly graze in the tundra-forest area known as *pedara.*

2) There is a term for reindeer lichens which have a similarity to tree branches-*pedarakorakha-njada* (lichen that looks like small trees in the forest), composed from the adjective *pedarakorakha* (like a small forest).

3) The term *parjalakha-njada* is composed of the adjective *parjalakha* (looking like a storage for food, made from poles), whereby *parja* is a storage for food, made from poles. At the same time, there is another word for the same lichen—— *ilebtsja-njada* (wild reindeer lichen).

4) There is a reindeer lichen name with three component terms for wild reindeer lichen *somboj-warawrakha-njada* (beautiful fibrous lichen that looks like *waraw*), where *waraw* is a word for the fiber made from the birch trees.

This intricate way of naming lichens mirrors Nenets reindeer herders' knowledge of their environment: the names for the lichens not only include information on the shape and form of a lichen, but also their ecology and seasonality in reindeer herding work. Experienced Nenets herders know each of the Nenet names for lichens, which give indications of the quality of reindeer herding grounds and pastures. Also, we noticed that some lichen terms identify their seasonal importance in reindeer herding work. For instance, *syrej njada* is specified as winter lichen (*Cladonia arbuscula*), while *ser"-njada* is identified only as white lichen (*Cladonia rangiferina*), and *ser"-syrej-njada* is described as white winter lichen (*Cladonia portentosa*). There are lichen names that are common in the forest areas, like *ty'-lambejrakha-njada* (reindeer antlers like lichen) or *syrej-njada* (winter lichen) (*Cladonia arbuscula*).

In addition, lichens that grow on tree trunks and branches play an important role in reindeer nutrition (Fig. 5*d*). Their role is especially important during periods of icing, which are called *salaba* in Nenets (Laptander 2023). During icing events on the tundra, if animals do not have any access to food on the surface, they may die from starvation after a few days. However, if a herd is moved to the forest-tundra *pedara* where there is some lichen on the trees, animals may survive. By eating tree lichens, reindeer spend less energy than when digging up terrestrial lichens from under the snow. As soon as the weather becomes warmer or the first snow patches melt, reindeer gain better access to the food on the ground, and usually recover quickly.

From this point of view, this knowledge of the tundra landscape and seasonality of tundra lichens and plants is akin to a detailed "manual" for carrying out successful reindeer herding work, which is passed down from generation to generation orally and only in the native Nenets language. These days, many of these reindeer lichen names are not familiar to young Nenets people who herd reindeer. They mostly know the general name for the reindeer lichen *njada*. Moreover, our research reveals the important connection that the Nenets language makes between practice on the land and the description of its features, when names for reindeer lichens are based on the description of their habitat. We indicated that most names of lichens can be divided into three groups: (1) they indicate places where they grow in the tundra: either near shrubs, sand or mires or describe the quality of the pasture ground if it is dry or wet. (2) appearance (e.g., with many thin branches, color (e.g., white lichen) and relation (e.g., looks like forest) is part of the plant classification. (3) seasonality of the reindeer diet: lichens are the primary winter feed for reindeer in winter; therefore, it is very significant to also have their description of appearances and growing sites in the tundra and the tundra-forest areas. This information is integrated into the very names of the lichens, which differs from the taxonomic nomenclature of lichens and vascular plants. This feature of the Nenets language can be explained by the needs of the reindeer herding culture.

Names for tundra grasses and flowers

In Nenets a name for all graminoids, encompassing both grasses and sedges is *ŋum"* (*Gramineae*). All other herbs and almost all flowers are called *ŋamde"(d)*. The paucity of flower and herb names can be related to the relatively short and very intensive summer period in the arctic tundra *taŋy"* and extremely hot days *yepdja*, when graminoids bloom for less than a month. Perhaps this can be one of the explanations as to why in the Nenets language there are not so many words for tundra plants and flowers (Table 5).

For example, *ŋuwtsja* (a little grass) is a short grass that stays green all winter. However, *ŋum"* together with *ŋamded"* (flowers), is a name for all different types of tundra plants, which relate information about: (1) growing location; (2) description of appearance; and (3) definition of plants by similarity.

Table 6 gives names of plants growing on thermokarst lakes. They are called *khasrjo-ŋamded"*. This term for such plants is composed of the two nouns *khasrjo* (a thermokarst lake) and *ŋamded"* (flower, grass). The same is the case for the Nenets term for water sedges and other typical mire plants *sada-ŋamded,"* composed of the two nouns *sada* (puddle) and *ŋamded"* (flower, grass). (a) The flora and terminology of the Yamal tundra wetlands, called mires, was well developed in Soviet times and in Western countries as well, especially in Finland (Botch and Masing 1983; Forbes 2005*a*; Forbes 2005*b*). In addition to *C. aquatilis*, other graminoids prevalent in the mires of Yamal (Fig. 6) include the sedges **Fig. 9.** (*a*) *Yensdej,* lingonberry, *Vaccinium vitis-idaea* L. (*b*) *Maraŋga,* cloudberry, and *Rubus chamaemorus* L.

Table 9. Names for trees and shrubs.

Nenets names	English translation	Latin name
• *njero*	willow	*Salix glauca* L.
• *narjana-njero*	red willow	*Salix lanata* L.
• *njerka*	willow	*Salix arctica* Pall.
pjuŋg	dwarf birch	*Betula nana* L.
•		

Eriophorum vaginatum, E. angustifolium, and *E. scheuchzeri*, and the grass *Dupontia fisheri* (Botch et al. 1971; Botch and Masing 1983).

In Table 7 the names for the plants (Fig. 7) *kharwkhako* (a) and *kharkhako* (b) are based on their description of similarity: horsetail *kharwkhako or khawrakha-ŋamded* can be translated as (a plant that looks like a small larch tree) and coltsfoot *kharkha-ŋamded* is translated from Nenets as (a plant in a form of a small ear). There is also cotton grass *tarenzja* (furry or fluffy plant), which reindeer eat from early spring until late autumn. Even in winter, reindeer can gain access to it by digging old leaves and rhizomes out of the snow. *Ty-wemnja* (reindeer sorrel) and *nartsoˇ* (buckbean) are described as the most preferred and favorite reindeer food. Reindeer love *nartsoˇ* so much that reindeer herders call it "reindeer candy" in Nenets. Here is the Nenets description of *nartsoˇ* (Fig. 8): *«Look at this plant——it is a good food for reindeer. Nartso is the best reindeer food!ˇ This plant grows only in wet places. If reindeer and calves eat it, they become healthy and strong enough to survive cold winters»* (Field material).

Berries in the reindeer diet

A general name for berries is *ŋodja* (Table 8). *Maraŋga* (cloudberry) *(Rubus chamaemorus* L.*), lamduj* (Arctic blueberry) (*Vaccinium uliginosum* L.), *yensdej* (lingonberry) *(Vaccinium vitis-idaea* L.) and *tosalja* (black crowberry) *(Empetrum nigrum* L.) have their own names (Fig. 9).

Almost all tundra berries are part of the reindeer diet. Black crowberry or crowberry *tosalja* is common in shrub habitats, open muskegs, and shorelines. Lingonberry grows in diverse habitats on the arctic tundra. Actually, there are three different Nenets names for lingonberries. In the south of the Yamal peninsula the Nenets call it *yensdej,* in the middle it is called *njarjana-ngodja* (red berry), and in the north in the Tambej and Sabetta areas its local name is *khorki-ngodja* [ptarmigans berry].

It is interesting, that the Arctic raspberry's Nenets name *le"mor'-ŋodja* literally translates as little birds' berries.

Cloudberry *maraŋga* grows in black spruce bogs, moist tundra, and shrub dominated habitat. Usually reindeer eat cloudberry leaves *maraŋga weba"* but also cloudberry branches and roots *maraŋga paŋg,* and even the berries *maraŋga sew,"* literally translated as eyes of the cloudberry.

A Nenets name for all trees and shrubs is *pja.* Here, we will describe the Nenets names for the shrubs and tundra trees, which are part of the reindeer diet (Table 9).

Leaves and shrubs are a favored food of reindeer. Reindeer start to eat soft and new leaves as soon as they appear in spring. They are also part of the reindeer diet all summer and autumn. In the Yamal tundra, there are two different species of willows. The first willow *njero*

Names for mushrooms

The Nenets name for mushrooms *tudako* (a species of fungi within the genus *Boletus*) can be connected to the term for reindeer white fat *tud*." Mushrooms are considered to be a fattening food for reindeer.

Table 10. Nenets names for reindeer pastures.

Nenets name for reindeer pastures	English translation
• *khado*	reindeer pasture
• *khadylawa*	pasture where reindeer always graze
• *khadyrtsj-meta-ya*	territory which is used as a reindeer pasture
• *njadej-ya*	territory with lichens
• *takhabej-ya*	broken ground
• *njarm*	reindeer pasture without lichen
• *yara*	sandy place
• *labtsasj-ya*	broken pastures
• *labta*	low tundra
khasrjo	a thermokarst lake, covered with grasses and sedges, until it begins to thaw
•	

Fig. 10. Near the Kara Sea the Nenets herders celebrate the turning point of the migration route.

(*Salix glauca* L.) is the most important forage for reindeer in summer. It is adapted to survive in Arctic conditions, specifically in the tundra. The leaves of willow, *njero weba,"* are an important food source for several Arctic animals. There is also a red willow *narjananjero (Salix lanata* L.), which has a small red border around the leaves and the veins of the leaves are also sometimes red, and they also do not have a white dusty coating like the ordinary willow *njero* leaves. It is also different from another sort of willow, *njerk*a (*Salix arctica* Pall.), which is much taller and grows near river banks. Dwarf birch *pjuŋg* (*Betula nana* L.) is native to the Arctic and other cool temperate regions of the Arctic Siberia. It is very common on the Yamal peninsula. This shrub is also part of the reindeer diet, especially in early summer.

Nenets herders traditionally do not eat mushrooms, since they always considered it to be the best food for reindeer (Khomich 1995:104). Even Yamal nomads believe that mushrooms are especially important for reindeer in autumn when they switch from a green diet toward lichens. However, this is effective only when mushrooms are abundant. When the mushroom season is poor and when there are few mushrooms of the *Leccinum* species, reindeer may expend a lot of energy running in search of these mushrooms. In those cases, they may lose even more weight than they would gain from eating them.

All reindeer herders described September, the mushroom's growing season, as the most difficult period of their work with reindeer since it is especially difficult to collect a herd in cold and rainy autumn weather. Additionally, in interviews, Yamal reindeer herders mentioned invasive types of mushrooms in the tundra. This information is based on interviews collected for the CHARTER project in the summer of 2021 from one female and one male reindeer

herder from the Laborowskaja tundra. These herders noted that after eating such mushrooms, animals can behave differently: they become extremely weak and do not have enough energy to pull sledges during migrations. The worst thing is that after eating such mushrooms, the reindeer may even die.

The names for different pastures and their quality

Even though domesticated reindeer get their food from the ground themselves, reindeer and people cooperate in their search for the best grazing sites on the tundra, which are called *khadyrtsj meta ya* (a place that is used as a reindeer pasture). The word *ya* is a name for land and for soil. A pasture trampled by a reindeer herd is called *takhabej ya* (broken pastures or broken ground) where the first word, *takhabej* means broken. While *khadyrtsj meta ya* defines a land where reindeer graze. Another word *khadylawa* (reindeer pasture) comes from the verb *khadyrtsj* (to graze). *Njadej ya* is the name for a tundra landscape with lichens. The word *khado* or *ty" khado* is another term for a reindeer pasture. The pastureland or a reindeer pasture without lichen is called *njarm*. There is also *yara* (a high sandy hill in the tundra or a sandy place). Usually, such places in the tundra do not have lichens (Table 10).

A low damp land, valley, where reindeer graze in summer is called *labta*. It is usually rich with lichens and other plants, including shrubs. Old thermokarst lakes, covered with grasses and sedges or tundra lakes - *khasrjo,* are very attractive to reindeer in spring, summer, and also autumn because the rich green food that grows there is an important component of the reindeer diet. Reindeer like to eat aquatic plants there. At the same time, there is also a special type of long aquatic sedge which is named *soir" (Carex aquatilis),* but it is very different from *edej ŋum"* which is translates literally as new grasses. Reindeer herders use this word *edej* for identifying every new species of plants that is not common in the tundra.

This corresponds to different life history stages within *C. aquatilis.* The new shoots that grow either early in the summer, or soon after being grazed/trampled, are different from later growth, either later in summer or some weeks after grazing/trampling, when the shoots can grow very tall in wet habitats.

The Nenets knowledge of the tundra environment and landscape reflects the nature in which they live and migrate. The Nenets seasonal migrations from the winter to summer pastures start from the early spring time, since they need to move their herds to the north, which are the traditional calving places. After a few weeks of rest, which can also mean less frequent or less long daily migration trips, they continue toward the Kara Sea (Fig. 10).

Those herders who reach the shore of the Kara Sea after migrating for up to 600 km gather to celebrate the turning point in their annual route. Usually, it coincides with the celebration of the Nenets midsummer day *ta" erj" yalja* on the second day of August and the peak of the cloudberry season *maraŋga yol'tsj*, which adds an additional delicacy to the picnic table. It is a most pleasurable time for people as well as for their reindeer. Even during *yepdja*–a period with very hot summer days in the middle of July–it is always cool near the Kara Sea: it is windy and there are fewer mosquitoes there. The grass and other plants there are brackish (have a taste of sea salt). Therefore, according to reindeer herders, all reindeer food near the sea is supposed to be extremely healthy and good for reindeer: the wind blows salty moisture onto the pastures, which makes them tasty. Hence, reindeer appetite increases, and as a result they gain weight more easily, which is important for reindeer survival in autumn, winter, and spring. It is also beneficial to the economic interests of herders as it may increase their income in the autumn slaughtering period when the meat is sold.

Discussion and conclusions

The context of the tundra environment and landscape to each other is such that we can see in the Nenets way of naming plants how it stands in contrast to the scientific taxonomy of genus and species, which takes plants out of their context, isolates them from their environment, abstracts them, and makes them "fit" for being conserved in vitrines or herbaria in storage halls. The Nenets way of naming plants is thus a beautiful example of what Ingold (2004) has argued to be a fundamentally important quality of humanity altogether—— not just of Indigenous people: relational thinking. In this meaning, any organism, here in our example plants and lichens is not a "discrete, pre-specified entity but …a particular locus of growth and development within a continuous field of relationships" (Ingold 2004:219).

We can therefore suggest that Nenets traditional ethnobotanical knowledge about reindeer lichens and plants names is important not only in the context of reindeer herding work, and their significant value in the Nenets culture, embedded in their traditional knowledge and language, but also as a powerful reminder of the added value of relational thinking, and what we lose if we restrict ourselves to a mere description of things or beings in abstract and discrete terms.

Like many other Indigenous peoples in the Arctic, Nenets reindeer herders have reported that climate change is seriously affecting their lives. In interviews reindeer herders said that this had a significant effect on migrations, herding, and ways of being in the tundra landscape. The expansion of industrial infrastructure in their areas has resulted in an increased scarcity of pastures which further exacerbates this phenomenon. This has led to a concentration of reindeer herds on pasture "bottle necks" on migration routes (Degteva and Nellemann 2013).

Natural gas is considered by the Nenets to be an essential basis for the earth's energy and the fertility of the tundra (Laptander 2020). As has been mentioned before, this is based on the Nenets animistic attitudes toward the tundra and its nature. Nenets herders gave their own explanations about recent changes in the tundra. One explanation is that when gas and oil workers started drilling in the frozen ground of the tundra for extracting oil and gas, they also hastened the thawing of the permafrost (Laptander 2023). The Nenets believe that natural gas *ya'-ind*": *ya* (earth) and *ind*" (breath) is the breath the earth. Therefore, tundra people consider that the degradation of some lichen cover on pastures to be not only because of their reindeer, but also due to industrial activities.

The perceptions of the Nenets reindeer herders are consistent with ecological studies showing declining or even disappearing lichens (Gorbunova et al. 2023). Lichen decline represents a pan-arctic phenomenon documented also in north Europe (Vuorinen et al. 2017) and America (Joly et al. 2009). In the western Arctic too, in addition to climate change, lichens as well as underlying soils are affected by air pollution (Ji et al. 2019). The reliance of lichens on atmospheric

moisture and nutrients makes them vulnerable to drying, because drought not only reduces lichens growth directly but also increases its susceptibility to trampling by reindeer (Heggenes et al. 2017; Crate et al. 2017). In recent years, more tundra lakes and small tundra rivers have disappeared in the Yamal tundra due to permafrost thaw (von Baeckmann et al. 2022). Obviously, when some types of plants or lichens disappear from the tundra, people stop using their names. At the same time, more invasive plants have recently appeared on the Yamal tundra. Consequently, Nenets reindeer herders do not (yet) have names for them and they seem to be uncertain if these new plants are good for their reindeer or not. Language loss is undoubtedly a serious global problem (Grenoble and Waley 1998; Harrison 2007), which is being accompanied by a reduction of our planet's diversity in many spheres, including biodiversity and religious and cultural diversity.

On the other hand, fieldwork with relational thinkers such as Nenets nomads also shows us that focusing on the comparison of distinct entities such as the presence or absence of lichens means that we may not detect a culture's capacity to adapt. Herders know that reindeer can also change their dietary habits toward a diet with reduced lichens, as we have been observing in multiple field seasons in winter in the northernmost Yamal tundra (Tambej area), where reindeer feed on pastures with very little lichen. While this will not change the value that herders ascribe to lichens, it at least means that the (hopefully temporary) disappearance of some vegetation from the tundra will not mean the end of nomadic reindeer herding as a livelihood, nor of Nenets as a language rich in relational thinking, which is an important contribution to humanity's cultural heritage.

Summarizing the above, in this work we showed that the Nenets ethnobotanical system of naming plants includes multiple ways of knowing that reveal not only the "what" but describe a plant from different perspectives to identify its habitat, in a striking divergence from western taxonomic practices. For example, it is common in many world languages that plant names can be a single word (single-lexeme names), while other plant names are complex and combine a modifier and a generic name of a plant (Berlin 1973; Legère 2009; Soldal et al. 2023). In the collection of Nenets lichens and plant terminology, one can see that vernacular plant classifications and landscape terms are tied to a deep knowledge of the tundra landscape. However, in the case of Nenets terminologies, these names are not always represented as single-lexemes. Mostly as demonstrated by the example of lichens——all their names are rather descriptive, and this actually facilitates their translation into European languages. From this point of view, this knowledge of the tundra landscape and tundra lichens and plants can be recognized as equal to professional working instructions for carrying out successful reindeer herding work, which are passed down from generation to generation orally and only in the native Nenets language. Additionally, we noticed that some of the lichen and plant names are used across the whole territory of our field work areas, while some of these words are used only at a local level by individual Nenets reindeer herders. Our findings also show that the Nenets' ethnoecological knowledge about the tundra is fundamental, epistemological, and rational. It is reflected in the Nenets religion——traditional beliefs about the respectful attitude of humans toward the spirits and custodians of the tundra. This also represents the Nenets individual and collective knowledge about the Arctic tundra and the environment in which they live and work.

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Data availability

Data are available upon reasonable request to the corresponding author. Access to interview transcripts or recordings will require informants' approval.

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The authors declare there are no competing interests.

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