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DYNAMICS OF THE PHYTOCOENOTIC ROLE OF *ARTHONIA LAPIDICOLA* (TAYLOR) BRANTH & ROSTR. IN EPILITHIC LICHEN GROUPINGS IN MAARDU PHOSPHORITE QUARRIES, NORTH ESTONIA

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Abstract. New to the lichen species of Estonia, *Arthonia lapidicola* (Taylor) Branth & Rostr. was found on limestone substrates of different exposure ages (9, 14, 19, 24 years) in Maardu phosphorite quarries in North Estonia. Here the dynamics of the phytocoenotic role of this species in lichen groupings is analysed. In Maardu quarries *A. lapidicola* quickly colonizes newly exposed limestone substrates, successfully competing with *Lecanora hagenii* (Ach.) Ach. and excluding the latter from the lichen groupings at the early successional stages. But at later successional stages, *A. lapidicola* itself is extruded from lichen groupings by foliose lichens *Phaeophyscia orbicularis* (Neck.) Moberg and *P. nigricans* (Flörke) Moberg during a period of five years.

Key words: *Arthonia lapidicola*, epilithic lichen groupings.

New to the lichen flora species of Estonia, *Arthonia lapidicola* (Taylor) Branth & Rostr. was found in Maardu quarries on limestone substrates of different ages of exposure. Maardu is a small town located in the northern part of Estonia, 15—18 km northeast of Tallinn. The investigated quarries were formed as a results of mining of the Maardu phosphorite deposits.

A. lapidicola is characterized by a scattered distribution in temperate Europe, Asia and North America.

According to Wirth (1980), *A. lapidicola* grown on limestone and calcareous silicate rocks, especially on small stones, stony soil and man-made substrates (roofing slates and so on). This lichen species is a weak competitive pioneer and it is excluded by the other lichen species at later successional stages.

The purpose of the present work was to study the phytocoenotic role of *A. lapidicola* in lichen groupings on newly exposed limestone substrates of different exposure ages in Maardu quarries.

METHODS AND MATERIAL

Field studies were carried out in 1990 in five quarries recultivated in 1981, 1976, 1971, 1966, 1961. Thus, the ages of investigated lichen groupings could be exactly dated. It was 9, 14, 19, 24, 29 years, respectively.

The lichen groupings of limestones were studied by using a 20×20 cm quadrat with a 2×2 cm grid. Sample plots were chosen at random. Three hundred plots were located in the quarries recultivated in 1981, 1966, 1961 (100 plots in each quarry), eight in the quarry recultivated in 1976 and five in the quarry recultivated in 1971.

The species composition of lichen groupings was described for each quadrat. The coverage and general frequency (in percentage) were estimated for each species. The coverage and general frequency were estimated also for the algae and mosses occurring in a quadrat.

The nomenclature of lichen species follows Santesson (1993). The list of lichens is presented below.

Lichen species mentioned in the text:

Acarospora cervina A. Massal.
Arthonia lapidicola (Taylor) Branth & Rostr.
Aspicilia contorta ssp. hoffmanniana Ekman & Fröberg in Fröberg
Caloplaca decipiens (Arnold) Blomb. & Forssell
Caloplaca holocarpa (Hoffm. ex Ach.) A. E. Wade
Caloplaca lactea (A. Massal.) Zahlbr.
Candelariella aurella (Hoffm.) Zahlbr.
*Lecania cuprea** (A. Massal.) v. d. Boom & Coppins in v. d. Boom
Lecania erysibe (Ach.) Mudd
Lecanora albescens (Hoffm.) Branth & Rostr.
Lecanora dispersa (Pers.) Sommerf.
Lecanora hagenii (Ach.) Ach.
Lecanora muralis (Schreb.) Rabenh.
Lecidella stigmatea (Ach.) Hertel & Leuckert
Phaeophyscia nigricans (Flörke) Moberg
Phaeophyscia orbicularis (Neck.) Moberg
Physcia adscendens (Fr.) H. Olivier
Physcia caesia (Hoffm.) Fürnr.
Sarcogyne regularis Körb.
Verrucaria muralis Ach.
Verrucaria nigrescens Pers.

RESULTS AND DISCUSSION

A. lapidicola was found in four of the five investigated quarries. Changes in the average coverage of *A. lapidicola* at sample plots and the general frequency of this species in quarries depending on the age of lichen groupings, are presented in Table 1. As Table 1 shows, *A. lapidicola* has maximal average coverage of sample plots in 19-year-old lichen groupings and maximal general frequency in 14-year-old ones. Then, with a subsequent increase in the age of lichen groupings, the average coverage of sample plots and the general frequency of this lichen species decrease. Finally, it is not present at all in 29-year-old lichen groupings.

* *Lecania cuprea* is a new species for Estonian lichen flora. Information data this species will be presented in a separate publication.

Table 1

Changes in the average coverage and general frequency of *Arthonia lapidicola* depending on the age of lichen groupings (all sample plots are considered)

Age of lichen groupings, years	General frequency, %	Average coverage, %
9	10	1
14	50	3
19	20	4
24	9	1
29	0	0

Table 2

Sørensen's coefficients of floristic similarities (K) between lichen groupings of different ages

Ages of lichen groupings, years	9	14	19	24
14	52			
19	43	67		
24	36	37	37	
29	28	30	31	69

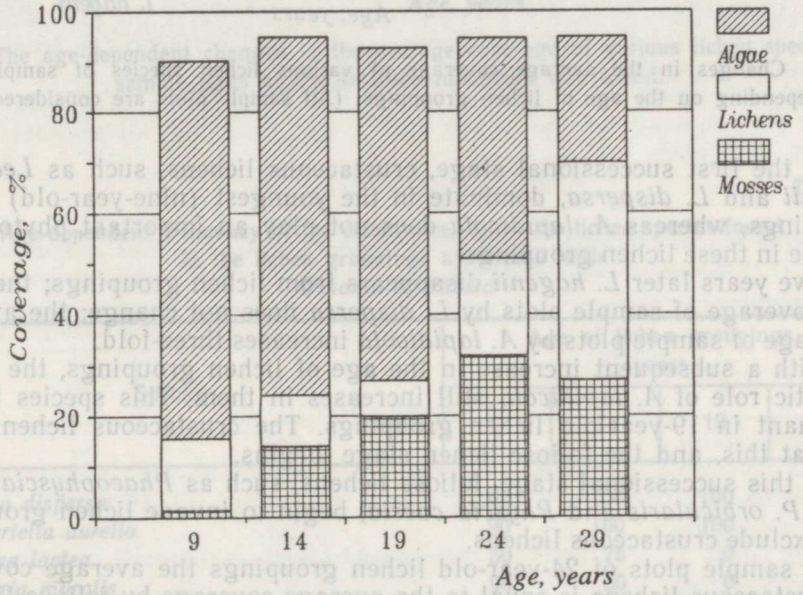

Fig. 1. Changes in the average coverage of lichens, mosses and algae of sample plots depending on the age of communities. (All sample plots are considered).

Fig. 1 shows that the average coverage by the algae decreases with an increase of the ages of the communities; at first the average coverage by mosses increases, reaching maximum in 24-year-old communities, and then it decreases; the average coverage by lichens at first decreases, reaching minimum in 19-year-old communities, and then increases, reaching maximal value in 29-year-old communities outrivalling mosses and algae.

Changes in the average coverage of sample plots by various lichen species depending on the ages of lichen groupings are presented in Fig. 2. As it can be seen in Fig. 2, the successional changes in the composition and structure of lichen groupings on limestones passed two stages during the thirty years.

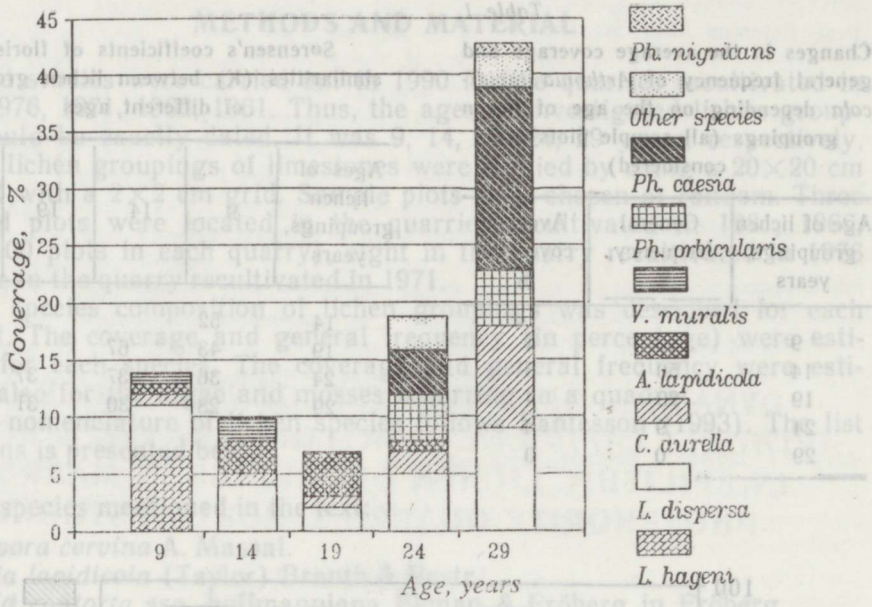

Fig. 2. Changes in the average coverage of various lichen species of sample plots depending on the age of lichen groupings. (All sample plots are considered).

At the first successional stage, crustaceous lichens, such as *Lecanora hagenii* and *L. dispersa,* dominate in the youngest (nine-year-old) lichen groupings, whereas *A. lapidicola* does not play an important phytocoenotic role in these lichen groupings.

Five years later *L. hagenii* disappears from lichen groupings; the average coverage of sample plots by *L. dispersa* does not change; the average coverage of sample plots by *A. lapidicola* increases three-fold.

With a subsequent increase in the age of lichen groupings, the phytocoenotic role of *A. lapidicola* still increases in them. This species is predominant in 19-year-old lichen groupings. The crustaceous lichen stage ends at this, and the foliose lichen stage begins.

At this successional stage, foliose lichens, such as *Phaeophyscia nigricans, P. orbicularis* and *Physcia caesia,* begin to invade lichen groupings and exclude crustaceous lichens.

At sample plots of 24-year-old lichen groupings the average coverage by crustaceous lichens is equal to the average coverage by folious lichens. The role of *A. lapidicola* in these lichen groupings decreases considerably.

In five years' time this lichen species disappears from lichen groupings. Foliose lichens become dominating in them, the role of crustaceous lichens decreases.

Analyses of Sørensen's coefficients of floristic similarity (Greig-Smith, 1964) of lichen groupings of different ages (Table 2) plainly show that the composition and structure of lichen groupings change considerably with an increase in their ages. Table 2 also shows that the successional changes in lichen groupings pass two stages. Therefore, there are two maximal Sørensen's coefficients which demonstrate sufficient floristic similarity between 14-year-old and 19-year-old lichen groupings, and between 24-year-old and 29-year-old ones. At the same time, there is a low floristic similarity between 19-year-old and 24-year-old lichen groupings. This fact refers to the fact that considerable changes in the composition and structure of lichen groupings occur in the course of five years, i. e., during the period when one successional stage is replaced by another.

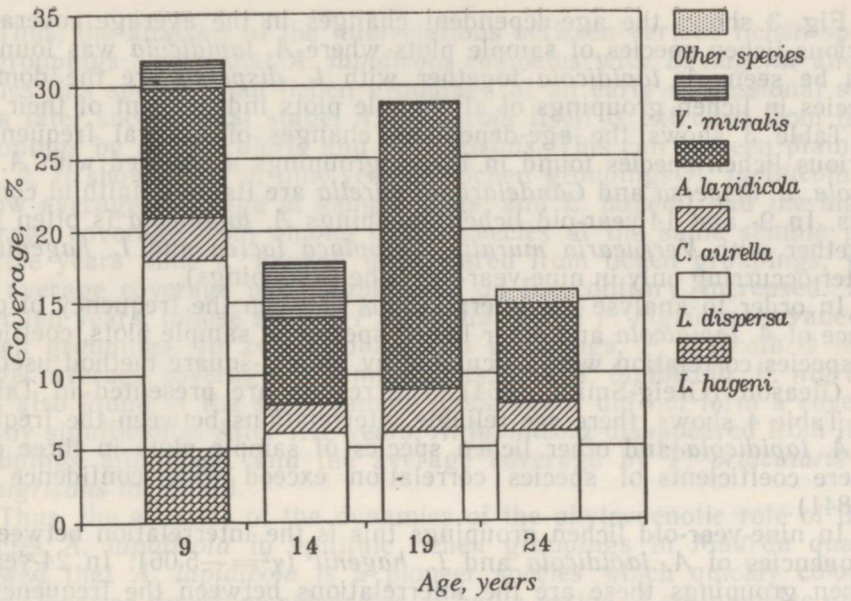

Fig. 3. The age-dependent changes in the average coverage of various lichen species of sample plots where *Arthonia lapidicola* was found.

Table 3

Age-dependent frequency of the occurrence, %, of the lichen species found in the lichen groupings associated with *Arthonia lapidicola*

Species	Age of lichen groupings, years			
	9	14	19	24
Lecanora dispersa	90	100	100	100
Candelariella aurella	90	100	100	89
Caloplaca lactea	50	75	0	22
Verrucaria muralis	90	50	0	33
Lecanora hagenii	70	0	0	0
Acarospora cervina	20	0	0	11
Aspicilia contorta ssp. hoffmanniana	10	0	0	11
Caloplaca decipiens	0	0	0	11
Caloplaca holocarpa	0	0	0	11
Lecania cuprea	10	0	0	0
Lecania erysibe	30	0	0	0
Lecanora albescens	0	0	0	22
Lecanora muralis	10	0	0	11
Lecidella stigmatea	20	25	0	33
Phaeophyscia nigricans	10	0	0	11
Phaeophyscia orbicularis	0	0	0	22
Physcia adscendens	0	0	0	33
Physcia caesia	0	0	0	33
Sarcogyne regularis	10	0	0	11
Verrucaria nigrescens	0	0	0	22

Fig. 3 shows the age-dependent changes in the average coverage of various lichen species of sample plots where *A. lapidicola* was found. As can be seen, *A. lapidicola* together with *L. dispersa* are the dominant species in lichen groupings of all sample plots independent of their ages.

Table 3 shows the age-dependent changes of general frequency of various lichen species found in lichen groupings associated with *A. lapidicola, L. dispersa* and *Candelariella aurella* are its most faithful companions. In 9- and 14-year-old lichen groupings *A. lapidicola* is often found together with *Verrucaria muralis, Caloplaca lactea* and *L. hagenii* (the latter occurring only in nine-year-old lichen groupings).

In order to analyse the interrelations between the frequency of occurrence of *A. lapidicola* and other lichen species at sample plots, coefficients of species correlation were calculated by the chi-square method used first by Gleason (Greig-Smith, 1964). The results are presented in Table 4. As Table 4 shows, there are reliable interrelations between the frequency of *A. lapidicola* and other lichen species of sample plots in three cases, where coefficients of species correlation exceed 95% confidence level (3.841).

In nine-year-old lichen groupings this is the interrelation between the frequencies of *A. lapidicola* and *L. hagenii* (χ^2=—5.06). In 24-year-old lichen groupings these are the interrelations between the frequencies of *A. lapidicola* and *P. nigricans* (χ^2=—7.91) and between the frequencies of *A. lapidicola* and *P. orbicularis* (χ^2=—4.47). All three coefficients of species correlation are negative numbers, which means that with an increase in frequency of one lichen species the frequency of another lichen species decreases.

Table 4

Coefficients of species correlation between frequency of *A. lapidicola* and other lichen species on sample plots in lichen groupings of different ages

Species	Age of lichen groupings, years			
	9	14	19	24
Acarospora cervina	1.29	—	—	0
Aspicilia contorta ssp. hoffmanniana	0.44	—	—	0.45
Caloplaca decipiens	—	—	—	0.71
Caloplaca holocarpa	1.25	—	—	0.37
Caloplaca lactea	0.47	0	—	0.55
Candelariella aurella	0	0	2.0	0
Lecania cuprea	1.15	—	—	—
Lecania erysibe	0.69	—	—	—
Lecanora albescens	—	—	—	1.49
Lecanora dispersa	0	0	0	0
Lecanora hagenii	−5.06	—	—	—
Lecanora muralis	1.11	—	—	0
Lecidella stigmatea	1.78	1.14	—	0
Phaeophyscia nigricans	0.44	—	—	−7.91
Phaeophyscia orbicularis	—	—	—	−4.47
Physcia adscendens	1.32	—	—	0
Physcia caesia	—	—	—	1.98
Sarcogyne regularis	0.44	—	—	0.32
Verrucaria muralis	0	2.66	—	0
Verrucaria nigrescens	—	—	—	1.34

95% confidence level = 3.841

Thus, the analysis of the interrelations between various lichen species in groupings shows that *A. lapidicola* competes with *L. hagenii* and excludes this species from lichen groupings at an early successional stage. At a later successional stage, *A. lapidicola* itself is extruded from lichen groupings by *P. orbicularis* and *P. nigricans*. This can be seen plainly in Fig. 2. It shows that in nine-year-old lichen groupings *A. lapidicola* had a low average coverage at sample plots, and *L. hagenii* had the highest average coverage from among lichen species at the same sample plots. In five years' time *L. hagenii* disappeared from lichen groupings, while the average coverage by *A. lapidicola,* on the contrary, increased. Then, after ten years, foliose species *P. orbicularis* and *P. nigricans* invaded the lichen groupings. In 24-year-old lichen groupings, *P. orbicularis* had a bigger average coverage at sample plots than *A. lapidicola. P. nigricans* was also found at the same sample plots, but it did not form a coverage of any significance. After five years, *A. lapidicola* disappeared from lichen groupings altogether, and the average coverage by *P. orbicularis* and *P. nigricans* increased.

Thus, the analysis of the dynamics of the phytocoenotic role of lichen species *A. lapidicola* in epilithic lichen groupings in Maardu quarries showed that *A. lapidicola* is a pioneer species which quickly colonizes newly exposed limestone substrates. It had a period of an intensive growth and it competed successfully with other lichen species during nineteen years. Afterwards this species was excluded from lichen groupings by foliose lichen species in the course of five years.

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REFERENCES

Greig-Smith, P. 1964. Quantitative Plant Ecology. Edinburgh, London.

Santesson, R. 1993. The lichens and lichenicolous fungi of Sweden and Norway. Lund, Sweden.

Wirth, V. 1980. Flechtenflora. Verlag Eugen Ulmer, Stuttgart.

SAMBLIKU *ARTHONIA LAPIDICOLA* (TAYLOR) BRANTH & ROSTR. FÜTOTSÖNOOTILISE OSATÄHTSUSE DÜNAAMIKA EPILIITSETES SAMBLIKURÜHMITUSTES MAARDU FOSFORIIDIKARJÄÄRIDES

Marina TEMINA

Arthonia lapidicola, Eesti lihhenofloora uus liik, leiti Maardu fosforiidikarjääri erivanuselistelt lubjakivipaljanditelt. *A. lapidicola* asustab suktsessiooni algstaadiumil värskelt paljandunud lubjakivisubstraate ja konkureerib edukalt liigiga *Lecanora hagenii,* tõrjudes selle samblikurühmitustest välja. Suktsessiooni hilisematel staadiumidel tõrjuvad lehtsamblikud *Phaeophyscia orbicularis* ja *P. nigricans* viie aasta jooksul samblikurühmitustest välja *A. lapidicola.*

ДИНАМИКА ФИТОЦЕНОТИЧЕСКОЙ РОЛИ ЛИШАЙНИКА *ARTHONIA LAPIDICOLA* (TAYLOR) BRANTH И ROSTR. В ЭПИЛИТНЫХ ЛИШАЙНИКОВЫХ ГРУППИРОВКАХ ФОСФОРИТОВЫХ КАРЬЕРОВ В МААРДУ, СЕВЕРНАЯ ЭСТОНИЯ

Марина ТЕМИНА

Изучено фитоценотическое поведение нового для лихенофлоры Эстонии вида *Arthonia lapidicola,* найденного на разновозрастных известняковых обнажениях фосфоритовых карьеров в Маарду. Установлено, что на ранней стадии сукцессии *A. lapidicola* заселяет свежеобнаженные известняковые субстраты и успешно конкурирует с видом *Lecanora hagenii,* вытесняя его из лишайниковых группировок. На более поздней стадии сукцессии *A. lapidicola* сама вытесняется из лишайниковых группировок листоватыми видами *Phaeophyscia orbicularis* и *P. nigricans* в течение пяти лет.