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Sphagnum-Polytrichum hummocks – a bryologically neglected plant formation

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ABSTRACT: The liverwort flora of *Sphagnum-Polytrichum* hummocks from the Polish Carpathians (mainly Tatra Mts) is characterized in respect to rare and relict species. An analysis of this flora showed that these hummocks form a kind of asylum for arctic alpine species, which are not infrequently restricted in their montane occurrence to this interesting plant formation.

KEY WORDS: Hepaticae, high mountain flora, Poland

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INTRODUCTION

In higher mountains reaching at least the subalpine vegetation belt, various peat mosses (mainly *Sphagnum acutifolium* Ehrh.) and various species of the genus *Polytrichum* Hedw. (mainly *P. strictum* Brid.) form hummocks which sometimes cover substantial areas above the tree line. In Poland they are particularly well developed in the Tatra Mts, but have been rather neglected by florists. The first paper on this formation was published by Jeník (1958), who described its structure and plausible genesis in the Slovakian part of the Tatras. The flowering plants growing on these hummocks, and constituting a structural element of them, are common species (e.g., *Vaccinium myrtillus* L., *V. uliginosum* L., *V. vitis-idaea* L., *Empetrum hermaphroditum* Hagerup). Also found growing on the hummocks are a few other vascular plants that are accidentally associated, as well as a few easily recognizable and widespread mosses [*Pleurozium schreberi* (Brid.) Mitt., *Hylocomium splendens* (Hedw.) B.S.G. and *Dicranum* Hedw. spp.]. This is probably the main reason why this formation has not been studied more carefully. However, these hummocks harbour a rich variety of rare and relict species of hepatic flora. Studies on this flora have revealed the existence of species never collected before in the Tatra Mts. For example, *Lophozia binsteadii* (Kaal.) Evans is widespread in hummocks but was col-

lected by the senior author for the first time in the Tatras in 1960, even though a substantial contribution to the Tatra Mts hepatic flora was published as early as 1885 by Szyszyłowicz. *Lophozia kunzeana* (Hüb.) Evans, which was earlier reported from one station in the Tatra Mts foothills at ca 1000 m, appeared to be an almost constant and common component of the hummocks in the subalpine zone – at present we are aware of over 100 stations. During floristic investigations of the hepatic flora of the Tatra Mts, the senior author paid attention to the hummock flora since the late 1950s, but more intensive studies of this formation began in 1985 and were not limited to the Tatras; they included the highest ranges of the Beskidy Mts (Babia Góra Mt.) and Bieszczady Zachodnie Mts, having at least the subalpine zone. H. Klama, E. Chudzińska and A. Bączkiewicz were also involved in some parts of the investigation.

Distribution of hummocks in the Polish mountains and some ecological remarks

In the Polish part of the Tatra Mts, the hummocks are most typically formed on north- and west-facing gentle slopes of the western part of the ridge called Tatry Zachodnie (West Tatras), for example on the eastern slopes (facing west) over the upper part of the Dolina Jarząbcza valley, the ridge between the summits of Czerwony Wierch Mt. and Łopata Mt. (between the Dolina Jarząbcza and Wyżnia Dolina Chochołowska valleys), the north slopes of Wołowiec Mt., west- and north-facing slopes of Ornak Mt., north-facing slopes over the Siwa Przełęcz pass, north-facing slopes under the Przełęcz Goryczkowa Pod Zakosy and Przełęcz Goryczkowa Świńska passes, Babi Grzbiet (in the upper Pyszniańska Dolina valley) and many other places (Figs 1–3). In the eastern Polish part called Tatry Wysokie (High Tatras) the hummocks are less common. We observed them on the northern slopes of Wołoszyn Mt. (above the beginning of Usypisty Żleb ravine, on the Popaski slopes), northern slopes of Żółta Turnia Mt., SE bank of Zadni Staw Polski lake, moraine slopes below Czarny Staw Nad Morskim Okiem lake, etc. There are similar hummocks in other high ranges of the Polish Carpathians: Bieszczady Zachodnie Mts (Szweykowski & Buczkowska 1996), Babia Góra Mt., and in a very impoverished state in the Karkonosze Mts (Sudetes), even though there are extensive peat bogs in these mountains.

According to Jeník (1958), who investigated such hummocks in the western part of the Slovakian Tatra Range, they were formed relatively recently on sheep tracks running parallel to contour lines. However, many times we have observed a chaotic distribution of hummocks; moreover, in some places a floristically similar formation built of *Sphagnum* and *Polytrichum* species is developed on extensive areas (several tens of meters across) without forming separate hummocks. We observed such areas not only in the Tatra Mts (e.g., on the north-facing slope of Ornak Mt. above Przełęcz Iwaniacka pass) but also in the Bieszczady Zachodnie Mts, on the north-facing slopes of Krzemień Mt. The last case is particularly interesting. After heavy rains in 1992, running water made an erosion gully through the central part of the formation, revealing under the plant cover a substantial layer of peat over 1 m thick. We interpret such cases as peat bogs hanging on the slopes (*Hängmoor* in German terminology) and suppose that a different genesis of

the hummocks is also possible. It seems probable that they are remnants of the mossy alpine tundra that was destroyed by sheep among other factors. We shall not speculate on the genesis of the formation in question, but suggest that palynological investigations would help solve that problem.

Fig. 1. *Sphagnum-Polytrichum* hummocks in the Tatra Mts – old, partially eroded hummocks on NE slope of Babi Grzbiet Mt. (upper Dolina Pyszniańska valley). Phot. A. Bączkiewicz.

Fig. 2. *Sphagnum-Polytrichum* hummocks in the Tatra Mts – N slope of Ornak Mt. (ca. 1700 m). Phot. K. Buczkowska).

Fig. 3. *Sphagnum-Polytrichum* hummocks in the Tatra Mts – hummock with *Lophozia binsteadii* (Kaal.) Evans growing between *Polytrichum* stems, general view. Phot. K. Buczkowska.

Our observations indicate that the hummocks have a distinct development cycle (see Fig. 4). A young hummock is flat and harbours only incidental growth of hepatics. When the hummocks get older they grow and become higher without a substantial extension of their diameter. After reaching a height of about 50 cm they begin to disintegrate, erode or even overturn. In the last case the plants die but sometimes begin to grow again on the freshly denuded surface.

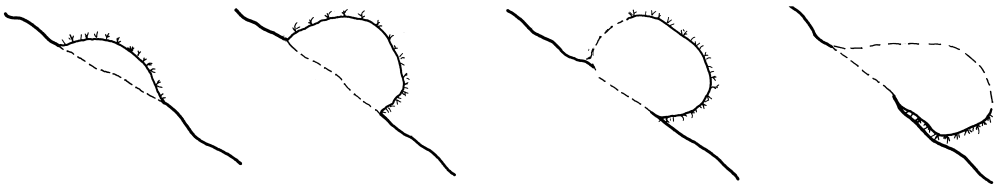

Fig. 4. Stages of hummock development.

Floristic differentiation

From casual observations it seems evident that the floristic composition of hummocks varies depending on the elevation and the substrate, to name only the main sources of variation. Hummocks formed on the northern slopes of Kopa Upłaziańska Mt. (built mostly of lime rock) are overgrown by a large form of *Tritomaria quinquedentata* (Huds.) H. Buch; this is a strange site for a plant that is widespread in the Tatra Mts but grows principally at lower elevations on mossy rocks and detritus in areas rich in lime. Similar hummocks formed on the northern slopes of Wołowiec Mt. (above the pass between Wołowiec and Rakoń Mts) harbour *Marsupella commutata* (Limpr.) Bernet, which usually grows among mosses on acidic rock detritus in granite parts of the Tatras.

Some geographical differentiation of the hepatic flora of the hummocks can also be observed. *Anastrophyllum michauxii* (F. Weber) H. Buch, a boreal species usually growing in spruce forests of the upper forest zone, has been found as a regular component of the hummock flora in the Bieszczady Zachodnie Mts (Szweykowski & Buczkowska 1996), and very rarely in hummocks on the northern slopes of Babia Góra Mt. (Szweykowski, Klama, Buczkowska, Bączkiewicz, in preparation). In the Tatra Mts the species is restricted in its occurrence to forests but has never been collected above the timber line. *Tritomaria exsectifomis* (Breidl.) Loeske, growing in many European mountain ranges, is abundant in hummocks in the Bieszczady Zachodnie Mts but rare on hummocks in the Tatra Mts, and seems to be absent from hummocks on Babia Góra Mt. Apart from the Tatras, Babia Góra Mt. is the only mountain in Poland reaching the alpine zone (1725 m). It harbours two very interesting plants in its hummock flora. These plants have been identified as *Lophozia* cfr. *latifolia* Schust. and *Lophozia* cfr. *rufescens* Schljakov. We are not aware of similar plants growing elsewhere in the Polish mountains.

Hepatics either grow among mosses and do not show above the surface of the hummock or else overgrow the mosses (most frequently *Sphagnum*) with delicate creeping stems; sometimes hepatics can be found growing at the very base of an old hummock (Fig. 5A–C). In all cases they are inconspicuous. This is probably the main reason they have not been reported from our mountains until recently, in spite of the collecting activity of many bryologists in the area under study.

Fig. 5. Growth of hepatics in *Sphagnum-Polytrichum* hummocks. A – among mosses; B – creeping on the upper surface of a hummock, C – at base of hummock.

List of rare and otherwise interesting species found so far on hummocks

1. ***Lophozia binsteadii*** (Kaal.) Evans – an arctic-alpine species, frequent on hummocks, particularly in the western part of the Tatra Mts (Polish part); restricted in its occurrence (in the Tatras) to hummocks (Fig. 3)

2. ***Lophozia kunzeana*** (Hüb.) Evans – a plant with a similar type of geographic distribution, but also growing in a few relict localities in the North Polish lowlands (Szweykowski 1956). It is an almost steady element of the hummocks in the Tatra Mts, and it has been found recently on hummocks on Babia Góra Mt. as well (Szweykowski *et al.*, in preparation).

3. ***Lophozia longiflora*** (Nees) Schiffn. (non *Lophozia guttulata* (Lindb.) Evans nec *Lophozia porphyroleuca* auct.) – a critical species growing in the North on *Sphagnum*; it is found in the Tatra Mts in many places exclusively on hummocks, sometimes en masse (e.g., on northern slopes of Wołowiec Mt.). It also grows on hummocks on Babia Góra Mt., but rarely (Szweykowski *et al.*, in preparation).

4. ***Lophozia*** cfr. ***latifolia*** Schuster. – an arctic species known so far from Greenland (Schuster & Damsholt 1974; Schuster 1988), Svalbard, Siberia and north Russia (Grolle & Long 2000); data from Scandinavia are, according to Grolle (1967), erroneous. A critical plant that agrees in every detail with Schuster's description and illustrations (Schuster 1969: 525–531) except for being strikingly brown-purple. The plant is being studied by the senior author.

5. ***Lophozia*** cfr. ***rufescens*** Schljakov – an Arctic species known so far from northern Russian territory from the Murmansk region to the Far East, also reported from Finland (Grolle & Long 2000). A critical plant which agrees very well with Schljakov's description (Schljakov 1980). According to Váňa (see Grolle & Long 2000: 117) it is only a synonym of *Lophozia sudetica*; however, according to Schljakov (1980: 118) one of the synonyms of *Lophozia rufescens* is *L. wenzelii* var. *lapponica* Buch & S. Arnell, which produces yellow-green gemmae. The plant is being studied by the senior author.

6. ***Lophozia atlantica*** (Kaal.) K. Müll. – an arctic-alpine species of distinct suboceanic character, generally rare in the Tatra Mts, it grows here relatively frequently on hummocks but is not restricted in its occurrence to them. Unknown from other Polish mountains.

7. ***Lophozia attenuata*** (Mart.) Dumort. – a boreal-montane plant growing first of all in montane forests; a frequent component of hummock flora; it is known from all mountains in Poland so far studied. However, typical forms are almost entirely restricted to forest zones; plants growing on hummocks are different, and their taxonomic status awaits elucidation.

8. ***Lophozia barbata*** (Schmid. *ex* Schreb.) Dumort. – a boreal species frequent in the forest zones in all Polish mountains studied so far; sporadically it grows also at higher elevations; found on hummocks only once in the Tatras (although it is widespread in the forest zones). It seems to be lacking from the hummock flora in the Bieszczady Zachodnie Mts (Szweykowski & Buczkowska 1996); neither it has been found on hummocks on Babia Góra Mt. (Szweykowski *et al.*, in preparation).

9. ***Bazzania trilobata*** (L.) S. Gray – a boreal species widespread in the upper forest zones in most Polish mountains studied so far, growing mainly in spruce forests; scattered stations are known in the lowlands (particularly in NE Poland); it has been found on hummocks only once in the Tatra Mts, but in the Bieszczady Zachodnie Range most of its stations are on hummocks. One station on hummocks was discovered recently on Babia Góra Mountain.

10. ***Anastrophyllum minutum*** (Schreb.) Schust. – a very frequent component of the hummock flora, but not restricted to it. It grows on hummocks in all mountains studied, particularly dominant in this formation on Babia Góra Mountain (Szweykowski *et al.*, in preparation).

11. ***Anastrophyllum michauxii*** (F. Web.) Buch – this rare species is nearly restricted in its occurrence to the forest zone in many mountain ranges, with only one station in the Białowieża Primeval Forest, North Polish Lowlands (Karczmarz & Kornijów 1981); in the Tatras it grows on rotten wood and on moist and shaded rocks exclusively in forest zones; however, in the Bieszczady Zachodnie Mts (Szweykowski & Buczkowska 1996) and on Babia Góra Mt. (Szweykowski *et al.*, in preparation) it grows on hummocks in the subalpine zone, having only a few stations in the forests.

12. ***Tritomaria exsectiformis*** (Breidl.) Loeske – a species of restricted occurrence in Central Europe; in the Tatras it has been found twice on hummocks; in the Bieszczady Zachodnie Mts it is not rare but grows exclusively on them (Szweykowski & Buczkowska 1996). It seems to be absent from the hummock flora on Babia Góra Mt.

13. ***Marsupella commutata*** (Limpr.) H. Bern. – the species is restricted in Poland to the Tatra Mts, where it is widespread on mossy rocks and rock detritus, occurring exclusively above the tree line; on hummocks is has been found so far only on the northern slope of Wołowiec Mt., where it is abundant.

14. ***Mylia taylorii*** (Hook.) S. Gray – a widespread species growing usually on rotten wood in montane forests, but also growing frequently on hummocks.

15. ***Mylia anomala*** (Hook.) S.Gray – a boreal species common in raised peat bogs in the north Polish lowland. Very rare in the mountains, except for hummocks: it is an almost steady component of their hepatic flora.

16. ***Calypogeia sphagnicola*** (H. Arn. & J. Perss.) Warnst. & Loeske – a species confined usually to peat bogs, growing in their wet parts (hollows). Very rare in the mountains, except for hummocks: in the Tatra Mts it is an almost steady component of their hepatic flora; it has been found also on hummocks in the Bieszczady Zachodnie Mts (Szweykowski & Buczkowska 1996) and, in only two places, on Babia Góra Mt. (Szweykowski *et al.*, in preparation). Plants growing on hummocks belong to forma *paludosa* (Warnst.) Schuster rather than to the typical form: they are larger, usually do not produce gemmae, and their oil bodies are for the most part segmented.

17. ***Calypogeia neesiana*** (Mass. & Carest.) K. Müll. – a species occurring in north Poland usually on peat bogs but also in heath (on naked soil), and rarely on rotten wood. In the forest zones of the Tatra Mts it is confined to peat bogs and their surroundings; above the tree line it occurs frequently and almost exclusively on hummocks. The plant is also widespread on hummocks in the Bieszczady Zachodnie Mts (Szweykowski & Buczkowska 1996) and on Babia Góra Mt. (Szweykowski *et al.* in preparation).

18. ***Cephalozia connivens*** (Dicks.) Lindb. – a boreal species confined to raised peat bogs and very characteristic of them; it is very rare in the mountains. In the Tatra Mts it has been found only a few times and exclusively on hummocks.

19. ***Lophozia ventricosa*** (Dicks.) Dumort. *em*. Buch – this boreal species can be identified only when living material is at hand, therefore its general geographical distribution and its ecology are not well understood; in Poland, however, where the oil bodies have been routinely checked in most cases, it occurs rarely on denuded soil in the lowlands and is much more frequent in the forest zones of the mountains; the species also grows above the tree line but its occurrence is more restricted there; in the Tatra Mts it is met frequently on hummocks but is not confined to this formation.

20. ***Lophozia silvicola*** Buch – this critical species can be identified only when living material is at hand, therefore its general geographical distribution and ecology are not well known; in Poland, however, where the oil bodies have been checked routinely in most cases, it grows rarely in the lowlands (mainly on denuded soil) and is widespread in the forest zones in the mountains; it grows above the tree line as well, but its occurrence is more restricted here; in the Tatra Mts the species can be found frequently on hummocks, but it is not confined to this formation; in the Bieszczady Zachodnie Mts, *Lophozia silvicola* seems to be nearly confined to hummocks (Szweykowski & Buczkowska 1996).

21. ***Kurzia trichoclados*** (K. Müll.) Grolle – this very rare plant, which is confined in its occurrence to Europe, has been found in Poland in only two places in the Tatra Mts; in both places it grows exclusively on hummocks.

22. ***Anastrepta orcadensis*** (Hook.) Schiffn. – this plant is widespread in higher mountain ranges and grows profusely in their forest zones; in the Tatra Mts it occurs frequently on hummocks also. The species behaves similarly in the Bieszczady Zachodnie range (Szweykowski & Buczkowska 1996) and on Babia Góra Mt.. (Szweykowski *et al.*, in preparation), but in these two mountain ranges hummocks are the main place of its occurrence.

23. ***Lophozia hatcheri*** (Evans) Steph. – a species widespread in the mountains in forest and subalpine zones, it also grows in a few places in the lowlands (sometimes en masse); in higher mountains it occurs frequently on hummocks.

24. ***Ptilidium ciliare*** (L.) Hampe – a plant widespread in pine forests in the lowlands and, avoiding deciduous forests at lower elevations, reappearing in spruce forests; it also occurs above the tree line but grows almost exclusively on hummocks there.

A suite of other species can also be found growing on hummocks sporadically: *Bazzania tricrenata* (Wahlenb.) Lindb., *Blepharostoma trichophyllum* (L.) Dumort. (relatively frequent on hummocks in the Bieszczady Zachodnie Mts – Szweykowski & Buczkowska 1996), *Cephalozia pleniceps* (Austin) Lindb., *Lophozia floerkei* (Weber & D. Mohr) Schiffn., *L. lycopodioides* (Wallroth) Cogn., *L. opacifolia* Culm. and *L. wenzelii* (Nees) Steph.

PHYTOGEOGRAPHICAL AND ECOLOGICAL CHARACTER OF HEPATIC FLORA OF HUMMOCKS

It is evident from the above list that the hepatic flora of the hummocks is very heterogeneous in terms of the geographical distribution and ecology of its particular species.

(1) First of all a group of arctic-alpine species should be mentioned. Here belong species widespread in the Arctic and Subarctic regions that are basically restricted to the higher elevations in Central Europe and only exceptionally can be found at scattered stations in the European lowlands; *Lophozia binsteadii* and *L. kunzeana* are typical members of this group. The first is restricted in Poland to the Tatra Mts and the latter grows in some places in the Sudetes, on Babia Góra Mt., and a few stations in the north Polish lowlands.

(2) The second group comprises boreal species bound to raised peat bogs; they are usually rare or very rare in the mountains, but interestingly enough are frequent and almost steady components of the hummock flora in the Tatra Mts and Bieszczady Za-

chodnie Mts, and can be found also on Babia Góra Mt. The most peculiar characteristics of their pattern of occurrence is that they are widespread in the lowlands and subalpine zones, with no or very few stations in between (the bizonal species of Suza 1938). Most typical species of this group are *Mylia anomala, Calypogeia sphagnicola* and *Cephalozia connivens* growing exclusively or nearly exclusively on peat bogs and hummocks. A less typical member of this group is *Calypogeia neesiana*, which is nearly restricted to peat bogs in the lowlands (it does grow in heath and acidic pine forests also, but exceptionally); in the Tatra and Bieszczady Zachodnie Mts it is most common in subalpine and alpine zones on hummocks but also grows on eroded soil (particularly in the Bieszczady Zachodnie Mts; Szweykowski & Buczkowska 1996).

(3) The third group harbours forest species, which frequently occur also above the tree line and then frequently or even exclusively on hummocks. Some of them are *Ptilidium ciliare, Lophozia lycopodioides, L. attenuata, Anastrepta orcadensis* and *Tritomaria exsectiformis*.

(4) The next group contains montane species that are ecologically versatile, growing on rocks, rock detritus and eroded soil: *Anastrophyllum minutum, Marsupella commutata, Lophozia wenzelii* and *Bazzania tricrenata*.

(5) Kurzia trichoclados should belong to a group of its own: probably an old species of very disjunct geographical area, generally very rare; so far as is known, it grows in the Tatra Mts exclusively on hummocks at two different sites; in spite of being such a rarity, it forms velvety cushions dominating many hummocks on the moraine slopes below Czarny Staw nad Morskim Okiem lake.

(6) The last group comprises incidental species that usually grow at other sites and only sporadically on hummocks: *Lophozia opacifolia,* a plant characteristic of late-snow areas, grows on hummocks on the northern slope of Wołoszyn Mt.; *Lophozia atlantica,* a species of rocks and rock detritus, is a frequent element of hummocks on the north slope of Ornak Mt.; *Cephalozia pleniceps* grows in the Tatras usually on humus over limestone rocks, and also has been found on hummocks on the banks of Czarny Staw Polski lake.

As is evident from the above discussion and the list of hepatics growing on hummocks, their flora is very heterogeneous; it is plausible that the ecological conditions of the hummocks (intensive light, steady humidity provided by peat mosses) provide an asylum for many different ecological elements. An important ecological condition seems to be that the hummocks form on1y where no running water is present, that is, well above the sources of brooks, streams, etc. Thus it is probably, an ombrophilous formation supplied by precipitation.

We hope that this short communication will draw bryologists' attention to this remarkable plant formation.

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