Bryophyte diversity in the Arctic wetland tundra along a site moisture gradient, Prudhoe Bay, Alaska

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INTRODUCTION

Thanks to specific adaptations, such as broad ability to recover from desiccation and freezing and low maximum photosynthetic rates, bryophytes thrive in northern wetland tundra ecosystems with ice-rich permafrost, where they often reach high diversity and abundance, and play an important role in many ecosystem processes. Unfortunately, species identification of mosses in the field is difficult, often requiring determination of microscopic characters. To exploit the potential of bryophytes present in tundra, we offer here a classification of bryophyte life-forms that can be easily recognised in the field. This approach enables to gain a better knowledge of ecological processes occurring in arctic tundra. Each aspect of bryophyte diversity (species richness, abundance, composition and distribution of life-forms) was studied in relation to site moisture gradient as water supply is a key variable which drives the diversity in bryophyte communities. This study is an exploratory examination of the use of bryophyte life-forms to help categorize the species-rich moss layer of nonacidic wetland tundra plant communities in the Prudhoe Bay region of Alaska.

STUDY AREA

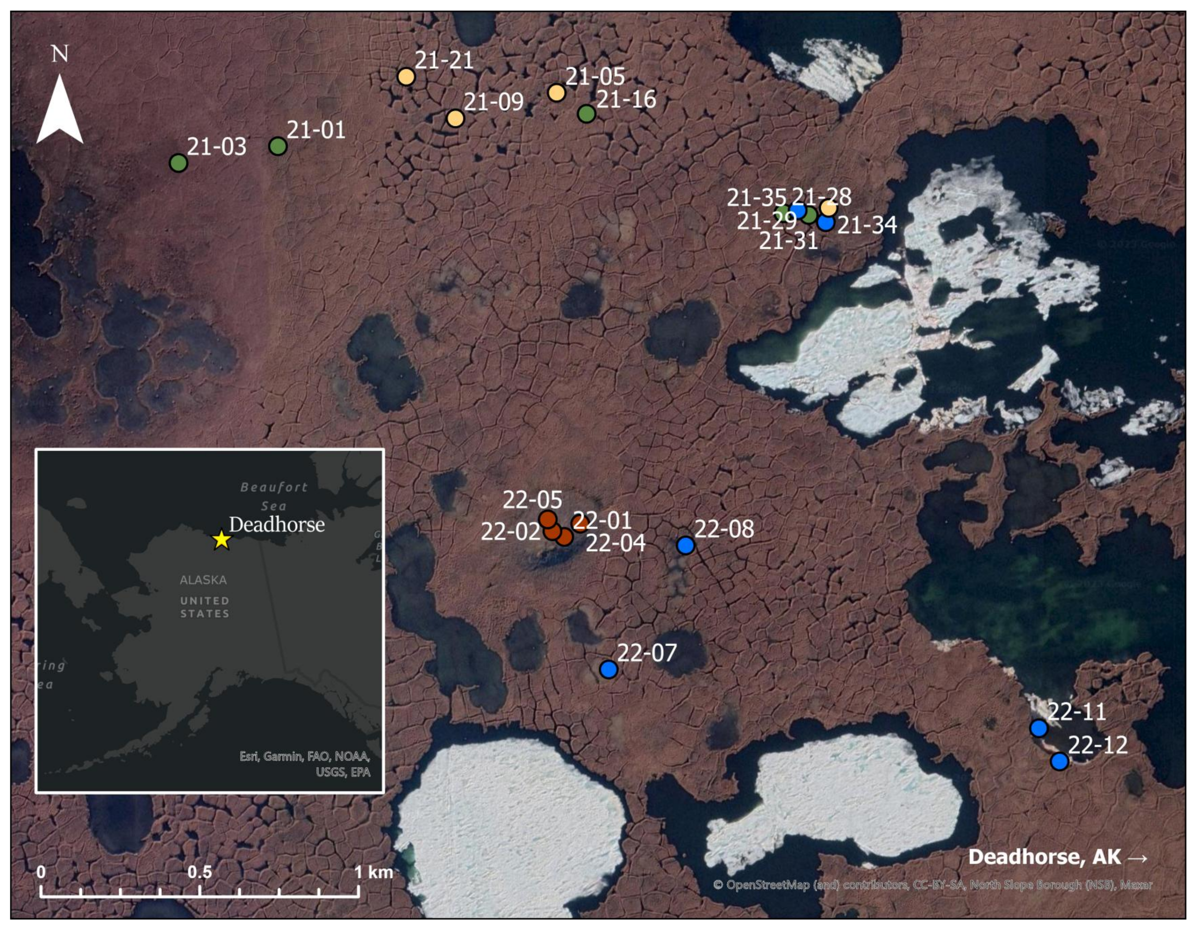


Fig. 1. Vegetation plots sampled at the NIRPO site within the Prudhoe Bay oilfield, Alaska.

SAMPLING METHODS

19 permanent vegetation plots

plot area: 1m^2

cover estimations according to nine-grade Braun-Blaquet cover-abundance scale

site moisture gradient represented by vegetation types:

dry tundra – types B1 and B2
moist tundra – types U3 and U4
wet tundra – types M2 and M4
aquatic tundra – M4/E1, E1 and E2

codes follow Walker (1985): Vegetation and environmental gradients of the Prudhoe Bay region, Alaska. – *CREEL* report 85-14, pp. 137–64

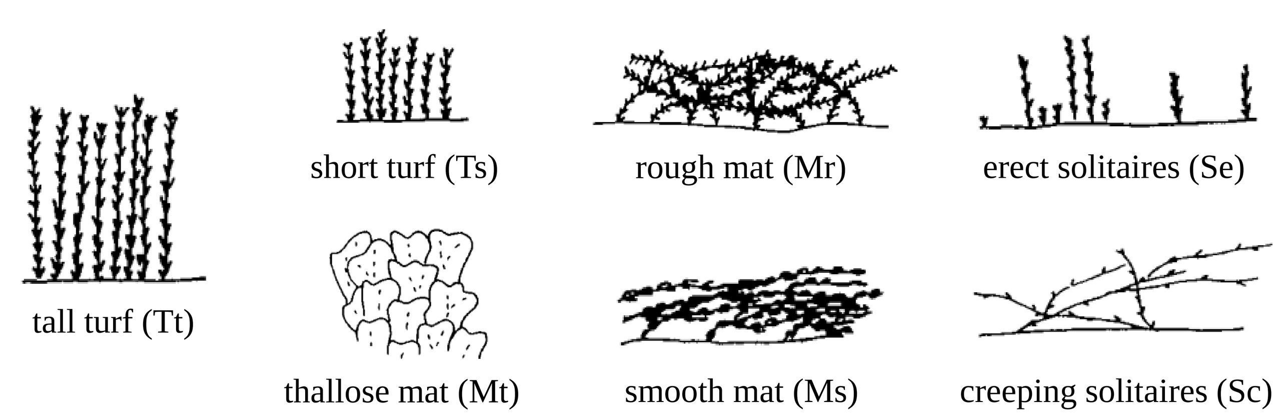
the selection of vegetation plots represents unique combinations of vegetation type and microrelief feature with at least one repetition for each vegetation type

DATA ANALYSIS

Mean values of species richness and mean cover values of bryophytes were calculated for each vegetation type (Fig. 2a,b). Detrended correspondence analysis (DCA) with square root transformation of percentage species covers was performed in R to examine trends in species composition along the site moisture gradient characterized by vegetation types (Fig. 3). To display the distribution of life-forms along the site moisture gradient covers of life-forms were plot with axes y log transformed (Fig. 4).

BRYOPHYTE LIFE-FORMS

7 distinct types occurring at the NIRPO research site;
illustrations are adapted from Grace (1995): A key to the growthforms of mosses and liverworts. – *Journal of Biological Education*, 29(4): 272–278



RESULTS

A total of 77 bryophytes were included in the analysis. **Species richness** (Fig. 2a) is highest in moist sites on raised microrelief features such as high-centered polygons and rims and decreases towards aquatic sites. In contrast, the **abundance of bryophytes** increases from dry towards aquatic sites (Fig. 2b). Both trends are commonly known from across the arctic tundra. The DCA shows a noticeable pattern in **species composition** along the first axes which corresponds to the moisture gradient (Fig. 3).

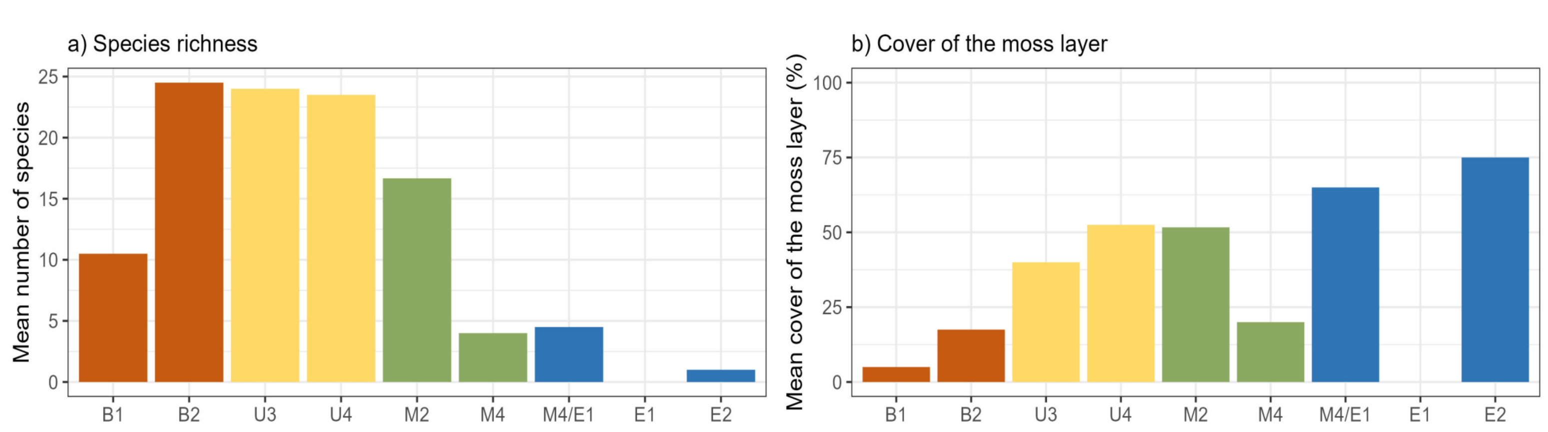


Fig. 2. Mean bryophyte species richness (a) and mean total bryophyte cover (b) per vegetation type.

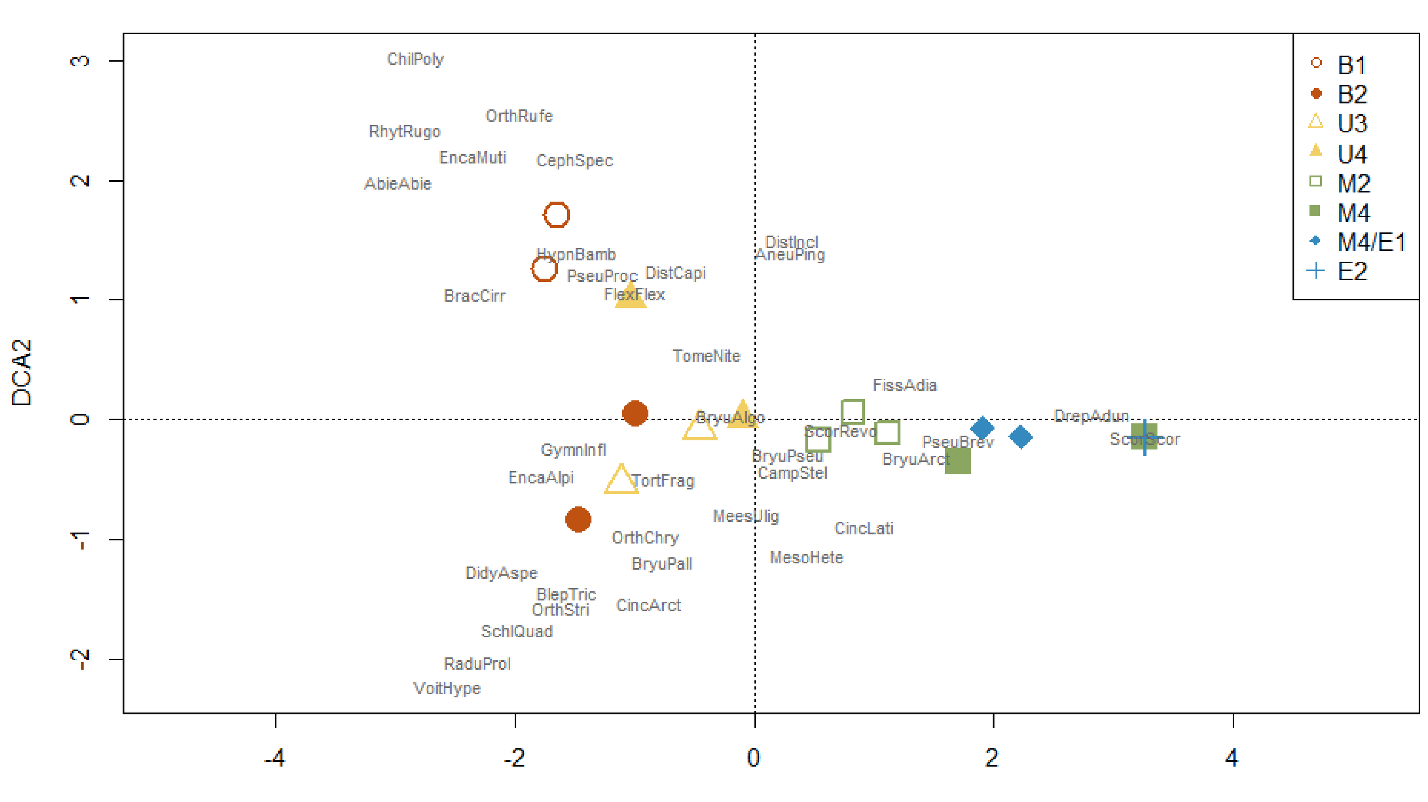


Fig. 3. DCA ordination diagram displaying both species and vegetation plots.

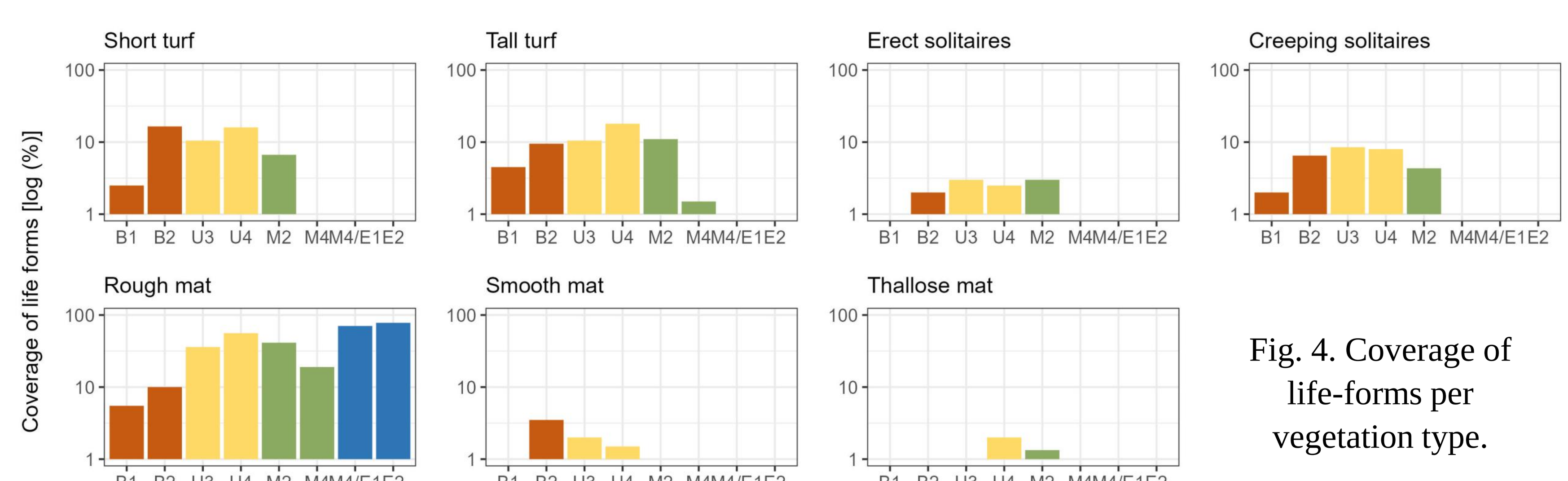
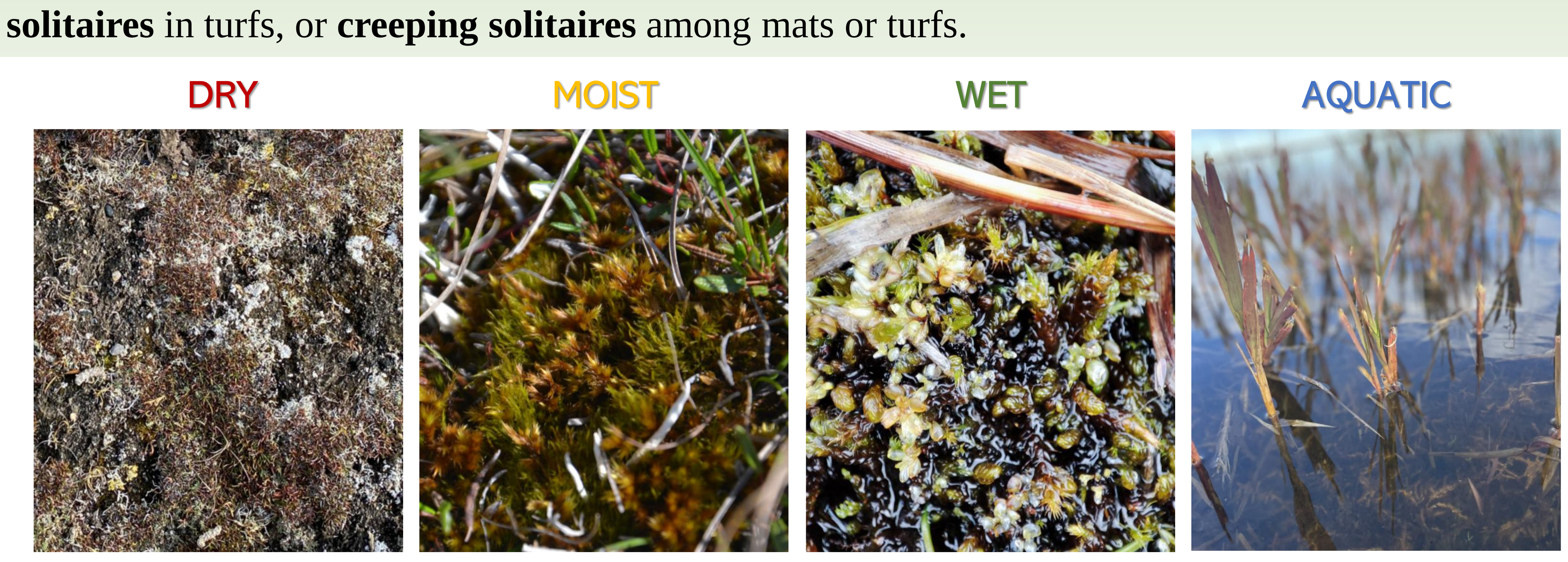


Fig. 4. Coverage of life-forms per vegetation type.

Mats occur at sites where the dessication stress is improbable. **Rough mats** dominate in wet and aquatic sites. Their prostrate appearance improves light capture in otherwise shaded or submerged conditions when light becomes a limiting factor rather than moisture. **Smooth mats** are common in more exposed dry sites where strong winds shape the shoots of the moss in one direction. **Turfs** are common in most types except the wettest sites as they represent a self-shading form favoured by species in harsh conditions in open landscape. **Short turfs** predominate **tall turfs**, which can be explain by impact of high light intensity on lenghtening of the main axes. **Solitaires** can be often found as a mixture of several species or can be present in otherwise monospecific colonies, **erect solitaires** in turfs, or **creeping solitaires** among mats or turfs.



Dry sites are preferred by species with affinity to open and disturbed habitats with lower amount of water supplies, which occupy left site of the ordination diagram. Moist tundra represents a transition between dry and wet sites with highest species richness in both prostrate and erect bryophytes, and leafy liverworts. Species present in this type tend to be related to higher site moisture while still performing full recovery after periods of lower water availability. Wet tundra is characterized by the presence of hygrophytic species that can withstand a considerable amount of standing water. Aquatic sites are typical with occurrence of prostrate species which form a prevailing and often monodominant vegetation cover. Such species possess morphological adaptations allowing them greater growth via prolonged photosynthetic activity and become dominant in wetlands.

DRY	MOIST	WET	AQUATIC
Abietinella abietina	*Tomentypnum nitens*	*Bryum pseudotriquetrum*	*Calliergon giganteum*
Encalypta mutica	*Flexitrichum flexicaule*	*Catascopium nigritum*	*Drepanocladus* sp.
Syntrichia ruralis	*Distichium capillaceum*	*Campylium stellatum*	*Pseudocalliergon brevifolium*
Rhytidium rugosum	*Orthothecium chryseum*	*Cinclidium* sp.	*Scorpidium scorpioides*
Pseudostereodon procerrimus	*Bryum pallescens*	*Meesia* sp.	
	Arnellia fennica	*Scorpidium revolvens*	
	Radula prolifera	*Cyrtomnium hymenophyllum*	
	Scapania simmonsii		

CONCLUSION

This study contributes to the ecological research at the NIRPO study site in the Prudhoe Bay region, where bryophytes are dominant component of most tundra plant communities. The analyses revealed distinct pattern in species richness, abundance, composition and distribution of life-forms along the site moisture gradient represented by vegetation types. Classification of life-forms may proved to be a useful concept that can serve a wide range of ecologists in an understanding and modeling the role of bryophytes in tundra ecosystem processes, such as controlling soil temperatures and the development of ice-rich-permafrost soils in these plant communities.

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