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Principal relationships among epiphytic communities on common oak (*Quercus robur* L.) trunks in Lithuania

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The diversity, frequency and richness of epiphytic communities on oak trunks are determined by different ecological factors. With changing the shading of trunks, the texture of tree bark, eutrophication level of some lichen communities disappear and are replaced by other lichen communities.

Key words: epiphytic communities, common oak, Lithuania

INTRODUCTION

In a broad sense, epiphytes are organisms that are constantly attached to trunks and branches of plants but do not draw water or mineral nutrients from living tissues of the host plant (phorophyte). Therefore links between epiphytes and phorophytes are mostly topical. Epiphytes are being intensively studied in different countries: floristically (Kuusinen, 1996; Hultengren, 1999; Rutkowski, Kukwa, 2000; Zedda, 2002, etc.), ecologically (Bates, 1992; Gauslaa, 1995; Romagni, Gries, 1997; Kürschner, 2003, etc.) and sociologically (Czarnota, 1997; Dale, John, 1999; Gloßner, Türk, 1999; Alvarez, Carballal, 2000; Zedda, 2001, etc.). Results of these studies are especially important for environment monitoring, determination of indicators for atmosphere purity and forest ecological stability. Sociological studies of epiphytic lichen and mosses in Lithuania were performed for six years (Prigodina 1998, 1999; Prigodina-Lukošienė, Naujalis, 2001; Prigodina-Lukošienė, 2001). This paper analyzes successions of lichen communities in relation to different ecological factors on *Quercus robur* trunks.

MATERIALS AND METHODS

Studies of epiphytes and their communities on common oaks were performed in 1999–2003 in oak-woods situated in different parts of Lithuania (in the western part: Juodkrantė oak wood (Klaipėda district), Kreiviškės, Liepija, Minija, Tamožinė forests (Plungė district); in the southern part: Drausgiris forest (Vilkaviškis district), Gojus forest (Prienai district), in the eastern part of Lithuania: Varnikai oak-wood (Trakai district), Dūkštos oak-wood (Vilnius district), Ginučiai forest (Ignalina district), Gustonys oak-wood (Panevėžys district). The research was performed in 79 plots where epiphytes of 524 oak trunks were studied. During the research, 1990 relevés were described.

Studies in each forest were carried out on 100 m^2 plots. All oaks growing in a plot were analyzed. The age of the trees was determined according to forest management data. All forests were devided into two groups: 1) half-life and maturing oak woods (age of prevailing trees ranged from 50 to 120 years); 2) old oak woods (age of prevailing trees exceeded 120 years). Participation of trees and shrubs in a forest community was evaluated according to vertical layers (M^1, M^2 and K) using the scale of J. Braun-Blanquet (1964).

Epiphytic lichen communities on oak trunks were described on 20 × 20 cm relevés. For the description each relevé was covered with transparent plastic frames graded into 4 cm^2 areas. Participation of epiphytic species was evaluated visually according to the J. Braun-Blanquet scale modified by V. Wirth (1972). During the field studies, the following variables were recorded: 1) overall area occupied by epiphytic communities (dm^2); (2) community exposition on a tree trunk; (3) trunk dimensions (m) in the points of relevé; (4) bark roughness (cm).

Sociological studies of epiphytes were performed following the principles of floristic-sociological classification of phytocoenoses defined by the J. Braun-Blanquet school (Braun-Blanquet, 1964) and were adapted for epiphyte study (Klement, 1955; Barkman, 1958). The primary classification of the communities was carried out using the Microsoft Excel program, grouping descriptions with similar species composition. For classification of sociological descriptions, the STATISTICA 5.0 program of statistical analysis (StatSoft, 1995) was employed, which performed the grouping of sociological descriptions using the methods of cluster analysis and principal components.

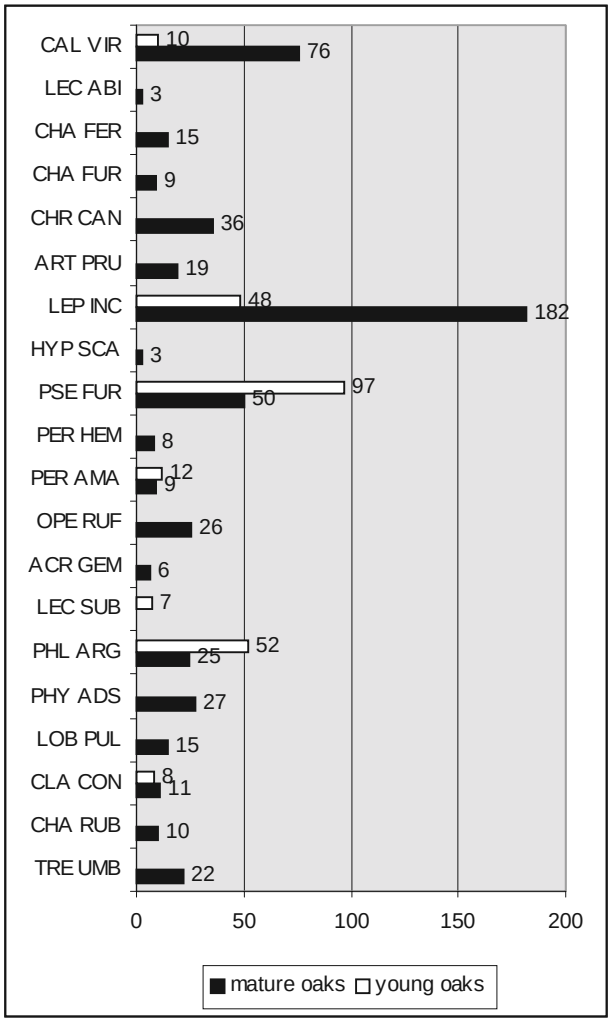

Fig. 1. The frequency of epiphytic communities in maturing and in old oak woods. On the axis of abscisses – the number of communities; on the axis of oordinates – the index of epiphytic communities (TRE UMB – *Trentepohlia umbrina*, CHA RUB – *Chaenothecopsidetum rubescentis*, CLA CON – *Cladonietum coniocraeae*, LOB PUL – *Lobarietum pulmonariae*, PHY ADS – *Physcietum adscendentis*, PHL ARG – *Phlyctidetum argenae*, LEC SUB – *Lecanoretum subfuscae*, ACR GEM – *Acrocordietum gemmatae*, OPE RUF – *Opegraphetum rufescentis*, PER AMA – *Pertusarietum amarae*, PER HEM – *Pertusarietum hemisphaericae*, PSE FUR – *Pseudevernietum furfuraceae*, HYP SCA – *Hypocenomycetum scalaris*, LEP INC – *Leprarietum incanae*, ART PRU – *Arthonietum pruinatae*, CHR CAN – *Chrysotrichetum candelaris*, CHA FUR – *Chaenothecetum furfuraceae*, CHA FER – *Chaenothecetum ferrugineae*, LEC ABI – *Lecanactidetum abietinae*, CAL VIR – *Calicietum viridis*)

RESULTS AND DISCUSSION

Seven classes of epiphytic communities were identified on oak trunks in Lithuania. Their communities belong to 7 orders, 10 alliances and 20 associations.

The frequency and distribution of epiphytic communities on oaks in different forests vary significantly (Fig. 1). The most frequent are *Leprarietum incanae* communities (27%). High frequency communites belonging to this association can be explained by wide ecological amplitudes of species they consist of. Besides, it is the only association of the class *Chrysotrichetea candelaris*, which forms communities in half-age forests both in the eastern and western parts of Lithuania. Communities of this association on maturing trees are less common, because epiphytic communities favouring averagely lit situations form there. In half-aged oak-woods of western Lithuania, communities of *Calicietum viridis* form on trunks of maturing trees. *Calicium viride*, a characteristic suboceanic species of this association, is particularly frequent on trunks of various tree species irrespectively of trunk diameter and bark texture. Meanwhile in eastern Lithuania, communities of *Calicietum viridis* are found only on oak trunks of mature climax forests. Such distribution is characteristic of other communities of *Chrysotrichetea candelaris* associations as well: *Arthonietum pruinatae*, *Chaenothecetum furfuraceae*, *Chaenothecetum ferrugineae*, *Lecanactidetum abietinae* and *Chrysotrichetum candelaris*. These associations are characteristic only of mature forests, because they consist of anombrophilous species, inhabiting only bark crevices which are more than 1.5 cm in depth and width.

Communities of the association *Pseudevernietum furfuraceae* are second of the most frequent ones (17%) in Lithuanian oak-woods. These communities are more frequent in maturing forests than in mature ones. Such distribution peculiarities can be explained by a different light regime in different forest age groups.

Significant differences in the frequency of epiphytic communities were determined in forests of varying age. Communities of only seven associations were found in maturing forests. On trunks of half-aged trees, apart from previously mentioned associations *Leprarietum incanae* and *Pseudevernietum furfuraceae* and association *Calicietum viridis* (in western Lithuania), communities belonging to the quite persistent pioneer or transient associations *Lecanoretum subfuscae*, *Phlyctidetum argenae* and *Pertusarietum amarae* were also registered. Communities of *Cladonietum coniocraeae* are quite frequent on trunks of oaks of similar age. The frequency of these communities on trunks of young oaks is determined by their bark texture, because they favour smooth – barked trunks. Another important ecological factor determining formation of these communities is better insolation of half-aged oak trunks if compared with mature ones. Communities of 19 associations were identified on trunks of mature oaks. Only communities of *Lecanoretum subfuscae* are not characteristic of trunks of old oaks, apparently due to the very rough bark of old trees.

Geographical differences of the communities are discussed within the limits of the associations *Calicietum viridis*, *Pseudevernietum furfuraceae* and *Pertusarietum hemisphaericae*. Communities of these associations dif-

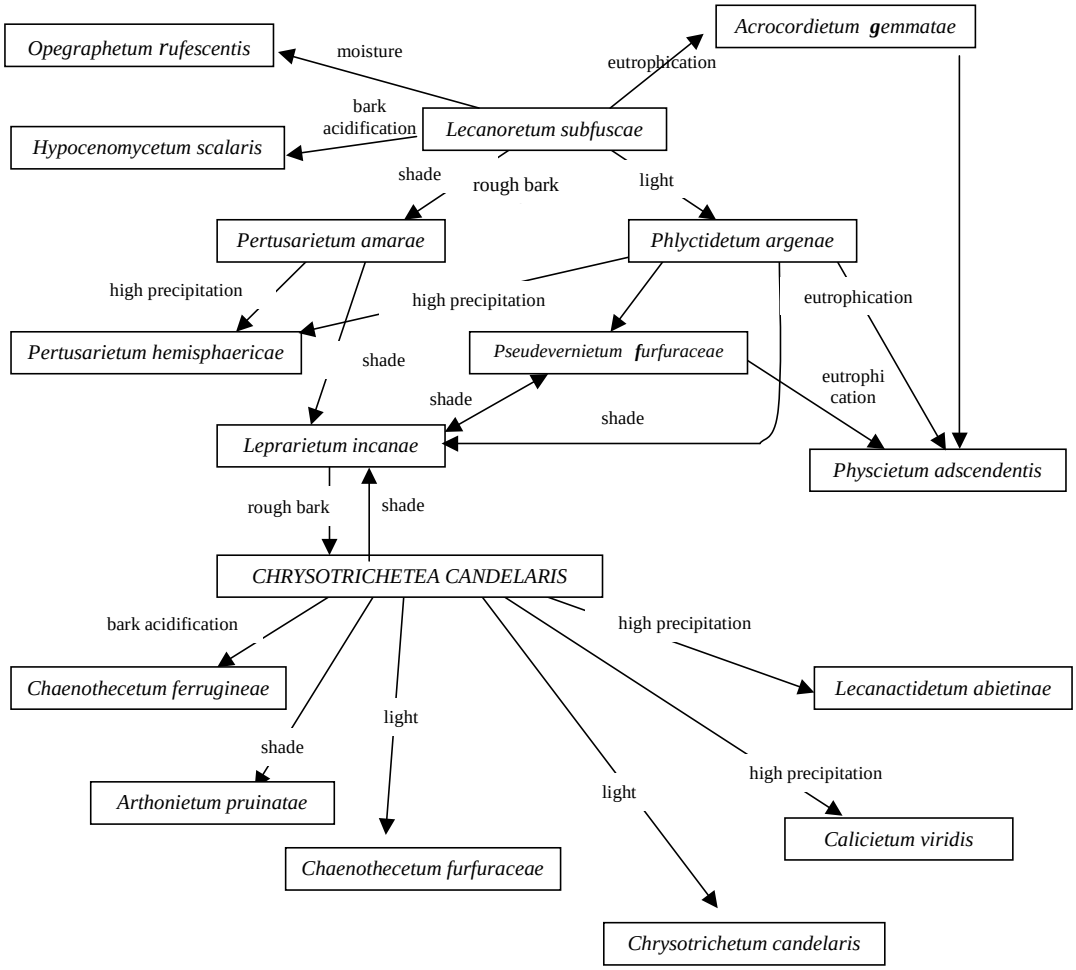

Fig. 2. Principal relationships among epiphytic communities on common oak

fer in eastern and western Lithuania by the distribution and prevalence of suboceanic species (*Pertusaria coccodes*, *Pertusaria hemisphaerica*, *P. pertusa*, etc.).

The majority (75%) of epiphytic communities on trunks of oaks in Lithuania favour rather dry to average dry bark, with the average pH 4.5. In regard to light regime, epiphytic communities can be distributed into four groups. The first group consists of the associations *Arthonietum pruinatae* and *Leprarietum incanae* established on oaks in most shaded parts of forests. The second group includes the associations *Lecanactidetum abietinae, Chaenothecetum furfuraceae*, *Chaenothecopsidetum rubescentis*, *Hypocenomycetum scalaris*, *Opegraphetum rufescentis* and *Pertusarietum amarae*, which inhabit shady places under dense tree canopies, unfavourable to most lichen species. The third group consists of eight associations (*Acrocordietum gemmatae*, *Calicietum viridis*, *Chaenothecetum ferrugineae*, *Chrysotrichetum candelaris*, *Cladonietum coniocraeae*, *Lobarietum pulmonariae*, *Phlyctidetum argenae* and *Trentepohlia umbrina*). Species of these communities favour rather shaded to averagely lit places. These communities usually form on oak trunks in thinned forest parts or in half-aged oak-woods where canopy density is about 70–80%. The fourth group consists of the associations *Lecanoretum subfuscae*, *Pertusarietum hemisphaericae*, *Pseudevernietum furfuraceae* and *Physcietum adscendentis* which form on oak trunks in most open parts of forests: glades, edges and roadsides.

According to demand for air humidity, extrahygrophilous and hygrophilous epiphytic communities dominate on oaks in Lithuania (85%). In regard to direct precipitation demand, on oak trunks prevail (60%) communities composed of anombrophilous species growing in crevices and fissures of bark well secured from direct rain. Such preference is characteristic of all communities of the class *Chrysotrichetea candelaris* and of communities of the associations *Pertusarieum amarae*, *Opegraphetum rufescentis* and *Chaenothecopsidetum rubescentis*. In regard to eutrophication, communities composed from anitrophylic lichen species dominate on oaks (60%).

Trunks of young oaks with smooth bark are inhabited by communities of the *Lecanoretum subfuscae* association. Lichen communities of this pioneer association are characterized by lichens from *the Lecanora subfusca* group: *Lecanora argentata*, *L. chlarotera* and *L. pulicaris*. The communities persist until the age of trees exceeds 30–50 years. 70–80-year-old trees in the forests studied are already maturing, their bark is

characterized by crevices 0.4–0.5 cm wide, which influence the decline of *Lecanoretum subfuscae* communities. The further succession of *Lecanoretum subfuscae* communities depends on the character of bark. If the pH of the bark drops significantly, communities of the acidophilous association *Hypocenomycetum scalaris* can appear (Fig. 2). Such a succession pathway is indicated by quite a big number of the *Lecanora* species in *Hypocenomycetum scalaris* communities. In case of a high eutrophication level, *Lecanoretum subfuscae* communities can be replaced by communities of the association *Acrocordietum gemmatae*, which are also characterized by presence of *Lecanora* species. Under high humidity, communities of the association *Opegraphetum rufescentis* can replace *Lecanoretum subfuscae* communities. Lichens *Arthonia spadicea*, *Arthothelium ruanum* and species of the genus *Opgerapha* generally favouring smooth-barked trunks of trees, appear in these communities. Large number of moss species in *Opegraphetum rufescentis* communities indicate their tendency to transform into bryophyte-dominated *Cladonietum coniocraeae* and *Lobarietum pulmonariae* communities. The latter association can establish only following a long time span in sufficiently humid unpolluted non-eutrophicated forests of a long ecological continuity. Communities of this association are characterized by *Lobaria pulmonaria*, an indicatory species of old forests. In most cases *Lecanoretum subfuscae* communities are replaced by *Pertusarietum amarae* and *Phlyctidetum argenae* communities. Communities of both associations are characterized by crustose sterile lichen species. The possibility of such succession is shown by a significant number of characteristic species of *Lecanoretum subfuscae* present in the communities of these two associations. With an increase of trunk shading and in presence of a favourable humidity regime, communities of the association *Lecanoretum subfuscae* can be replaced by *Pertusarietum amarae* communities, while on well-lit tree trunks they can be replaced by *Phlyctidetum argenae* communities. In the conditions of high precipitation (in the western part of Lithuania 800–900 mm and in the eastern part 650–700 mm annually (Bukantis, 1994) in well-lit places *Phlyctidetum argenae* and *Pertusarietum amarae* communities can be replaced by *Pertusarietum hemisphaericae* communities, which are characterized by lichen species from the Lithuanian Red Date Book, *Pertusaria pertusa* and *P. hemisphaerica*. This succession pathway is shown by presence of numerous transient species in communities registered in the maritime Juodkrantė oak-wood. However, this succession pathway is rare in Lithuania. Most often *Phlyctidetum argenae* communities transform into *Pseudevernietum furfuraceae* communities with macrolichens. The main condition for such succession is a good insolation of trunks. This succession pathway is confirmed by presence of foliose and fruticose lichens in *Phlyctidetum argenae* communities. With the maturation of oak-woods, the shading of tree trunks increases because of a shrub layer development, the increasing density of tree crowns and intensive growth of understorey trees. These conditions usually determine formation of *Leprarietum incanae* communities. They can replace all previously mentioned communities. The changing bark texture, development of deep crevices and fissures can influence replacement of *Leprarietum incanae* by various communities of the class *Chrysotrichetea candelaris*, which is characterized by calicioid lichens. Several potential ways of such development are possible. Bark acidification is favourable for establishment of *Chaenothecetum ferrugineae* communities. Pristine environment and shading are crucial for the formation of *Arthonietum pruinatae* communities, meanwhile low light favours the formation of *Chaenothecetum furfuraceae* and *Chrysotrichetum candelaris* communities and the prevalence of *Calicietum viridis* communities with the characteristic species *Chaenotheca trichialis*. Under conditions of high precipitation, communities of *Leprarietum incanae* can be replaced by suboceanic communities of *Calicietum viridis* with the characteristic species *Calicium viridis* and communities of the *Lecanactidetum abietinae* association.

The structure of epiphytic communities on common oak in Lithuania is characteristic of the structure of epiphytic communities in deciduous forests in temperate planes of middle Europe (Klement, 1955; Barkman, 1958; Hofmann, 1993; Killmann, Boecker, 1998). A comparison of epiphytic communities according to their species composition and distribution peculiarities in Lithuania and other European localities shows that the eastern distribution area borders of six associations (*Arthonietum pruinatae*, *Calicietum viridis*, *Lecanactidetum abietinae*, *Opegraphetum rufescentis* and *Pertusarietum hemisphaericae*) cross the territory of Lithuania. The central parts of their distribution lie in Western and Central Europe. Species composition in the communities of these associations in Lithuania differs from the composition of the same communities in forests of Western Europe. Communities of the above mentioned associations in Lithuanian oak woods have no oceanic species which are characteristic of the epiphytic communities of mountain regions of Western Europe: *Schismatomma pericleum*, *Arthonia leucopellaea*, *Ochrolechia androgyna*, etc. (Bielczyk, 1986; Mohr, 1992; Neuwirth, Türk, 1993; Gloßner, Türk, 2001). The species composition and frequency of other communities found on oaks is close to those in forests of middle Europe. Thus, the diversity, frequency and richness of epiphytic communities on oak trunks in Lithuania, like in deciduous forests of middle Europe, are determined by the geographical situation of locality, naturalness of a forest, eutrophication level, the age of trees, tree's growth situation in the forest, the density of trees and shrubs, the texture of tree bark, shading of trunks, inclination degree of tree trunk and the influence of surrounding plants. Determination of the decisive ecological factors influencing the change of epiphytic communities allows

to judge about the present and past of forests, while the growing level of eutrophication and tree cutting gives a possibility to forecast their future.

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PAGRINDINIAI EPIFITŲ BENDRIJŲ TARPUSAVIO SAITAI ANT PAPRASTOJO ĄŽUOLO (*QUERCUS ROBUR* L.) KAMIENŲ LIETUVOJE

S a n t r a u k a

Ant paprastojo ąžuolo Lietuvoje buvo diagnozuotos 7 epifitų klasių bendrijos. Nustatytos bendrijos priskirtos 7 eilėms, 10 sąjungų ir 20 asociacijų.

Epifitų bendrijų įvairovę, dažnumą ir gausumą ant paprastojo ąžuolo kamienų sąlygoja geografinė vietovės padėtis, medžių amžius, medžio augimo vieta miške, medžių ir krūmų suglaustumas, kitų augalų poveikis, medžio žievės pobūdis, medžių kamieno užpavėsinimas, medžio kamieno palinkimo laipsnis bei eutrofikacijos lygis. Keičiantis šiems ekologiniams veiksniams, keičiasi ąžuolo kamienų epifitų bendrijų sudėtis.

Raktažodžiai: epifitų bendrijos, paprastasis ąžuolas