

Lichens and their substrate preferences on the Pakri Peninsula (Northwest Estonia)

Ljudmilla Martin¹, Tiina Randlane² & Jüri Martin¹

¹Euroacademy, Mustamäe tee 4, 10621 Tallinn, Estonia.

E-mail: lmartin@euroakadeemia.ee

²Institute of Ecology and Earth Sciences, University of Tartu, Lai 38/40, 51005 Tartu, Estonia.

E-mail: tiina.randlane@ut.ee

Abstract: A checklist of lichenized and lichenicolous fungi of the Pakri Peninsula is presented and an overview of substrate preferences of recorded taxa is compiled. The list includes 243 species, eight of them appear new to Estonia: *Catillaria atomarioides*, *Lecanora persimilis*, *Micarea lithinella*, *Opegrapha calcarea*, *Staurothele rupifraga*, *Thelidium olivaceum*, *T. papulare* and *Verrucaria hochstetteri*. *Verrucaria maculiformis*, which was considered extinct in Estonia, is re-found, and *Staurothele caesia*, which has earlier been recorded as dubious for Estonia, is verified hereby. The greatest diversity of species is recorded among epilithic taxa, altogether with 121 species of which 63 species occurred on calcareous stones, 60 on granite, 18 on concrete and 12 on sandstone.

Kokkuvõte: Pakri poolsaare (Loode-Eesti) samblikud ja nende substraadieelistused

Esitatakse Pakri poolsaare lihhenseerunud ja lihhenikoolsete seente nimekiri ning käsitletakse nende liikide substraadieelistusi. Nimekiri sisaldab 243 liiki, neist kaheksa (*Catillaria atomarioides*, *Lecanora persimilis*, *Micarea lithinella*, *Opegrapha calcarea*, *Staurothele rupifraga*, *Thelidium olivaceum*, *T. papulare* ja *Verrucaria hochstetteri*) on Eestile uued. Üks samblik (*Verrucaria maculiformis*), mida varem peeti Eestis tõenäoliselt hävinuks, on taasleitud ning teise, eelnevalt kaheldavalt määratud liigi (*Staurothele caesia*) leidumine siin on nüüd tõestatud. Samblike suurim liigirikkus tuvastati epilithide hulgas – kokku leiti erinevatelt kivisubstraadidelt 121 liiki, neist 63 liiki lubjakivilt, 60 graaniidilt, 18 betoonilt and 12 liivakivilt.

INTRODUCTION

The Pakri Peninsula is situated in the northwestern part of the Estonian mainland, Harjumaa County, between the Lahepere and Paldiski Bays of the Baltic Sea (59°19–23'N 24°02–10'E) (Fig. 1). The length of the peninsula is 12 km, the width is 5 km, and the area in total is c. 40 km². The climate of the Pakri Peninsula resembles that of the western and northwestern coasts of Estonia and the climate of our islands: the average annual temperature is 5,9 °C; the coldest month is February, with the average temperature of -3,8 °C, and the average temperature of the warmest month July is 16,6 °C. The mean precipitation is 567 mm, dropping to 356 mm in the warm period (from April to October). The average annual sunshine duration is 1800 hours, and the snow cover duration amounts to 90–100 days (EMHI, Kliima).

The Pakri Peninsula is a plateau which is bordered by the Ordovician and Cambrian limestone outcrop. The highest part of the limestone bank on the Pakri Cape is 24,8 m above the sea level. The relief of the peninsula is flat, with some ice-edge formations, like ridges and

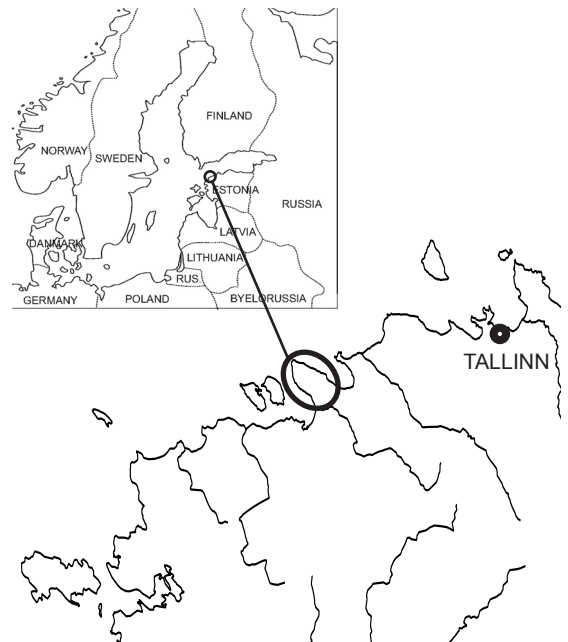


Fig. 1. Location of the study area.

moraines (Fig.2). The surface covering is mainly gravel and slag, the thickness of which ranges from some centimeters to some meters. The bedrock of the soil includes Cambrian sands and clay, sorted out gravel, clay and sands (Kink, 1996). Lithologically different types and formations of calcareous substrate are represented, e.g. limestone and dolomites from Vão Formation (Lasnamäe Stage), Kõrgekalda Formation (Uhaku Stage) and glauconite limestone from Toila Formation (Volkhov Stage) (Raukas, 1988). The Pakri Peninsula is a vivid example of the northern coast of the North-Estonian Klint (North-Estonian limestone escarpment) with its peculiar landscape.

Different vegetation types are found on the peninsula. The so-called klint forest is an unusual habitat for temperate broad-leaved tree species (*Acer platanoides* L., *Fraxinus excelsior* L., *Tilia cordata* Mill., *Quercus robur* L., and *Padus avium* Mill.) in northern Europe; it occurs as a narrow stripe on the talus slopes (Paal, 1998; Jüriado et al., 2009). Already Lippmaa (1935) singled out the area with this special vegetation as “*Estonia clivosa*”. In the lower coastal areas alder trees (*Alnus incana* (L.) Moench) predominate (Tamm et al., 1997). Coniferous trees, mainly *Pinus sylvestris* L., are found in small numbers on the eastern coast, on drifted sand. Alvar forests represent one of the rarest forest types in Europe – their distribution is limited to limestone areas with very thin soil layer ranging from a couple of cm to 30 cm; they spread only in western and northwestern Estonia and southern Sweden (incl. Gotland and Öland) (Laasimer, 1965; Meier & Paal 2009). Other forest types, with the soil turning marshy with over moisture can also be found on the peninsula (Truus &

Kannukene, 1996). The wetter the soil, the wider is the extent of rich paludified forest types (e.g. *Filipendula* site type with *Alnus glutinosa*, *Betula pubescens* Ehrh., and *Fraxinus excelsior*). The vascular flora of the Pakri Peninsula includes 542 taxa, 177 out of them have been found before 1970s (Jõe & Ramst, 1996; Kukkk & Kull, 2005). Calciphilous plant species which prefer calcareous soil dominate in the flora. Several new species (*Crambe maritima* L., *Dactylorhiza maculata* (L.) Soó, *Daphne mezereum* L., *Pulsatilla pratensis* (L.) Mill.) were recorded only recently, in 2009, in the Pakrineeme research area, where altogether 167 vascular plant species were registered (Martin et al., 2009).

Pakri Landscape Reserve was founded in 1998 to protect the local landscape, with its fauna and flora. The Reserve is situated in Harjumaa, on the territory of Paldiski city, containing predominantly the coastal areas of the Pakri Peninsula, northern parts of Suur-Pakri (Stora-Rågö) and Väike-Pakri (Lilla-Rågo) Islands, also, the sea between them together with Kappa and Bjargranne islets, plus the southern part of Väike-Pakri Island. The total area of the Reserve is 1450 ha (Vabariigi Valitsuse määrus 97, 1998).

During the World War 2nd and thereafter, there were great changes in the land use on the Peninsula. For more than 50 years, between 1939–1995, the peninsular territory had been closed for economic activities and civilian visits. Therefore only scarce data about the lichen biota of the Pakri Peninsula were known earlier. The aim of the present study was to compile a checklist of lichenized, lichenicolous and allied fungi of this remarkable area, and give an overview of substrate preferences of recorded taxa.



Fig. 2. Plateau of the Pakri Peninsula (left), and coastal terraces of limestone pebbles.

MATERIAL AND METHODS

The list of taxa is based on the herbarium specimens which are stored in the herbaria of the following institutions: H – Finnish Museum of Natural History, University of Helsinki (Finland), ICEB – Euroacademy (Tallinn, Estonia), TAAM – Institute of Agricultural and Environmental Sciences, Estonian University of Life Sciences (Tartu, Estonia), TAM – Estonian Museum of Natural History (Tallinn, Estonia), and TU – Natural History Museum, University of Tartu (Tartu, Estonia).

The list of earlier collections from the Pakri peninsula was compiled using the database of Estonian lichens *eSamba* (<http://www.ut.ee/ial5/lich/baasid/esamba.html>) which mainly accumulates data from TU and TAM. The database was scanned using key words “Pakri Peninsula” and “Paldiski”, resulting in 112 references to the herbarium specimens representing 70 species. Information of lichen specimens collected by the following persons was included: Ernst Häyren (collecting performed in 1924), Inga Jürjado (1997, 2001), Eugen Niclasen (1910), Erast Parmasto (1995), Taimi Piin (1960), Silvi Pärn-Eilart (1960), Jaak Ruubel (1932), Veli Räsänen (1929), Mari Sarv (1995), and Heljo Ting (1960). Furthermore, fresh material of more than 600 lichen samples was collected by Ljudmilla Martin and Jüri Martin in 1999 in the central part of the peninsula; in 2009–2010 on its northeastern coast; and by Tatjana Shadrina in 2005 on concrete in various localities of the peninsula. The fresh material was mainly identified by the first author.

The data about red-listed species originate from Randlane et al. (2008), and the data about protected species from *Rüigi Teataja* (Vabariigi Valitsuse määrus 195, 2004; Keskkonnaministri määrus 51, 2004). A rare species is defined here as a species with ten or less recorded localities in Estonia (Randlane & Saag, 1999); the information about rarity comes from the databases *eSamba* (<http://www.ut.ee/ial5/lich/baasid/esamba.html>) and *eElurikkus* (<http://elurikkus.ut.ee/>). The nomenclature follows Randlane et al. (2009).

RESULTS AND DISCUSSION

The list of taxa

In total 243 species of lichenized and lichenicolous fungi are listed on the Pakri Peninsula

(Appendix), eight of them appear new to Estonia. Among recorded taxa, 233 are lichenized and 10 belong to the group of lichenicolous fungi. One species which was considered regionally extinct is re-found, and another species which has earlier been recorded as dubious in Estonia is verified hereby.

The oldest specimens available from this area were collected by Niclasen in 1910 (one species – *Physcia tenella* (Scop.) DC.), by Häyren in 1924 (two species) and by Räsänen in 1929 (25 species); Räsänen identified also the samples collected by Ruubel in 1932. During the whole soviet period, a few specimens were collected by Piin, Pärn-Eilart and Ting in 1960 close to the road to Paldiski city; only in 1990ies the peninsula was re-opened for civil public. The following taxa are recorded according to the old collections exclusively, and were not re-found during recent field work: *Arctoparmelia incurva* (Pers.) Hale, *Cetraria ericetorum* Opiz, *Diploschistes muscorum* (Scop.) R. Sant., *Flavocetraria nivalis* (L.) Kärnefelt & A. Thell, *Gyalecta jenensis* (Batch) Zahlbr., *Phaeophyscia ciliata* (Hoffm.) Moberg, *Schaereria fuscocinerea* (Nyl.) Clauzade & Cl. Roux, *Solorina saccata* (L.) Ach., *Staurothele frustulenta* Vain., *Umbilicaria torrefacta* (Lightf.) Schrad., and *Usnea hirta* (L.) F.H. Wigg. (Appendix). Among them, three species (*Arctoparmelia incurva*, *Flavocetraria nivalis* and *Solorina saccata*) are assigned to the red-listed categories in the recent Red List of Estonia (Randlane et al., 2008) and two species (*Gyalecta jenensis* and *Staurothele frustulenta*) appear rare in Estonia (Randlane & Saag, 1999).

Species new to Estonia

CATILLARIA ATOMARIOIDES (Müll. Arg.) Kilius – Harjumaa Co., Pakri Peninsula, 59°23'03"N 24°04'11"E, on a granite boulder on the marine terrace, leg. Ljudmilla & Jüri Martin 10.07.2009 (ICEB). The species is characterized by a dark brown or greenish black true exciple, and it differs from the similar *C. chalybeia* (Borrer) A. Massal. by the colourless hypothecium. On the British Isles it is frequent on siliceous rocks, but has earlier been much overlooked (Smith et al., 2009). In Fennoscandia it is recorded in Norway and Sweden (Santesson et al., 2004).

LECANORA PERSIMILIS (Th. Fr.) Nyl. – Harjumaa Co., Pakri Peninsula, 59°23'02"N 24°04'11"E, on dry twigs of *Rosa* sp. in a coastal meadow, leg. Ljudmilla & Jüri Martin 08.07.2009 (ICEB). A

member of the *Lecanora dispersa* group, being most similar to *L. sambuci* (Pers.) Nyl. which differs in having 12 or more spored asci, or to *L. hagenii* (Ach.) Ach. which often has pruinose disc and white or grey lecanorine apothecial margin. *L. persimilis* has epruinose disc, often brownish biatorine apothecial margin and 8 spores in asci. The taxon is common on branches and twigs of deciduous trees and shrubs with a neutral bark (Śliwa, 2007). In Fennoscandia it is recorded in Norway and Sweden (Santesson et al., 2004); in the Baltic states – in Lithuania (Motiejunaite, 2011).

MICAREA LITHINELLA (Nyl.) Hedl. – Harjumaa Co., Pakri Peninsula, 59°22'59"N 24°04'20"E, on the side surface of granite gravel in the old quarry on the plateau, leg. Ljudmilla & Jüri Martin 22.08.2009 (ICEB). The species is considered a pioneer colonizer of shaded stones, widespread but overlooked (Smith et al., 2009). In Fennoscandia it is recorded in Finland, Norway and Sweden (Santesson et al., 2004), in the Baltic states – in Lithuania (Motiejunaite, 2011).

OPEGRAPHA CALCAREA Turn. ex Sm. – Harjumaa Co., Pakri Peninsula, 59°23'07"N 24°04'35"E, on limestone gravel on the sea terrace, leg. Ljudmilla & Jüri Martin 08.07.2009 (two specimens, ICEB). Another saxicolous *Opegrapha* species, *O. rupestris* Pers., which has earlier been recorded in Estonia, differs by K+ brown-red reaction on the exciple while *O. calcarea* has K+ olive-green exciple reaction (Smith et al., 2009). In Fennoscandia it is known in Norway and Sweden (Santesson et al., 2004).

STAUROTHELE RUIPIFRAGA (A. Massal.) Arnold – Harjumaa Co., Pakri Peninsula, 59°23'06"N 24°04'23"E, on limestone gravel on the sea terrace, leg. Ljudmilla & Jüri Martin 08.07.2009 (four specimens, ICEB); 59°22'47"N 24°05'11"E, on a pile of limestone gravel on the forest edge, on the edge of the plateau, leg. Ljudmilla & Jüri Martin 29.06.2009 (two specimens, ICEB). The species is easily recognized by the perithecia immersed in pits of the substrate, by 4(-5)-spored asci, and by dark brown, often opaque ascospores (Orange, 2008; Smith et al., 2009). In Fennoscandia it is recorded in Finland (Pykälä, 2010b), Norway and Sweden (Santesson et al., 2004).

THELIDIUM OLIVACEUM (Fr.) Körb. – Harjumaa Co., Pakri Peninsula, 59°22'47"N 24°05'11"E, on

a pile of limestone gravel on the forest edge, on the edge of the plateau, leg. Ljudmilla & Jüri Martin 29.06.2009, det. Juha Pykälä 15.10.2010 (ICEB). The species is characterized by dark olive-brown diffuse to determinate thallus, relatively small semi-immersed to almost superficial perithecia (0.2–0.3 mm in diam.), and black involucrellum, contiguous with the exciple. Ascospores are (0-)1-septate, ellipsoidal to subcylindrical, 15–25 × 6–12 µm (Pykälä, 2007; McCarthy, 2011). In Fennoscandia it is recorded in Finland (Pykälä, 2007), and in the Baltic states – in Latvia (Piterans, 2001); known also in Denmark (Søchting & Alstrup, 2008).

THELIDIUM PAPULARE (Fr.) Arnold – Harjumaa Co., Pakri Peninsula, 59°22'47"N 24°05'11"E, on a pile of limestone gravel on the forest edge, on the edge of the plateau, leg. Ljudmilla & Jüri Martin 29.06.2009 (two specimens, ICEB). Characterized by the relatively large perithecia (0.4–0.8 mm in diam.), well-developed involucrellum, and 3(-5)-septate, large (36–50 × 14–19 µm) ascospores. The species is often found on wet calcareous rocks (Orange, 2008; Smith et al., 2009). In Fennoscandia it is recorded in Finland (Pykälä, 2010a), Norway and Sweden (Santesson et al., 2004).

VERRUCARIA HOCHSTETTERI Fr. – Harjumaa Co., Pakri Peninsula, 59°23'07"N 24°04'35"E, on limestone gravel on the sea terrace, leg. Ljudmilla & Jüri Martin 08.07.2009 (ICEB); 59°22'47"N 24°05'11"E, on a pile of limestone gravel on the forest edge, on the edge of the plateau, leg. Ljudmilla & Jüri Martin 29.06.2009 (ICEB). The species is characterized by immersed thallus, large perithecia sunken in pits, absence of involucrellum and large (29–35 × 16–20 µm) ascospores (Orange, 2008; Smith et al., 2009). In Fennoscandia it is recorded in Finland (Pykälä 2010a), Norway and Sweden (Santesson et al., 2004).

Protected, red-listed and rare species

Out of 243 species of lichenized and lichenicolous fungi recorded on the Pakri Peninsula (Appendix), 11 species are included in the so-called red-listed categories of the latest Red List of Estonia (Randlane et al., 2008): one species (*Arctoparmelia incurva*) belongs to the category Endangered; four (*Arthonia lapidicola* (Taylor) Branth. & Rostr., *Leptogium schraderi* (Bernh.) Nyl., *L. subtile* (Schrad.) Torss., *Opegrapha*

rupestris) – to the category Vulnerable; three (*Cladonia pocillum* (Ach.) Grognot, *Flavocetraria nivalis*, *Solorina saccata*) – to the category Near Threatened; two (*Leptogium gelatinosum* (With.) J.R. Laundon, *Melanelia soredata* (Ach.) Goward & Ahti) – to the category Data Deficient; and one species (*Verrucaria maculiformis* Kremp.) belonged to the category Regionally Extinct, being thus re-found hereby. One of the red-listed lichens, *Solorina saccata*, is assigned to the legally protected species in Estonia – to the protection category II (Vabariigi Valitsuse määrus nr 195, 2004). About half of the recorded taxa, 127 species, are placed in the Red List category Least Concerned, while 105 species have not been evaluated against the criteria proposed by IUCN guidelines for the system of red list categories yet. Among the not-evaluated taxa, however, many species appear rare in Estonia; therefore the estimation of ‘rare’ versus ‘common’ taxa was performed (Randlane & Saag, 1999. The number of rare taxa (70 species), with ten or less recorded localities in Estonia, forms almost one third of all recorded species on the peninsula) (Appendix). One of the rare lichens, *Staurothele caesia* (Arnold) Arnold, has earlier been recorded as dubious in Estonia (Randlane & Saag, 2004) as the according herbarium material had not been studied, and the taxon was included in the list on literature data only (Bruttan, 1870). Now the occurrence of this species in Estonia is verified.

Lichens on different substrates

The following main substrate groups were considered: deciduous trees, coniferous trees, lignum, calcareous stone, concrete, granite, sandstone, soil, and lichens (Fig. 3).

The greatest diversity of species is recorded among **epilithic taxa**, altogether with 121 species of which 63 species occurred on calcareous stones, 60 on granite, 18 on concrete and 12 on sandstone. Calcareous substrate includes rock fragments and pebbles which occur in three different ecotopes on the Pakri peninsula: (1) limestone pebbles and rocks on the plateau and in quarries, (2) limestone outcrops on the slope of the klint under the canopy of deciduous trees, and (3) limestone pebbles of coastal terraces. The first ecotope is the most rich in species, with *Arthonia lapidicola*, *Aspicilia moenium* (Vain.) G. Thor & Timdal, *Lecanora dispersa* (Pers.)

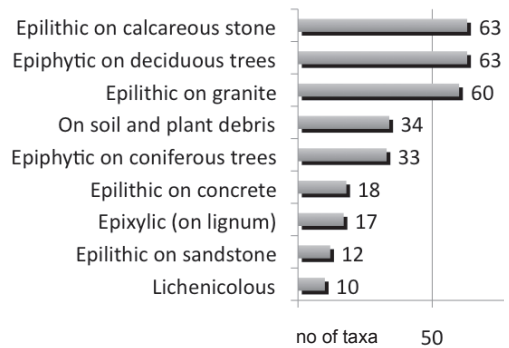


Fig. 3. Distribution of lichenized and lichenicolous fungi recorded on the Pakri Peninsula between the main substrate groups.

Sommerf., *Lecidella stigmatea* (Ach.) Hertel & Leuckert and *Verrucaria muralis* Ach. dominating on pebbles and rocks on the plateau and in quarries. Several common lichens, e.g. *Aspicilia calcarea* (L.) Mudd, *Caloplaca citrina* (Hoffm.) Th. Fr., *Lecanora dispersa*, *Rinodina immersa* (Körb.) Arnold etc. are abundant on limestone pebbles of the coastal terraces. Some species are adapted to the specific habitats, e.g. *Acarospora heppii* (Nägeli ex Hepp) Nägeli was found in the pits and fissures of the unstable limestone pebbles on the marine terraces close to the coastline while *Gyalecta subclausa* Anzi was found in the localities outside the direct influence of the sea, on the lower surface of loose limestone rocks, or on the surface covered with mosses or other stones. Lichen diversity was separately recorded on concrete, an artificial substrate which is most similar to limestone by its chemical and physical properties. On the Pakri peninsula, many military structures of concrete were built during the last 100 years, and debris and fragments of these are still exposed. The species richness of lichens is smaller on concrete compared with limestone, and only common species (e.g. *Aspicilia moenium*, *Caloplaca citrina*, *C. decipiens* (Arnold) Blomb. & Forssell, *Candelariella aurella* (Hoffm.) Zahlbr., *Lecanora albescens* (Hoffm.) Branth & Rostr., *Protoblastenia rupestris* (Scop.) J. Steiner etc.) were listed on this substrate. Granite substrate includes erratic boulders and pebbles (including crystalline pebbles of granite, gneiss and schist). *Acarospora fuscata* (Nyl.) Arnold, *Amandinea punctata* (Hoffm.) Coppins & Scheid., *Aspicilia cinerea* (L.) Körb., *Cande-*

lariella vitellina (Hoffm.) Müll. Arg., *Catillaria chalybeia* (Borrer) A. Massal., *Lecanora rupicola* (L.) Zahlbr., *Lecidea lapicida* var. *pantherina* Ach., *Parmelia saxatilis* (L.) Ach., and *Xanthoparmelia conspersa* (Ach.) Hale are common taxa on granite. The species composition of granite boulders located on the plateau and on marine terraces differs with regard to rare species. For example, *Acarospora smaragdula* (Wahlenb.) A. Massal., *Ramalina subfarinacea* (Nyl. ex Cromb.) Nyl., and *Sarcogyne privigna* (Ach.) A. Massal. grow on the boulders on the plateau while *Amandinea cacuminum* (Th. Fr.) H. Mayrhofer & Sheard, *Buellia aethalea* (Ach.) Th. Fr., and *Pseudosagedia chlorotica* (Ach.) Hafellner & Kalb were found on the boulders on marine terraces. *Lecidella scabra* (Taylor) Hertel & Leuckert was recorded only on the pebbles of sandstone on marine terraces.

Epiphytic lichen biota includes 81 species on the Pakri peninsula. One of the main factors, affecting the occurrence of epiphytic lichen species, is the acidity of the phorophyte bark. Coniferous trees (and birch) have normally acid and deciduous trees have subneutral bark in unpolluted areas (Wirth, 1995). In the study area coniferous trees are represented by two species, *Pinus sylvestris* (hereafter 'pine') and *Juniperus communis* L. Pines grow here in two separate localities: on the plateau in south-eastern part of the peninsula, and on the coastal sandy plain in the north-eastern part of the peninsula. Altogether 31 lichen species were recorded on pines. Common acidic and acidophilic lichens, e.g. *Hypogymnia tubulosa* (Schaer.) Hav., *Parmeliopsis ambigua* (Wulfen) Nyl., *Platismatia glauca* (L.) W.L. Culb. & C.F. Culb., species of *Bryoria* and *Usnea* are absent on the Pakri peninsula (*U. hirta* was found once in 1929). *Buellia schaereri* De Not., *Dimerella pineti* (Ach.) Vězda, *Hypogymnia physodes* (L.) Nyl., *Lecanora symmicta* (Ach.) Ach. and *Parmelia sulcata* Taylor are common here on pine trunks; these species have wider amplitude to acidity of substrate (Wirth, 1995). Subneutrophilic and neutrophilic species *Lecidella elaeochroma* (Ach.) M. Choisy, *Physcia adscendens* (Fr.) H. Olivier, *P. tenella*, *Ramalina fastigiata* (Pers.) Ach., and *Xanthoria parietina* (L.) Th. Fr. were recorded on pines on the plateau, indicating a change in the chemical composition and properties of the tree bark. On the pines growing on coastal plain, on the con-

trary, typical species of acidic bark, e.g. *Micarea prasina* Fr., *Ochrolechia pallescens* (L.) A. Massal., *Scoliciosporum chlorococcum* (Stenh.) Vězda and *Vulpicida pinastri* (Scop.) J.-E. Mattsson & M.J. Lai, were found. 63 species of epiphytic lichens were recorded on the phorophytes with neutral or subneutral bark. The greatest diversity of species occurred on *Fraxinus excelsior* growing on the plateau (27), and on *Acer platanoides* growing on the coastal plain (22). *Lecania naegelia* (Hepp) Diederich & Van den Boom, *Lecanora carpinea* (L.) Vain., *L. rugosella* Zahlbr., *Lecidella elaeochroma*, *L. euphorea* (Flörke) Hertel, species of the genera *Physcia*, *Physconia*, and *Xanthoria* were abundant on different deciduous trees and shrubs. *Anaptychia ciliaris* (L.) Körb. and *Ramalina fraxinea* (L.) Ach. grew only on *Fraxinus excelsior* on the plateau.

Thirty four species were recorded among **epigeic lichens**. Species of *Cetraria*, *Cladina*, *Cladonia*, *Peltigera* and *Stereocaulon* grow on the coastal plains in areas with sandy soil, among the dispersed graminaceous vegetation. *Collema tenax* (Sw.) Ach., *Leptogium lichenoides* (L.) Zahlbr., *L. schraderi*, *L. subtile*, *Mycobilimbia* species, *Rinodina conradii* Körb., *Peltigera rufescens* (Weiss) Humb. and *Verrucaria xyloxena* Norman were found on the plateau, on the calcareous alvar soil among mosses.

ACKNOWLEDGEMENTS

We are grateful to Olle Hints (Institute of Geology, Tallinn University of Technology) for the assistance in determination the rock samples; to Tatjana Shadrina, MSc, for the permission to use her data about lichens on concrete, and to Elena Andrianova, MSc (both from Euroacademy), for the help in collecting and sorting material. Authors thank Juha Pykälä (Finnish Environmental Institute) for identifying some *Thelidium* and *Verrucaria* samples. The research was partly financed by Euroacademy grant EU KK d 01, and Baltic Gas, Ltd., contract on strategic environmental assessment.

REFERENCES

- Bruttan, A. 1870. Lichenen Est-, Liv- und Kurlands. *Arch. Naturk. Liv-, Ehst- u. Kurl. Zweiter Serie* 7: 163–326.
 EMHI, *Kliima* – <http://www.emhi.ee/?ide=6,299>

- eElurikkus – <http://elurikkus.ut.ee/>
 eSamba – <http://www.ut.ee/ial5/lich/baasid/esamba.html>
- Jõe, L. & Ramst, V. 1996. Taimede nimestik 1994–1995. – In: Kink, H. (koost.) *Pakri poolsaar – loodus ja inimtegevus*. Teaduste Akadeemia Kirjastus, Tallinn, lk 40–43. (In Estonian).
- Jüriado, I., Liira, J. & Paal, J. 2009. Diversity of epiphytic lichens in boreo-nemoral forests on the North-Estonian limestone escarpment: the effect of tree level factors and local environmental conditions. *Lichenologist* 41: 81–96.
- Keskkonnaministri 19. mai 2004. a. määrus nr 51. III kaitsekategooria liikide kaitse alla võtmine (Decree of the Estonian Minister of Environment no. 51. 19.05.2004). *Riigi Teataja Lisa* 27.05.2004, 69, 1134.
- Kink, H., (koost.) 1996. *Pakri poolsaar – loodus ja inimtegevus*. Teaduste Akadeemia Kirjastus, Tallinn. (In Estonian).
- Kukk, T., & Kull, T. (eds) 2005. *Atlas of the Estonian flora*. Institute of Agricultural and Environmental Sciences of the Estonian University of Life Sciences, Tartu. 528 pp.
- Laasimer, L. 1965. *Eesti NSV taimkate*. Valgus, Tallinn. 400 lk. (In Estonian).
- Lippmaa, T. 1935. Eesti geobotaanika põhijooni. Acta et Commentationes Universitatis Tartuensis (Dorpatensis) A28(4): 1–151.
- Martin, J., Martin, L. & Pärn, H. 2009. Pakrineeme detaiplaneeringu keskkonnamõju strateegiline hindamine. Euroakadeemia. 66 pp. (In Estonian).
- McCarthy, P. M. 2011. *Checklist of the Lichens of Australia and its Island Territories*. Australian Biological Resources Study, Canberra. Version 19 August 2011.
<http://www.anbg.gov.au/abrs/lichenlist/introduction.html>.
- Meier, E. & Paal, J. 2009. Cryptogams in Estonian alvar forests: species composition and their substrata in stands of different age and management intensity. *Annales Botanici Fennici* 46: 1–20.
- Motiejunaite, J. 2011. *Checklist of lichens and allied fungi of Lithuania*. <http://www.botanika.lt/struktura/checklist.pdf>
- Orange, A. 2008. *British Pyrenocarpous Lichens*. National Museum of Wales. http://www.thebls.org.uk/content/documents/British_Pyrenocarpous_Lichens.zip
- Paal, J. 1998. Rare and threatened plant communities of Estonia. *Biodiversity and Conservation* 7: 1027–1049.
- Piterans, A. 2001. Checklist of the lichens of Latvia. *Latvijas Vegetacija* 3: 5–46.
- Pykälä, J. 2007. Additions to the lichen flora of Finland. II. Calcareous rocks and associated soils in Lohja. *Graphis Scripta* 19(1): 17–32.
- Pykälä, J. 2010a. Additions to the lichen flora of Finland. IV. *Graphis Scripta* 22(1): 18–27.
- Pykälä, J. 2010b. Additions to the lichen flora of Finland. V. *Graphis Scripta* 22(2): 54–62.
- Randlane, T. & Saag, A. (eds) 1999. Second checklist of lichenized, lichenicolous and allied fungi of Estonia. *Folia Cryptogamica Estonica* 35: 1–132.
- Randlane, T. & Saag, A. (eds) 2004. *Eesti pisisamblikud (Microlichens of Estonia)*. Tartu Ülikooli Kirjastus, Tartu. 582 pp. (In Estonian).
- Randlane, T., Jüriado, I., Suija, A., Lõhmus, P. & Lepik, E. 2008. Lichens in the new Red List of Estonia. *Folia Cryptogamica Estonica* 44: 113–120.
- Randlane, T., Saag, A. & Suija, A. 2009. *Lichenized, lichenicolous and allied fungi of Estonia*. Ver. December 30, 2009 – <http://esamba.bo.bg.ut.ee/checklist/checklist-2009/home.php>
- Raukas, A. 1988. Eestimaa viimastel aastamiljonitel. Valgus, Tallinn. 280 pp. (In Estonian).
- RT I 1998, 41, 631. Leigeri looduskaitseala ja Pakri maastikukaitseala kaitse alla võtmine kaitse-eeskirjade ja välispiiride kirjelduste kinnitamine. VV määrus nr 97, 5.05.1998. (In Estonian).
- Santesson, R., Moberg, R., Nordin, A., Tønsberg, T. & Vitikainen, O. 2004. *Lichen-forming and lichenicolous fungi of Fennoscandia*. Museum of Evolution, Uppsala University, Uppsala. 359 pp.
- Šliwa, L. 2007. A revision of the *Lecanora dispersa* complex in North America. *Polish Botanical Journal* 52: 1–70.
- Smith, C. W., Aptroot, A., Coppins, B. J., Fletcher, A., Gilbert, O. L., James, P. W. & Wolseley, P. A. 2009. *The Lichens of Great Britain and Ireland*. British Lichen Society, London. 1046 pp.
- Söchting, U. & Alstrup, V. 2008. *Danish Lichen Checklist*. Ver. 2. – <http://www.bi.ku.dk/lichens/dkchecklist/>
- Tamm, H., Abner, O., Sultson, J., Reisner, S. & Mäss, L. 1997. *Taimekoosluste seire allprogramm "PANGAMETSAD"* Mullastiku ning järelkasvu, alusmetsa ja puittaimede tõusmete uurimistulemused Muuksi, Kalvi ja Pakri pangametsades. http://seire.keskkonnainfo.ee/seireveeb/arundand/4433_aru97_pangametsad.doc
- Truus, L., Kannukene, L. 1996. Taimkate. – In: Kink, H. (koost.) *Pakri poolsaar – loodus ja inimtegevus*. Teaduste Akadeemia Kirjastus, Tallinn, lk 33–39. (In Estonian).
- Vabariigi Valitsuse 5. mai 1998. a määrus nr 97. Leigeri looduskaitseala ja Pakri maastikukaitseala kaitse alla võtmine kaitse-eeskirjade ja välispiiride kirjelduste kinnitamine. (Decree of the Estonian Government no. 97. 5.05.1998). *Riigi Teataja I*, 41, 631.
- Vabariigi Valitsuse 20. mai 2004. a määrus nr 195. I ja II kaitsekategooriana kaitse alla võetavate liikide loetelu (Decree of the Estonian Government no. 195. 20.05.2004). *Riigi Teataja I* 21.05.2004, 44, 313.
- Wirth, V. 1995. *Flechtenflora*. 2. Aufl. Verlag Eugen Ulmer, Stuttgart. 661 S.

<i>Physcia adscondens</i>	fq	LC	B	AB	A	A	B	A	A
<i>Physcia aipolia</i>	fq	LC		A					
<i>Physcia caesia</i>	fq	LC						A	A
<i>Physcia dubia</i>	fq	LC							
<i>Physcia stellaris</i>	fq	LC		B	B				
<i>Physcia tenella</i>	fq	LC		AB	A				
<i>Physconia distorta</i>	fq	LC	B	AB	B				
<i>Placynthium icmalea</i>	fq	LC	B		B				
<i>Placynthium nigrum</i>	fq	LC					B		
<i>Polyblastia albida</i>	fq	LC		AB	AB	C			AB
<i>Polyblastia cupularis</i>	r	NE		A					
<i>Porpidia soredizodes</i>	r	NE						B	B
<i>Porpidia tuberculosa</i>	r	NE						B	B
<i>Protoblastenia calbia</i>	r	NE			A				
<i>Protoblastenia rupestris</i>	fq	LC			AB	C			A
<i>Protoparmelia badia</i>	fq	NE						B	AB
<i>Protoparmeliopsis muralis</i>	fq	LC							
<i>Pseudevernia furfuracea</i>	fq	LC			A				
<i>Pseudogagedia chlorotica</i>	r	NE							
<i>Ramalina farinacea</i>	fq	LC	AB	B	AB				
<i>Ramalina fastigiata</i>	fq	LC		AB	AB				
<i>Ramalina fraxinea</i>	fq	LC		A					
<i>Ramalina subfarinacea</i>	r	LC							
<i>Rhizocarpon distinctum</i>	fq	NE						B	A
<i>Rhizocarpon geographicum</i>	fq	NE						B	B
<i>Rhizocarpon grande</i>	r	NE						B	B
<i>Rhizocarpon polycarpum</i>	fq	NE						AB	B
<i>Rhizocarpon reductum</i>	fq	NE						B	
<i>Rinodina bischoffii</i>	fq	NE						AB	
<i>Rinodina conradii</i>	r	NE							B
<i>Rinodina exigua</i>	fq	LC		AB					
<i>Rinodina immersa</i>	fq	NE						AB	
<i>Rinodina pyrrena</i>	fq	LC	AC				B		
<i>Rinodina sspodes</i>	fq	LC					B		
<i>Sarcogyne privigna</i>	r	NE						B	A
<i>Sarcogyne regularis</i>	fq	NE							A
<i>Schaereria fuscocinerea</i>	fq	NE							
<i>Schismatomma pericleum</i>	fq	NE							
<i>Scoliosporium chlorococcum</i>	fq	LC	B						
<i>Scoliosporium umbrinum</i>	fq	NE						B	AB
<i>Solorina saccata</i>	r	NT						C	
<i>Sphaerellothecium propinquellum</i>	fq	NE							B

