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Recent data on occurrence the sporophytes in populations of dioecious moss, *Nyholmiella obtusifolia* in North-Eastern Poland

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Abstract: Moss *Nyholmiella obtusifolia* is relatively common in Poland, but mostly sterile specimens are found in herbarium collections. Sporogenes were created very rare. During bryological explorations conducted in NE Poland in 2009 – 2011, sporophytes were found in four populations of *N. obtusifolia*, which account for approximately 7% of the surveyed populations.

Key words: *Nyholmiella obtusifolia*, sporogones, sporophytes, Poland

Introduction

The genus *Nyholmiella* Holmen & Warncke contains two species, *N. gymnostoma* and *N. obtusifolia*, which have been described by Bridel as *Orthotrichum gymnostomum* and *O. obtusifolium* in the subgenus *Orthophyllum*.

The distinctness of species belonging to the subgenus *Orthophyllum* from other taxa of the genus *Orthotrichum* was noted by Delogne who was the first to place two species, *O. gymnostomum* and *O. obtusifolium,* into the subgenus *Orthophyllum*. Hagen (1908) went one step further, forming a separate genus for the above species, namely *Stroemia* Hag. They were distinguished by obtuse leaves with incurved or plane leaf margins and incrassate leaf cells with a stout central papilla on each side. Since *Stroemia* was an illegitimate name, it was later replaced by *Nyholmiella* Holmen & Warncke (Damsholt et al. 1969). A later revision of the genus *Orthotrichum* resulted in the inclusion of *O. gymnostomum* and *O. obtusifolium* into *Orthotrichum* (Vitt 1973), as the above features were also observed in other representatives of this genus.

Nyholmiella obtusifolia and *N. gymnostoma* may be distinguished from each other on the basis of the peristome, which is double in the former and lacking in the latter. The gametophytes of the two species are easily separated by leaf margins and cell papillosity: *N. gymnostoma* has inrolled margins and two papillae per leaf cell surface, while *N. obtusifolia* has erect margins and unipapillose cell surfaces. During a bryological survey in Newfoundland (Canada) the hybrid between *Nyholmiella obtusifolia* and *N. gymnostoma* has been found (Hedderson 1986). The taxonomical characters are intermediate between the two taxa.

Phylogenetic studies of the genus *Orthotrichum* showed a clear distinctness between members of the subgenus *Orthophyllum* and the other *Orthotrichum* species, which supported the reactivation of the genus *Nyholmiella* (Goffinet et al. 2004, Sawicki et al. 2009, Sawicki et al. 2010). A molecular analysis with the use of selected classes of markers (nrDNA, cpDNA, ISJ and ISSR) resolved *Nyholmiella* as a sister group to monoecious *Orthothrichum* species with immersed stomata (Sawicki et al. 2009, Sawicki et al. 2010), surprisingly revealing a lower degree of genetic similarity to the dioecious *Orthotrichum lyellii* and monoecious *Orthotrichum* with superficial stomata.

Nyholmiella obtusifolia is widespread in the European continent (north to Svalbard), Greenland, the Caucasus, the Himalayas, Turkey, central and eastern Asia and North America. *N. gymnostoma* occurs in Europe (north to Fennoscandia), the Caucasus, Turkey, Afghanistan, Japan and North America. Both species can also be found in Poland (Ochyra et

al. 2003). The populations of *N. obtusifolia* are relatively abundant, in both urbanized areas and natural forest ecosystems. *N. gymnostoma* has been seldom reported from Poland. Between ten and twenty localities of the species had been described by German botanists from the region of Warmia and Mazury (NE Poland), but despite a thorough exploration of the area the occurrence of *N. gymnostoma* could not be confirmed.

N. obtusifolia is relatively common in Poland, but mostly sterile specimens are found in herbarium collections. Sporogenes are seldom present. The mature capsule is oblong-cylindrical, strongly 8-ribbed to base and 1/2 emergent. Stomata are superficial, located at or above the middle of the capsule. The peristome is double: 8 reflexed exostome teeth and 8 endostome segments. The calyptra is short-conic, naked, papillose. Spore size is from 20 to 25 μm (capsule development is shown in Figures 1-6).

On the territory where the species occur together, *N. obtusifolia* might be confused with *Orthotrichum flowersii*. However, *O. flowersii* has immersed stomata, reflexed to revolute leaf margins, and it is autoicous. In addition, *O. flowersii* does not have distal leaf cells with one papilla per cell, while *N. obtusifolia* does.

The taxonomic distinctness of *N. gymnostoma* and *N. obtusifolia* has been confirmed by molecular analyses. Nuclear ITS sequences, the chloroplast *trn*H-*psb*A region, and ISJ and ISSR markers revealed the existence of numerous species-specific substitutions, indels and bands (Plášek et al. 2009, Sawicki et al. 2009, Sawicki et al. 2010).

Results and discussion

During bryological explorations conducted in NE Poland in 2009 – 2011, sporophytes were found in four populations of *N. obtusifolia*, which account for approximately 7% of the surveyed populations. The locations of those populations are shown in Map 1. In the monitored populations, new sporophytes first appear in March and April, capsules mature and spores are dispersed in September and October. The studied populations were similar in terms of abundance, but they differed considerably with respect to the number of sporophytes. In 2009 – 2011, the highest number of sporophytes (23 to 34) was noted in the population located in Kortowo (a part of Olsztyn city). The number of sporophytes in the remaining populations ranged from 4 (Gietrzwałd village) to 11 (a population in the vicinity of Wyszków town).

The mechanisms determining sporophyte formation in the populations of dioecious mosses have not been investigated in detail to date. In the majority of dioecious moss species, sexual dimorphism is weakly pronounced, except in a few cases (Shaw & Goffinet 2000). Among *Orthotrichum* species, differences in the size of males and females were observed in *Orthotrichum lyellii* (Vitt 1971). Male and female gametophytes may also differ in spore germination and clonal proliferation patterns (McLetchie 1992, Shaw & Beer 1999). Due to the absence of differences in the structure of the vegetative organs, it is often impossible to determine whether both male and female plants are present in the population. The presence of representatives of one sex only is not sufficient for sporophyte development.

The success of sexual reproduction is also determined by weather conditions during the maturation of antheridia and archegonia. In mosses, fertilization occurs in the aquatic environment, and a distance between male and female plants is often a limiting factor. Sperm transport may be mediated by small invertebrates (Cronberg et al. 2006) whose presence may be another prerequisite for successful reproduction.

An analysis of the sex ratio in the populations of dioecious mosses is difficult due to low and periodically manifested sexual dimorphism. Sex-linked molecular markers are increasingly applied in bryological studies (McLetchie and Collins 2001, Fujisawa et al. 2001, Korpelainen et al. 2008). Such markers are currently being developed for *Nyholmiella*

obtusifolia (Milewicz & Sawicki 2011), in order to identify the factors affecting the sex ratio and sexual reproduction success in the populations of this species.

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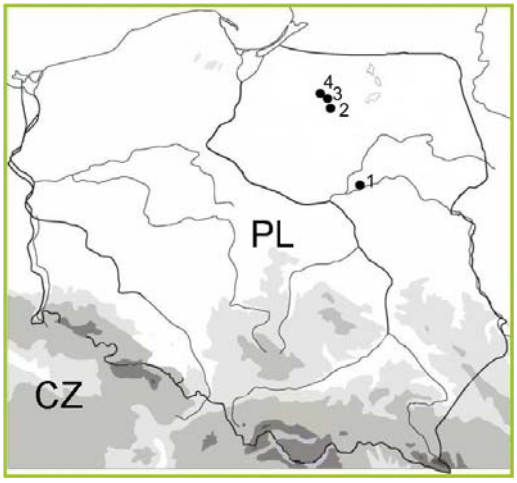
Figs 1-6: Photomicrographs of *Nyholmiella obtusifolia* ontogeny. 1. Sterile population with gemmae (in detail). 2. Sterile plants with gemmae presented on abaxial leaf surface. 3. Calyptra (naked). 4. Young capsule with the lid. 5. Peristome of mature capsule. 6. Old discharged capsules.



Map 1: Locality of the populations of *Nyholmiella obtusifolia* with sporophytes: 1 – Leszczedół near Wyszków, 2 – Baudy (22 km SE from Olsztyn), 3 – Olsztyn-Kortowo, 4 – Gietrzwald (17 km WN from Olsztyn).