ANTARCTIC AND ARCTIC SOILS AS HABITATS FOR ORGANISMS

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Outline of contents: A concept of an ecological rating of habitats is given by this approach, which comprises different polar soil. This concept was used to understand strong differences in kind and intensity of vegetation cover, in the amount of bacterial biomass and in some examples in the activity of soil animals of sites with permafrost of the Continental Antarctic, the Maritime Antarctic and of some Canadian Islands.

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1. Introduction

Plant roots as well as soil organisms have special demands to their living space. The supply of heat, water, soil gases, and inorganic nutrients present the general frame, soil dwelling animals, microorganisms and organic matter in addition. The rooting space and the living room of organisms can be restricted mechanically by a lack of coarser pores and/or to high stability of the pore system. These site characteristics influence the kind of species and the amount of individuals. In areas with active permafrost, cryoturbation influences also soil organisms as well as plant roots.

The various soil ecological properties show wide variability and it renders difficult to set general frames for interactions between landscape, nutrients, soil organic matter and biological features. Main problems are due to different scales in space and time on which organisms, physical or chemical processes act. Nevertheless, several attempts have been made to rate significant properties for generalisations and to establish a better view on specific interactions (Schlichting et al. 1995, Bölter & Blume 2002).

2. Methods

Field description and feeding experiments.

Site and soil description were performed after FAO (1990); soil classification after ISSS/ISRIC/FAO (1998); micro and meso faunal activity were characterised by the bait-laminae-test after Törne (1990).

Laboratory analysis of soils (details see Schlichting et al. 1995).

Particle size (sieve and pipette method after H_2O_2 and HCl extractions and $(NaPO_3)_6$ dispersion); organic carbon (TOC): dry oxidation at 1200°C, coulom. CO_2 measurements and substraction of carbonatic C; total and available nitrogen (N_t: Kjeldahl digestion; N_{min}: extraction of NH_4 and NO_3 w. $CaCl_2$; colorim. measur. of NH_4 and NO_3); available or weatherable phosphorus (P_a extract with NH_4- lactate/acetic acid, P_v extract with hot HCl after humus oxidation at 500 °C, colorimetric P measurement); carbonates (H_3PO_4 treatment at 80°C and CO_2 measurement like TOC, transformation into $CaCO_3$; available nutrients (exchange of Ca_a, Mg_a and K_a w. $BaCl_2$, measurement by AAS;);

soil reaction: potentiometric measurement of pH ($CaCl_2$) at 1:2.5 (soil:water); electrical conductivity: measurement at 1:2.5 (soil:water) and transformation to the water content of the saturation extract after contents of clay and org. matter; bulk density and available water capacity (d_b and awc: dry weight and water content of 100 ml core samples at pF 1.8 and 4.2; or calculation of awc from texture, gravel and humus content); bacterial carbon was estimated from biovolume data, which were obtained from epifluorescence microscopy (Bölter et al. 2002).

Ecological Rating of Habitats.

Plant growth is restricted to the period without snow cover. The main living space for soil dwelling organisms in soils with permafrost is about 10 to 30 to 80cm depending on permafrost. Cryoturbation makes life difficult for soil organisms, particularly for longer living plants and animals. Vascular plants and cryptogams depend in different ways on these conditions. Cryptogams depend on fluid water which rises with soluble nutrients by capillary forces, whereas vascular plants can profit from deeper horizons, to about 30cm. This depth can be limited by rocks near surface or by high stone contents and thus is described as the possible depth for roots to penetrate the soil. Available water to plants and soil organisms is characterised by the available water capacity in the living space (Table 1).

The available oxygen gets low with increasing water content, as indicated by redoximorphic features, e.g., rusty mottles. Nutrient availability can be characterised by the amount of exchangeable kations and anions in the main rooting zone. Soil organic matter (SOM) content and quality can be used to characterise the living conditions for heterotrophic organisms, a SOM with low C-N-ratios (<20) describe a system of N-remineralization.

For ecological rating of the habitats (see table 1) we followed basically the recommendations of Schlichting et al. (1995), but adapted to sites with permafrost conditions after Bölter and Blume (2002).

Table 1. Assessments of ecological site conditions (after Schlichting et al. 1995) in polar regions for 30 cm soil depth, in brackets for 10 cm of Casey area

Tab.1. Przybliżenia warunków ekologicznych siedlisk (za Schlichting et al. 1995) w regionach polarnych na głębokości 30 cm w glebie, w nawiasach dla głębokości 10 cm w obszarze Casey

Step	I very low	2 low	3 medium	4 slightly high	5 high	6 very high	7 extreme high
Sfp* months	0-1	1.5	3	6	9	12	
r.p.[1] .%	100	85	60	40	15	0	
awc[2] $l\ m^{-2}$	< 15 (5)	30 (10)	60 (20)	90 (30)	140 (47)	200 (67) >	
e.c. mS/cm[5]	< 0.75	2	3	4	8	15 >	
N_{min} $g\ m^{-2}$	< .02 (.01)	0.1 (.05)	2.0 (1.0)	4.5 (2.3)	12 (6)	25 (13) >	
K_a $g\ m^{-2}$	< 2 (1)	8 (4)	24 (12)	48 (24)	80 (40)	200 (100) >	
Ca_a $g\ m^{-2}$	< 4 (2)	15 (7.5)	50 (25)	100 (50)	200 (100)	500 (250) >	
Mg_a $g\ m^{-2}$	< 2 (1)	5 (2.5)	15 (7.5)	30 (15)	60 (30)	150 (75) >	
P_v (P_a) $g\ m^{-2}$	< 5 (0.5)	25 (!.5)	125 (5)	175 (13)	250 (20)	400 (50) >	
org. m.kg m^{-2}	< 0.2 (0.1)	0.5 (0.25)	1.0 (0.5)	2 (1)	4 (2)	8 (4) >	
bac.[3] $g\ m^{-2}$	< 0.3 (0.2)	0.6 (0.4)	1.2 (0.8	3 (2)	6 (4)	>	
feed[4]%	< 5	15	40	60	80	95 >	

* snow free period; okres bezśnieżny

[1] penetrability by roots (mass% of stones + gravels, rock = 100%; mean of 3 (1) dm; zdolnosc przerośnięcia korzeniami

[2] available water capacity (+ groundwater if high groundwater table); pojemność wody dostępnej (+wody gruntowe o ile wysokie lustro)

[3] bac bacterial biomass in g Cm^{-2} (rating of ″ microbial biomass after Machulla (1997), with an adaption due to mean temperature of the vegetation period after Blume et al. (1991); bac-biomasa bakterii w g cm^{-2} (podział ½ biomasy mikroorganizmów wg Machulla (1997) z dostosowaniem do średniej temperatury okresu wegetacyjnego wg Blume et al. (1991)

[4] feed activity (relative feeding %) during 10 days in relation to offered food stripes after Törne (1990); aktywność odżywienia (względne odżywienie w%) podczas 10 dni w odniesieniu do dostępnych skrawków pokarmu wg Törne (1990)

[5] electrical conductivity of the saturation extract; przewodność elektrolityczna ekstraktu nasyconego

3. Site Conditions

3.1. Continental Antarctic

Directly south of the Australian Casey Station (66° 17.5' S, 110° 32' E), Windmill Islands, soils of a hill were mapped (Blume et al. 2002) and studied (Table 2: C1-5). The rocks consist of a layered sequence of gneisses with shists and migmatites (Seppelt 2002a). The hill (35-46 m above sea level a.s.l.) is partly covered with boulders and a thin layer of finer grained morainic materials, the foot slope and valleys are partly covered with silty moraines. Rocks and moraine material are totally free of carbonates. A detailed description of these sites is given by Blume et al. (2002b).

Hapli-turbic Cryosols were formed due to strong cryoturbation in foot slope area. Loamy Stagni-turbic Cryosols of the hill are influenced by cryoturbation too, whereas gravely sandy Podzols (Fig. 1 C3) are free of active cryoturbation. They are enriched with organic matter, partly due to an influence of bird's excrements (Table 2: C3 u. 4). Wet depressions are covered by peat (C5). Permafrost exist between 30 and 80 cm below soil surface.

The mean annual temperature is - 9.3°C. January is the warmest month with +0.2°C. Most of the annual precipitation of 176 mm is snow. Areas of not more than 32 m a.s.l. are generally covered with snow around the year: their soils are not covered by vegetation therefor. Boulders and sandy soils above 32 m a.s.l. are covered by fruticose lichens, and peat by mosses with small lichens (Table 3: C1-5). No vascular plants exist (Seppelt 2002b).

Table 2 Soil conditions (C mean of first 10 cm, others of 30 cm) of sites with permafrost (30-100 cm below surface) in the Southern and the Northern hemisphere

Tab.2. Warunki glebowe (C średnio w górnych 10 cm, inne do 30 cm) w siedliskach z wieczną zmarzliną (30-100 cm poniżej powierzchni) na południowej i północnej półkuli

Casey, Wilkes Land, gneiss + schist, partly w. moraine cover (Blume and Bölter 1996)

site	Soil (after WRB)	a.s.l. m[1]	direction	skel. %[2]	texture[3]	pH	b.s. %	TOC %	carb. %
C1	Hapli-turbic Cryosol	33	E	25	SL	4.5	55	0.2	0
C2	Stagni-turbic Cryosol	44	SW	28	CL	4.4	55	0.6	0
C3	Lepti-gelic Podzol	44	SW	34	S	4.3	42	2.5	0
C4	Skeleti-gelic Podzol	38	N	85	S	4.2	63	4.0	0
C5	Foli-gelic Histosol	38	N	7		4.1	75	24	0

Arctowski, King George Island, tholeiite basalt w. solifluct. deposits (Kuhn 1997)

A1	Molli-gelic Cambisol	38	N	35	SL	5.5	85	2.2	0
A2	Tephri-regic Cryosol	40	N	45	SL	5.4	86	0.2	0
A3	Ortithionic-g. Leptos.	55	NO	64	LS	6.0	90	0.2	0
A4	Dystri-gelic Fluvisol	0.2	flat	33	S	4.3	25	5.9	0
A5	Tephri-regic Cryosol	122	SO	35	LS	6.4	93	0.1	<0.1

Somerset Island, Canada; weak polygons; calcaric sediments w. moraine cover

S1	Calca.-turbic Cryosol	40	flat	30-50	L	7.4	100	6.3	33
S2	Calca.-turbic Cryosol	85	S	30-50	SL	7.3	100	2.2	40

King William Island, Canada; limestone w. fluvio-glacial gravel, weak polygons

K1	Skeleti-leptic Cryosol	05	SW	>70	S	7.4	100	5.7	46
K2	Skeleti-hapl. Cryosol	10	flat	>70	LS	7.6	100	0.6	92

Banks Island, Canada; large polygons; calc. sed. w. moraine cover

B1	Molli-turbic Cryosol	250	W	5-10	L	7.6	100	4.1	3.5
B2	Skeleti-hapl. Cryosol	290	flat	50-70	SL	7.5	100	1.2	14

[1] meter above sea level; m powyżej poziomu morza
[2] gravel + stones in vol.%; żwir + kamienie w% objętościowych
[3] C clay, L loam, S sand; C – ił, L – glina, S - piasek

3.2. Maritime Antarctic

Sites and soils around the Polish Arctowski Station (62°1'S, 58°28'W), Admiralty Bay, King George Island, were mapped (Kuhn 1997, Blume et al. 2002a) and studied (Table 2: A1-5). The rocks are mainly formed of tertiary tholeiite basalt. They are covered by solifluction deposits, young moraines, and with fluvial sands and gravel along the sea shore. Carbonate contents of the unweathered substrates are zero to low (< 2%) (Blume et al. 2002a).

Cryosols (Table 2: A2, A5) with medium to strong cryoturbation exist beside gelic Leptosols (A3), Cambisols (A1), Umbrisols and Fluvisols (A4;

Table 3 Climate conditions and plant cover of sites with permafrost in the Southern and the Northern hemisphere (only dominant plant species are listed)

Tab.3. Warunki klimatyczne i pokrywa roślinna w siedliskach z wieczna zmarzliną w południowej i północnej półkuli (wyszczególniono tylko dominujące rodzaje roślin)

Casey, Continental Antarctic; 66°17'S, 110°32'E; mean temp. –9.1°C, mean precip.195 mm

site	Sfp* month.	temp. ˚C[1]	O_2-Defic.	bac-C[2]	feed %[3]	plant %[4]	plants
C1	0-1	+ 0.1	No	5.4		0-1	Soil algae, lichens: Buellia sp., Umbillcaria sp.
C2	2-3	+ 0.2	subsoil	2.8		0	Soil algae
C3	2-3	+ 0.2	no	19		10	Lichens (Usnea sphacelata) on gravel
C4	2-3	+ 0.4	subsoil			5	Lichens (U. sphacelata) on gravel
C5	1-2	+ 0.4	subsoil	22		100	Lichens (Buellia figida) on mosses (Ceratodon purpureus)

Arctowski, Maritime Antarctic; 62°10'S, 58°28'W; mean temp. -2.7°C, mean precip. 510 mm

A1	4	+ 1.7	no	740	15	90	Deschampsia antarctica, Colobanthus quitensis., mosses
A2	4	+ 1.7	no	47	7	10	D. antarctica
A3	4	+1.6	no	23	11	50	D. antarctica., lichens
A4	5	+ 2.0	partly	340	15	95	Mosses (Ceratodon sp.)
A5	3	+ 1.0	no	19	11	0	Soil algae

[5] Somerset Island, 72°55'N, 93°27'W; mean temp. -13°C, mean precip. 100-200 mm

S1	1-2	+ 1.5	no	397		100	Cassiopea tetragona., Dryas integrifolia., Saxifraga oppositifolia,, Salix arctica
S2	2	+ 2	no	150		10	Carex misandra, C. stans, Arctagrostis latifolia,, Eriopherum angustifolia, D. integrifolia., S. arctica

[5] King William Island, 69°06'N, 98°55'W; mean temp. -14°C, mean precip. 100-150 mm

K1	-1	+ 0.1	no	66		100	D. integrifolia, S. arctica, Papava radiatus, Draba sp., S. oppositofolia
K2	3	+ 1.5	no	27		5	Poa arctica, P. abbreviata., Carex sp., D. integrifolia, Saxifraga trifolium, Draba sp..

[6]Banks Island, 71°43'N, 123°44'W; mean temp. -13.7°C; mean precip. 127 mm

B1	2	+ 3	no	319		100	Carex sp., D. integrifolia., S. arctica
B2	1-2	+ 2.5	no	18		30	D. integrifolia, Draba cinerea, Artemisia borealis, S. arctica

* snow free period in months; okres bezśnieżny w miesiącach

1 mean temperature of summer months; średnie temperatury miesięcy letnich

2 bacterial carbon in mg m^{-2}; węgiel bakterii w mg m^{-2}

3 feed: relative feeding% during 10 days in relation to offered food; odżywienie: względne odżywienie w% podczas 10 dni w relacji do dysponowanego materiału

4 plant cover of soil surface; pokrywa roslinna na powierzchni gleby

5 data from: "Terrestrial Ecozones" (http://www.cciw.ca), botanical data from Eriksen & Elven 1999, Lévesque (pers. comm.); dane z: "Terrestrial Ecozones" (http://www.cciw.ca), dane botaniczne z Eriksen & Elven 1999, Lévesque (osobiste doniesienie)

6 data for Sachs Harbour (72°N, 125°16'W); dane dla Sachs Harbour (72°N, 125°16'W)

Fig. 1 A4) without active cryoturbation (Blume et al. 2002).

The mean annual temperature is –2.7°C, and the precipitation 510mm near the station (Rakusa-Suszczewski 2002). The lowlands are free of snow for 5 months, areas between 25 and 60m a.s.l. for 4 months, higher situated positions for 3 months. An variation of permafrost between 50 and deeper 100cm below soil surface were found. Very young moraines as well as sites above 100m a.s.l. are nearly free of vegetation; the others are more or less covered by the only two vascular plant species of Antarctica (*Deschampsia antarctica* and *Colobanthus quitensis*) beside several lichens and mosses (Table 3: A1-5; Olech 2002).

3.3. Arctic Islands of Canada

Sites and soils of Somerset Island (72°55'N, 93°27'W), King William Island (69°6'N, 98°55'W), and Banks Island (71°43'N, 123°44'W) beside others were described during the Tundra Northwest Expedition 1999 (Bölter 1999). Calcaric sediment and limestone are covered by moraines and fluvioglacial sediments. Mainly Cryosols (e.g. Fig.1 B1) show permafrost between 30 and >100 cm, and medium to strong active cryoturbation exist in these areas (Table 2: S, K and B; Tarnocai 2004).

The mean annual temperature of all sites is between –10 and –15°C, the mean annual precipitation between 100 and 300 mm, mainly in form of snow. For 1.5 to 3 months the soil surface is free of snow and during this temperature lies between +1.5 to + 3°C to C1.5 to 3 months without snow (Table 3: S, K and B). Many different vascular plant species exist, herbages like *Dryas octopetala* and *Salix arctica* as well as grasses like *Carex misandra* and *Poa arctica,* beside lichens and mosses (Table 3: sites S, K and B). The vegetation cover differs very strongly between 5 and 100% (Table 3: S, K and B).

Figure 1. Representative sites with permafrost; (a) Lepti-gelic Podzol (C3); (b) Dystri-gelic Fluvisol (A4); (c) Molli-turbic Cryosol (B1)

Ryc.1. Reprezentatywne siedliska ze zmarzliną; (a) ranker bielicowy zmarzlinowy (C3), (b) gleba fluwialna zmarzlinowa (A4), (c) gleba zmarzlinowa próchniczna (B1)

4. Ecological Rating of the Described Habitats

In the following the described habitats were rated according to the scheme (Table 1) with respect to their ecological properties.

4.1.Continental Antarctic

Sites C2 – C5 at Casey Station are located on a hill which leads to a much longer snow-free time than nearby located areas in depressions due to snow drift during winter. On the one hand, such condition can favour plant growth because of a longer period of light; on the other hand, such location suffers from dryness and erosion processes. Locations in depressions or directly leeward of large boulders have much longer times of snow cover and wet conditions, thus providing habitats for soil algae and cyanobacteria, but only small accumulations of organic matter occurs with subsequently low loads of heterotrophic organisms (sites C1 and C2).

Hence, these environmental conditions do not allow the establishment of a developed biocenosis. Further, they represent Turbic Cryosols (Table 2) which also prevents the establishment of lichens or mosses. Due to the quartz-rich substrate at site C1 (see Blume et al. 2002a), only low amounts of K, Ca, and Mg can be found (Table 4). Site C2, a Turbic Cryosol with water stagnation (which reflects oxygen deficiency from time to time) shows a higher level of Mg, because the parent material is schist. Site C3 is a Gelic Podzol with a stabilized surface by fruticose lichens growing on small pebbles. Here we find elevated bacterial biomass and organic matter with low C/N ratio. The available water capacity, however, is in minimum and the top horizon suffers from dry conditions due to sandy skeletal texture. Site C4, a Gelic Podzol too, is an ancient penguin rookery and the cover to 15cm is up to 100% coarse gravel. Therefore, available water capacities as well as available nutrients are very low to low, except medium amounts of phosphate. Site C5 represents a top soil of a shallow peat bog influenced by melt water, but dry conditions during late summer in its top layers. Nutrient levels can be described as medium.

Table 4 Ecological conditions (sites C mean of first 10 cm, others of 30 cm) of sites with permafrost in the Southern and the Northern hemisphere; (methodological details see Schlichting et al. (1996))

Tab.4. Warunki ekologiczne (siedliska z Cśr. w górnych 10 cm, inne do 30 cm) siedlisk ze zmarzliną na południowej i północnej półkuli (metodologiczne detale patrz Schlichting et al. (1996))

Casey, Wilkes Land

site	[1]cryo-turbat	sali-nity[2]	awc[3] $l\ m^{-2}$	N_{min} $g\ m^{-2}$	[4]K_a $g\ m^{-2}$	[4]Ca_a $g\ m^{-2}$	[4]Mg_a $g\ m^{-2}$	[4]P_a $g\ m^{-2}$	org.m.[5] $kg\ m^{-2}$	C/N
C1	high	1.4	16	0.1	2.1	3.1	1.2	19	0.35	6.3
C2	high	1.0	14	0.1	19	74	120	19	1.3	10
C3	v. low	1.2	13	0.2	1.8	3.9	2.2	31	6.4	4.6
C4	v. low	2.6	3	0.02	0.8	2.4	0.8	4.9	1.0	12
C5	v. low	3.0	32	0.4	4.9	29	15	7.3	14	12
Arctowski, King-George Island								P_v		
A1	low	1.7	41	4.2	15	390	190	130	8.3	8.0
A2	high	0.3	8	0.2	20	370	210	120	0.87	10
A3	low	0.5	22	0.2	16	250	140	90	0.70	
A4	low	1.0	190	0.8	10	89	41	260	7.6	3.8
A5	high	1.2	36	.01	51	250	250	72	0.39	3.1
Somerset Island								P_v		
S1	med.	1.0	59		11	540	6.1	85	24	11
S2	high	1.3	49		13	600	15	71	7.3	10
King William Island								P_v		
K1	med.	1.1	9		3.2	290	7.9	43	4.0	34
K2	med.	1.2	9		0.5	11	0.4	5	0.5	22
Banks Island								P_v		
B1	med.	1.5	80		21	1340	37	122	23	13
B2	med.	0.9	27		8.0	166	8.2	36	3.1	12

[1] intensity of cryoturbation: high to very low; intensywność krioturbacji: wysoka do bardzo niskiej

[2] electr. conduct. of the sat. extr. In mS/cm: very low <0.75, low 0.75-2, moderate 2-3; przewodność elektrolityczna w ekstrakcie w mS/cm: bardzo niska <0.75, niska 0.75-2, umiarkowana 2-3

[3] awc: available water capacity; awe: pojemność wody dostępnej

[4] K_a, Ca_a, Mg_a, P_a: exchangeable ions; Pv = hot HCl P; K_a, Ca_a, Mg_a, P_a: wymienne jony

[5] org. m.:(= TOC*2); organiczna substancja:(= TOC*2)

All sites at Casey have medium to high amounts of available phosphorous. This can be attributed to recent and ancient bird colonies. Oxygen deficiencies can be found in the subsoils due to water logging. Sea borne salts can often be enriched by capillary rise (Blume et al. 2002) with effects on the osmotic pressure (Bölter & Blume 2002).

4.2. Maritime Antarctic

At King George Island, the snow free period is much longer and extends to 4 to 5 months at sites below 60 m a.s.l. The local milder maritime climate allows the establishment of the only Antarctic vascular plants. Actual cryoturbation (sites A2 and A5) and patterns of solifluction hampers the establishment of a permanent extended vegetation cover. Sites A1 and A4 show an elevated microbial carbon contribution with respect to high amounts of organic matter. These sites also show highest results in feeding activity (mainly by collemboles, nematodes and mites: Bölter et al. 1997). All sites (except A4, a Fluvisol) show relatively high amounts of available Ca and Mg despite high stone contents due to basaltic and volcanic ashes as parent material.

4.3. Arctic Islands of Canada

Strong differences exist in the intensity of plant cover (Table 3: S, K and B) and the amount of bacterial biomass (Tab. 4, and Bölter 2004) between the studied soils. They also show that strong differences in the ecological conditions should exist.

The highest amount of bacterial biomass was found in sites S1 and B1 (Table 3). These sites show extremely high amounts of organic matter with a low C/N value (as fodder of microbes), a medium to slightly high available water capacity and medium (K, Mg) to extremely high (Ca) amounts of nutrients (see Table 4 and 1). But the vegetation period of these sites is relatively short and is combined with a low mean temperature. Thus, the amount of bacterial biomass is absolutely low.

The biomass of all of the other sites is very low, even under conditions of a longer vegetation period together with a higher mean temperature. We think that main restrictions are related to low amounts of organic matter (e.g., K2), relatively low amounts of nutrients, especially Mg (e.g. K2), a low available water capacity (e.g., K1 and 2). However, local oxygen deficiency (Table 3) does not restrict microbial activity and plant growth.

Table 3 also shows the main plant species. In general, plant species with very different optimal site conditions are combined with each other: e.g. *Dryas integrifolia* (which likes dry eutrophic s.) together with *Eriopherum angustifolium* (which likes wet mesotrophic sites) at site S1. This is the result of large differences in local site conditions, which sometimes change from dm to dm: i.e., the pattern of this site is a result from by dry stony rings and loamy moist centres of polygons.

5. Summary

A concept for an ecological rating of habitats is given by this approach, which comprises different polar soils. This concept was used to understand strong differences in kind and intensity of vegetation cover, in the amount of bacterial biomass and in some examples in the activity of soil animals of sites with permafrost of the Continental Antarctic, the Maritime Antarctic and of some Canadian Islands.

It could be shown that mainly the length of the snow free period, the intensity of cryoturbation and the amount of accumulated organic matter control plant cover and bacterial activity; but also the water, air and nutrient conditions have an important influence. This influence, however, is more closely related to local and seasonal aspects.

6. References

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ANTARKTYCZNE I ARKTYCZNE GLEBY JAKO SIEDLISKA DLA ORGANIZMÓW

Podsumowanie

W opracowaniu przedstawiono koncepcję ekologicznego wywartościowania siedlisk, które obejmują różne polarne gleby. Koncepcję tę zastosowano aby zrozumieć ostre zróżnicowania w rodzaju intensywności pokrywy roślinnej, ilości biomasy bakterii oraz w niektórych przypadkach aktywności zwierząt glebowych w siedliskach ze zmarzliną na kontynentalnej Antarktyce, morskiej Arktyce i na niektórych kanadyjskich wyspach.

Należy stwierdzić, że głównie długość okresu bezśnieżnego, intensywność procesów krioturbacji oraz ilość zakumulowanej biomasy decydują o pokrywie roślinnej i intensywności zasiedlania bakteriami. Istotny wpływ maja także warunki wodne, powietrzne i odżywcze. Te wpływy, zazwyczaj są ściśle uzależnione od aspektów lokalnych i sezonowych.