

AD-A039 152

COLD REGIONS RESEARCH AND ENGINEERING LAB HANOVER N H F/G 8/12
POLAR DESERTS OF THE TAIMYR PENINSULA (POLIARNYE PUSTYNI POLUOS--ETC(U)
APR 77 N V MATVEYEVA, Y I CHERNOV
CRREL-TL-622

UNCLASSIFIED

NL

1 OF 1
ADA039 152



END
DATE
FILMED
6-77

TL 622



Draft Translation 622

April 1977

12
new

POLAR DESERTS OF THE TAIMYR PENINSULA

N.V. Matveyeva and Yu.I. Chernov

AD A 039 152

DDC
MAY 10 1977
C

AD No. _____
DDC FILE COPY.

CORPS OF ENGINEERS, U.S. ARMY
COLD REGIONS RESEARCH AND ENGINEERING LABORATORY
HANOVER, NEW HAMPSHIRE

cont
for 1473A

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

and isolation of plants growing in the turf, slowness of the decomposition process, absence of peat accumulation, concentration of life in the narrow band near the surface of the ground, a tendency towards reduction in size of the species of animals and plants, the replacement of large forms by smaller forms, the formation of cushioned forms in plants, especially in mosses and lichens. A characteristic feature is also the absence of intrazonal grouping, especially mixed grass and grassy meadows. On the basis of the data obtained, the Chelyuskin region belongs to the polar desert zone, the southern boundary of which apparently runs through Taimyr at the 77° latitude.

deg N

1473 B



SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

14 CRREL-TL-622

DRAFT TRANSLATION 622

ACCESSIONING FOR	
NTIS	Write Section <input checked="" type="checkbox"/>
DDC	Bufi Section <input type="checkbox"/>
UNANNOUNCED	<input type="checkbox"/>
JUSTIFICATION	
BY	
DISTRIBUTION/AVAILABILITY CODES	
DIST.	AVAIL. and/or SPECIAL
A	

6

ENGLISH TITLE: POLAR DESERTS OF THE TAIMYR PENINSULA

FOREIGN TITLE: (POLIARNYE PUSTYNI POLUOSTROVA TAIMYR)

10

AUTHOR: N.V. Matveyeva and Yu.I. Chernov

21

Draft trans. of

SOURCE: ~~Moscow~~ Botanical Journal, 1976, vol. v61, n3, p. 297-312, 1976, Jnl. (USSR)

by Rosetta Stone.

CRREL BIBLIOGRAPHY
ACCESSIONING NO.: 30-4095

11 apr 77

12 36p.

Translated by Rosetta Stone, Nashua, N.H. for U.S. Army Cold Regions Research and Engineering Laboratory, 1977, 32p.

NOTICE

The contents of this publication have been translated as presented in the original text. No attempt has been made to verify the accuracy of any statement contained herein. This translation is published with a minimum of copy editing and graphics preparation in order to expedite the dissemination of information. Requests for additional copies of this document should be addressed to the Defense Documentation Center, Cameron Station, Alexandria, Virginia 22314.

037100 #

USSR ACADEMY OF SCIENCES

HERALD OF THE USSR ACADEMY OF SCIENCES

(Reprint)

10

Moscow - 1976

N. V. Matveyeva, Yu. I. Chernov

POLAR DESERTS OF THE TAIMYR PENINSULA

This article gives the characteristics of the natural conditions, the composition in terms of flora and fauna, and the vertical and horizontal structure of the communities in the northernmost point of Eurasia - Chelyuskin Cape. In comparison with the tundra zone, there is noted a sharp impoverishment of flora and fauna in all groups, especially flowers, birds and mammals, and also a change of dominance in the growth cover and in the animal population. The basic features of the communities are a very rarified cover, the fractionation and isolation of plants growing in the turf, slowness of the decomposition process, absence of peat accumulation, concentration of life in the narrow band near the surface of the ground, a tendency towards reduction in size of the species of animals and plants, the replacement of large forms by smaller forms, the formation of cushioned forms in plants, especially in mosses and lichens. A characteristic feature is also the absence of intrazonal grouping, especially mixed grass and grassy meadows. On the basis of the data obtained, the Chelyuskin region belongs to the polar desert zone, the southern boundary of which apparently runs through Taimyr at the 77° latitude.

General Characteristics of the Area Studied

The Taimyr Peninsula extends far to the north. On it is the northernmost point of mainland on our planet - Cape Chelyuskin

(77°43' northern latitude). The northernmost part of Taimyr - the Chelyuskin peninsula - extends far into the sea. Its sea borders exceed those of the land by several times; therefore its position approaches that of an island. It is not surprising that in terms of climatic conditions this region is closer to those of the islands in the Arctic Ocean than to those of the mainland part of Taimyr.

The climatic conditions in the region of Cape Chelyuskin are extremely severe. The growing season here is limited to two months. Only in July and August are there positive mean monthly temperatures (1.5° and 0.8°) (Fig. 1), but during this time there are days with negative mean diurnal temperatures, especially in the latter half of August. The mean annual humidity of the air is 87%, while in the summer months it is 90-94%. Cloudy weather prevails and the summers are very often foggy.

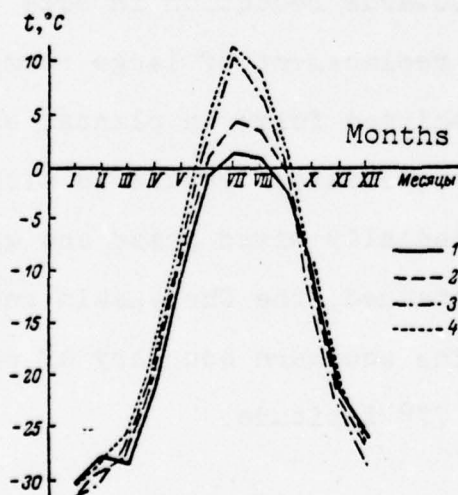


Fig. 1. Average temperature for every month.
 1 - Polar deserts zones (Cape Chelyuskin)
 2 - Arctic Tundra subzone (Mariya Pronchishchevaya's Bay)
 3 - Typical Tundra subzones (Tareya)
 4 - Subzone of Tundra brushwoods (Kresty)

The total annual precipitation is 200 mm. Snow lies on the ground until the first decade of July and completely melts during the summer. Snowflakes remain only rarely under cliffs in ravines formed by rivers. A blanket of snow is formed in the latter half of September, and more rarely in the first half. The average depth to which the frozen ground melts is 40 cm. Melting of the soil begins at the beginning of July and reaches a maximum at the beginning of August.

The mean daily temperature of the surface of the soil is higher than that of the air by 1 to 2 degrees. Only in the case of a sharp increase for one or two days does the soil not have time to heat up and the temperature at the surface may be equal to or even lower than the temperature of the air. Microclimatic observations for the diurnal course of the temperature have shown that there is an increase during the day and a decrease during the night (Fig. 2).

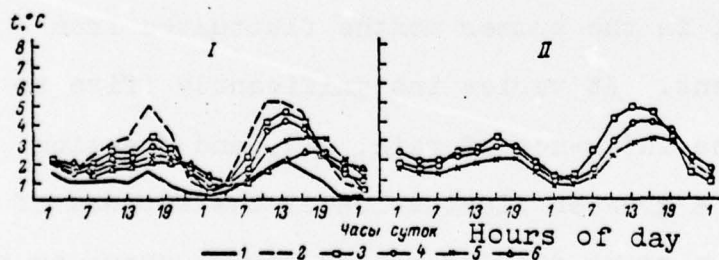


Fig. 2. Temperature changes during the day. (Cape Chelyuskin, July, 1974)

1) air, 2) ground surface, 3) 2 cm. deep, 4) 5 cm. deep, 5) 10 cm. deep, 6) 20 cm. deep.

I - Bare ground

II - Moss soil in a fracture

In the soil the diurnal course of the temperature at a depth of 20 cm is practically constant. It is somewhat more pronounced in the upper levels: the difference between the diurnal and nocturnal temperatures at a depth of two centimeters amounts to 3 to 3.5 degrees and a total of 1 to 1.5 degrees at a depth of 20 cm. The mossy covering has little influence on the diurnal fluctuations of temperatures since here there are only developed isolated mossy plants confined to crevices. The width of the mossy bands of the diameter of the cushions does not exceed 10 cm. They have a pyramid shape and their volume is sharply reduced going down the plant. The temperature in the upper levels of the soil is 1.5 to 2 degrees higher than that of the air in the daytime and 0.5 at night. Thus, the life processes of the roots of flowering plants, of soil invertebrates, and microorganisms which are in the uppermost levels transpire at temperatures of two to four degrees.

The wetness of the soil in the summer months fluctuates from fifteen to twenty percent. It varies insignificantly (five to seven percent) under the influence of rain, fog, and freezing of the soil. There is a greater fluctuation of the wetness of the soil in areas with a great deal of ground cover, where on the whole it is ten percent more than in those areas with a more sparse ground cover.

The research area is located in the vicinity of the Cape Chelyuskin polar station. The station areas are located on the sloping ridge between the valley of the Kunar River and the

seashore. The topography here is represented by ridges of emerging bedrock, the height of which does not exceed ten meters above sea level, alternating with concave segments of quaternary deposits elongated in the meridional direction in the form of bands ten to thirty meters wide. The altitude drop between convex and concave segments is very insignificant and gradual. Most numerous are large fragments and finely fragmented outcrops of argillaceous and calcareous aleurolites. As a result of frost heaves, detritus 0.6-0.8 meters in length crops out vertically. Rarer is the breakdown of quartz veins generally having a circular shape with a diameter of up to 10 meters. There are outcrops of dolomites in the form of narrow strata.

In places where the bedrock crops out there is no fine soil (melkozem); it accumulates only under the cushions of lichens and mosses populating the fissures between rocks. The soil forming rocks are quaternary marine deposits represented by medium and more rarely heavy argillaceous deposits. Soil layers are as a rule not expressed; there is only noted a variation in the wetness (the lower levels are generally wetter), and also in the content of detritus and its size (the quantity increases with an increase in depth). In rare cases, traces of gleying are noticed. Humus coloration is present only in soils which have developed on dolomite outcrops. Since the growth cover does not form a contiguous mantle, a large part of the ground is not at all affected by the soil forming processes. Peat formation is practically absent; it is only to be found where there is a reticulate growth cover - in fissures under mossy sod there is sometimes a slight

peat formation accumulation. Under isolated cushions of mosses there is no peat. Decomposition transpires extremely slowly and the cushion *Rhacomitrium lanuginosum* is found having an age of over one hundred years, on the lower part of which there are well preserved twigs and leaves. The number of roots, even at the surface, is very small; at a depth of up to ten to fifteen centimeters only single roots penetrate. The yearly growth of the ground mass of flowering plants according to our data amounts to a total of three to five grams per square meter. Mosses and lichens are distinguished by a slower growth rate; moreover, there is practically no tearing away of the biomass: they are preserved in the living state for a very long time. The basic mass of soil fauna is concentrated in the upper 2-3 centimeter level. Only nematodes penetrate to ten centimeters.

The reason for the meager soil formation process must be attributed to the absence of a densely contiguous (and often even an intermittently reticulate) growth cover, the low productiveness of plants, the slow tearing away of the biomass, the prolonged life cycles and the slow rate of the life processes of the soil invertebrates, slowness of the decomposition processes, the shortness of the growing season, the insignificant depth of soil thawing, low temperatures -- all of which have a negative effect on the life processes of all organisms.

The most characteristic feature is the widespread polygonal cracking of the ground into regular pentagons and hexagons. Scarcely disrupted by vegetation, they often have rough angles

and vertical fissure walls. The diameter of the polygons is on the average 0.5 meters and more rarely 0.8 to 1.0 meters.

There is also noted a secondary fissuring into irregular polygons of lesser diameter (0.10 - 0.15 meters). As a result of frost selection, fine rubble protrudes out on the surface of the polygons and in the form of flat flakes the rubble covers the polygons by better than 50%. The cracks are very often filled in by such rubble, with practically no admixture of fine earth, and the flakes of rubble are oriented vertically.

Composition of Flora and Fauna and the Role of Various Forms in the Community

The flora in the region is extremely impoverished. We noted forty-six species of flowering¹ plants belonging to twelve families and twenty-two genera. Five leading families (Saxifragaceae - 10 species; Graminaceae - 10; Cruciferae - 6; Caryophyllaceae - 5; Ranunculaceae - 3) make up three-fourths of the species. The remaining seven families are represented by one or two species. The flora consists exclusively of arctic and arctoalpine species predominantly with circum-polar distribution. In the makeup of the growth cover, flowering plants play a very insignificant role, never in the capacity of dominants and very rarely as codominants. More than half of the flora is represented

1. Data about the flora of flowering plants is based on our collections, collections of I. N. Safronova (1973) and some other collectors. (Herbarium is in the V. L. Komarov's Botanical Institute in Leningrad).

by rarely encountered specimens; somewhat more varieties are noted on the southern slopes of streamlet banks. In watershed areas only about ten species comprise the growing community; in terms of phytocenosis significance (covering, abundance, occurrence) the first place is held by representatives from the Gramineae family (Plippsia algida, Deschampsia borealis, Alopecurus alpinus), then the Caryophyllaceae (Cerastium regelii, Stellaria edwardsii) and the Saxifragaceae (Saxifraga oppositifolia, S. Cernua, and S. foliolosa). Of other species of more or less notable occurrence, there are Draba subcapitata, D. oblongata, Papaver radicum, Cardamine bellidifolia, Saxifraga caespitosa, S. rivularis, Eritrichium villosum.

There is a large number of families absent from the local flora, including those playing a significant role throughout all tundra zones. Thus, completely absent are representatives from the families Cyperaceae, Compositae, Scrophulariaceae and Leguminosae; there is only one species representing the family Salicaceae, namely Salix polaris. The same is observed among mosses and lichens; the basic dominants of tundra regions, including also the subzone of arctic tundra (Tomenthypnum nitens, Hylocomium alaskanum, Ptilidium ciliare) give up their positions here. T. nitens and H. alaskanum are encountered as insignificant mixtures; P. ciliare is absent. Only Aulacomnium turgidum retains its activity: in more moist areas it may dominate. The leading position in the composition of plant communities is held by species which in all tundra zones in the Taimyr have a

subordinate significance and are encountered only as admixtures. These are Orthotecium chryseum, Ditrichum flexicaule, Dicranoweisia crispula, Rhacomitrium lanuginosum, Bryum tortifolium, Drepanocladus revolvens. There are almost no water and swamp mosses, and there are no Sphagnaceae. But in spite of the impoverishment of flora, mosses retain the leading position in the composition of the vegetational cover.

The role of lichens is significantly greater than it is in the more southerly regions. In a phytocenosis role they only slightly yield to the mosses; but in individual communities the lichens predominate. The most active are species of the genus Cetraria, such as C. delisei, C. ericetorum, C. laevigata, and C. cucullata. They often form almost pure plant cushions, being attached to the substrate and forming borders along cracks. Noted for their frequent occurrence are Thamnolia vermicularis s.l. (sometimes even communities are formed with this species predominating), Stereocaulon rivulorum, Dactylina ramulosa, Psoroma hypnorum, Sphaerophorus globosus, Parmelia omphalodes. At the same time the species diversity of lichens is small: in one community we counted from seven to twenty species (in a typical tundra subzone there were thirty to forty species). Practically absent are bushy lichens of the Cladonia genus; rarely there are foliate lichens of the genera Nephroma and Peltigera. In contrast with other polar deserts of the Franz Josef Land (Alexandrova, 1969), on Cape Chel-yuskin there is a rather insignificant role played by scale lichens of the Ochrolechia and Pertusaria genera. Only Toninia lobulata

is encountered rather frequently on the bare ground. Dark, slimy lichens with a blue-green phycobiomass (of the Collemataceae and Pannariaceae families) form thin scales which are scarcely noticeable at first glance, reminiscent in outward appearance of algae. They cover the soil with a thin scale which at some time during the summer period may dry up. The upper layer in such areas, especially with sandy and sandy loam soils, is colored green.

One of the most important features of the structure of the growth cover is the tendency of the majority of species to form cushion forms, which is observed here not only in flowering plants but also in plants and lichens. For flowering plants there is very often also a sharp reduction in size. Thus, with Saxifraga cernua, S. oppositifolia, Cerastium regelii, Stellaria edwardsii, Draba oblongata, Eritrichium villosum, the diameter of the cushion does not exceed five centimeters, and the thickness is two to five centimeters. Often floriferous shoots practically do not project out of the surface of the cushion. We noted the formation of practically spherical cushions 10 cm and sometimes 20 cm in diameter and five to ten centimeters high for such mosses as Dicranoweisia crispula, Ditrichum flexicaule, Rhacomitrium lanuginosum; small cushions (3-4 cm in diameter) are formed by Bryum tortifolium and Andreaea rupestris. Even such "lattice" lichens such as Orthothecium chryseum form solid sod in the form of mounds up to five centimeters high in the center. The most sharply defined cushion forming plants of the lichens are Cetraria ericetorum

and C. delisei. They form hemispherical cushions 10-15 cm in diameter and 5-10 cm high, which are almost never attached to the ground, and are easily removed with the most trivial effort. In the center of the base of the cushion there is always a small amount of fine soil, even in cases where they are attached to bare rocks. After an apparently maximum diameter (around 15 cm) is achieved, in the center of the cushion there begins a process of atrophy and a dent is formed at the top. Cushions of smaller sizes are formed by Stereocaulon rivulorum (1-3 cm in diameter and 5-6 cm high), Psoroma hypnorum (1-3 cm in diameter and 1-2 cm high), Dactylina ramulosa (5-6 cm in diameter and 4-5 cm high), Cetraria tilesii (2-3 cm in diameter and 1-2 cm high), and Parmelia omphalodes (2-3 cm in diameter and 1-2 cm high). It is interesting to notice that even Thamnia vermicularis s.l. forms very dense and rather solid accumulations of the pure plant cover type.

The pillow-like spherical shape of growth pattern is a manifestation of the general biological law of surface economy under cold conditions, which, for example, in animals is manifested as a reduction in the projecting parts of the body (Allen's rule). The spherical surface is the smallest possible surface area for a given volume. In this shape the basic mass of the plant is concealed inside the cushion and hidden from the effects of unfavorable outside conditions. When milder temperatures prevail, nutrients are accumulated and soil invertebrates propagate. Species capable of forming cushions flourish and have better viability, which is especially noticeable in mosses.

The animal world of Cape Chelyuskin is very scant. This is especially obvious in the case of birds. In the year of our research in the watershed area there nested a total of two species: the sandpiper Calidris maritima and the snow bunting Plectrophenax nivalis. If we take into consideration that the snow bunting is connected with the stone deposits along the shore, we may consider that here there is a total of one characteristic inhabitant of the zonal community. Besides these two species, in the settlement there nested the white wagtail Motacilla alba, and in the closer bird colonies at the seashore - the ivory seagull Pagophila eburnea, the gull Larus hyperboreus, the silver gull L. argentatus, the kittiwake Rissa tridactyla, the polar tern Sterna paradisea, the short-tailed Stercorarius parasiticus and the long-tailed S. longicaudus skuas. According to indirect data, there should be nesting in this region the white sandpiper Calidris alba and the Icelandic sanderling C. canutus, but we have not found them. (In the most recent research in the Arctic tundra regions, in the Maria Pronchishchevaya Bay, we noted thirty-five species of birds, of which fifteen were typical inhabitants of the zonal communities. Significantly, the marine sandpiper does not nest there.)

Two species of lemmings live on Cape Chelyuskin: the Siberian Lemmus sibiricus and the ungulate Dicrostonyx torquatus; their density is relatively high in spite of the fact that plant cover is sparse and exhibits low productivity. In summer they are confined to rock scatterings, while in winter they are obviously distributed more uniformly, since they utilize the pads of

lichens Cetraria delisei and C. Ericetorum for their nests, gnawing them and turning them into debris. In places they attempt to hollow out borrows, even in rocky, dense, frozen ground, though they more often utilize natural shelters. Lemmings eat practically all species of the local flowering flora: Saxifraga cernua, Cerastium regelii, Papaver spp., Saxifraga oppositifolia, Draba subcapitata; of the grasses they prefer Phippsia algida, and are less likely to eat Deschampsia borealis.

The structure of the invertebrates found here is unique. Such extremely important components of the animal population throughout the entire tundra zone as earthworms (Lumbricidae) and Tipulidae are absent. The absence of Tipula carinifrons -- the most characteristic arctic species of Tipulidae -- is particularly significant (its population in the arctic tundra is especially high in uncovered soil). No spiders or Coleoptera are encountered (ground, rove, and leaf beetles are also common in the arctic tundra). Necrophagous diptera are absent (there are at least 10 species in the arctic tundra of the Taimyr). No Lepidoptera or Hymenoptera are found (nor ichneumons, saw flies, or bumblebees). Oribatidae (armored ticks) are extremely rare, and only a few specimens of them have been found. Their population in the tundra zone sharply drops off from the figures for the forest belt, though they survive there as an important dominant of the complex of microarthropods. (Representatives of some of these groups may inhabit this region and their absence from our samples may be attributed to the extremely severe weather conditions of the year. Thus, complete absence of ichneumon wasps and night moths seems unlikely.)

Four groups of invertebrates (Nematoda, Enchytraeidae, Collembola, and Chironomidae) constitute the basis of the animal population of the soil and moss and lichen sod cover in this region. Parasitic ticks, Trichoceridae, and Mycetophilidae are of lesser importance. Tartigrada are encountered in samples containing nematodes. No data could be obtained on Protozoa. All these groups are taxonomically highly impoverished. Thus, only 11 species of Collembola are found here (there are 62 species in the region of the Tarei), 1 species of Mycetophilidae, and 2 species of Trichoceridae. Land chironomides are relatively variable. At least 10 species with highly unique morphologies are native to the region. However, in spite of the fact that the composition is impoverished, the overall density and biomass of the invertebrates per unit of area is only slightly less, and sometimes even higher, than in more southern regions (and not only in tundra!). The density of Collembola is on the order of 10,000 - 300,000 specimen/m² (20,000 - 40,000 specimen/m² in the subzone of typical tundra in zonal communities and up to 100,000 specimen/m² in meadows). The density of parasitic ticks here is also the same as in the typical tundra subzone (2000 - 5000 specimen/m²). The density of Enchytraeidea under the moss belts and pads is about 3000 - 6000 specimen/m², and in open ground, 200 - 1000 specimen/m² (they do not often attain densities of 1000 specimen/m² in mossy tundra).

The population density of Chironomid larvae, which varies from 50 to 1500 specimen/m² in different biotopes, is even more remarkable. Land chironomides are constantly encountered in more

southern subarctic regions as well, in particular in spots of uncovered ground of mottled tundra. However, they are never encountered in as high a quantity. They are represented here by several unique arctic species with typical image life forms. The wings of some of them are sharply shortened, though prehensile legs -- adaptations clearly suited for life in open land under strong wind conditions -- have effectively developed. As a whole, this group can be considered as an ecological vicariate of the mosquitos and crane flies, which play as great a role and which are represented by analogous life forms in the tundra. However, Tipulidae are among the largest insects in the tundra, while Chironomidae, in view of their size, are best subsumed under the category of meiofauna. Of the class of Oligochaeta, only the small mesophilic forms of Enchytraeidae are native here; large hydrophilic worms and earthworms are absent. Winter and fungus mosquitoes are also represented by very small species. This is without doubt one phenomenon of the general tendency for "miniaturization" of the organic world in the polar deserts, noted above in the case of plants. It is also observed for other groups of invertebrates.

The high density of enchytraeids, collemboles, and chironomids results in a relatively high zoomass, which for certain communities attains 10 g/m^2 , and for isolated microgroupings scaled on the basis of 1 m^2 , is 20 g . This is somewhat higher than in the case of zonal groupings of the typical tundra subzone (Chernov, 1973). However, there the zoomass base is made up of large forms, such as earthworms and tipulide larvae. Therefore, in spite of

the low temperatures, the total metabolism of the animal population in these communities must attain relatively high levels. In addition, such a high biomass is one of the consequences of the low rate of metabolic activity and of the lengthened life cycle, i.e. the result of the accumulation of mass, and not of high productivity.

The chief dominants of the animal population of the polar deserts are groups belonging to the microphages, i.e. subsisting on microscopic soil algae, fungi, and possibly bacteria. This type of food supply is typical for chironomid larvae, many nematodes, and collemboles. Enchytraeids are usually classified as saprophages. Like the earthworms, they are assumed to subsist on decomposed plant debris. Their food supply undoubtedly includes substantial amounts of saprophilic living microorganisms, which they swallow together with plant debris and detritus. In view of the extraordinarily weak processes of organic decomposition and the insignificant amounts of debris from higher plants in polar deserts, we may assume that their food supply is based on quite rich microflora, chiefly algae. In this region aquatic vegetation is practically undeveloped, and both algaeflora and aquatic microfauna are apparently quite scarce in the few and small bodies of water. At the same time algae play a major role in land communities. The composition of the trophic groups of invertebrates is in good agreement with these facts. The maximal population size of chironomides is clearly confined to areas with the greatest abundance of algae. They are particularly numerous under crustose slime lichen mixed with blue-green algae.

The chief dominants of the ground animal population are groups whose evolution is connected with aquatic communities. Thus, in the case of the chironomids the ground life forms as a whole are secondary and are not sharply characteristic phenomena inherent to a small number of species. Meanwhile, aquatic chironomids are absent, whereas ground forms with soil larvae are represented by a relatively large number of species with extremely varied life forms, land chironomids meanwhile maintaining trophic relations with the microflora (particularly algae). All the chief dominants of the collemboles are also indigenous hydrophilous forms. Thus, water-logged habitats are generally typical for most Hypogastruridae, whose representative (the arctic-alpine H. tullbergi) is one of the most massive species. Two other massive forms (Folsomia regularis and Isotoma fenica) in more southern regions, including the tundra, predominantly inhabit water-logged habitats (Anan'eva, 1973).

Enchytraeids are also representatives of families that, on the whole, still interact with the aqueous medium. For example, in the tundra many of them inhabit strongly water-logged biotopes or bodies of water. Only mesophilic forms are encountered in polar desert communities.

Thus, the animal world of the polar deserts exhibits a highly unique phylogenesis. A kind of inversion of aquatic communities to dry land occurs, and it is here that certain specific features of trophic relations characteristic of aquatic biogeocenoses are preserved, in addition to sharp adaptive evolutionary transformations of different taxonomic groups within these communities.

Vertical Structure of Communities

The absence of stratified division is a characteristic feature of the vertical structure of plant communities. (Fig. 3). All organic life is concentrated in the surface layer. The thickness of the moss pads is on the average at most 5 cm. Lichens are either embedded in the moss sod cover or grow in the soil, forming a single layer (by height) with the moss. The height of the flowering plants is so low that they are unable to also form an independent layer. Their vegetative organs penetrate the moss sod cover, while the floriferous shoots are only rarely raised above them. The mean height of the flowering plants, together with their floriferous shoots is 3-4 cm. If a species forms a pad, e.g. Draba oblongata, D. Subcapitata, Eritrichium villosum, and Saxifraga oppositifolia, the floriferous shoots do not extend beyond them and the blossoms are found directly on the surface of the ground layer. The maximal length of the floriferous shoots occurs in the case of poppies (6-8 cm), but they usually are wound around ground warmer than the air, and only the blossoms are slightly raised. The floriferous shoots of the grasses Deschampsia borealis and Alopecurus alpinus may reach somewhat greater heights (up to 10 cm) in favorable years.

Since herbage as such is not expressed, the entire complex of herbal invertebrates is lacking, and there are no anthophylls.

The roots are concentrated in the moss sod cover at the very surface of the ground, and only a few of them reach depths of 10-15 cm. The bulk of the soil invertebrates (Enchytraeidae, mosquito and collembola larvae) are concentrated in the 0-2 cm

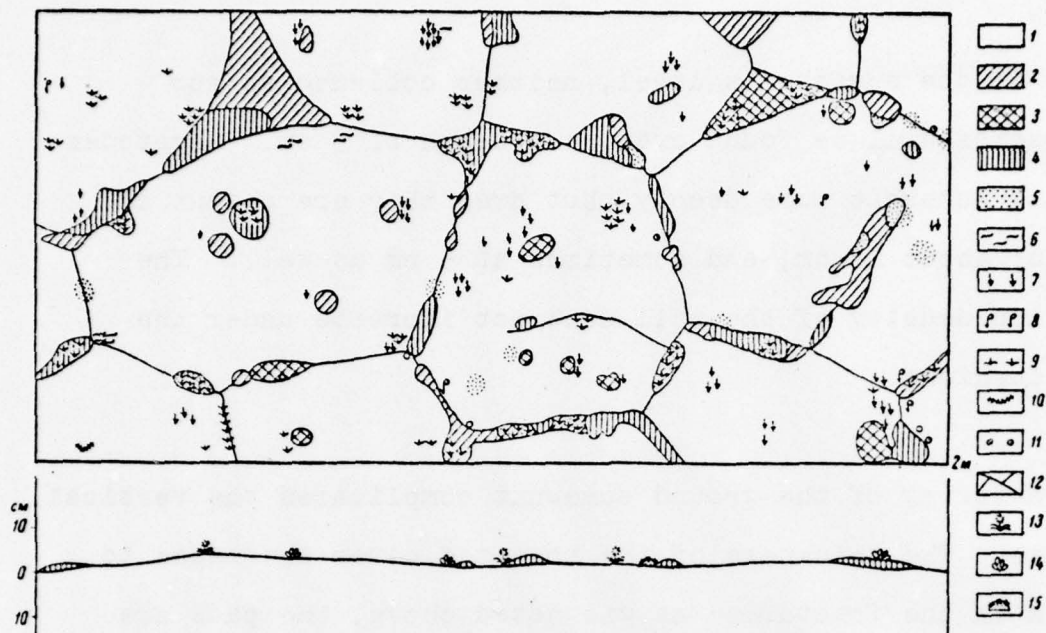


Fig. 3. Vertical and horizontal structures of desert-type lichen-moss community. Horizontal projection (1 x 2 m), vertical profile (1:10). 1) uncovered soil with detritus; 2) Aulacomnium turgidum; 3) Bryum tortifolium; 4) Orthotecium strictum; 5) Psoroma hypnorum; 6) Thamnolia vermicularis; 7) Phippsia algida; 8) Saxifraga cernua; 9) Cerastium regellii; 10) Stellaria edwardsii; 11) Draba sp.; 12) fractures filled with detritus; 13) Phippsia algida; 14) Cerastium regellii; 15) Draba sp.

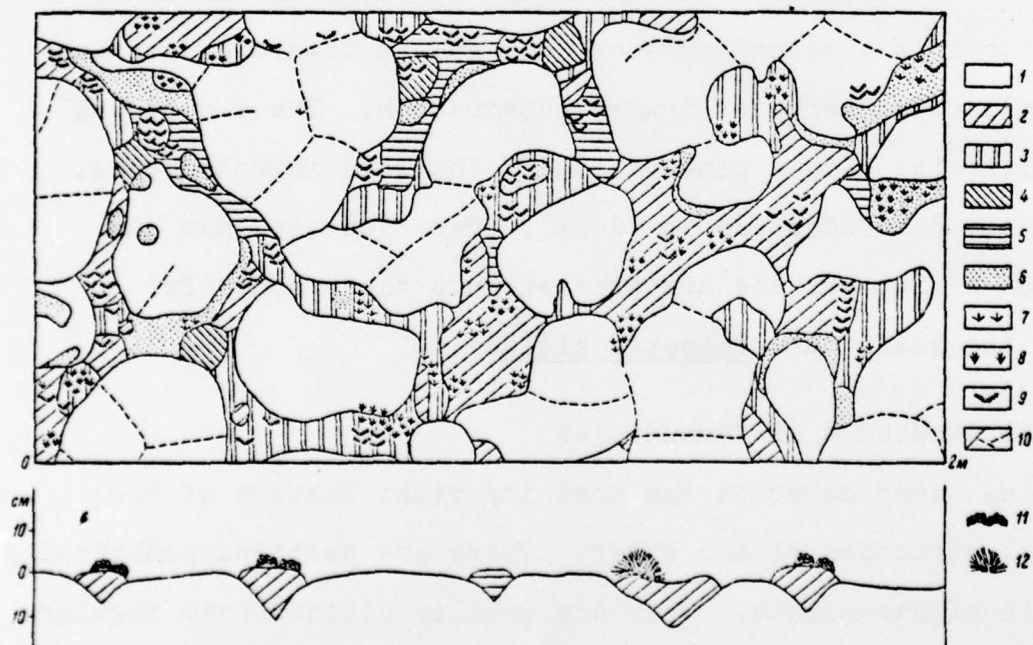


Fig. 4. Vertical and horizontal structures of tundra-type lichen-moss community. Horizontal projection (1 x 2 m), vertical profile (1:10). 1) uncovered soil; 2) Aulacomnium turgidum; 3) Racomitrium lanuginosum; 4) Polytrichum sp.; 5) Tomenthypnum nitens; 6) Psoroma hypnorum; 7) Cerastium regellii; 8) Deschampsia borealis; 9) Stellaria edwardsii; 10) fractures filled with detritus; 11) Stellaria edwardsii; 12) Deschampsia borealis.

layer. If the surface is level, neither collemboles nor enchytraeids will be found even at a depth of 3 cm. Nematodes penetrate somewhat more deeply, but even they are absent at depths of about 10 cm, and sometimes at 5 cm as well. The population density of the soil does not increase under the lichen cushions.

The fracturing of the ground somewhat complicates the vertical structure. The thickness of the moss sod cover increases to 10-15 cm in the fractures; as was noted above, the pads are pyramidal in shape, sharply contracted downward, like a wedge in the fracture (Fig. 4). The flowering plants inhabiting these mossy fractures do not rise above the sod cover, though the latter penetrates not only their roots, but the pedicels and even the leaves as well. The thickness of the plant cover in the fractures is somewhat greater, not due to upward growth but rather as a consequence of inward penetration. The fracturing also facilitates deeper penetration of the soil invertebrates, particularly nematodes (up to 10 cm). Rare species that can survive on a flat surface are pressed onto the ground (for example, the small mats Phippsia algida).

Horizontal Structure of Communities

A broken up plant cover is the most important feature of the horizontal structure of the cover. There are sections practically lacking in higher plants. They are usually divided into regular polygons with planar or slightly convex surfaces. However, sections of these polar deserts can only be formally said to be

uncovered ground. In fact, these areas are highly active and saturated communities with characteristic coenotypic relations. Their surface is covered as a rule with algae. Isolated flowering plants and Bryophyta forming small pads or slightly convex surfaces inhabit the more advanced stages of development of polygonal deserts. The mats P. algida settle on the surface of the polygons, while mossy and lichen sods are often confined to the fractures and, especially, polygon corners. The plant cover does not form closed limbs about the polygons; these limbs are usually narrow broken bands extending in places like fractures (Fig. 5).

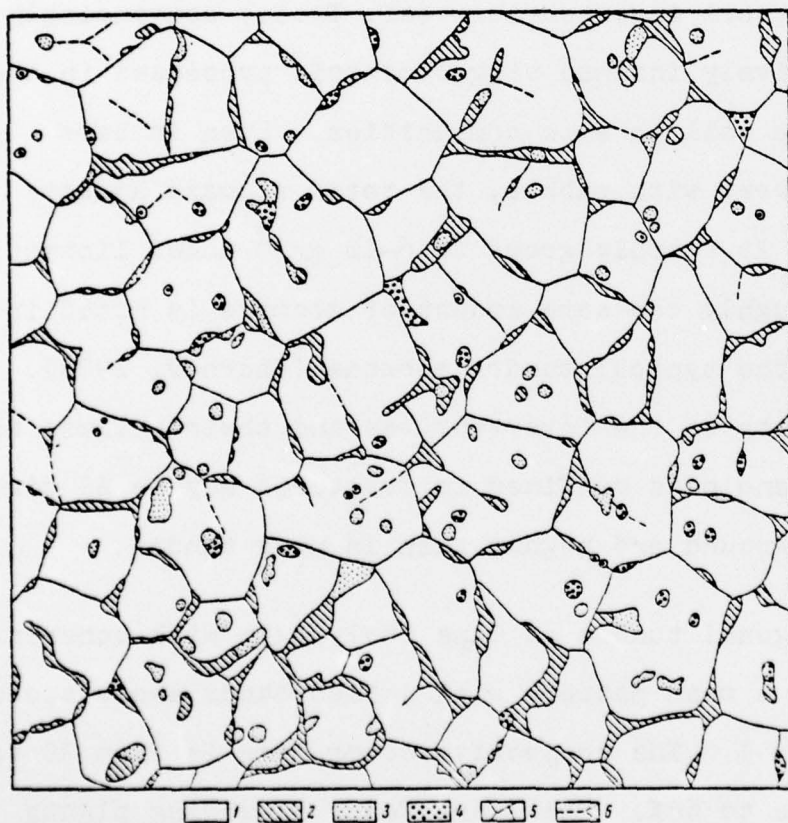


Fig. 5. Horizontal structure of desert-type lichen-moss community (polygons 40-50 cm in diameter). Area 5 x 5 m in size. 1) uncovered soil; 2) Bryophyta; 3) lichen; 4) Flowering plants; 5) frost clefts; 6) exfoliation joints in polygons.

As a result of the tendency noted above for the plants to form pads, the bands have a sharply defined character, since they are formed by the contiguous floral beds and cushions, the boundary between which is usually quite noticeable. The width of the bands of plant cover is 1, 2, or 3 cm, and its depth, at most 1-2 cm. When the moss sod cover expands, it widens and deepens the fractures. However, its coherence remains insignificant and it slightly extrudes from the fracture; in this case no traces of peat formation either in the fractures or in the lower half of the sod cover is apparent.

The distribution of soil invertebrates (cf. Table) convincingly indicates the relatively intense biogeocoenotic processes in the surface layer of the soil in such communities. Even in bare ground entirely covered with rubble, the total zoömass amounts to about 1-2 g/m². It sharply grows to 6-10 g/m² under lichen or alga crusts. Roughly the same amount of zoömass is noted in overgrown spots in the typical tundra subzone (Chernov, 1973). The population density of the invertebrates and their biomass in moss-lichen strips and pads confined to fractures may be 20 times that of uncovered ground and higher than in moss tundra.

There are also polygonal tundra on Cape Chelyuskin with coherent plant cover forming a mesh pattern with joined bands about spots of bare ground (Fig 4). The projective cover here is from 30 to 40 %, more rarely up to 60%. There are fewer flowering plants here comparing to more southern polygonal arctic-type tundra and they are significantly narrower, while the number of spots per

unit of area is much greater (there are about 30 spots per 100 m² in mossy tundra of the typical tundra subzone, slightly more than 100 in polygonal arctic tundra, and about 400 on Cape Chelyuskin). No sections with plant cover continuum were encountered.

Thus, the distribution of the plant sod cover in this region is characterized either by incoherent or floral padding (Fig. 6a, b) and by a polygonal mesh continuum (Fig. 6c,d). The alternation

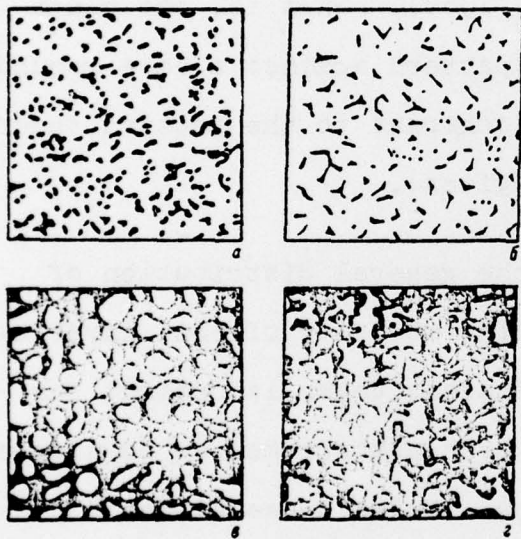


Fig. 6. Different types of plant distribution. a,b) floral padding; c,d) polygonal mesh continuum.

of these two types, and often their combination as well, create the entire variety characteristic of the horizontal structure of the plant groupings. In the floral padding type the general pattern of plant distribution is not completely determined by

the nature of the ground fracturing, since the pads are not always confined to the fractures. In the polygonal mesh plant distribution the pattern may vary along the fractures as a function of the shape and dimension of the polygons, whose diameter is in the range from 10-15 cm to 1-2 m. Floral pads and envelopes, however, are sporadically encountered in the polygons. Lichen-moss bands forming a mesh pattern in turn exhibit a floral padding structure being put together of separate moss and lichen pads. All the plant groupings have a clearly expressed "superimposed" nature (Govurukhin, 1960). That is, the plant cover is composed of a particular pattern against a bare ground, which in this case is primary (in contrast to the mottled tundra characteristic of more southern regions).

According to our observations on the general distribution of plants, their vital activity, and the activity of soil invertebrates, the floral padding type of plant cover is optimal for this region, though the polygonal mesh pattern may be considered more advanced in terms of coenotype. Under these climatic conditions plants become shorter in the central sections of the sod cover, become water-logged, and gradually die in the case of a relatively sparse cover even in narrow strips. In the floral padding distribution, in spite of the dispersion and scarceness of cover, the plants optimally utilize space without exerting a depressing effect on each other and the other components of the biocoenosis. Padding plays a positive role in maintaining the snow cover, is highly aerated, and is subject to risks of

long-term water-logging to a lesser degree than are dense strips of moss sod cover. Optimal conditions for invertebrates are also created in small, rounded and not too dense padding; here the mass of invertebrates can reach values of 100 mg/dm^2 (cf. table). As the moss sod cover grows and its thickness increases, conditions deteriorate. In this case a comparison between the two communities is instructive. One community will be characterized by a floral padding distribution and 20% total cover, and the other community, by a polygonal mesh distribution and 60% total cover. In the latter community, the population and mass of soil invertebrates is on the whole lower, particularly due to the decrease in the population of collemboles (most massive group) in dense and broad (up to 10 cm) moss strips, which cover a major part of the area of the community. Their population here is $1/3$ to $1/2$ that of narrow moss strips and less than $1/6$ that of isolated moss pads.

Table. Population (specimen/dm²) of different groups and total mass* (mg/dm²) of invertebrates in polar desert communities (CAPE Chelyuskin, July 1974).

A Группы животных	B Лишайниково-моховая полигональная пустыня (общее покрытие растениями 5%)				C Мохово-лишайниковое сообщество с куртинами по кустовому распределению растительности (общее покрытие растениями 20%)			D Лишайниково-моховое сообщество с полигонально-сетчатым распределением растительности (общее покрытие растениями 60%)		
	E оголенные щебнистый грунт	F лишайниковые корки на щебнистом грунте	G узкие (1-2 см) ленты мхов по трещинам	H мховые подушки по краю трещин	I оголенный грунт с лишайниками	J узкие мохово-лишайниковые ленты по трещинам	K моховые подушки	L оголенный грунт с лишайниками	M узкие (1-2 см) ленты мхов по трещинам	N плотные и широкие (до 10 см) дикранале торфянистые полосы в трещинах
Энхитриды	2	10	27	34	17	65	32	5	10	13
Гамазовые клещи	0	22	16	66	0	71	58	19	48	18
Коллемболы	84	174	702	1875	161	1855	3663	914	1262	591
Личинки комаров зловонных	0	13	14	5	16	5	7	2	4	2
Общая масса, мг/дм ²	5	33	64	84	50	125	108	29	44	34

P

* Без нематод и простейших.

- Key: A) Animal Group;
 B) Polygonal lichen-moss Desert (5% total plant cover);
 C) Moss-lichen Community with Floral Padded Plant Distribution (20% total plant cover);
 D) Lichen-moss Community with Polygonal Mesh Plant Distribution (60% total plant cover);
 E) "bare" debris ground;
 F) crustose lichen on debris ground;
 G) narrow (1-2 cm) moss strips in fractures;
 H) moss pads at edge of fractures;
 I) "bare" ground with lichen;
 J) narrow moss-lichen strips along fractures;
 K) moss pads;
 L) "bare" ground with lichen;
 M) narrow (1-2 cm) moss strips along fractures;
 N) dense and broad (up to 10 cm) dicranale peat strips in fractures;
 O) Enchytraeidea
Parasitiforms
Collembola
Trichoceridae
 Total Mass, mg/dm²
 P) *Without nematodes or Protozoa.

In addition to the clear, sometimes geometrically regular structure of the plant cover within the community (microstructure), sharp, almost linear boundaries between communities, small in extent,

and partial shifting in space should also be noted. There are practically no transitions between different communities. Since the transforming effect of the plant cover is minimal, it only reflects both the composition and structure of the smallest changes in the environment. The boundaries between communities that have evolved in types of ground with different mechanical compositions are particularly sharp. Often, however, sharp boundaries are observed in similar types of soil, and in these cases is due to the difference in moisture and snow cover.

In the current work we have not attempted to provide a description of the entire variety of plant communities encountered in the region under investigation. Our purpose has been to point out only the most characteristic and important features of the structure of the plant cover. We only note that lichen-moss, moss, and lichen communities predominate in the watersheds. The mosses Orthothecium chryseum, Aulacomnium turgidum, Rhacomitrium lanuginosum, Ditrichum flexicaule, and Dicranoureisia crispula and the lichens Cetraria delisei, C. ericetorum, C. cucullata, and Thamnolia vermicularis s.l. are the dominants. These communities are significantly less poly-dominant than the moss tundra, and one or two species are usually clearly dominant in them. The projective plant cover varies from 5-10% to 60-70% as a function of position in topography, the mechanical composition of the soil, and moisture. Their structure as a whole is typified by all the characteristic features noted above. These lichen-moss communities may be considered as zonal communities.

Intrazonal groupings in habitats with specific soil and climatic conditions and unique plant cover confined to them have not developed. Such intrazonal groupings in the typical tundra subzone include the mixed grass or single-grass meadowlands on the southern slopes as well as swampland. The greatest dispersion of the moss sod cover and a somewhat greater abundance of mixed grasses, including Papaver spp., Ranunculus sulphureus, Saxifraga caespitosa, and S. platysepala, are evident on Cape Chelyuskin. These species are extremely rare in other regions, while here they exhibit great vitality and pass very rapidly through phenophases; these species, however, are individually scattered throughout the moss sod cover and do not form overgrowths. On the southern slopes the amount of heat is here only insignificantly more than on the horizontal surfaces and slopes of any other exposure, and with its general scarcity, it is insufficient for the creation of meadowland. Marshland groupings are also absent, though there are broad areas with seepage of water that become water-logged in summer, i.e. characterized by conditions under which marshland forms in the tundra zone. There are also sections almost devoid of any plant cover and filled with polygonal deserts.

The swampy hollows formed by soil thawing in the watersheds most resemble puddles of water less than 10 cm in depth; there is no specific water or marshland plant cover. That is, those species which grew first are subject to a process in which they become water-logged and die off. Sometimes, more xerophilous mosses are replaced by species of the genus Calliergon, though the latter are depressed, too. Moisture excess exerts a harmful influence

on the vital activity of plants and soil invertebrates. This depression is not compensated for by replacement by other species and a stage of degradation begins.

Conclusion

The zonal situation of many regions of the Taimyrs and the zonal division of the Taimyrs as a whole are contradictorily expressed in the literature and cartographic materials. The area of Cape Chelyuskin is sometimes said to belong to the arctic tundra subzone, at others to the arctic (polar) desert zone. These contradictions can be attributed to at least two causes: the absence of a unified approach to zonal division, criteria by which various units are distinguished, and actual data on plant cover. B. N. Gorodkov (1935) and F. V. Sambuk (1937), with reference to the brief observations of Kjellman (1883) and A. Birulya (1907), subsumed Cape Chelyuskin under the arctic tundra zone, while A. I. Leskov (1947) has referred to it as a high-arctic nival region. On the geobotanic maps of the USSR (m. 1: 4,000,000 (1954); m. 1:15,000,000 (1964); and others) Cape Chelyuskin is made part of the arctic deserts with Severnaya Zemlya and the Byrrang mountains. In the collection, "Taimyr-Severnaya Zemlya Region" (1970), no polar desert zone (the latter is noted only for Severnaya Zemlya) is distinguished for the continent and Cape Chelyuskin is shown as part of the arctic tundra subzone.

From the data we have obtained on the flora and structure of the plant cover and animal population structure, we now agree with

those authors who have considered Cape Chelyuskin as part of the polar desert zone (Leskov, 1947; Tikhomirov, 1948; Sochava and Gorodkov, 1956; Aleksandrova, 1971). The boundary of the polar deserts in the Taimyrs is apparently at 77°N (the latitude of Tereza Klavenes Bay). Diagnostic indicators of the polar desert zone can be found in studies by V. D. Aleksandrova (1969, 1971). The region of Cape Chelyuskin corresponds to all these indicators and its plant cover resembles that of the polar deserts of Severnaya Zemlya (Korotkevich, 1958) and Franz-Josef Land (Aleksandrova, 1969).

The basic features according to which we have subsumed Cape Chelyuskin under the class of polar desert zones are as follows:

- 1) high disperseness of plant cover, faulting of plant sod cover, uncovered ground is primary: the area of uncovered ground exceeds the area of the plant cover;
- 2) slowness of decomposition processes, absence of peat accumulation and, in general, weak peat formation process;
- 3) concentration of life in a narrow layer at the soil surface; absence of vertical differentiation;
- 4) general "miniaturization" of life: decrease in numbers of species of plants and animals, replacement of larger species by smaller species;
- 5) sharp impoverishment of flora and fauna in all groups;
- 6) replacement of dominants comparing to tundra zone: mosses and lichens absolutely predominate in the plant cover, and flowering plants have a minimal role; typical tundra mosses, such as Tomenthypnum nitens, Hylocomium alaskanum, Aulacomnium turgidum, and Ptilidium ciliare, which are widely dispersed throughout the entire tundra zone, including the

arctic tundra subzone, are replaced by Orthothecium chryseum, Rhacomitrium lanuginosum, Ditrichum flexicaule, Bryum tortifolium, and Dicranoweisia crispula; the animal population lacks large saprophages, particularly earthworms, and microphytophages predominate; 7) the formation of padded forms in all groups of plants, particularly mosses and lichens; 8) absence of shrubs from the plant cover; 9) absence of intrazonal groupings: mixed-grass meadowland and marshland.

LITERATURE CITED

1. V. D. Aleksandrova (1957). "Demarcation of Arctic Deserts and Tundra by Type of Plant Cover." Reports to the Second Invited Conference of the VBO, IV. Section of Flora and Plant Cover.
2. V. D. Aleksandrova (1969). "Above and Below-Ground Mass of Plant in Polar Desert of Franz-Josef Land." Probl. bot., 11.
3. V. D. Aleksandrova (1971). "Principles for the Zonal Division of Plant Cover of the Arctic." Bot. Zh., 56, No. 1.
4. S. I. Anan'eva (1973). "Collemboles of Western Taimyr." In: Biogeocoenoses of the Taimyr Tundra and their Productivity, Vol. 2.
5. A. Birulya (1907). "Studies on the Life of Birds of the Polar Coastline of Siberia." Zap. Imp. Akad. Nauk, Ser. VIII, Fiz-Mat. Otd., XVIII, No. 2.
6. Yo. I. Chernov (1973). "Geozoological Characteristics of the Taimyr Biogeocoenotic Station." In: Biogeocoenoses of the Taimyr Tundra and their Productivity, Vol. 2.
7. Geobotanical Map of the USSR (1:4,000,000) (1954).
8. Geobotanical Map of the USSR (1:15,000,000) (1964).
10. B. N. Gorodkov (1935). The Plant Cover of the Tundra Zone of the USSR.
11. V. S. Govorukhin (1960) "Mottled Tundra and Plicated Soil of the North" (50 Anniversary of V. N. Sukacheva's Theory of Mottled Tundra)". Zemlevedenie, 5.

12. E. S. Korotkevich (1958). "Plant Cover of Severnaya Zemlya." Bot. Zh., 43, No. 5.
13. A. I. Leskov (1947). "Arctic Tundra Region." In: Geobotanical Regionalization of the USSR.
14. F. V. Sambuk (1937). "Brief REview of the Plant Cover of the Taimyrs." Problemy Arktiki, 1.
15. V. B. Sochava and B. N. Gorodkov (1956). "Arctic Deserts and Tundra." In: Plant Cover of the USSR, Vol. 1.
16. R. K. Sisko (ed.) (1970). Taimyr-Severnaya Zemlya Region.
17. B. A. Tikhomirov (1948). "Science for the Flora of Extreme Polar Regions of Eurasia." Byull. MOIP, Otd. Biol., 53 No. 4.
18. F. G. Kjellman (1883). "Die Phanerogamenflora der Sibirischen Nordkueste." In: Die Wissenschaftlichen Ergebnisse der Vega-Expedition, Vol. 1.

V. L. Komarov's Botanical
Institute of the Academy of
Sciences, USSR.
Leningrad

Submitted Wednesday,
May 8, 1975

and

A. N. Severtsev's Institute
of Evolutionary Morphology
and Ecology of Animals.
Moskow.