

DISTRIBUTION OF FIVE INTERESTING WOODLAND KEY HABITAT BRYOPHYTE INDICATOR SPECIES IN LATVIA

Sanita Putna, Anna Mežaka

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Distribution of five epiphytic bryophyte species (*Anomodon longifolius*, *Homalia trichomanoides*, *Jamesoniella autumnalis*, *Lejeunea cavifolia*, *Neckera pennata*), which are Woodland Key Habitat (WKH) indicators was analyzed in Latvia. The relationship between forest density and distribution of WKH bryophyte indicator species was observed in the present study. *Homalia trichomanoides* and *Neckera pennata* were the most widespread bryophyte species. *Jamesoniella autumnalis* and *Lejeunea cavifolia* showed an Eastern distribution trend, but *Anomodon longifolius* have found rarely than other studied species.

Key words: epiphytic bryophytes, indicator species, bryophyte distribution, Woodland Key Habitat.

Sanita Putna. Administration of Nature Protection, Rezekne, Zemnieku iela 16a, LV-4601, Latvia, e-mail: sanita.putna@inbox.lv

Anna Mežaka. Research Institute for Regional Studies, Rezekne Higher Education Institution, Atbrivosanas aleja 115, Rezekne, LV-4601, Latvia, e-mail: anna.mezaka@ru.lv

INTRODUCTION

In Northern Europe, one of the tools that have been used in the evaluation of forest ecosystem value is woodland key habitats (WKHs), which are small forest stands with high biodiversity (Timonen et al. 2010). WKHs are identified by old-growth characteristics, including structural elements and indicator or specialist species (Ek et al. 2002, Timonen et al. 2010).

Epiphytic bryophytes are among indicators applied to determine forest continuity and naturalness (Ek et al. 2002, Mežaka et al. 2010). The richness and abundance of epiphytic species are depending on forest stand age, host tree species, age, size, and growth rate. Epiphyte community composition changes with height

on a tree, in relation to light intensity, relative humidity, and features of the tree bark (Znotiņa 2003). Bryophyte species mostly from late succession stages were found (e.g. *Anomodon longifolius*, *Neckera pennata*) (Putna & Mežaka 2014) in WKHs of Northern Latvia. The studies about epiphytic bryophyte species geographical distribution in Latvia are still lacking. The data about distribution of epiphytic bryophytes are fragmentary, the results from research are mainly obtained in individual projects, but there are still lacks for summary of bryophyte distribution trends, which are important to nature conservation.

The objective of the present study is to characterize and compare five WKH bryophyte indicator species distribution in Latvia.

MATERIALS AND METHODS

Data about bryophyte indicator species distribution (Fig.1-5.) was collected from Forest State Agency data base and personal database of Anna Mežaka. Data from epiphytic bryophyte studies (Putna 2013) in Gulbene district (North-East Latvia) - Dūres mežs Nature Reserve (mixed coniferous-deciduous and aspen forests), Kadājs Nature Reserve (spruce and mixed spruce and black alder wetland forests), Krapas gārša Nature Reserve (broad-leaved, mixed coniferous-deciduous and black alder wetland forests), Pededzes lejtece Nature Reserve (deciduous and mixed coniferous-deciduous forests), Sitas and Pededzes paliene Nature Reserve (deciduous forests), Zepu mežs Nature Reserve (deciduous forests) were used for the present study.

The forest stand age amplitude of Forest State Agency data was 60-140 years and older, personal database of A. Mežaka – from 40 until 210 years and data of S. Putna - from 40 until 103 years. The study sites were selected based on the WKH inventory data (Ek et al. 2002; Anonīms 2003). Maps of bryophyte distribution were made by ESRI ArcView GIS 10.0 using database GIS Latvija 9.2. Information about mosses and liverworts were collected from different sources (Ignatova et al. 2009, Atherton et al. 2010, Strazdiņa et al. 2011).

Anomodon longifolius – Moss with very slender, yellowish-green shoots up to 2 cm long. Erect, irregularly branched shoots arise from creeping primary stems. Leaves are 1–2.5 mm long, with a base that runs down onto the stem. Grows on tree trunks and rocks in wooded valleys, and particularly favours ravines. Substrate pH 5.6-7.1 (Atherton et al. 2010., Strazdiņa et al. 2011).

Homalia trichomanoides – Moss with yellowish-green shoots up to 6 cm long, leaves are smooth and shiny. Distributed in deciduous forests on tree trunks and also on rocks, substrate pH 3.6-7.4 (Atherton et al. 2010., Strazdiņa et al. 2011).

Jamesoniella autumnalis – Liverwort with medium-sized shoots (0.5–2.5 mm wide) and round leaves (about 1 mm wide and long) is often pale green. Fertile material is easier to identify because male bracts are lobed (entire in similar species). Female bracts are more finely divided, and the perianth has long, thin teeth at its mouth. Y-shaped branching is another diagnostic feature (Atherton et al. 2010).

Lejeunea cavifolia – Liverwort with small shoots up to 2 cm long and 0.5–1.5 mm wide, delicate, pale or dark green. It has a row of large, rounded, often more or less overlapping, bilobed underleaves. The lobule is relatively small and the underleaves are about 2 or 3 times the width of the stem. Often fertile, with small, five keeled perianths. *Lejeunea cavifolia* grows on trees, dead wood and soil in shaded and humid places, particularly woodland, substrate pH 5.1-6.0. It often creeps through other bryophytes (Atherton et al. 2010., Strazdiņa et al. 2011), Red-listed in Latvia, category 2 (Āboliņa 1994).

Neckera pennata – Moss, plants medium-sized to large, light green, whitish- to brownish-green, glossy. Secondary stems 4-7 cm long, 3.0-4.0 mm wide with leaves, curved upwards, pinnately branched, shoots strongly complanate, branches 5-12 mm long, *Neckera pennata* is frequent and abundant on tree trunks, mostly on deciduous – *Acer*, *Ulmus*, *Tilia*, *Populus*, substrate pH 3.8-6.1 (Ignatova et al. 2009., Strazdiņa et al. 2011), Red-listed in Latvia, category 2 (Āboliņa 1994).

RESULTS

Largest WKH areas (> 710 ha) were found in Ventspils, Dobeles, Bauskas, Jēkabpils, Madonas, Gulbenes, Alūksnes and Balvu district. In these territories, except Ventspils district, also was found highest number of studied WKH bryophyte indicator species. High number of WKH bryophyte indicator species were found in Bauskas, Ogres and Limbažu district, where WKH area is 221- 500 ha and in Aizkraukles district, where WKH area is 501-710 ha (VMD et al. 2005).

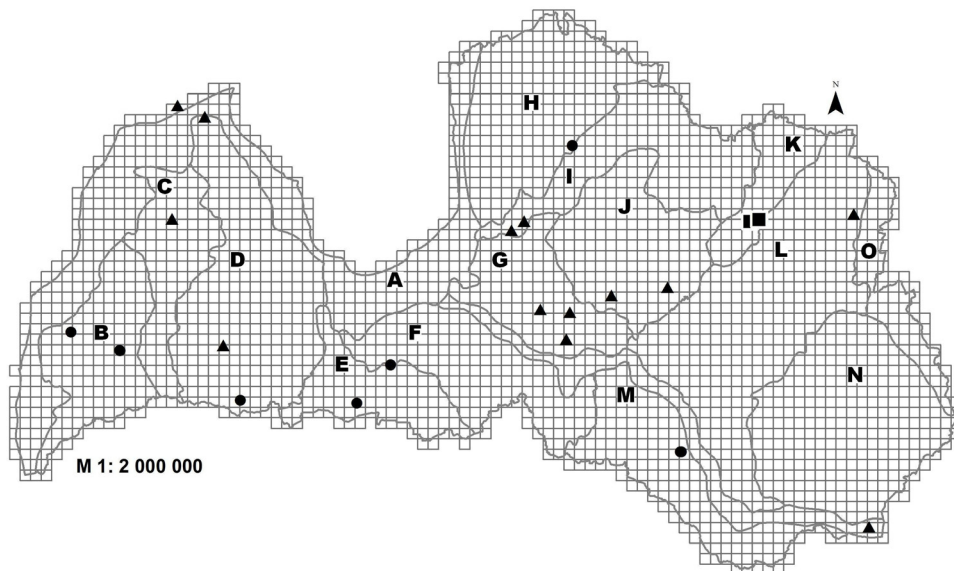


Fig.1. *Anomodon longifolius* distribution in Geobotanical regions of Latvia in 5x5 km square network. (Latvian State Forest Service data (circle), personal database of Anna Mežaka (triangle), personal data base of Sanita Putna (square)). Geobotanical regions (Ramans 1994): A-Piejūra, B-Kursa, C-Ventas land, D - Austrumkursā, E-Rietumzemgale, F-Austrumzemgale, G-Dienvidvidzeme, H-Ziemeļvidzeme, I-Gaujas land, J-upland Vidzeme, K-Austrumvidzeme, L-Aiviekstes land, M-Augšzeme, N-upland Latgale, O-Austrumlatgale.

After Geobotanical region or landscape zone classification in Latvia (Ramans 1994), relatively small number of WKH bryophyte indicator species were found in Piejūra, Rietumzemgale Geobotanical regions and upland of Latgale. Higher number of WKH bryophyte indicator species was found in nature regions Austrumkursā, Rietumkursā, Ventas land, Ziemeļvidzeme and Gaujaszeme (Fig.2,3,5). Highest concentration of studied WKH indicator species was found in Austrumzemgale, Dienvidvidzeme, Aiviekstes land and Augšzeme Geobotanical regions. The relationship between forest density and distribution of WKH bryophyte indicator species is observed in Geobotanical regions of Austrumzemgale and Dienvidvidzeme.

All studied WKH bryophyte indicator species mostly were found in middle and North-East part of Latvia, except *Anomodon longifolius* (Fig.1). After Latvian State Forest Service data *A. longifolius* have found rarely than other studied species and none of records were found

in Gulbene district. After data of S. Putna (2013) *A. longifolius* was found in Krapas gārša Nature Reserve and in Pēdēdzes lejtece Nature Reserve on six sample trees –*Fraxinus excelsior*, *Ulmus glabra*, *Ulmus laevis*, *Tilia cordata* and *Alnus glutinosa*, mostly on North-West and West exposure. After Latvian State Forest Service data *Anomodon longifolius* have found rarely than other studied species and none of records were found in Gulbene district. *Anomodon longifolius* was found in Krapas gārša Nature Reserve and in Pēdēdzes lejtece Nature Reserve after the data of S. Putna. *Anomodon longifolius* was found also on *Ulmus laevis*, *Populus tremula*, *Quercus robur* after the database of A.Mežaka.

Neckera pennata and *Homalia trichomanoides* was the most common of studied bryophytes. Large number of both species was found also in Gulbene district, especially in mixed broad leaved forest of Pēdēdzes lejtece Nature Reserve. *Homalia trichomanoides* (Fig.2) mostly was found on *Populus tremula*, *Fraxinus excelsior*

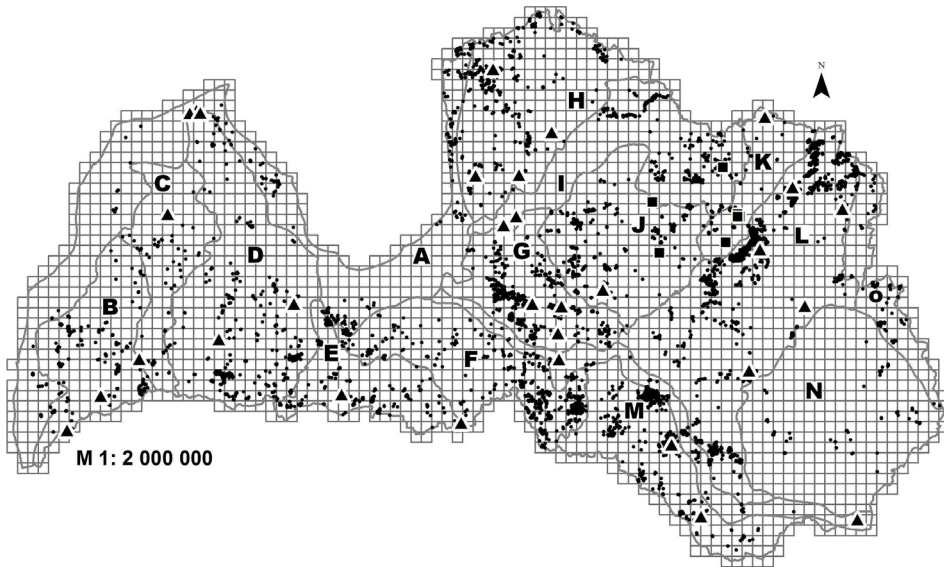


Fig.2. *Homalia trichomanoides* distribution in Geobotanical regions of Latvia in 5x5 km square network. (Latvian State Forest Service data (circle), personal database of Anna Mežaka (triangle), personal data base of Sanita Putna (square)). Geobotanical regions (Ramans 1994): A-Piejūra, B-Kursa, C-Ventas land, D - Austrumkursā, E-Rietumzemgale, F-Austrumzemgale, G-Dienvidvidzeme, H-Ziemeļvidzeme, I-Gaujas land, J- upland Vidzeme, K-Austrumvidzeme, L-Aiviekstes land, M-Augšzeme, N- upland Latgale, O-Austrumlatgale.

and *Ulmus glabra*, but less on *Tilia cordata*, *Acer platanoides*, *Alnus glutinosa* and *Alnus incana* on lowest part of tree stems until 50 cm height, but in some places until 1.50 m height on North-West, South-West and West exposure after the data of S. Putna. After the data base of A. Mežaka, *H. trichomanoides* was found also on *Quercus robur*; *Populus tremula*, *Ulmus laevis*, *Carpinus betulus*, *Betula pendula*, *Sorbus aucuparia*.

Neckera pennata (Fig.3) was also found on typical tree species – mostly on *Populus tremula* and *Acer platanoides*, less on *Sorbus aucuparia*, *Tilia cordata*, *Ulmus glabra* and *Fraxinus excelsior*. Mostly *Neckera pennata* have mosaic growth on groups by 20x20 cm or 40x30 cm and usually was found until 1.50 m or even higher on tree stem with dominant exposure in North, North-East and West sides after the data of S. Putna. *Neckera pennata* was found also on *Ulmus laevis*, *Carpinus betulus*, *Betula pendula*, *Quercus robur* after the database of A. Mežaka.

Quite similar distribution trend found for *Lejeunea cavifolia* and *Jamesoniella autumnalis*, especially in Geobotanical regions Austrumzemgale, Dienvidvidzeme and Augšzeme. *Lejeunea cavifolia* (Fig.4) have dispersed distribution in all territory of Latvia, but the highest number of records was found in Eastern part of Central Latvia. After the data of S. Putna *L. cavifolia* was found only in Krapas gārša Nature Reserve on two sample trees – *Populus tremula* and *Sorbus aucuparia* at middle tree stem part in small groups on North and North-West exposure. After the data base of A. Mežaka, *L. cavifolia* was found also on *Ulmus glabra*, *U. laevis*, *Fraxinus excelsior*, *Acer platanoides*, *Tilia cordata*.

Jamesoniella autumnalis (Fig.5) was found mostly in Eastern part of Central Latvia. *Jamesoniella autumnalis* was found only in black alder wetland forests and swamp forests of Kadājs Nature Reserve on *Betula pendula* together with *Dicranum scoparium* and *Plagiothecium laetum* after the data of S. Putna. In both places



Fig.3. *Neckera pennata* distribution in Geobotanical regions of Latvia in 5x5 km square network. (Latvian State Forest Service data (circle), personal database of Anna Mežaka (triangle), personal data base of Sanita Putna (square)). Geobotanical regions (Ramans 1994): A-Piejūra, B-Kursa, C-Ventas land, D - Austrumkursa, E-Rietumzemgale, F-Austrumzemgale, G-Dienvidvidzeme, H-Ziemeļvidzeme, I-Gaujas land, J- upland Vidzemes, K-Austrumvidzeme, L-Aiviekstes land, M-Augšzeme, N- upland Latgale, O-Austrumlatgale.

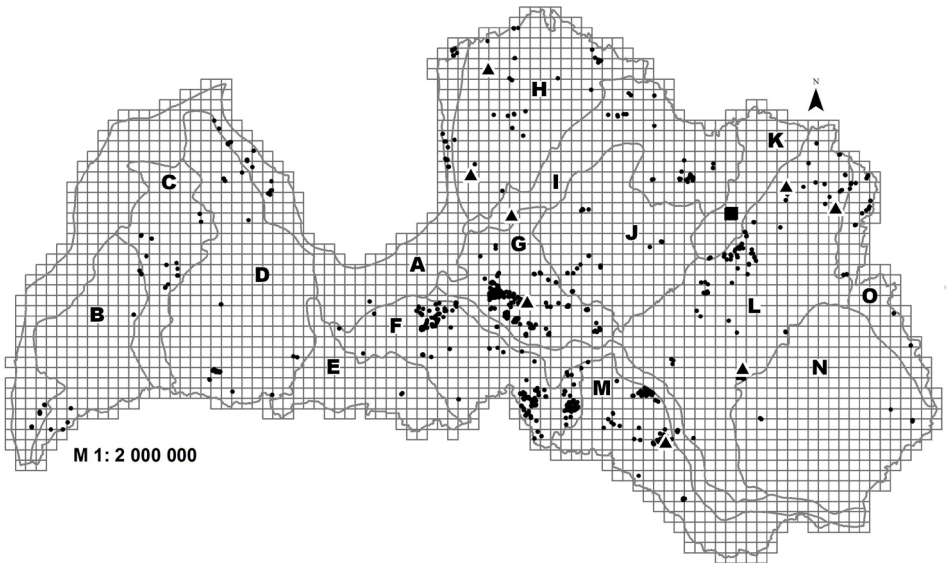


Fig.4. *Lejeunea cavifolia* distribution in Geobotanical regions of Latvia in 5x5 km square network. (Latvian State Forest Service data (circle), personal database of Anna Mežaka (triangle), personal data base of Sanita Putna (square)). Geobotanical regions (Ramans 1994): A-Piejūra, B-Kursa, C-Ventas land, D - Austrumkursa, E-Rietumzemgale, F-Austrumzemgale, G-Dienvidvidzeme, H-Ziemeļvidzeme, I-Gaujas land, J- upland Vidzeme, K-Austrumvidzeme, L-Aiviekstes land, M-Augšzeme, N- upland Latgale, O-Austrumlatgale.

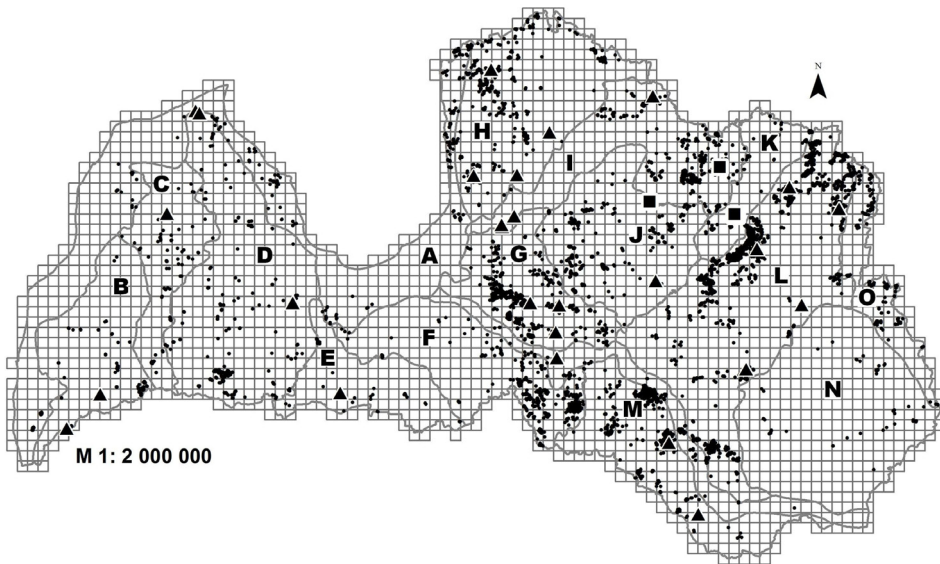


Fig.5. *Jamesoniella autumnalis* distribution in Geobotanical regions of Latvia in 5x5 km square network. (Latvian State Forest Service data (circle), personal database of Anna Mežaka (triangle), personal data base of Sanita Putna (square)). Geobotanical regions (Ramans 1994): A-Piejūra, B-Kursa, C-Ventas land, D - Austrumkursā, E-Rietumzemgale, F-Austrumzemgale, G-Dienvidvidzeme, H-Ziemeļvidzeme, I-Gaujas land, J- upland Vidzeme, K-Austrumvidzeme, L-Aiviekstes land, M-Augšzeme, N- upland Latgale, O-Austrumlatgale.

J. autumnalis was found on tree stem lowest part until 36 cm height at North exposure. After the data base of A. Mežaka, *J. autumnalis* was found also on *Tilia cordata*.

DISCUSSION

Climatic conditions and forest type probably are main factors influencing differences in bryophyte species distribution. The highest distribution of WKH indicator species was found in territories with higher average annual precipitation amount and higher broad-leaved forest cover (Kalniņa 1995).

In the present study *Homalia trichomanoides* and *Neckera pennata* were the most widespread bryophyte species as in other studies in Latvia (Anonims 2003., Putna, Mežaka 2014) and in Estonia, where *Neckera pennata* have decreasing distribution and it also has been considered to be an indicator species of old-growth forests

(Ingerpuu et al. 2007). After Latvian State Forest Service data *Lejeunea cavifolia* have rather dispersed distribution in Latvia, but after A. Mežaka (2009), and Latvian State Forest Service data *L. cavifolia* was more common in Central and Eastern parts of Latvia. In the present study the distribution of *Jamesoniella autumnalis* was connected with deciduous trees – *Alnus glutinosa* and *Betula pendula* as in study by M. Firstova (2011), but in boreal forests of Canada *J. autumnalis* is one of bryophytes with highest indicator value on dead wood (Mills & Macdonald 2005). *Anomodon longifolius* was the less common bryophyte species in the present study being rather common only in Central part of Latvia. As in this study, *A. longifolius* was mostly found on broad-leaved trees, e.g. *Quercus robur* by S. Ikauniece et al. (2012)

The present study contributes to the knowledge of epiphytic bryophyte distribution and ecology in North-East Latvia. Further studies about bryophyte distribution and ecology in Latvia are

necessary for better understanding of species distribution trends and their environmental requirements.

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