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# Observations on Mycobiota in Estonia

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**Abstract**: Observations on Estonian fungi by occasion of several field trips resulted in some noteworthy records. *Melanoleuca pallidicutis* is described as a new species. *Clitocybe concava, Coprinus romagnesianus, Cortinarius stillatius, Leucopaxillus cutefractus* and *Paxillus vernalis* are recorded for the first time in Estonia. A list of such fungi not reported on the island of Ruhnu so far or which have been observed on other host plants than indicated in former studies is appended.

**Kokkuvõte:** Vaatlusi Eesti seenestikust.

Antud töös kirjeldatakse uus liik *Melanoleuca pallidicutis*. Eestile registreeriti uued liigid: *Clitocybe concava, Coprinus romagnesianus, Cortinarius stillatius, Leucopaxillus cutefractus* ja *Paxillus vernalis*. Ruhnu saare seenestiku nimekirjas tuuakse ära saarele uued liigid.

## INTRODUCTION

By occasion of several field trips through different parts of Estonia some collections of rare or noteworthy fungi have been made by the author of the present paper. The Mycobiota of Estonia are quite well investigated thanks to the efforts of the team of mycologists working in Tartu. The published checklists of Estonian Mycobiota (Järva & Parmasto, 1980; Järva & al., 1998) were used for information about the novelty of own observations. Special attention has been paid by Estonian mycologists to selected sites in the country where the diversity of Mycobiota is recorded permanently and very intensively. One of these sites of special interest is the small island of Ruhnu in the Riga Gulf south of Saaremaa. The author of this paper made a field trip to this island with the aim to contribute some new records. Also the island of Saaremaa had been visited several times by the author. Moreover, from September to December 2004 it was made possible to the author to stay in Tartu taking part in teaching at the Estonian Agricultural University (EAU). The records of fungi being dealt with in this paper originate mainly from the three parts of Estonia mentioned above.

## METHODS

The conventional methods for the mycological field work and light microscopy have been used. The quotation of colours was carried out by aid of Methuen (Kornerup & Wancher, 1967) and Locquin (1957); f. i., 5 C 5 + Y 05 means that the colour quotation is accomplished by adding to the colour sample 5 C 5 in Methuen the filter Y 05 provided in the Chromotaxia of Locquin.

## NOTEWORTHY SPECIES

### Melanoleuca pallidicutis Bresinsky spec. nova

Whereas the genus *Melanoleuca* appears to be very well defined and may easily be recognized and identified (mostly already in the field) the delimitation of species, on the other hand, is quite difficult. A clear and convincing concept to handle the diversity on the species level is still missing. Nevertheless some species within the genus are easily characterized by exceptional characters. The species described below seems to fulfil the criteria of a fairly well delimitated new species.

**Diagnosis latina:**

*Pileus ad 10 cm in diam., discoideus, in medio modice depressus et cum umbo obtuso, colore pallide griseo-ochraceo, in umbone ipso acrius ochraceo. Margo non pruinosus, acutus, in convexum decurvatus. Superficies subnitens eademque, si megaloscopio utaris, subtiliter et innatae subtomentosa, nudis oculis glabra. Lamellae sinuatae, intermixtae, confertae, angustae, 6 mm latae, aetate iuvenili albidae, deinde cremeo-carneae. Stipes 9 x 0.8 cm, clavato-bulbosus, albidus, ab imo griseo-ochraceus superfusus. Superficies subtiliter per longitudinem striata, in summo glabra vel parum distincte pruinosa. Bulbus in basi plus minus obliquus, subter applanatus, albus, villis*

*et pilis hirsutis albis spisse contectus, qui villi et fibrae mycelii cum foliis betulinis emortuis stramenti sunt coniuncti. Caro alba, odore prope saponaceo, in pileo tenuis ac spongiosa, in stipite solida ac longitudine striata. Sporae oblongae vel ellipsoideae, altero ferme tanto longiores quam latiores, 8.0–9.5 x 4–5 µm, amyloideae, verrucis amyloideis minus confertis tectae. Cheilocystidia et pleurocystidia adsunt, lageniformia, interdum propius basim admodum ventricosa, in summa parte muricata, 60 x 10 µm. Hyphae fibrarum rhizoidei pari tractu sitae, angustae, 5–7 µm latae, quae nonnumquam vel angustiores ramulos angulis acutis abeuntes faciunt. Fibulae in septis hypharum desunt. Hyphae pilei pellis cutem efficiunt consistentem in hyphis iacentibus paene regulariter intricatis, nec stricte parallelis nec radiate sitis, 5(–13) µm latis. Hyphae secretiferae adsunt in cute. Pigmenta in strato exteriore cutis sub microscopio subflavida videntur, cytoplasmatica, intraparietalia, non crustacea. Dermatocystidia desunt, caulocystidia non observabantur. Habitat ad marginem paludis in silva uliginosa betularum loco humido et turfoso, in stramento a foliis emortuis betularum orto. Holotypus depositus est in Herbario Mycologico Tartuensis (TAA): Estonia, insula Saaremaa, Koigi Raba prope Pöide, 29.08. 2004, leg. A. Bresinsky. Isotypus in Herbario Monacensi (M).*

**Etymology**: the epithet relates to the pale colour of the cap surface in fresh condition.

**Description** **Fig. 1**

Pileus: 10 cm in diameter, disk-shaped with somewhat depressed centre bearing an obtuse umbo. Colour pale greyish-ochraceous, umbo more intensively ochraceous. Margin not pruinose, acute, decurved. Surface somewhat shining, at the same time minutely and innately tomentose under the lens, smooth and not covered by a tomentum if observed with the naked eye. Gills emarginated, unequal, crowded, narrow, 6 mm broad, completely whitish when young, later creamy with light carneous tinge and pale towards the edges. Spore print whitish, soon cream coloured. Stipe 9 x 0.8 cm, clavate-bulbous. Colour whitish, from the basis towards the middle part greyish-ochraceous. Surface minutely striate, at the tip glabrous or more or less pruinose. Basal bulb more or less oblique, flattened underneath, white, covered by a white tomentum and by white rhizoids which are connected with leaf litter of *Betula*. Context: white, odour somewhat like soap, in the cap narrow, 3 mm broad, spongy, in the stipe solid, fibrous.

Spores oblong-ellipsoid, nearly twice as long as broad, 8.0–9.5 x 4–5 µm, amyloid, covered with scattered amyloid warts, plague present and sometimes visible close to the apiculus. Basidia 4-spored. Pleuro- and cheilocystidia present, lageniform, sometimes ventricose towards the basis, at the tips muricate, 60 x 10 µm. Hyphae of the rhizoid fibres narrow, x 5–7 µm, sometimes with very narrow branches, with granulose yellowish coloured content, densely parallel arranged, clamp connections at the hyphal septa missing. Hyphae of pileipellis forming a cutis which consists of irregular interwoven, not strictly parallel and not radial arranged repent, 5 (–13) µm broad hyphae. Pigmentation of the exterior layer of the cutis faintly yellowish, cytoplasmatic and intraparietal, not incrusting. Hyphae of the cortical layer of pileus intermingled with secretory hyphae; these are 5–6 µm in diameter, occasionally branched, straight, curved or even somewhat coiled, obviously without cross septa, their content hyaline and homogenous (hydromorphic according to Clémençon, 2004). Dermatocystidia lacking. Caulocystidia not observed.

Habitat: At the margin of a bog on whet, turfy soil, in the litter formed by leafs of *Betula*, within a wet stand of *Betula*. Holotype: Estonia, island of Saaremaa, Koigi Raba near Pöide, 29.08.2004, leg. A. Bresinsky. Deposited in the Mycological Herbarium in Tartu (TAA), Isotype in the Herbarium of Munich (M).

**Comments:**

The species seems to be quite well characterized by the bulb at the base of the stipe bearing white rhizoids. At the first glimpse the specimens appear to be quite bright, even almost whitish; however, after they have been collected the colour of the pileus tends to change to greyish ochraceous. Because of the quite prominent colours of the caps in later stages the species will not key out among the white species of *Melanoleuca* (see Horak, 2005). Following the key to the other groups within *Melanoleuca* one will end up in the group with lageniform cystidia having not deeply ochraceous to orange-ochraceous coloured gills. Because of fairly large sized pilei (10 cm) which are not conspicuous

pruinose on their upper surfaces, if seen with the naked eye, one will end up near *M. polioleucea*, from which, however, our species differs by the bulbous rhizoid bearing base of stipe, the brighter colour of the cap and by the secretory hyphae in the cortical layer of the pileus.

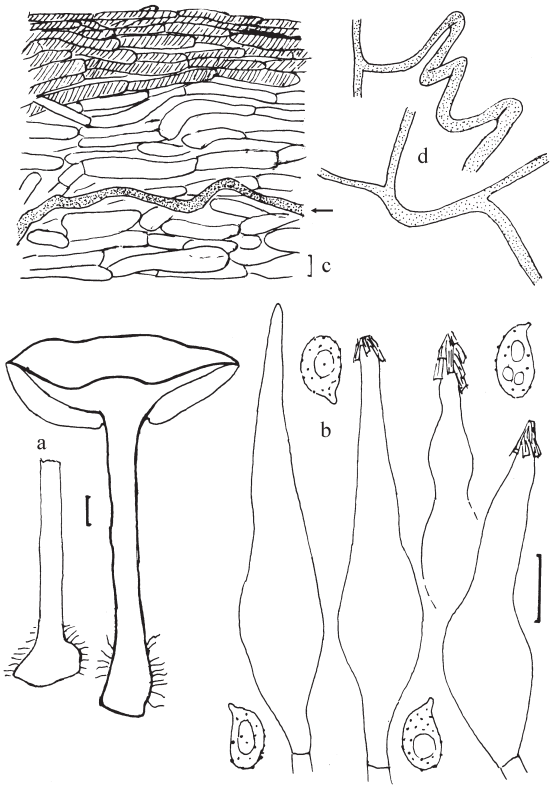


**Fig. 1.** *Melanoleuca pallidicutis* spec. nova. a: fruitbody (scale 1 cm). – b: cheilo- and pleurocystidia, spores (scale 10 µm). – c: cross section through cortical layer of pileus, arrow indicates secretory hypha (scale 10 µm). – d: secretory hyphae (scale as in c).

Agrocybe pediades (Pers.: Fr.) Fayod
The species, collected on the dunes at Limo beach of Ruhnu island, is regarded as identical with or at least to be very close to *A. semiorbicularis*. Under that name the taxon is listed in the Estonian checklist of fungi (Järva & al., 1998).

Clitocybe concava (Scop.: Fr.) Gillet
This medium-sized species has been described under different names according to Horak 2005: *Gerronema nitriolens* (J. Favre) Clémençon, *Clitocybe umbilicata* (Schaeff.: Fr.) Singer Also *C. strigosa* Harmaja might be identical. It is quite well characterized among the representatives of the genus *Clitocybe* by having a hygrophaneous pileus and greyish to grey-brownish gills, by its strongly infundibuliform and deeply greyish brown caps, by rather conspicuous rhizoids at the base of the stipe, by faint nitrous odour of the flesh and by 4-spored basidia with spores measuring 6–8 x 3–4.5 µm. A collection of this species had been made on the island of Saaremaa. Since it has not been listed in the checklist of Estonian fungi (Järva & al. 1998), a complete description of the record will be presented here.

**Notes on the Estonian record:**

Pileus: 5 cm, infundibuliform-umbilicated, margin undulate, incised, crenate, not striate. Surface glabrous, smooth, butyraceous, with concentric zones. Colour ochraceous-greyish-brown, olivaceous-ochraceous, resembling the colour of *Cantharellus tubaeformis* if seen from above, matching 7 D–E 5 in Methuen. Hygrophaneous, fading in radial stripes and then completely to a less intensive greyish-ochraceous colour. Margin not involute, somewhat denticulate. Gills: decurrent, unequal, narrow, moderately crowded, leaving downside surface of the pileus partially visible, towards the stipe sometimes forked, side of gills smooth, greyish-ochraceous; edges entire and even, with same colour as the sides. Stipe: 6 x 0.4 cm, round or somewhat compressed, tapering or clavate towards the base, flexuous, tough, elastic, whitish pruinose at the top and at the base, otherwise equal coloured to the pileus but somewhat lighter. At the top of the stipe between the inserted gills silky and white. Surface under the lense minutely striate. At the base strigose from white rhizoids. Context: somewhat tough, elastic, odour resembling that of washing-soap mixed with a nitrous component, not farinaceous, colour light ochraceous, context in stipe with central hole.

Microscopic features: Spores were seen only rarely. What have been identified as spores measured 5–6–6.5 x 3–3.5–4 µm. Basidia 4-spored. Clamps at hyphal septa present (in context of stipe readily to be seen).

Habitat / location: among bryophytes in a pine wood on acid soil. Estonia, Saaremaa, Murika near Leisi, 31.08.2004.

**Comments:**

Using the flora of Hansen & Knudsen (1992) the species keys out as *C. strigosa* Harmaja. The spore size given for that species fits quite well at the lower range of values with the measurements taken from the Estonian material. It might be that *C. concava* and *C. strigosa* represent one and the same species; in this case the epithet concava would have priority against strigosa. From the illustrations available, the plate given by Bresadola (1927–1933, table 177) fits best with the material collected in Estonia.

Coprinus romagnesianus Singer

This taxon is sometimes recognised as a variety (Krieglsteiner, 1991) of *C. atramentarius*, sometimes as a species of its own (Horak, 2005). It is closely related to *C. atramentarius* anyway. In case that it is recognised as a variety, the correct name would be *C. atramentarius* var. *squamosus* Bres. because this name is older than *C. atramentarius* var. *romagnesianus* (Singer) Krieglst. If recognized as a species, *C. romagnesianus* is the proper name to be used.

**Notes on the Estonian record:**

Pileus: 6 x 6 cm, conical before expansion, occasionally from the straight margin towards the centre incised. Colour greyish-ochraceous, lighter towards the margin. Surface striate-furrowed, sericeous-fibrillous, at the centre covered with accumbent, ochraceous brown, persistent scales which may not be removed by browsing. Gills: *Coprinus*-like, deliquescent, broad, resembling those of *C. atramentarius*. Stipe: 5–6 (–8) x 0.6 cm, white, minutely striate, at the top pruinose, near base with annular zone. Context: white, soft, deliquescent together with gills. Microscopic features: Spores 9.0–11.5 x 5.0–5.5 µm, smooth, with somewhat oblique germ pore. Habitat / location: gregarious or even tufted on and beneath a deciduous trunk, attached to wood (stump, main roots), even if seemingly humicolous. Estonia, City of Tartu, park near Emajõgi, 20.09.2004.

Cortinarius stillatius Fr. (= *C. pseudosalor* J.E. Lange)

**Notes on the Estonian record:**

Clamps at the septa of hyphae missing, cheilocystidia ballon-like, spores amygdaliform, 14.5–16 x 7.5–8.5 µm. Estonia, Ruhnu island, W of Limo, pine forest, August 2004. Recorded from Latvia (Urbonas & al., 1986), but not from Estonia so far (Järva & Parmasto, 1980; Järva & al., 1998). The spore size matches with those given in Hansen & Knudsen (1992); they are, however, bigger than mentioned in Horak (2005).

Leucopaxillus cutefractus Noordel.

The species is belonging to the complex of *Leucopaxillus albissimus* (Peck) Singer s.l. = *Leucopaxillus paradoxus* (Cost. & Dufour) Boursier s.l. The record of *L. albissimus* s.l., which had been made by the author on the island of Ruhnu is presumably the first one for Estonia. The field notes given here had been taken from freshly collected carpophores which grew along the margin of an unpaved small road in close connection to a living tree of *Acer platanoides*. The delimitation against other species within the genus *Leucopaxillus* and the identification to one of the members within the complex of *L. albissimus* s.l. will be discussed separately after the description of the Estonian record has been given.

**Notes on the Estonian record:**

Pileus: 8–11 cm in diameter with involute margin, plano-convex with flat disc occasionally or, more commonly, with broad, obtuse umbo. Surface cracked in tiny areola, outside cracked areas smooth, mat, almost felted, dry. Whitish to ochraceous, on dried specimens even ochraceous-yellow. Margin for a short distance (0.5 cm) weakly ridged. Gills: unequal, more or less crowded and decurrent, cream-coloured, from the background ochraceous, narrow (0.5 cm). Side of gills smooth, edges entire, minutely whitish pruinose. Near insertion at the stipe forked and anastomosing. Stipe: 5–8 x 1.5–3 cm, the slightly enlarged basal part is radicating, caespitose-concrescent, without ring, white, with tiny felted, whitish to ochraceous coloured scales, at the basal part distinct felted tomentous, centric to slightly eccentric. Context: compact, rather tough, odour pleasant (resembling that of *Boletus edulis*) to slightly unpleasant, rather persistent, also on dried material for a longer time observed, occasionally also with faint sweetish trait resembling perfumed soap.

Microscopic characters: Spores 6.5–7.5 x 5.0–5.6 µm, strongly amyloid, warted, containing one rather big droplet, broadly ellipsoid, some of the spores collapsed in Melzer`s reagent.

Cheilocystida present, partially crowded, filamentous-flexuose, occasionally inflated at their basal parts, hyaline, with cross septa, 30–40 x 2.5–3 µm. Clamps at hyphal septa present.

Habitat: caespitose at the ground nearby a trunk of a living tree of *Acer platanoides*, on sandy soil, eventually connected with the main roots of the tree, close to the margin of an unpaved small road. Location: Estonia, Riga gulf, Ruhnu island, in the village, 17.08.2004 leg. A. Bresinsky. Specimens deposited in the Mycological collections of Tartu (TAA).

**Comments**:

Our record fits almost perfectly with the features of *Leucopaxillus cutefractus* Noordel., given by the author of this species. The craqued surface of the cap, which is not merely white rather than more and more ochraceous when getting old, seems to be an important character. The filamentous cheilocystida ad the edges of the gills are easily to be seen and they are regarded by Noordeloos (1995) as a differential character against *L. paradoxus* (= *albissimus* s. str.). The size of spores is in accordance with the values given by Noordeloos. The radicating stipe of the Estonian collection needs some comment. Noordeloos' drawing of *L. cutefractus* in the Flora Agaricina Neerlandica does not show stipes with such a feature. However, in the diagnosis for that species the statement is given that the stipe is "...usually strongly swollen towards base, but extreme base mostly attenuated and almost rooting." Since some degree of rooting is admitted by Noordeloos as a character of *L. cutefractus*, the rooting stipe of our Estonian collection is actually not in contradiction to his species concept and therefore apparently in agreement to the type material. *L. cutefractus* is a member of a species complex around *L. albissimus* (= *L. paradoxus*, = *L. cerealis*). It is, at the time being, not quite clear if the taxa which have been established in the frame of this complex have to be regarded as species of their own or only as variants or forms within a quite variable single species. The decision about this question is not easily to be taken since all members of this complex are quite rare and only occasionally observed. In this regard attention has to be paid also to *L. nauseosodulcis* (P. Karst.) Singer & A.H. Sm. which obviously has been described on the basis of material collected in Finland. According to Hansen & Knudsen (1992) this species comes very close to the members of the discussed complex, differing from *L. albissimus* by more or less eccentric, robust and fasciculate stipes which measure 4–14 x 1–5 cm; the smell has been described as unpleasant, especially on drying. All these features fit more or less also on our collection of *L. cutefractus* in Estonia. So it remains necessary to investigate the type material of *L. nauseosodulcis* in comparison to *L. cutefractus* in order to answer the question of the possible identity of both taxa. Taking the whole complex of *L. albissimus* s.l. into consideration, specimens from coniferous woods and those from deciduous trees and woods, respectively, may turn out to be not conspecific. In case of *L. cutefractus* occurrence in connection with deciduous trees is reported; this is again in agreement with the Estonian record of that species. For *L. albellus* and *L. paradoxus*, however, also coniferous woods are mentioned as habitats. Records from coniferous woods should not be confused with *L. lentus*. Attention has also to be paid to *L. barbarus* Maire which has been recorded from North-Africa (Malençon & Bertault, 1975) and Southern Europe (Horak, 2005). This species has been regarded to be closely related to (or even identical with ?) *L. cutefractus* (see Horak, 2005). The spores of *L. barbarus*, measuring 7–9 (–10) x 4–5.5 µm, differ somewhat in size from L. cutefractus, measuring 6.5–8 (–8.5) x 4.5–6 (–6.5) µm. Moreover, the smell of the carpophores and the appearance of the surface of the pilei are quite different in both species.

From the coloured plates which are available in quite a large number the presentation Md 825 (as *L. paradoxus*) seems to fit best to the record of *L. cutefractus* from Estonia. The specimens show the typical form, colour and surface of the pileus, moreover decurrent gills, swollen base of stipe which is rooting. The habitats mentioned are deciduous (more rarely coniferous) woods. Also the picture Ct 2737 (*L. albissimus*) demonstrates specimens with somewhat radicating stipes quite well. Finnaly the paintings Lu 1.42.3 A and B (*L. albissimus* var. *cutefractus*) are characteristic although the stipes are not shown to be radicant. [Abbreviations: Md = Marchand (1986); Ct = Cetto (1993); Lu = Ludwig (2001)].

Paxillus vernalis Watling (= *Paxillus validus* C. Hahn)

The Swedish mycologist Nils Fries (Fries, 1985) was the first one to observe some kind of genetic diversity within the complex of *Paxillus involutus* (Batsch) Fr. His mating tests revealed at least two different groups within *Paxillus involutus* s.l. which are completely incompatible to each other. Hahn & Agerer (1999) found anatomical differences in the rhizomorphs and sclerotia of *Paxillus involutus* s.l., indicating the existence of two different species additionally to *P. involutus* s. str. In the opinion oft the author of this paper, however, only one extra species can be distinguished taxonomically so far and the correct name to be applied for it should be *Paxillus vernalis* Watling.

*P. vernalis* has been described as a new species on the basis of specimens originating from North America. Records from Europe have not been known until recently. However, Jarosch & Bresinsky (1999) concluded on behalf of their DNA-studies that the fungus associated with deciduous park trees in Europe is nothing else than *P. vernalis*. In Europe *P. vernalis* is bound as a mycorrhiza partner to planted deciduous trees in parks, at roadside verges and in other manmade habitats; most favoured mycorrhizal partners are *Tilia, Quercus, Populus tremula, Corylus* and *Betula*. From these habitat requirements it might be concluded that *P. vernalis* has been introduced via tree nurseries to Europe.

In Michigan (USA) *P. vernalis* was brought to my attention through the late A.H. Smith. Before the formal establishment of the taxon was accomplished by Watling (1969), the fungus had been studied by A.H. Smith and was expected by him to be a new species. Authentic material had been turned over by A.H. Smith to the author of the present paper under the name *P. vernalis* already in 1967, two years before Watling described it under the same name; the material of 1967 is deposited in the herbarium of Munich (M) and had been used for the DNA-analysis by Jarosch & Bresinsky. Later I have had the opportunity to observe *P. vernalis* on the university campus of Regensburg over a period of many years. The discriminating characters between *P. involutus* s. str. and specimens assigned to be *P. vernalis* are in terms of morphological appearance and conventional microscopic characters not as clear as they are on the DNA-level.

**Description of the Estonian record**:

Pileus: 15–20 cm in diameter, plane with depressed centre and at the same time with broadly enrolled margin which is irregular incised. Marginal zone minutely ridged and with flaring felted squamulae (pocket-lens!), quite broad: distance from the outermost margin up to the surface of the pileus approximately 2 cm in adult individuals and at least 0.6 cm in pretty young caps. The surface of cap shiny, in the centre glabrous and smooth, towards the margin with innated or adherent reticulate intertwined felted fibres (pocket-lens!). Ochraceous-brown, 5 C 5 + Y 10, 5 C 6 + Y 10. Gills: unequal, crowded, more or less easily removable from pileus, decurrent, repeatedly anastomosing and forked towards the stipe, 0.5 cm broad. Edges smooth, slightly waved and weakly pruinose at most (pocket-lens!). Colour light ochraceous, sensitive if browsed and then changing colour patch-wise to a dark brown; this happens more obviously close to the stipe rather than close to the margin of the cap, 5 B 5 + Y 10, 5 B 5 + G 05, 5 B 6 + G 20, patches 5 D-E 6. Spore print: deep ochraceous brown with vinaceous component if freshly dropped, 5 D 6, 5 D 4 + M 05. Changing its colour more and more to a distinct ochraceous brown when getting older. Stipe: stout and in comparison to diameter of the cap very short, 3.5–4 x 4 cm, tapering towards the base, with the same colour as on the cap, changing its colour to dark brown from the base upwards. At the base of stipe with attached humus masses. Context: at the beginning clear yellowish, changing its colour to light ochraceous, from 3 A 4 to 4 B 4 + R 05, in the base of the stipe to a deeper red brown, quite faster than in other parts of the carpophore. Flesh in the pileus spongy, 2 cm broad (when measured in the middle of the radius of the cap) in adult pieces, and even 1.5 cm in pretty young material, in the stipe more compact.

Microscopic features: Spores broadly ellipsoid, 8–8.5 x 5.0–5.5 µm. Cheilocystidia (50–60 x 9–10 µm) and pleurocystidia (35–40 x 8–10 µm) abundant, fusoid-ventricose, with brown content in the upper half; walls in the neck somewhat flexuous, more prominent so in

the pleurocystidia; tips of cheilocystidia appear to be more rounded than those of pleurocystidia which might have quite acute tips.

Habitat / location: under planted birch trees at the entrance area Institute of Zoology and Botany in Tartu, 6.9.2004. Some of the fruit bodies were infected with *Hypomyces chrysospermus* Tul.

**Comments:**

The differences between *P. vernalis* and *P. involutus* have been demonstrated by Watling (1969) and by Smith & al. (1979). The European records of *P. vernalis* agree quite well with the descriptions of both authors from North America. Some aspects have to be mentioned in detail.

Seasonal appearance of fruitbodies: According to Watling fruit bodies of *P. vernalis* appeared in 1965 in early summer and were observed in quite a considerable number over a longer period during wet weather conditions. In contrast fruit bodies of *P. involutus* tended to show up solitarily to gregariously from summer to fall. Actually the fruiting time of both species was overlapping with a slight tendency of earlier fruiting in case of *P. vernalis*. Fruiting of *Paxillus vernalis* in spring had been observed only in exceptional cases: out of a quite considerable number of records only three were found to fruit already in June, all the other ones later in the summer or even in the fall. So the applied name "vernalis" is somewhat misleading.

On the campus of the university of Regensburg in Germany fruit bodies of *P. vernalis* (= *P. validus*; type locality) appeared abundantly mostly at the beginning of the local mushroom season in the fall, however, sometimes already as early as in May.

Spore print: According to Watling and Smith & al. cocoa-brown to vinaceous brown in *P. vernalis*, and deep yellow-brown to ochraceous-brown in *P. involutus*. Taking into account own observations on fresh material originating from Germany and from Estonia, there is indeed a slight difference in the colours of the spore deposits in agreement with Watling (1969) and with Smith & al. (1979). However, spore print colours in *Paxillus* are susceptible to colour changes, taking place after a while, as it is evident on the bruised gills and on the freshly cut context being exposed to the air. So this character has to be considered with great care. Only freshly dropped spore masses will permit to observe some slight differences between both taxa; after some time the minute differences will disappear more and more.

Size of fruitbodies: The stipe of *Paxillus vernalis* near its apex measures 2–4 cm in diameter, whereas *P. involutus* reaches only 0.4–2 cm (Smith & al., 1979; Watling, 1969). This difference might be quite reliable for keeping apart both species. An additional character is the width of the involute margin of the expanded pileus: in case of *P. vernalis* it is quite more than 1 cm (up to 1.5–2 cm), in *P. involutus* it is 0.6 cm at most.

## NEW AND REMARKABLE RECORDS OF MYCOBIOTA ON RUHNU ISLAND

The fungal biota of Ruhnu Island in the Baltic gulf south of Saaremaa have been studied most intensively by Parmasto & Parmasto (2005). In their recent survey altogether 602 species of fungi are listed which have been found on the island so far. Nevertheless some groups of fungi are according to their own statement still underrepresented. This applies to agarics and boletes which have been almost neglected up to the present time. In the following list only such species are included which apparently are new for the island or which have been observed on substrata or in habitats so far not mentioned. More common representatives of readily fruiting fleshy fungi appeared to be during the stay of the author on the island (August 2004): *Amanita porphyrea, Cantharellus cibarius, Macrolepiota nympharum, Paxillus atrotomentosus, Pleurotus pulmonarius, Russula decolorans, Tylopilus felleus.*

Herbarium specimens of records are deposited in the mycological Herbarium in Tartu (TAA; partially also in M).

### ASCOMYCOTA

#### Erysiphales

Erysiphe cichoracearum DC.: *Phlox* (new host for Ruhnu) – village of Ruhnu, 17.8.2004.

E. pisi DC.: *Pisum sativum* (new host for Ruhnu) – village of Ruhnu, 18.8.2004.

Sawadaea tulasnei (Fuckel) Homma: *Acer platanoides* – village of Ruhnu, 14.8.2004.

**BASIDIOMYCOTA**

**Agaricales s.l.**

Agaricus campestris L: Fr. – village of Ruhnu, 21.8.2004.

Agrocybe pediades (Fr.) Fayod – dunes, Limo, Korsbacka, 17.8.2004.

Amanita fulva (Schaeff.) Fr. – Linbacka, 13.8.2004.

A. spissa (Fr.) P. Kumm. – *Picea*, Valgi, Austerkeld, 17.8.2004.

Bolbitius titubans (Bull.: Fr.) Fr. [= *B vitellinus* (Pers.) Fr.] – *Phragmites*, village of Ruhnu, 18.8.2004.

Conocybe tenera (Schaeff.: Fr.) Fayod s.l. – Kuunsi, 19.8.2004.

Cortinarius bolaris (Pers.: Fr.) Fr. – Linbacka, 22.8.2004.

C. mucosus (Bull.: Fr.) Cooke – *Pinus*, Kuunsi, 19.8.2004.

C. orellanoides Rob. Henry (= *C. speciosissimus* Kühner & Romagn.) – *Pinus, Picea*, village of Ruhnu, Norrkelt, 21.8.2004.

C. stillatius Fr. (= *C. pseudosalor* J.E. Lange)– Valgi, 15.8.2004.

Crinipellis scabella (Alb. & Schwein.: Fr.) Murrill – Limo, 16.8.2004.

Delicatula integrella (Pers.: Fr.) Fayod – *Alnus*, Reio, 23.8.2004.

Hypholoma fasciculare (Huds.: Fr.) P. Kumm. – Linbacka, 13.8.2004.

Lactarius musteus Fr. – *Pinus*, Valgi, Austerkeld, 17.8.2004.

Leccinum aurantiacum (Bull.) Gray – *Populus tremula*, Valgi, 14.8.2004.

L. percandidum (Vassilkov) Watling – *Betula*, Linbacka, 22.8.2004.

L. versipelle (Fr. & Hök) Snell – *Betula*, Haubierre, Valgi, 15.8.2004.

Lentinus lepideus (Fr.: Fr.) Fr. – on a piece of wood (trunk) near sea shore, in the Honkenyetum, apparently halotolerant, Limo, Korsbacka, 17.8.2004.

Leucopaxillus cutefractus Noordel. – *Acer platanoides*, village of Ruhnu, 17.8.2004.

Limacella glioderma (Fr.) Maire – village of Ruhnu, Norrkelt, 21.8.2004.

Macrolepiota mastoidea (Fr.: Fr.) Singer – August 2004.

Mycena galericulata (Scop.: Fr.) Gray – *Alnus*, Reio, 23.8.2004.

Panaeolina foenisecii (Pers.: Fr.) Maire – village of Ruhnu, 24.8.2004.

Pleurotus ostreatus (Jacq.: Fr.) P. Kumm. – Whereas *P. pulmonarius* (Fr.) Quél. is quite common on the island of Ruhnu, growing on *Sorbus aucuparia*, as has been observed by Parmasto & Parmasto (2005), no record has been mentioned for *P. ostreatus* so far. One finding of a *Pleurotus* species in the area of Kuunsi – Staknäs, near the sea shore on a piece of wood (log) in the Honkenyetum, where it is apparently halotolerant, collected on 21.8.2004, has been identified as the latter species. The distinction between *P. pulmonarius* and *P. ostreatus* in the field is not always easy, however, the moderately bigger size of the fruit body and the somewhat deeper colours on the cap support the identification as *P. ostreatus*.

Rhodocybe popinalis (Fr.) Singer – 8.2004; exact location on Ruhnu not recorded.

R. truncata (Schaeff.) Singer ex Bon – *Picea*, Haubierre, Valgi, 15.8.2004.

Russula acrifolia Romagn. – Valgi, village of Ruhnu, 15.8.2004.

R. chloroides (Krombh.) Bres. – Baskiarri-Valgi, 14.8.2004.

R. clavipes Velen. (= *R. elaeodes* ss. auct.) – Valgi, 15.8.2004, det. W. Jurkeit.

R. nauseosa (Pers.) Fr – Valgi, Austerkeld, 17.8.2004.

R. ochroleuca (Pers.) Fr. – Limbacka, 22.8.2004.

R. pulchella I. G. Borshch. – *Betula*, Valgi, Basskiarre, 16.8.2004.

R. sanguinea (Bull.) Fr. – *Pinus*, Valgi Austerkeld, 17.8.2004.

R. versicolor Jul. Schäff. – *Betula*, Reio, 23.8.2004.

R. xerampelina (Schaeff.) Fr. s.l. – see under *R. clavipes* Velen.

Tricholoma aestuans (Fr.) Gillet – *Pinus*, Overkirke, 20.8.2004.

**Aphyllophorales**

Hydnellum aurantiacum (Batsch: Fr.) P. Karst. – Valgi, 15.8.2004.

**Gasteromycetes**

Bovista plumbea Pers.: Pers. – Kuunsi, 19.8.2004.

B. pusilla (Batsch: Pers.) Fr. (= *Lycoperdon ericetorum* Pers.) – Salthammen, 20.8.2004.

Calvatia utriformis (Bull.: Pers.) Jaap – Kuunsi, 19.8.2004.

Phallus hadrianii Vent.: Pers. – Ammophiletum, Honkenyetum, Limo, 16.8.2004.

Scleroderma bovista Fr.– Valgi, 15.8.2004.

S. citrinum Pers. – Limbacka, 22.8.2004.

**Urediniomycetes**

Microbotryum dianthorum (Liro) H. Scholz & I. Scholz [=*Ustilago dianthorum* Liro] : *Dianthus deltoides*, Kuunsi, 19.8.2004.

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# Lichens from Nanortalik, Aappilattoq, Narsaq Kujalleq/ Frederiksdal and Taserssuaq, South Greenland

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**Abstract:** A total of 206 taxa of lichens are reported from four localities in South Greenland. *Rhizocarpon lecanorinum* is reported as new to Greenland. 10 lichens are new to South Greenland, viz. *Aspicilia caesiocinerea, Bryonora pruinosa, Candelariella arctica, Cladonia luteoalba, Lecanora swartzii, Lecidea silacea, Lepraria eburnea, L. vouauxii, Rhizocarpon lavatum and Umbilicaria nylanderiana.* Geology, climate and vegetation of the localities are briefly treated.

**Kokkuvõte:** Lõuna-Gröönimaa (Nanortalik, Aappilatoq, Narsaq Kujalleq/Frederiksdal ja Taserssuaq) samblikud

Lõuna-Gröönimaa neljas kogumiskohas on registreeritud 206 samblikutaksonit. Esmakordselt on Gröönimaalt leitud *Rhizocarpon lecanorinum*. Kümme liiki (*Aspicilia caesiocinerea, Bryonora pruinosa, Candelariella arctica, Cladonia luteoalba, Lecanora swartzii, Lecidea silacea, Lepraria eburnea, L. vouauxii, Rhizocarpon lavatum* ja *Umbilicaria nylanderiana*) on esmasleiud Lõuna-Gröönimaa jaoks. Lühidalt tutvustatakse ka kogumisalade geoloogiat, kliimat ja taimkatet.

## INTRODUCTION

Contrary to many areas in North and East Greenland the access to South and South West Greenland is generally easy and has been so for a very long period. In spite of the fact that comparatively few professional lichenologists have visited the last mentioned regions, the lichen flora of South and South West Greenland is among the best known in Greenland. About 400 lichens have previously been reported from South Greenland south of 61°30'N (Alstrup, 1979, 1981, 1982, 1986, 1987; Branth & Grønlund, 1888; Breuss & Hansen, 1988; Dahl, 1950, Dahl et al., 1937; Hansen, 1978a, 1983, 1984, 2003, 2004; Hansen & Lund, 2003; Hansen et al., 1987a & b; K. Hansen, 1971; Moberg & Hansen, 1986; Thomson, 1984, 1997). Only half of these lichens have been found in connection with the present investigation. The number of localities (4) is low compared with the total number of localities investigated since 1928–29, when J. Vahl made very extensive collections of lichens in South Greenland (> 100). Vahl collected both macro- and microlichens, while, for example, K. Hansen concentrated on the macrolichens in his study of the distribution and ecology of the lichens of South Greenland (K. Hansen, 1971). Just as the present author, E. Dahl made extensive collections of the two main types of lichens, but he only published his macrolichens (Dahl, 1950).

A short survey of the previous investigations of the lichen flora of the southernmost part of South West Greenland has been given by Hansen & Lund (2003). In 2003 the lichen material deposited at the Botanical Institute, University of Århus, was transferred to the herbarium C. This important material includes numerous Greenland lichens. The lichens that either appear to be new to Greenland or are rare in this area will be published separately by the present author.

### Localities and geology

The following four localities (Fig. 1), all of which are characterized by their comparatively simple geological conditions (Escher & Stuart Watt, 1976), were investigated by the author.

1. Nanortalik. 60°09'N, 45°15'W. Alt. 0–559 m. 26 June–6 July 1993, 17–21 July 2004 & 29 July–3 August 2004. Archaean gneiss and different intrusive rocks and dykes (Escher & Stuart Watt, 1976). – The town, Nanortalik, is located at the middle of the eastern part of Nanortalik Ø (Fig. 2). The major part of the collecting work was carried out in the immediate surroundings of the town, but lichens were collected in all parts of the island, even the top of the highest mountain (alt. 559 m a. s. l.) of the island, which covers an area of c. 20 km$^2$.

2. Aappilattoq. 60°09'N, 44°17'W. Alt. 0–150 m 22–27 July 2004. Archaean gneiss. – Contrary to Nanortalik, which is situated at the outer coast, Aappilattoq (Fig.3) has a sheltered position on a foreland in the big fjord system north of Eggers Ø with the southernmost point of Greenland, Kap Farvel. The distance between Nanortalik and Aappilattoq is about 50 km. A 960 m high mountain separates the settlement from an extensive mountain system with mountains up to more than 1500 m high.
3. Narsaq Kujalleq/Frederiksdal. 60°00'N, 44°40'W. Alt. 0–100 m. 28 July 2004. Ketilidian granite and hypersthene gabbro. – The settlement is located in a wind-exposed lowland area (Fig. 4) at the outer coast, c. 15 km south of Nanortalik and Aappilattoq.
4. Taserssuaq. 60°16'N, 44°43'W. Alt. 0–50 m 30 July 2005. Ketilidian granite. – Lichens were collected near a small, mixed *Larix*-plantation (Fig. 5) at the western end of the lake, Taserssuaq, which is situated near the big fjord, Tasermiut.

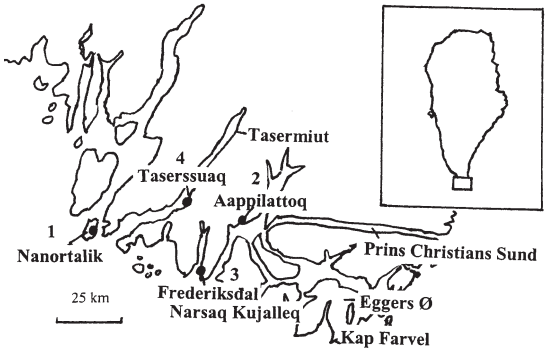


**Fig. 1.** Location of investigation area in South Greenland. 1 – Nanortalik. 2 – Aappilattoq. 3 – Frederiksdal/Narsaq Kujalleq. 4 – Taserssuaq. The small Greenland map shows the position of the investigation area.

**Fig. 2**. View of Nanortalik from a cairn situated at the top of a mountain ridge just north of the town. Orphniospora moriopsis and Pseudephebe minuscula occur abundantly on the rock surface near the cairn.

**Climate**

The mean temperature of the warmest month, July, is 6°C at Nanortalik, whereas the mean temperature of the coldest month, February, is -9°C according to measurements made by Asiaq/Grønlands Forundersøgelser. The annual precipitation is 845 mm (2000). The climatic conditions at Narsaq Kujalleq are presumably comparable with that of Nanortalik, while the climate at Aappilattoq and Taserssuaq is comparable to that of Narssaq with mean temperatures of July and February averaging 8°C and -8°C, respectively, and a somewhat smaller annual precipitation (Hansen & Lund, 2003).

## MATERIAL AND METHODS

Lichens were collected at numerous sample plots at the four localities situated in South Greenland. The collected material, a total of 600 specimens of lichens, was studied with Zeiss light microscopes. Selected specimens of *Stereocaulon* were identified by means of TLC. The material is deposited at the Botanical Museum, University of Copenhagen (C).

## RESULTS AND DISCUSSION

According to Feilberg (1984), South Greenland can be divided up into the following six vegetational zones: 1. a hyper-oceanic, low arctic zone totally without scrubs; 2. an oceanic, low arctic zone with occurrence of willow scrubs; 3. a suboceanic, low- or subarctic zone with presence of birch- and willow scrubs; 4. a subcontinental, low arctic zone with occurrence of willow scrubs; 5. a subcontinental, subarctic zone with presence of birch- and willow scrubs; 6. a residual zone with presence of willow copses. This zone extends from about 60°45'N and northwards in South East Greenland. It is presumably oceanic. Zones 1–5 extend in numerical order from the outer coast to the inland part of South Greenland. The four localities visited in the summer of 2004 are situated in two zones, viz. 1 (Nanortalik and Narsaq Kujalleq) and 3 (Aappilattoq and Taserssuaq). Previous collections are unevenly distributed in the six zones with most collections from the subarctic zones and somewhat fewer from the oceanic zones, in particular from the southernmost part of South East Greenland (Dahl et al., 1937).

**Fig. 3.** Steep gneissic rock surfaces just west of the houses of Aappilattoq. The boulders hold a comparatively rich nitrophilous lichen vegetation.

Much additional collecting work is needed, before more precise phytogeogeographical conclusions can be made as regards the lichens, in particular the microlichens. A list of selected species, which were not found during the present investigation, but which are supposed to be more common than the few finds seem to indicate, is given together with the references in the following.

*Belonia russula* Körb. ex Nyl. (Alstrup, 1981, 1986)

*Caloplaca flavovirescens* (Wulfen) Dalla Torre & Sarnth. (Hansen, 1978a)

*C. verruculifera* (Vain.) Zahlbr. (Hansen et al., 1987a)

*Cladonia ochrochlora* Flörke (Hansen, 1983)
*Dermatocarpon meiophyllizum* Vain. (Hansen, 2003)
*Fuscopannaria ahlneri* (P. M. Jørg.) P. M. Jørg. (Alstrup, 1986)
*Gyalidea lecideopsis* (A. Massal.) Lettau (Hansen et al., 1987b)
*Lecanora boligera* (Norman ex Th. Fr.) Hedl. (Hansen, 2004)
*L. saligna* (Schrad.) Zahlbr. (Hansen, 2004)
*Mycoblastus affinis* (Schaer.) T. Schauer (Hansen, 2003
*Naetrocymbe punctiformis* (Pers.) R. C. Harris (Branth & Grønlund, 1888)
*Protoparmeliopsis muralis* (Schreb.) M. Choisy (Hansen, 1978a)
*Psora globifera* (Ach.) A. Massal. (Hansen, 1978a)
*Psorula rufonigra* (Tuck.) Gotth. Schneid. (Alstrup, 1986; Hansen, 2004)
*Punctelia stictica* (Duby) Krog (Alstrup, 1979)
*Pyrrhospora cinnabarina* (Sommerf.) M. Choisy (Branth & Grønlund, 1888; Alstrup, 1982)
*Rhizocarpon eupetraeum* (Nyl.) Arnold (Hansen, 1978a)
*R. viridiatrum* (Wulfen) Körb. (Thomson,1997)
*Ropalospora lugubris* (Sommerf.) Poelt (Thomson, 1997)
*Schaereria cinereorufa* (Schaer.) Th. Fr. (Hansen, 2004)

**General remarks on the lichen vegetation**

The fact that climatic factors such as temperature and precipitation correlate with the distance from the outer coast of South Greenland, is distinctly reflected by the lichen vegetation (Dahl, 1950; K. Hansen, 1971; Hansen, 1978a). The terricolous lichen vegetation occurring in the surroundings of Nanortalik and Narsaq Kujalleq is strongly influenced by their lowarctic, oceanic climate. More or less open *Empetrum hermaphroditum-Vaccinium uliginosum-Betula glandulosa* heaths occur commonly near the two towns. They are rich in lichens such as *Alectoria nigricans, Arctocetraria andrejevii,*

**Fig. 4.** The landscape near Narsaq Kujalleq / Frederiksdal is dominated by gently sloping rocks covered with a well-developed terricolous and saxicolous vegetation rich in lichens.

*Cetraria islandica, Cetrariella delisei, Cladonia bellidiflora, C. borealis, C. mitis, C. pleurota, C. stellaris, C. stygia, C. uncialis, Flavocetraria nivalis, Ochrolechia frigida, Pertusaria oculata, Stereocaulon alpinum* and *S. paschale*. All of these species usually grow abundantly at their habitats contrary to, for example, *Arthrorhaphia citrinella, Baeomyces rufus, Diploschistes muscorum* and *Pyrenopsis furfurea,* all pioneers on more or less disturbed, mineral soil. Nephroma arcticum was found growing in mixed dwarf shrub heaths with *Ledum groenlandicum.* Fell-field vegetation with lichens such as *Alectoria nigricans, A. ochroleuca, A. sarmentosa* ssp. *vexillifera, Cetraria muricata, Cladonia amaurocraea, Flavocetraria cucullata, F. nivalis, Ochrolechia frigida, Sphaerophorus globosus* and *Thamnolia vermicularis* occurs both in the lowland around the two towns and – with somewhat fewer species – on the top of the highest mountain on Nanortalik Ø. The fell-field lichens grow in a characteristic sociation with *Diapensia lapponica, Juncus trifidus* and *Silene acaulis* on this mountain top. A very luxuriant fell-field community with *Hypogymnia physodes* occurs in the vicinity of both towns. Many macrolichens, for example, *Cetraria islandica, Cladonia ecmocyna, Peltigera aphthosa, P. canina* and *Stereocaulon alpinum,* are also extremely well-developed at Taserssuaq. Around Aappilattoq the dwarf shrub heaths and fell-fields form a compact mosaic vegetation among the *Betula glandulosa* and *Salix glauca* thickets, and they are comparatively poor in lichens. Thus species such as *Alectoria ochroleuca, A. sarmentosa* ssp. *vexillifera, Arctocetraria andrejevii, Cladonia stellaris, Nephroma arcticum* and *Stereocaulon paschale* apparently are lacking at this locality. In spite of the rare occurrence of "heath species" such as *Cladonia floerkeana* and *Pycnothelia papillaria* the lichen flora of Aappilattoq is more similar to that of the most oceanic parts of South East Greenland, particularly as regards the abundant occurrence of snow-patch communities with species such as

**Fig. 5.** Small, mixed Larix-plantations with up to 7 m high trees occur at the western end of the lake, Taserssuaq, near the fjord Tasermiut. Dead shrubs of Juniperus communis are densely covered with lichens such as Cladonia carneola, C. cyanipes and Nephroma parile in this area.

*Cetrariella delisei, Cladonia ecmocyna, C. trassii, Lepraria eburnea, Pertusaria oculata, Solorina crocea* and *Stereocaulon glareosum* (Dahl et al., 1937; Hansen, 1978b). Solorina crocea grows abundantly on the slopes along a watercoarse at Aappilattoq. The area between Kap Farvel and Skjoldungen (c. 63°30'N) is comparatively poorly known lichenologically and is in need of a thorough floristical investigation.

Absence or presence of willow and birch copses is a very important factor as regards the definition of the vegetational zones of South Greenland (Feilberg, 1984). Although rather low and open near the coast, *Salix glauca* copses occur at all of the four localities investigated, while *Betula pubescens* copses are found in the inland (Taserssuaq), only. The usually corticolous lichen, *Parmeliopsis hyperopta,* grows in a somewhat sheltered habitat among boulders at Aappilattoq, but otherwise Nanortalik and Taserssuaq are richest in epiphytic lichens with *Cetraria sepincola, Lecanora fuscescens, L. symmicta, Nephroma parile, Parmeliopsis ambigua* and *Rinodina archaea* as the most important species. Additional information about the corticolous lichen flora of South Greenland can be found in Hansen (1978a) and Alstrup (1982). The ground in the copses is often fairly rich in mosses, which is the preferred habitat for, for example, *Peltigera aphthosa, P. canina* and *P. leucophlebia.* Contrary to the gravely and stony soil in the fell-fields the soil in the dwarf shrub heaths and the thickets is usually rich in humus and often covered by plant remains. This is an excellent substrate for lichens such as *Biatora vernalis, Buellia papillata, Caloplaca ammiospila, C. cerina, C. jungermanniae, C. tiroliensis, Cladonia carneola, C. cyanipes, C. cornuta, Psoroma hypnorum* and *Trapeliopsis granulosa. Chaenotheca furfuracea* and *Lichenomphalia hudsoniana* grow on peat.

The different types of siliceous rocks at the four investigated localities hold several interesting types of saxicolous lichen vegetation. On Nanortalik Ø, where all parts of the island were investigated, nitrophilous influence of the rocks via guano formed by gulls, ravens, snow buntings and other bird species results in abundant growth of lichens such as *Aspicilia caesiocinerea, Caloplaca scopularis, Candelariella arctica, Lecanora straminea, Parmelia sulcata, Phaeophyscia sciastra, Physcia caesia, P. dubia, Platismatia glauca, Protoparmelia badia, Rhizocarpon disporum, Umbilicaria arctica* (dominant), *Xanthoparmelia conspersa, Xanthoria candelaria* and *X. elegans.* The last-mentioned species occurs in an interesting sociation with Physcia caesia and Pleopsidium chlorophanum on vertical and overhanging rocks at both Nanortalik and Aappilattoq. *Acarospora molybdina, Caloplaca alcarum* and *Lecanora contractula* are influenced by both guano and spray from the sea. *Lecanora straminea, Umbilicaria arctica* and *Xanthoria candelaria* also grow abundantly on such rocks and boulders at Aappilattoq, sometimes together with *Amandinea coniops, Caloplaca fraudans, Candelariella coralliza* and *Rhizoplaca melanophthalma.* The last-mentioned species were not found at Narsaq Kujalleq, but in return lichens such as *Placopsis gelida* and *Umbilicaria nylanderiana* were recorded on more or less manured rocks at this locality. Limonite-covered gneisses and dykes are of particular importance on Nanortalik Ø, but also occur at the other three localities. Such rocks hold an interesting lichen vegetation consisting of taxa such as *Acarospora sinopica, A. smaragdula, Aspicilia cinerea, Bellemerea alpine, Calvitimela armeniaca, Lecidea lapicida v. lapicida, L. silacea, L. tesselata, Miriquidica atrofulva, M. garovaglii, M. leucophaea, M. lulensis, M. nigroleprosa, Porpidia flavicunda, P. flavocaerulescens, P. melinodes, Rhizocarpon badioatrum, R. bolanderi, R. grande, Sporastatia testudinea* and *Tremolecia atrata.* The distinct ochraceous and rusty colouration of these lichens forms a marked contrast to the surrounding black and greyish brown lichens, for example, *Allantoparmelia alpicola, Brodoa oroarctica, Orphniospora moriopsis, Pseudephebe minuscule, Umbilicaria hyperborea* and *U. torrefacta. Staurothele fissa* and *Umbilicaria deusta* grow on rocks in watercourses and waterchannels at Aappilattoq.

**Annotated list of lichens**

The following list of lichens is based on the author's collections, which include totally 206 taxa. The list cannot be considered representative as regards genera such as *Acarospora, Aspicilia* and some lecideoid and leprose, crustose lichens, which have been neglected during the present investigation. Nomenclature follows Santesson et al. (2004) with some exceptions. Numbers 1, 2, 3 and 4 indicate the four localities listed above.

Annotations are given as regards the substrate of the lichens, the plant communities in which they occur and presence of apothecia (ap.) or perithecia (pe.); "st." means that the specimen is sterile. The frequency is mentioned, where it was possible to estimate it. Collections which have been distributed previously from the herbarium (C) as part of "Lichenes Groenlandici Exsiccati" (LGE) are stated by their numbers. These numbers can also be found in a new index of Lichenes Groenlandici Exsiccati fascicle I–XXX (Hansen, 2006). Selected references are cited.

Acarospora molybdina (Wahlenb.) A. Massal. – 1, 2. On gneissic seashore rocks, together with *Caloplaca alcarum* and *Lecanora contractula*; ap.; locally abundant.

A. sinopica (Wahlenb.) Körb. – 1, 2. On crusts of limonite on different siliceous rocks together with *Porpidia flavocaerulescens* and *Tremolecia atrata*; ap.; rare.

A. smaragdula (Wahlenb.) A. Massal. – 2. On gneissic rock; ap.; rare.

Alectoria nigricans (Ach.) Nyl. – 1, 2, 3. On soil in dwarf shrub heaths; st.; common. LGE 1001, 1024.

A. ochroleuca (Hoffm.) A. Massal. – 1, 3. On soil in dwarf shrub heaths; st. LGE 1002.

A. sarmentosa (Ach.) Ach. ssp. vexillifera (Nyl.) D. Hawksw. 1, 3. In fell-fields, together with, for example *Cetraria muricata, Flavocetraria nivalis* and *Sphaerophorus globosus*; st.; locally abundant. LGE 498, 948.

Allantoparmelia alpicola (Th. Fr.) Essl. – 1, 2, 3. On different siliceous rocks; ap.

Amandinea coniops (Wahlenb.) M. Choisy ex Scheid. – 2. On gneissic seashore rocks; ap.

Amygdalaria panaeola (Ach.) Hertel & Brodo – 1. On gneissic rock; st.; rare.

Arctocetraria andrejevii (Oxnr) Kärnefelt & A.Thell– 1, 3, 4. On soil in depressions in dwarf shrub heaths, together with *Cetrariella delesei, Cladonia stygia* and *C. trassii*; st.; locally abundant. LGE 962, 1009.

Arctoparmelia centrifuga (L.) Hale – 1, 2, 3. On different siliceous rocks; ap.; locally abundant. LGE 989.

A. incurva (Pers.) Hale – 1, 2, 3. On different siliceous rocks; st.

Arthrorhaphis citrinella (Ach.) Poelt – 1, 2, 3. Pioneer on disturbed mineral soil; rarely on mosses; st. LGE 981.

Aspicilia caesiocinerea (Nyl. ex Malbr.) Arnold – 1. On manured gneissic rock, together with, for example, *Phaeophyscia sciastra* and *Xanthoparmelia conspersa*; ap. New to South Greenland.

A. cinerea (L.) Körb. – 1. On crust of limonite on gneissic rock, together with *Umbilicaria torrefacta*; ap.

A. mastoidea (Lynge) Thomson – 1, 2. On gneissic and basaltic rocks; also on pure quartz; ap.

Baeomyces rufus (Huds.) Rebent. – 1, 2. On bare soil in snow-patches and openings in dwarf shrub heaths; st.

Bellemerea alpina (Sommerf.) Clauzade & Cl. Roux – 1, 2. On gneissic and basaltic rocks with crusts of limonite, together with *Porpidia flavocaerulescens* and *Umbilicaria torrefacta*; ap.

B. cinereorufescens (Ach.) Clauzade & Cl. Roux – 1. On gneissic rocks, together with *Rhizocarpon grande*; ap.

B. subsorediza (Lynge) R. Sant. – 2. On gneissic rocks, together with *Calvitimela armeniaca, Sporastia testudinea, Tremolecia atrata* and *Umbilicaria torrefacta*; st. The species is fairy common in South Greenland (Alstrup, 1986).

Biatora vernalis (L.) Fr. – 2, 4. On plant debris and mosses; st.

Brodoa oroarctica (Krog) Goward – 1, 2, 3. On exposed siliceous rocks, together with *Parmelia omphalodes, Pseudephebe minuscula* and *P. pubescens*; ap. LGE 953, 980, 998.

Bryocaulon divergens (Ach.) Kärnefelt – 1. On soil in dwarf shrub heath, together with *Alectoria nigricans*; st.; rare.

Bryonora pruinosa (Th. Fr.) Holt.-Hartw. – 1. On dead mosses; ap. New to South Greenland.

Bryoria chalybeiformis (L.) Brodo & D. Hawksw. – 1. On soil in dwarf shrub heaths; st.

B. nitidula (Th. Fr.) Brodo & D. Hawksw. – 1. On soil in dwarf shrub heath, together with *Alectoria nigricans*; st.

B. simplicior (Vain.) Brodo & D. Hawksw. – 1. On dead twig; st.

Buellia papillata (Sommerf.) Tuck. – 1. On plant remains, together with *Rinodina turfacea*; ap.

Caloplaca alcarum Poelt – 1, 2. On gneissic seashore rocks manured by birds, together with *Acarospora molybdina* and *Lecanora contractula*; ap.

C. ammiospila (Wahlenb.) H. Olivier – 2. On plant remains, together with *C. cerina* and *C. tirolensis*; ap.

C. cerina (Ehrh. ex Hedw.) Th. Fr. – 2. On plant debris; ap.

C. fraudans (Th. Fr.) H. Olivier – 2. On strongly weathered siliceous rock, together with *Xanthoria candelaria*; ap.; rare.

C. jungermanniae (Vahl) Th. Fr. – 1. On plant remains; ap.

C. nivalis (Körb.) Th. Fr. – 1. On mosses; ap.

C. scopularis (Nyl.) Lettau – 1. On gneissic seashore rock, together with *Lecanora contractula*; ap.

C. tetraspora (Nyl.) H. Olivier – 2. On mosses; ap.

C. tiroliensis Zahlbr. – 2. On plant debris; ap.

Calvitimela aglaea (Sommerf.) Hafellner – 1. On gneissic rock; ap.

C. armeniaca (DC.) Hafellner – 1, 2. On exposed gneissic rock with traces of limonite, together with *Ochrolechia tartarea, Orphniospora moriopsis, Pseudephebe minuscula* and *Umbilicaria torrefacta*; ap.

Candelariella arctica (Körb.) R. Sant. – 1. On gneissic seashore rock manured by birds, together with *Acarospora molybdina* and *Physcia caesia*; ap. New to South Greenland.

C. aurella (Hoffm.) Zahlbr. – 1. On mortar; ap.

C. coralliza (Nyl.) H. Magn. – 2. On gneissic rock manured by birds, together with *Rhizocarpon geographicum* and *R. rittokense*; st.; rare.

C. placodizans (Nyl.) H. Magn. – 2. On mosses; ap.

C. vitellina (Hoffm.) Müll. Arg. – 1, 2. On gneissic rocks manured by birds, together with, for example, *Xanthoria elegans*; ap.

Cetraria islandica (L.) Ach. – 1, 2, 3, 4. On soil in dwarf shrub heaths and fell-fields; ap.; common. LGE 963, 974, 977, 1021.

C. muricata (Ach.) Eckfeldt – 1, 2, 3, 4. On soil in dwarf shrub heaths and fell-fields; st.; common.

C. sepincola (Ehrh.) Ach. – 1, 4. On twigs of *Betula glandulosa* and other dwarf shrub species, together with *Lecanora fuscescens, L. symmicta, Parmeliopsis ambigua* and *P. hyperopta*; ap.

Cetrariella delisei (Bory ex Schaer.) Kärnefelt & Thell – 1, 2, 3. In depressions in dwarf shrub heaths, together with, for example, *Arctocetraria andrejevii*; ap.; common. LGE 959, 992, 1004.

Chaenotheca furfuracea (L.) Tibell – 1. On peat soil; ap.; rare.

Cladonia amaurocraea (Flörke) Schaer. – 1, 2, 3. On soil in fell-fields and dwarf shrub heaths; st.

C. bellidiflora (Ach.) Schaer. – 1, 2, 3, 4. On soil in dwarf shrub heaths; ap.; common. LGE 947.

C. borealis S. Stenroos – 1, 2. On soil in dwarf shrub heaths and fell-fields and near snow-patches; ap. LGE 965.

C. carneola (Fr.) Fr. – 1, 2, 4. On soil rich in humus and plant debris; st.

C. chlorophaea (Flörke ex Sommerf.) Spreng. – 1, 2, 3, 4. On soil; ap.; common.

C. cornuta (L.) Hoffm. – 1, 4. On plant debris in heaths; ap.

C. crispata (Ach.) Flot. – 1, 2, 3. On soil in dwarf shrub heaths; st.

C. cyanipes (Sommerf.) Nyl. – 4. On plant remains, together with *Cladonia carneola*; st.; rare.

C. ecmocyna Leight. – 1, 2, 4. On soil near snow-patches; ap. LGE 976.

C. fimbriata (L.) Fr. – 1, 2. On plant debris and mosses; st.

C. floerkeana (Fr.) Flörke – 2. On soil, together with *Cladonia bellidiflora*; ap.; rare.

C. gracilis (L.) Willd. – 1, 2, 3, 4. On soil in dwarf shrub heaths; ap.; common.

C. luteoalba Wheldon & A. Wilson – 1. On soil rich in humus; st.; rare. New to South Greenland.

C. macrophylla (Schaer.) Stenh. – 1, 2. On soil in dwarf shrub heaths; ap.

C. macrophyllodes Nyl. – 1, 2, 4. On soil rich in humus in open patches in dwarf shrub heaths; ap. LGE 978.

C. mitis Sandst. – 1, 2, 3, 4. On soil in dwarf shrub heaths and fell-fields; st.; common. LGE 966, 984, 1022.

C. phyllophora Hoffm. – 2, 3. Among mosses on soil in dwarf shrub heaths; ap. LGE 983.

C. pleurota (Flörke) Schaer. – 1, 2, 3. On soil in dwarf shrub heaths; ap.

C. pyxidata (L.) Hoffm. – 1, 2, 4. On soil and plant remains in dwarf shrub heaths and fell-fields; ap.

Cladonia squamosa Hoffm. – 1, 2. On soil in dwarf shrub heaths; ap.

C. stellaris (Opiz) Pouzar & Vêzda – 1. On soil in different dwarf shrub heaths; st.; locally abundant. LGE 529, 961.

C. stygia (Fr.) Ruoss – 1, 2, 3, 4. On soil in different dwarf shrub heaths; st.; common. LGE 968, 1013.

C. sulphurina (Michx.) Fr. – 1, 4. On soil rich in humus in dwarf shrub heaths; st.

C. trassii Ahti – 1, 2, 3. On soil in depressions in dwarf shrub heaths; st.; locally abundant.

C. turgida Hoffm. – 1. On soil in *Empetrum hermaphroditium-Vaccinium uliginosum* heath; st.; rare. LGE 533. The species is occasionally occurring in South Greenland (Dahl, 1950; Thomson, 1997).

C. uncialis (L.) Weber ex F. H. Wigg – 1, 2, 3, 4. On soil in dwarf shrub heaths, together with *Cladonia mitis*; st.; common. LGE 1005.

Diploschistes muscorum (Scop.) R. Sant. – 2. On mineral soil; ap.; rare.

Ephebe hispidula (Ach.) Horw. – 1, 2. On gneissic rocks near streams; st. LGE 973.

Euopsis pulvinata (Schaer.) Vain. – 2. On soil, together with *Cladonia borealis* and *Psoroma hypnorum*; ap.

Flavocetraria cucullata (Bellardi) Kärnefelt & A. Thell – 1, 2, 3. On soil in different dwarf shrub heaths, together with *Alectoria nigricans, Cetraria islandica, C. muricata, Flavocetraria nivalis* and *Sphaerophorus globosus*; ap. LGE 1008.

F. nivalis (L.) Kärnefelt & A. Thell – 1, 2, 3, 4. In dwarf shrub heaths and fell-fields; st.; common. LGE 958, 1003.

Frutidella caesioatra (Schaer.) Kalb – 1, 2. On mosses on rocks; ap.

Hypogymnia physodes (L.) Nyl. – 1, 3. On soil in wind-exposed fell-fields, together with, for example, *Alectoria sarmentosa ssp. vexillifera, Cetraria muricata, Ochrolechia frigida* and *Sphaerophorus globosus*; st.; locally abundant. LGE 527, 999.

Lecanora argopholis (Ach.) Ach. – 2. On gneissic rocks; ap.

L. cenisia Ach. – 1. On gneissic rocks; ap.

L. chloroleprosa (Vain.) H. Magn. – 1, 2. On gneissic rocks and gravel; st.

L. contractula Nyl. – 1, 2. On gneissic seashore rocks influenced by guano; ap.

L. fuscescens (Sommerf.) Nyl. – 1, 2, 4. On twigs of, for example, *Betula glandulosa, together with Parmeliopsis ambigua* and *P. hyperopta*; ap.

L. intricata (Ach.) Ach. – 1, 2. On gneissic rocks; ap.

L. polytropa (Ehrh. ex Hoffm.) Rabenh. – 1, 2, 3. On different siliceous rocks; ap.; common.

L. straminea Ach. – 1, 2. On gneissic seashore rocks manured by birds, together with, for example, *Umbilicaria arctica* and *Xanthoria candelaria*; ap.

L. swartzii (Ach.) Ach. – 1. On gneissic overhang; ap. New to South Greenland. The specimen has a greyish brown thallus, which reacts K + yellow and C + orange, and accordingly can be referred to ssp. swartzii.

L. symmicta (Ach.) Ach. – 1, 3. On twigs of *Betula glandulosa*, together with, for example, Nephroma parile; ap.

Lecidea atrobrunnea (Ramond ex Lam. & DC.) Schaer. – 1. On gneissic rocks with patches of limonite, together with *Orphniospora moriopsis*; ap.

L. auriculata Th. Fr. – 1. On gneissic rocks; ap.

L. lapicida (Ach.) Ach. v. lapicida – 1. On gneissic rocks with patches of limonite; ap.

L. lapicida (Ach.) Ach. v. pantherina Ach. – 1, 2. On gneissic rocks, together with *Lecanora polytropa* and *Protoparmelia badia*; ap.

L. silacea Ach. – 2. On crust composed of limonite on gneissic boulder; ap.; rare. New to South Greenland.

L. tessellata Flörke – 1, 2. On gneissic rocks, together with, for example, *Tremolecia atrata* and *Xanthoria elegans*; ap.

Lecidella euphorea (Flörke) Hertel – 1. On dead twig; ap.

Lecidoma demissum (Rutstr.) Gotth. Schneid. & Hertel – 2. On soil; ap.; locally abundant.

Lepraria eburnea J. R. Laundon – 1, 2. On soil in snow-patches. LGE 971. New to South Greenland.

L. neglecta (Nyl.) Lettau – 1. On mosses on gneissic boulder.

L. vouauxii (Hue) R.C. Harris – 1. On mosses. New to South Greenland.

Leprocaulon subalbicans (I. M. Lamb) I. M. Lamb & A. M. Ward – 1, 2. On mosses.

Leptogium lichenoides (L.) Zahlbr. – 1. On mosses; st.

Lichenomphalia alpina (Britzelm.) Redhead et al. – 1. On mosses on moist soil.

L. hudsoniana (H. S. Jenn.) Redhead et al. – 1. On peat.

Massalongia carnosa (Dicks.) Körb. – 1. On mosses; st.

Melanelia commixta (Nyl.) A. Thell – 1, 2. On gravel, together with *Pseudephebe pubescens*; ap. LGE 497.

M. disjuncta (Erichsen) Essl. – 1. On gneissic rocks; st.

M. hepatizon (Ach.) A. Thell – 1, 2, 3. On different siliceous rocks; ap. LGE 993.

Miriquidica atrofulva (Sommerf.) A. J. Schwab & Rambold – 1, 2. On rocks rich in iron minerals; st.

M. garovaglii (Schaer.) Hertel & Rambold – 1, 2. On gneissic rocks with patches of limonite; ap.

M. leucophaea (Flörke ex Rabenh.) Hertel & Rambold – 2. On gneissic rock with patches of limonite, together with *Bellemerea alpina* and *Lecanora intricata*; ap.

M. lulensis (Hellb.) Hertel & Rambold – 2. On gneissic rock with patches of limonite, together with *Pleopsidium chlorophanum*; ap.; rare.

M. nigroleprosa (Vain.) Hertel & Rambold – 1, 2. On different siliceous rocks with patches of limonite, together with *Umbilicaria torrefacta* and *U. virginis*; st.

Multiclavula vernalis (Schwein.) R. H. Petersen – 1. On moist soil near path.

Myxobilimbia lobulata (Sommerf.) Hafellner – 2. On bare, mineral soil; ap. LGE 997.

Nephroma arcticum (L.) Torss. – 1, 3. On soil and mosses in dwarf shrub heaths; st.; locally abundant. LGE 532, 967.

N. parile (Ach.) Ach. – 1, 4. On dead branches of, for example, *Betula glandulosa* and *Juniperus communis*; st. LGE 1018.

Ochrolechia frigida (Sw.) Lynge – 1, 2, 3. On soil, plant remains and mosses in dwarf shrub heaths, together with, for example, *Cetraria muricata* and *Sphaerophorus globosus*; ap.; common. LGE 964.

O. grimmiae Lynge – 1. On *Racomitriun lanuginosum*; ap.

O. lapuënsis (Räsänen) Räsänen – 1, 3. On plant remains in dwarf shrub heaths and snow-patches; st.

O. tartarea (L.) A. Massal. – 1, 2, 3. On different siliceous rocks, together with, for example, *Parmelia saxatilis, Pseudephebe minuscula* and *Rhizocarpon geographicum*; ap. LGE 1017.

Ophioparma ventosa (L.) Norman – 1, 2, 3. On different siliceous rocks; ap.

Orphniospora moriopsis (A. Massal.) D. Hawksw. – 1, 2. On gneissic rocks, together with, for example, *Pseudephebe minuscula* and *Rhizocarpon geographicum*; ap.; locally abundant. LGE 1023.

Parmelia omphalodes (L.) Ach. – 2, 3. On different siliceous rocks, together with *Parmelia saxatilis*; st.

P. saxatilis (L.) Ach. – 1, 2, 3. On siliceous rocks; ap.; common. LGE 954, 986.

P. sulcata Taylor – 1, 2, 3. On different siliceous rocks manured by birds; st. LGE 952, 1000.

Parmeliopsis ambigua (Wulfen) Nyl. – 1, 4. On branches of, for example, *Betula glandulosa*; st.

P. hyperopta (Ach.) Arnold – 1, 2, 4. On branches of *Betula glandulosa* and *Juniperus communis*; ap.

Peltigera aphthosa (L.) Willd. – 1, 2, 3, 4. Among mosses in marshes and open scrubs; ap.; common. LGE 1020.

P. canina (L.) Willd. – 1, 4. Among mosses in open scrubs; st.

P. didactyla (With.) J. R. Laundon – 1, 2. On mosses and soil in dwarf shrub heaths and open thickets; st.

P. leucophlebia (Nyl.) Gyeln. – 1, 2. On soil and among mosses in marshes and open thickets; ap.

P. malacea (Ach.) Funck – 1, 2. On soil and mosses in dwarf shrub heaths; st.

P. polydactylon (Neck.) Hoffm. – 1. On mosses in dwarf shrub heath; ap.; rare. LGE 960.

P. rufescens (Weiss) Humb. – 1, 2, 3, 4. On mosses and soil in dwarf shrub heaths; st.; common.

P. scabrosa Th. Fr. – 1. Among mosses in dwarf shrub heaths; st.

Pertusaria dactylina (Ach.) Nyl. – 1. On plant debris in dwarf shrub heaths; st.

P. geminipara (Th. Fr.) C. Knight ex Brodo – 1. On mosses in dwarf shrub heaths; st.

P. oculata (Dicks.) Th. Fr. – 1, 2, 3. On mosses and plant debris in dwarf shrub heaths and near snow-patches; st.; common.

P. panyrga (Ach.) A. Massal. – 1. On plant debris in dwarf shrub heath, together with *Ochrolechia frigida*; ap.; rare.

Phaeophyscia sciastra (Ach.) Moberg – 1. On gneissic rock manured by birds, together with, for example, *Xanthoparmelia conspersa*; st.

Physcia caesia (Hoffm.) Fürnr. – 1, 2. On gneissic rocks manured by birds, together with, for example, *Rhizocarpon disporum*, and on old bones; ap. LGE 982.

P. dubia (Hoffm.) Lettau – 1. On gneissic rock manured by birds, together with *Xanthoria candelaria*; st.

Placopsis gelida (L.) Linds. – 3. On strongly weathered gneissic rock; st.

Platismatia glauca (L.) W. L. Culb. & C. F. Culb. – 1. On gneissic boulders, together with, for example, *Ochrolechia tartarea* and *Sphaerophorus fragilis*; st.; rare. LGE 496.

Pleopsidium chlorophanum (Wahlenb.) Zopf – 1, 2. On vertical and overhanging faces of gneissic rocks; ap.

Polychidium muscicola (Sw.) Gray – 1. On mosses and gneissic rock; st.

Porpidia flavicunda (Ach.) Gowan – 2, 3. On gneissic rocks with thin layer of limonite, together with *Tremolecia atrata*; ap.

P. flavocaerulescens (Hornem.) Hertel & A. J. Schwab – 1, 2, 3. On different siliceous rocks with patches of limonite, together with, for example, *Tremolecia atrata* and *Umbilicaria torrefacta*; st. LGE 969.

P. melinodes (Körb.) Gowan & Ahti – 1. On gneissic rocks rich in iron, together with, for example, *Miriquidica atrofulva* and *Rhizocarpon grande*; st.

Protopannaria pezizoides (Weber) P. M. Jørg. & S. Ekman – 1. On mosses in rocky cave; ap.; rare.

Protoparmelia badia (Hoffm.) Hafellner – 1, 2. On gneissic boulders manured by birds; ap.

Pseudephebe minuscula (Nyl. ex Arnold) Brodo & D. Hawksw. – 1, 2, 3. On different siliceous rocks, together with, for example, *Allantoparmelia alpicola* and *Umbilicaria hyperborea*; ap.

P. pubescens (L.) M. Choisy – 1, 2. On gneissic rocks and gravel, together with, for example, *Melanelia commixta* and *Umbilicaria hyperborea*; ap.

Psoroma hypnorum (Vahl) Gray – 1, 2, 4. On mosses, plant debris and soil in dwarf shrub heaths and snow patches, together with, for example, *Cladonia macrophyllodes* and *Solorina crocea*; ap. LGE 955, 988.

Pycnothelia papillaria (Ehrh.) Dufour – 2. On soil; st; rare. The species has previously been collected in South Greenland by P. Eberlin and V. Alstrup (Dahl, 1950; Alstrup, 1986).

Pyrenopsis furfurea (Nyl.) Leight. – 2. On soil and gravel; ap.

Rhizocarpon badioatrum (Flörke ex Spreng.) Th. Fr. – 2. On gneissic rocks with patches of limonite, together with *Miriquidica nigroleprosa, Umbilicaria torrefacta* and *U. virginis*; ap.

R. bolanderi (Tuck.) Herre – 1, 3. On different siliceous rocks, together with *Rhizocarpon geographicum* and *Tremolecia atrata*; ap.

R. disporum (Nägeli ex Hepp) Müll. Arg. – 1. On manured gneissic rock, together with, for example, *Aspicilia caesiocinerea*; ap.

R. geminatum Körb. – 2. On rocks composed of gneiss or dolerite; ap.

R. geographicum (L.) DC. – 1, 2, 3. On different siliceous rocks, together with, for example, *Orphniospora moriopsis, Pseudephebe minuscula* and *Tremolecia atrata*; ap.; common. LGE 950.

R. grande (Flörke) Arnold – 1, 2. On manured gneissic rocks in somewhat moist situations, together with, for example, *Porpidia melinodes* and *Umbilicaria torrefacta*; ap.

R. inarense (Vain.) Vain. – 1, 2. On gneissic rocks, together with, for example, *Rhizocarpon rittokense* and *Umbilicaria torrefacta*; ap.

R. jemtlandicum (Malme) Malme – 1. On gneissic rock; ap.

R. lavatum (Fr.) Hazsl. – 1. On moist gneissic rock rich in iron, together with *Tremolecia atrata*; ap. New to South Greenland.

R. lecanorinum Anders – 2. On gneissic rock; ap.; rare. New to Greenland.

R. praebadium (Nyl.) Zahlbr. – 1. On gneissic rock; ap.

R. rittokense (Hellb.) Th. Fr. – 1, 2, 3. On different siliceous rocks; ap.

R. superficiale (Schaer.) Vain. – 1, 3. On different siliceous rocks, together with, for example, *Pseudephebe minuscula*; ap.

Rhizoplaca melanophthalma (DC.) Leuckert & Poelt – 2. On gneissic rock manured by birds; ap.

Rinodina archaea (Ach.) Arnold – 1. On twigs of *Salix glauca*, together with, for example, *Nephroma parile* and *Lecanora fuscescens*; ap.

Rinodina turfacea (Wahlenb.) Körb. – 1. On plant debris, together with, for example, *Ochrolechia frigida*; ap.

Solorina crocea (L.) Ach. – 1, 2, 3, 4. On soil near snow-patches and along ravine; ap.; common. LGE 975.

Sphaerophorus fragilis (L.) Pers. – 1, 2, 3. On different siliceous rocks, together with, for example, *Parmelia saxatilis* and *P. sulcata*; ap.; common. LGE 956.

S. globosus (Huds.) Vain. – 1, 2, 3. On soil in dwarf shrub heaths and fell-fields, together with, for example, *Alectoria sarmentosa* ssp. *vexillifera, Cetraria islandica* and *C. muricata*; ap.; common. LGE 957, 979, 1007.

Sporastatia testudinea (Ach.) A. Massal. – 1, 2. On gneissic rocks with patches of limonite, together with, for example, *Bellemerea subsorediza, Umbilicaria hyperborea* and *U. torrefacta*; ap.

Staurothele fissa (Taylor) Zwackh – 2. On gneissic rocks in watercourse; pe.

Stereocaulon alpinum Laurer – 1, 2, 3, 4. On soil in dwarf shrub heaths and lichen heath, together with, for example, *Cladonia mitis* and *Stereocaulon paschale*; ap.; common. LGE 531, 996, 1012, 1019.

S. arcticum Lynge – 1. On soil in dwarf shrub heaths; st. LGE 528. Thallus contains atranorin and stictic acid (TLC).

S. arenarium (L. I. Savicz) I. M. Lamb – 1, 2, 3. On gravelly soil near snow-patches and in fell-fields; st. LGE 991. Thallus contains atranorin and porphyrilic acid (TLC).

S. glareosum (L. I. Savicz) H. Magn. – 1, 2. On gravelly soil, together with, for example, *Solorina crocea*; ap. LGE 526, 985.

S. paschale (L.) Hoffm. – 1, 3. On soil in dwarf shrub heaths and lichen heaths; st. LGE 530.

S. rivulorum H. Magn. – 1. On soil in snow-patches, together with, for example, *Cetrariella delisei, Pertusaria oculata* and *Solorina crocea*; st. LGE 499.

S. vesuvianum Pers. – 1, 2. On gneissic rocks with patches of limonite; st.

Thamnolia vermicularis (Sw.) Schaer. v. subuliformis (Ehrh.) Schaer. – 1, 2, 3. On soil and gravel in dwarf shrub heaths and fell-fields; common. LGE 1006,1015.

Trapeliopsis granulosa (Hoffm.) Lumbsch – 1, 2, 4. On soil rich in humus, together with, for example, *Cladonia sulphurina*; st.

Tremolecia atrata (Ach.) Hertel – 1, 2, 3. On different siliceous rocks with patches of limonite; ap.; common.

Umbilicaria arctica (Ach.) Nyl. – 1, 2, 3. On different siliceous rocks manured by birds; ap. LGE 949, 990, 1011.

U. cylindrica (L.) Delise ex Duby – 1, 2. On gneissic rocks; ap. LGE 951.

U. deusta (L.) Baumg. – 1, 2. In waterchannels on gneissic rocks; st. LGE 970.

U. havaasii Llano – 1, 3. On different siliceous rocks; st.

U. hyperborea (Ach.) Hoffm. – 1, 2, 3. On different siliceous rocks; ap.; common. LGE 994.

U. nylanderiana (Zahlbr.) H. Magn. – 3. On siliceous rock; ap. LGE 1010. New to South Greenland. The species has previously been reported from Central West and North West Greenland (Hansen, 2002, 2004).

U. proboscidea (L.) Schrad. – 1, 2. On gneissic rocks; ap.

U. rigida (Du Rietz) Frey – 1, 2. On gneissic rocks; ap.

U. torrefacta (Lightf.) Schrad. – 1, 2. On gneissic rocks; generally in fairly moist situations; ap.

U. vellea (L.) Hoffm. – 1, 2. On moist, vertical, gneissic rocks; st.

U. virginis Schaer. – 1, 2, 3. On different siliceous rocks; ap.; common.

Verrucaria striatula Wahlenb. – 1. On gneissic seashore rocks; in particular in the splash zone; pe. The species has recently been reported as new to Central West Greenland (Hansen, 2005). There is a previous report of V. striatula from South Greenland (Nylander, 1862).

Xanthoparmelia conspersa (Ach.) Hale – 1. On gneissic rocks manured by birds; st.

Xanthoria candelaria (L.) Th. Fr. – 1, 2, 3. On different siliceous boulders manured by birds, together with, for example, *Parmelia sulcata, Physcia dubia* and *Umbilicaria arctica*; ap.; common. LGE 1014.

X. elegans (Link) Th. Fr. – 1, 2, 3. On different siliceous rocks manured by birds, together with, for example, *Physcia caesia*; ap.; common.

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# Mycobiota of the Naissaar Nature Park (Estonia)

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**Abstract:** The results of a comprehensive study of fungi and myxomycetes in the Naissaar Nature Park (Estonia) are reported. In 1998–1999 and 2001–2003, 440 species of fungi and 24 species of myxomycetes were registered. Thirty eight species deserve attention as rare in Estonia, including 18 fungal species new for Estonia. Six of the latter are first published records: *Bolbitius variicolor*, *Camarophyllopsis foetens*, *Mycena cinerella* var. *subviscida*, *Mycena purpureofusca*, *Psathyrella piluliformis* and *Psilocybe montana*. Five fungal species, such as *Hydnellum ferrugineum, Bankera fuligineoalba*, *Macrolepiota nympharum*, *Phellinus niger* and *Sarcosoma globosum*, belong to the Estonian Red Data Book, four of them are protected by law.

**Kokkuvõte:** Naissaare Looduspargi seenestik.

Esitatakse ülevaade Naissaare Looduspargi seenestikust. Aastail 1998–1999, 2001–2003 registreeriti saarel 440 liiki seeni ja 24 liiki limakuid. Eestis haruldasi liike leiti saarelt 38, neist esmasleide oli 18 seeneliiki, millest 6 avaldatakse esmakordselt selles töös: *Bolbitius variicolor*, *Camarophyllopsis foetens*, *Mycena cinerella* var. *subviscida*, *Mycena purpureofusca*, *Psathyrella piluliformis* ja *Psilocybe montana*. Viis seeneliiki kuuluvad Eesti Punasesse raamatusse: *Hydnellum ferrugineum, Bankera fuligineoalba*, *Macrolepiota nympharum*, *Phellinus niger* ja *Sarcosoma globosum*, viimastest 4 liiki on Eestis riikliku kaitse all.

## INTRODUCTION

Naissaar is a small island (18.6 km$^2$) in the Gulf of Finland. Regardless of the small area, it is highly variable in natural conditions – all the most important forest site types in Estonia, except alvars, are represented there. In addition to various forest types, there are many dunes in the coastal area and boreo-nemoral grassland wooded meadows in the southern point of the island (Martin & Pärn, 1999).

For a long period, Naissaar was a military object of top secrecy that was exploited intensively. Although military constructions have caused changes in natural communities of some regions, the greater part of the island has been preserved as a primitive, rather unspoiled natural complex (Truus & Ratas, 1995). There are all conditions for the development of rich and diverse mycobiota on the island.

Civilian people were not allowed to visit Naissaar up to the beginning of this century. Therefore, mycologists made first short trips to Naissaar in the summers of 1998–1999, but exhaustive mycological fieldwork was carried out in 2001–2003. This study, providing a list of fungi and myxomycetes, data on species distribution and ecology, and also fungi of the Estonian Red Data Book and protected by law, is the first to publish records on the mycobiota of Naissaar Island.

## MATERIAL AND METHODS

The bulk of the material used in the paper contains fungi and myxomycetes registered and collected during the fieldwork on the island in 2001–2003, to which the data recorded in earlier years (1998–1999) has been added. The material was registered in the following periods by following persons: 4 July 1998 – Kuulo Kalamees; 27–29 June 1999 – Bellis Kullman, Erast Parmasto; 4–6 October 2001 – Kuulo Kalamees, Veiko Kastanje, Kadri Pärtel, Irja Saar; 2–4 May 2002 – Kuulo Kalamees; 30 May–1 June 2002 – Veiko Kastanje, Bellis Kullman, Irja Saar; 9–12 September 2003 – Kuulo Kalamees, Vello Liiv, Irja Saar.

All specimens collected are deposited in the Mycological Herbarium (TAA) of the Institute of Agricultural and Environmental Sciences of the Estonian University of Life Sciences.

The list following the system by Kirk et al. (2001) contains data on 440 fungus species and 24 species of myxomycetes. Thirty eight species are defined as rare in Estonia: 18 species are new records in Estonia, 5 species belong to the Estonian Red Data Book (see Järva et al., 1999),

including 4 species protected by law (Category I-III) (see I ja II kaitsekategooriana..., 2004; III kaitsekategooria..., 2004).

Finding localities and dates are indicated if the species was found in one or two different places on the island. The species occurring in five or more localities are indicated as frequent.

Vegetation site types are mainly presented in accordance with Paal (1997), in a few cases with Lõhmus (2004). Forest types are defined on the basis of a dominant tree species:
1121 Pisy – *Cladina* boreal heath pine (*Pinus sylvestris*) forest;
1121 Bepe – *Cladina* boreal heath birch (*Betula pendula*) forest;
1122 Pisy – *Calluna* boreal heath pine (*Pinus sylvestris*) forest;
1132 Piab – *Vaccinium myrtillus* dry boreal spruce (*Picea abies*) forest;
1132 Pisy – *Vaccinium myrtillus* dry boreal pine (*Pinus sylvestris*) forest;
1141 Piab – *Oxalis-Vaccinium myrtillus* fresh boreal spruce (*Picea abies*) forest;
1141 Pisy – *Oxalis-Vaccinium myrtillus* fresh boreal pine (*Pinus sylvestris*) forest;
1162 Quro – *Aegopodium* fresh boreo-nemoral oak (*Quercus robur*) forest;
1162 Tico – *Aegopodium* fresh boreo-nemoral lime (*Tilia cordata*) forest;
1312 Bepe – *Oxalis-Vaccinium vitis-idaea* dry boreal birch (*Betula pendula*) forest (Lõhmus 2004);
1312 Pisy – *Oxalis-Vaccinium vitis-idaea* dry boreal pine (*Pinus sylvestris*) forest (Lõhmus 2004);
1321 Bepu – *Polytrichum-Vaccinium myrtillus* poor paludified birch (*Betula pubescens*) forest;
1321 Piab – *Polytrichum-Vaccinium myrtillus* poor paludifying spruce (*Picea abies*) forest;
1323 Pisy – *Vaccinium uliginosum* poor paludified pine (*Pinus sylvestris*) forest;
1412 Algl – *Calla* minerotrophic mobile water swamp alder (*Alnus glutinosa*) forest;
1412 Bepu – *Calla* minerotrophic mobile water swamp birch (*Betula pubescens*) forest;
1421 – Mixotrophic bog willow (*Salix* sp.) forest;
1421 Bepu – Mixotrophic bog birch (*Betula pubescens*) forest;
214 – Boreo-nemoral grassland, wooded meadow;
2311 – Saline coastal meadow;
511 – Coastal dunes.

## LIST OF SPECIES

## FUNGI

## ZYGOMYCOTA

### Mucorales

Spinellus cf. fusiger (Link) Tiegh. – on *Mycena* spp., 1321 Piab, 1141 Piab, Mustametsa ots, Taani kuninga aed, 5/6 Oct 2001.

## ASCOMYCOTA

### Erysiphales

Erysiphe aquilegiae DC. var. ranunculi (Grev.) Zheng et Chen – on *Anemone* sp., 1162 Tico, Taani kuninga aed, 5 Oct 2001, TAA 182068.

E. geraniacearum U. Braun & Simonyan – on *Geranium* sp., 2311, Kabelikari, 9 Sept 2003, TAA 185889.

E. krumbholzii U. Braun – on *Chrysosplenium alternifolium*, Vallimägi, 9 Sept 2003, TAA 185891.

E. pisi DC. – on *Vicia* sp., 2311, Kabelikari, 9 Sept 2003, TAA 185892.

Podosphaera clandestina (Wallr.) Lév. var. aucupariae (Erikss.) U. Braun – on *Sorbus aucuparia*, Vallimägi, 9 Sept 2003, TAA 185893.

Sawadaea tulasnei (Fuckel) Homma – on *Acer platanoides*, Vallimägi, 9 Sept 2003, TAA 185890.

Sphaerotheca aphanis (Wallr.) U. Braun – on *Alchemilla* sp., 1321 Piab, Mustametsa ots, 6 Oct 2001, TAA 165886.

Uncinula adunca (Wallr.: Fr.) Lév. – on *Salix* sp., 1321 Piab, on roadside, Oct 2001, Sept 2003, TAA 165868, 165880.

### Helotiales

Albotricha acutipila (P. Karst.) Raitv. – on grass litter, 1321 Piab, Mustametsa ots, 30 May 2002, TAA 179857.

A. ammophilae Dennis & Spooner – on grass litter of *Ammophila arenaria*, 511, Hülgekari ots, 4 Oct 2001, TAA 165860; **rare.**

Ascocoryne cylichnium (Tul.) Korf – on deciduous wood, 1321 Piab, 1162 Tico, Suursadam, Taani kuninga aed, 4/6 Oct 2001.

Bisporella citrina (Batsch: Fr.) Korf & S.E. Carp. – on deciduous wood, 1321 Piab, Mustametsa ots, 5 Oct 2001, 31 May 2002.

Chlorociboria aeruginascens (Nyl.) Kanouse – on deciduous wood, 1321 Piab, Mustametsa ots, 5 Oct 2001.

Claussenomyces prasinulus (P. Karst.) Korf & Abawi – on fallen cones of *Picea abies*, 1141 Piab, Taani kuninga aed, 6 Oct 2001, TAA 165957; **new record** (Raitviir, 2002).

Hamatocanthoscypha laricionis (Velen.) Svrček var. laricionis – on fallen cones of *Picea abies*, 1141 Piab, Taani kuninga aed, 6 Oct 2001, TAA 165956.

Hyaloscypha fuckelii Nannf. var. fuckelii – on wood, 1321 Piab, 1162 Tico, 1412 Bepu, Oct 2001, TAA 165874, 165952, 165953.

H. herbarum Velen. – on debris of *Populus tremula*, Suursadam, 30 May 2002, TAA 179849.

Hymenoscyphus caudatus (P. Karst.) Dennis – on debris of *Populus tremula*, 1321 Piab, Mustametsa ots, 5 Oct 2001, TAA 165877.

H. epiphyllus (Fr.) Rehm – on debris of *Populus tremula*, 1321 Piab, Mustametsa ots, 5 Oct 2001, TAA 165875.

H. equisetinus (Velen.) Dennis – on dead stems of *Equisetum palustre*, 1412 Algl, Sinkarka, 1 June 2002, TAA 185510; **new record** (Raitviir, 2002).

H. scutula (Fr.) W. Phillips – on dead stems of *Lycopus europaeus*, Hülgekari ots, 4 Oct 2001, TAA 165889.

H. scutula (Fr.) W. Phillips var. *scutula* – on grass litter, 1162 Tico, Taani kuninga aed, 6 Oct 2001.

H. translucens (White) Arendh. – on debris of *Betula* sp., 1412 Bepu, Sinkarka, 6 Oct 2001, TAA 165951; **new record** (Raitviir, 2002).

Lachnum apalum (Berk. & Broome) Nannf. – on dead leaves of *Scirpus sylvaticus*, 1412 Bepu, Sinkarka, 1 June 2002, TAA 185509; **new record** (Raitviir, 2002).

L. charretii Raitv. & G. Garcia – on debris of *Betula* sp. and *Salix* sp., 1321 Piab, Mustametsa ots, 31 May 2002, TAA 179854, 179851; **new record** (Raitviir, 2002).

L. clavigerum (Svrček) Raitv. – on grass litter, 1321 Piab, Mustametsa ots, 30 May 2002, TAA 179855.

L. impudicum Baral – on deciduous wood, 1321 Piab, 1162 Tico, Oct 2001, TAA 165882, 165881, 165873, 165954.

L. cf. subauratum (Ellis) Raitv. – on debris of *Betula* sp., 1412 Bepu, Sinkarka, 1 June 2002, TAA 179860; **new record** (Raitviir, 2002).

L. virgineum (Batsch: Fr.) P. Karst. – on wood of *Salix* sp., 1321 Piab, Mustametsa ots, 31 May 2002, TAA 179851.

Micropeziza cornea (Berk. & Broome) Nannf. – on dead leaves of *Eriophorum* sp., 1323 Pisy, Kunilasoo, 5 Oct 2001, TAA 165892; **new record** (Raitviir, 2002).

Mollisia cinerea (Batsch) P. Karst. – on deciduous wood, 1321 Piab, Mustametsa ots, 31 May 2002, TAA 179852, 182078.

M. clavata Gremmen – on dead stems of *Filipendula ulmaria*, 1321 Piab, Mustametsa ots, 31 May 2002, TAA 179855; **new record** (Raitviir, 2002).

M. ligni (Desm.) P. Karst. – on wood of *Betula* sp., 1321 Piab, 1162 Tico, Mustametsa ots, Taani kuninga aed, 5/6 Oct 2001, TAA 165899, 165955.

M. perparvula P. Karst. – on wood of *Betula* sp., 1321 Piab, Mustametsa ots, 31 May 2002, TAA 179858; **new record** (Raitviir, 2002).

M. ramealis (P. Karst.) P. Karst. – on wood of *Betula* sp., 511, 1162 Tico, Mustametsa ots, Taani kuninga aed, 5 Oct 2001, 1 June 2002, TAA 165871, 182087.

Phaeohelotium nobile (Velen.) Dennis – on deciduous wood, 1412 Bepu, Sinkarka, 6 Oct 2001, TAA 165887; **new record** (Raitviir, 2002).

Ph. trabinellum (P. Karst.) Dennis – on wood of *Betula* sp., 1141 Piab, Suursadam, 4 Oct 2001, TAA 165888; **new record** (Raitviir, 2002).

Propolis versicolor De Not. – on wood of *Betula* sp., 1321 Piab, Suursadam, 4 Oct 2001, TAA 165857.

Psilachnum inquilinum (P. Karst.) Dennis – on dead stems of *Equisetum* sp., 1412 Bepu, Sinkarka, 1 June 2002, TAA 185510.

Rutstroemia conformata (P. Karst.) Nannf. – on debris of *Alnus* sp., 1321 Piab, 1412 Bepu, Suursadam, Sinkarka, 30 May/1 June 2002, TAA 179850, 179862.

R. luteovirescens (Roberge) W.L. White – on debris of *Populus tremula*, 1162 Tico, Taani kuninga aed, 6 Oct 2001.

Tapesia prunorum (Fr.) Fuckel – on wood of *Betula* sp., 1412 Bepu, Sinkarka, 1 June 2002, TAA 179861, 182086; **new record** (Raitviir, 2002).

**Hypocreales**

Hypomyces microspermus Rogerson & Samuels – on *Xerocomus chrysenteron*, 10 Sept 2003, TAA 185647.

Nectria cinnabarina (Tode: Fr.) Fr. – on deciduous wood, Lõunaküla, Vallimägi, 9 Sept 2003.

Pseudonectria tilachlidii W. Gams – on *Piptoporus betulinus*, 214, Lõunaküla, 9 Sept 2003, TAA 185663.

**Pezizales**

Aleuria aurantia (Fr.) Fuckel – on sandy road, Miiniladu, 11 Sept 2003, TAA 185645.

Antracobia macrocystis (Cooke) Boud. – 1162 Tico, Taani kuninga aed, June 1999, TAA 179060, 179063, 179065, 179066.

A. maurilabra (Cooke) Boud. – 1162 Tico, Taani kuninga aed, June 1999, TAA 179059, 179061.

Gyromitra infula (Fr.) Quél. – 1321 Piab, 1412 Algl, Oct 2001.

Helvella crispa Fr. – 1321 Piab, Mustametsa ots, 10 Sept 2003, TAA 185605.

H. lacunosa Fr. – 1321 Piab, Mustametsa ots, 5 Oct 2001, TAA 165958.

H. latispora Boud. – 1321 Piab, Mustametsa ots, 5 Oct 2001, TAA 165876.

Humaria hemisphaerica (Fr.) Fuckel – 1321 Piab, 1162 Tico, Mustametsa ots, Taani kuninga aed, 5 Oct 2001, 11 Sept 2003.

Neottiella vivida (Nyl.) Dennis – 1121 Pisy, Hülgekari ots, Mustametsa ots, 4/5 Oct 2001, TAA 165861, 165870.

Otidea leporina (Fr.) Fuckel – 1321 Piab, Kabelikari, 9 Sept 2003, TAA 185578.

O. onotica (Fr.) Fuckel – 1162 Tico, Taani kuninga aed, 11 Sept 2003, TAA 185652.

Peziza badia Pers.: Fr. – on roadside, Suursoo, 26 June 1999, TAA 179048.

P. depressa Pers. – 1321 Piab, Mustametsa ots, 10 Sept 2003, TAA 185615; **rare.**

P. echinospora P. Karst. – on burnt ground, Kunilasoo, 29 June 1999, TAA 179064.

P. varia Fr. – on deciduous wood, 511, Suursadam, Vallimägi, 31 May 2002, 9 Sept 2003, TAA 179859, 185589.

Pyronema omphalodes P. Karst. – on burnt ground, Kunilasoo, 29 June 1999, TAA 179068.

Sarcosoma globosum (Fr.) Rehm – on needle debris, 1321 Piab, Kabelikari, 4 May 2002, TAA 176170; **protected by law (CategoryI), Estonian Red Data Book.**

Scutellinia crinita (Bull.: Fr.) Lamb. – 1132 Pisy, Haldja, 29 June 1999, TAA 179069.

S. heterosculpturata Kullman & Raitv. – Suursoo, 26 June 1999, TAA 179047; **rare.**

**Rhytismatales**

Lophodermium pinastri (Schrad.) Chevall. – on needle debris of *Pinus sylvestris*, 1323 Pisy, 6 Oct 2001, TAA 176150; frequent.

Rhytisma acerinum (Pers.) Fr. – on *Acer platanoides*, 1162 Tico, 1321 Piab, Taani kuninga aed, Kabelikari, 6 Oct 2001, 9/11 Sept 2003; frequent.

R. salicinum (Pers.) Fr. – on *Salix* sp., 1321 Piab, Mustametsa ots, 5 Oct 2001, TAA 165867.

**Taphrinales**

Protomyces macrosporus Unger – on *Aegopodium podagraria*, 1162 Tico, Taani kuninga aed, 5 Oct 2001; frequent.

Taphrina betulina Rostr. – on *Betula* sp., 1421 Bepu, 1132 Piab, Suursadam, Mustametsa ots, 30 May 2002, 10 Sept 2003.

**Xylariales**

Xylaria hypoxylon (L.: Fr.) Grev. – 1321 Piab, Mustametsa ots, 31 May 2002.

**BASIDIOMYCOTA**

**Uredinales**

Gymnosporangium cornutum Arthur ex F. Kern – on *Sorbus aucuparia*, 1321 Piab, Kabelikari, 9 Sept 2003.

Melampsora populnea (Pers.) P. Karst. – on *Mercurialis perennis*, 1162 Tico, Taani kuninga aed, 1 June 2002, TAA 182093.

Puccinia poarum E. Nielsen – on *Tussilago farfara*, on roadside, Miiniladu, 11 Sept 2003, TAA 185894.

P. pygmaea Erikss. var. ammophilina (Mains) Cummins & H.C. Greene – on *Ammophila arenaria*, 511, Noodamajand, 12 Sept 2003, TAA 185665.

Trachyspora intrusa (Grev.) Arthur – on *Alchemilla* sp., 1321 Piab, Mustametsa ots, 31 May 2002, TAA 182077.

**Exobasidiales**

Exobasidium vaccinii (Fuckel) Woron. – on *Vaccinium vitis-idaea*, 1132 Pisy, Kunilamägi, 5 Oct 2001.

**Dacrymycetales**

Calocera cornea (Fr.) Fr. – on wood of *Betula* sp., 511, Hülgekari ots, 4 Oct 2001.

C. viscosa (Fr.) Fr. – 1162 Tico, 1312 Pisy, Taani kuninga aed, Mustametsa ots, 6 Oct 2001, 10/11 Sept 2003.

**Tremellales**

Exidiopsis calcea (Pers.) K. Wells – on wood of *Picea abies*, 1321 Piab, Mustametsa ots, 31 May 2002, TAA 185507.

Tremella mesenterica Fr. – 1321 Piab, Suursadam, 4 Oct 2001.

**Cantharellales**

Cantharellus aurora (Batsch) Kuyp. – 1323 Pisy, 1312 Pisy, Kunilasoo, Mustametsa ots, 5 Oct 2001, 10 Sept 2003.

C. cibarius Fr.: Fr. – 1121 Pisy, 1121 Bepe, 1312 Pisy, 1122 Pisy, 1162 Tico, 1321 Piab, July 1998, Oct 2001, Sept 2003; frequent.

C. tubiformis Bull.: Fr. – 1321 Piab, 1312 Pisy, 1323 Pisy, 1132 Piab, 1122 Pisy, 1162 Tico, Oct 2001, Sept 2003; frequent.

Clavulina rugosa (Fr.) J. Schröt. – 1162 Tico, Taani kuninga aed, 11 Sept 2003, TAA 185649.

Hydnum repandum L.: Fr. – 1132 Piab, Kunilasoo, 5 Oct 2001.

H. rufescens Fr. – 1321 Piab, 1162 Tico, 1312 Pisy, Oct 2001, Sept 2003.

**Ceratobasidiales**

Thanatephorus fusisporus (J. Schröt.) Hauerslev & P. Roberts – on wood of *Tilia cordata*, 1162 Tico, Taani kuninga aed, 6 Oct 2001, TAA 165941; **rare.**

**Hymenochaetales**

Coltricia perennis (L.: Fr.) Murrill – 1122 Pisy, 1121 Pisy, 1132 Piab, Oct 2001, Sept 2003, TAA 165897.

Hymenochaete tabacina (Sowerby: Fr.) Lév. – on stems of *Rosa rugosa*, 1321 Piab, Suursadam, 4 Oct 2001, TAA 165859.

Hyphodontia arguta (Fr.: Fr.) J. Eriksss. – on wood of *Betula* sp., Mustametsa ots, 5 Oct 2001, TAA 165923.

Inonotus obliquus (Fr.) Pilát – on *Betula* sp., 1321 Piab, 1132 Pisy, 1162 Tico, 1421 Bepu, Oct 2001, May 2002, Sept 2003.

I. radiatus (Sowerby: Fr.) P. Karst. – on wood of *Salix* sp., 1421 Bepu, Suursadam, 30 May 2002.

Oxyporus populinus (Fr.) Donk – on wood of *Acer platanoides*, 1162 Tico, Kabelikari, Taani kuninga aed, 1 June 2002, TAA 185511.

Phellinus alni (Bondartsev) Parmasto – on wood of *Malus sylvestris*, 1162 Tico, Taani kuninga aed, 6 Oct 2001, TAA 165884.

Ph. conchatus (Pers.: Fr.) Quél. – on wood of *Salix* sp., 1321 Piab, Oct 2001, May 2002, TAA 165913, 182070, 182099.

Ph. igniarius (L.: Fr.) Quél. – on wood of *Salix caprea*, 1312 Pisy, 1321 Piab, Mustametsa ots, 10 Sept 2003.

Ph. nigricans (Fr.: Fr.) P. Karst. – on wood of *Betula* sp., 1421 Bepu, Mustametsa ots, 10 Sept 2003.

Ph. pini (Brot.: Fr.) Ames – on wood of *Pinus sylvestris*, 1321 Piab, Mustametsa ots, 31 May 2002.

Ph. punctatus (Fr.) Pilát – on wood of *Salix* sp., 1321 Piab, Oct 2001, May 2002.

Ph. tremulae (Bondartsev) Bondartsev & Borisov – on *Populus tremula*, 1321 Piab, 1421 Bepu, Mustametsa ots, Suursadam, May 2002.

**Polyporales**

Albatrellus confluens (Alb. & Schwein.: Fr.) Kotl. & Pouzar – 1321 Piab, Lõunaküla, 11 Sept 2003, TAA 185637.

Antrodia serialis (Fr.) Donk – on wood of *Pinus sylvestris* and *Picea abies*, 1121 Pisy, 1132 Piab, Hülgekari ots, Mädasadama, 4 Oct 2001, 30 May 2002, TAA 165910, 185513.

A. xantha (Fr.) Ryvarden – on wood, 1162 Tico, Taani kuninga aed, 1 June 2002, TAA 185512.

Bjerkandera adusta (Willd.: Fr.) P. Karst. – on wood of *Betula* sp., 1121 Pisy, Hülgekari ots, 4 Oct 2001, TAA 165911.

Ceriporia reticulata (Hoffm.: Fr.) Domanski – on wood of *Sorbus aucuparia*, 1321 Piab, Mustametsa ots, 5 Oct 2001, TAA 165924.

Chondrostereum purpureum (Pers.: Fr.) Pouzar – on wood of *Salix* sp., 1321 Piab, Mustametsa ots, 31 May 2002, TAA 185502.

Climacocystis borealis (Fr.: Fr.) Kotl. & Pouzar – on wood of *Picea abies*, 1321 Piab, Lõunaküla, 11 Sept 2003, TAA 182096.

Daedaleopsis confragosa (Bolt.: Fr.) J. Schröt. – on deciduous wood, 1132 Piab, 1312 Pisy, Mädasadama, Mustametsa ots, 30/31 May 2002, 10 Sept 2003, TAA 182098, 185515.

Datronia mollis (Sommerf.: Fr.) Donk – on wood, 1162 Tico, Taani kuninga aed, 6 Oct 2001, TAA 165929.

Fomes fomentarius (Fr.) Kickx – on wood of *Betula* sp., 1321 Piab, 214, 1421 Bepu, 1412 Bepu, 1162 Tico, Oct 2001, May 2002, Sept 2003; frequent.

Fomitopsis pinicola (Fr.) P. Karst. – on wood, 1321 Piab, 1162 Tico, Oct 2001, May 2002, Sept 2003; frequent.

Ganoderma applanatum (Pers.) Pat. – on wood of *Quercus robur*, 1162 Tico, Taani kuninga aed, 6 Oct 2001.

Gloeophyllum sepiarium (Wulfen: Fr.) P. Karst. – on wood, Mustametsa ots, 10 Sept 2003.

Hapalopilus nidulans (Fr.) P. Karst. – on wood, 1321 Piab, Mustametsa ots, 5 Oct 2001.

Hyphoderma radula (Fr.: Fr.) Donk – on wood of *Sorbus aucuparia*, 1162 Tico, Taani kuninga aed, 01 June 2002, TAA 182095.

Laetiporus sulphureus (Bull.: Fr.) Murrill – on deciduous wood, 1162 Tico, Taani kuninga aed, 11 Sept 2003.

Lentinus lepideus (Fr.: Fr.) Fr. – on railway sleepers, Suursadam, 27 June 1999, 30 May 2002, TAA 174582, 182073.

L. suavissimus (Fr.) Singer – on wood of *Salix* sp., 1321 Piab, Mustametsa ots, 5 Oct 2001, TAA 176089.

L. torulosus (Pers.: Fr.) Lloyd – on wood of *Pinus sylvestris*, 1132 Pisy, Suured mäed, 6 Oct 2001, TAA 176108.

Meruliopsis taxicola (Pers.: Fr.) Gilb. & Ryvarden – on wood of *Pinus sylvestris*, Hülgekari ots, 4 Oct 2001, TAA 165908.

Panus conchatus (Bull.: Fr.) Fr. – on wood of *Betula* sp., 1132 Pisy, Miiniladu, 11 Sept 2003.

Piptoporus betulinus (Bull.: Fr.) P. Karst. – on wood of *Betula* sp., 1121 Pisy, 1321 Piab, 214, 1421 Bepu, 1412 Bepu, 1162 Tico, Oct 2001, May 2002, Sept 2003.

Polyporus brumalis (Pers.) Fr. – on wood of *Populus tremula*, 1321 Piab, Mustametsa ots, 31 May 2002, TAA 185503.

P. ciliatus Fr. – on wood, 511, 1162 Tico, July 1998, May/June 2002, TAA 147939, 182082, 182094.

P. varius Fr. – on deciduous wood, 1321 Piab, Mustametsa ots, 10 Sept 2003.

Postia caesia (Schrad.: Fr.) P. Karst. – on wood of *Picea abies*, 1321 Piab, Suursadam, Kabelikari, 4 Oct 2001, 9 Sept 2003, TAA 165906, 182091, 185573.

Sistotrema confluens Pers.: Fr. – on wood, 1321 Piab, Mustametsa ots, 5 Oct 2001, TAA 165989.

Trametes ochracea (Pers.) Gilb. & Ryvarden – on wood of *Betula* sp., 1321 Piab, 1312 Pisy, Mustametsa ots, 31 May 2002, 10 Sept 2003, TAA 182100, 185621.

T. velutina (Fr.) G. Cunn. – on wood of *Betula* sp., 1132 Pisy, Kunilamägi, 31 May 2002, TAA 185508.

Trechispora farinacea (Pers.: Fr.) Liberta – on wood of *Corylus avellana* and *Quercus robur*, 1162 Tico, Taani kuninga aed, 6 Oct 2001, TAA 165928, 165933.

T. mollusca (Pers.: Fr.) Liberta – on wood of *Salix* sp., 1321 Piab, Mustametsa ots, 31 May 2002, TAA 185501.

Trichaptum abietinum (Dicks.: Fr.) Ryvarden – on wood of *Picea abies*, 1321 Piab, 1132 Piab, Oct 2001, May 2002, Sept 2003, TAA 182069.

Tubulicrinis subulatus (Bourdot & Galzin) Donk – on wood of *Pinus sylvestris*, 1121 Pisy, Suursadam, Hülgekari ots, 4 Oct 2001, TAA 165907, 165909.

**Thelephorales**

Bankera fuligineoalba (Schmidt: Fr.) Pouzar – on path, Hülgekari ots, Kunilamägi, 4/5 Oct 2001, TAA 165863, 165895; **protected by law (Category III), Estonian Red Data Book.**

Boletopsis grisea (Peck) Bondartsev & Singer – 1121 Pisy, 1321 Piab, Hülgekari ots, Lõunaküla, 4 Oct 2001, 11 Sept 2003, TAA 165862, 185635.

Hydnellum ferrugineum (Fr.) P. Karst. – on path, Kunilamägi, Männiku, Miiniladu, 5 Oct 2001, 9/11 Sept 2003, TAA 165894, 165896, 185594, 185643; **Estonian Red Data Book.**

H. peckii Banker – on path, Kunilamägi, 5 Oct 2001, 10 Sept 2003, TAA 165866, 185625.

Phellodon niger (Fr.: Fr.) P. Karst. – 1132 Pisy, Miiniladu, 11 Sept 2003, TAA 185644; **protected by law (Category III), Estonian Red Data Book.**

Phellodon tomentosus (L.: Fr.) Banker – 1121 Pisy, 511, Oct 2001, Sept 2003, TAA 165864, 165893, 185661.

Pseudotomentella atrofusca M.J. Larsen – on wood of *Corylus avellana*, 1162 Tico, Taani kuninga aed, 6 Oct 2001, TAA 165928.

Sarcodon glaucopus Maas Geest. & Nannf. – 1132 Pisy, 1122 Pisy, Männiku, Miiniladu, 9/11 Sept 2003, TAA 185592, 185642.

S. cf. imbricatus (L.: Fr.) P. Karst. – 1121 Pisy, 1132 Pisy, Oct 2001.

S. leucopus (Pers.) Maas Geest. & Nannf. – 511, Taani kuninga aed, 12 Sept 2003, TAA 185662.

Thelephora terrestris Pers.: Fr. – 1122 Pisy, 1323 Pisy, 1121 Pisy, 1421 Bepu, Oct 2001, May 2002, Sept 2003, TAA 182081.

Tomentella lilacinogrisea Wakef. – on wood of *Pinus sylvestris*, 1321 Piab, Mustametsa ots, 5 Oct 2001, TAA 165917.

T. stuposa (Link) Stalpers – on wood of *Tilia cordata*, 1162 Tico, Taani kuninga aed, 6 Oct 2001, TAA 165927.

**Boletales**

Boletus betulicola (Vassilkov) Pilát & Dermek – 1121 Bepe, Mustametsa ots, 5 Oct 2001.

B. edulis Bull.: Fr. var. edulis – 1132 Pisy, 1121 Pisy, 1122 Pisy, 1321 Piab, 1162 Tico, Oct 2001, Sept 2003, TAA 185627; frequent.

B. pinophilus Pilát & Dermek – 1132 Pisy, 1132 Piab, 1321 Piab, 1122 Pisy, Oct 2001, Sept 2003; frequent.

Chalciporus piperatus (Bull.: Fr.) Bat. – 1321 Piab, Lõunaküla, 11 Sept 2003.

Chroogomphus rutilus (Schaeff.: Fr.) O.K. Mill. – 1321 Piab, 1312 Pisy, 1121 Pisy, 1132 Pisy, 1162Tico, Oct 2001, Sept 2003; frequent.

Gomphidius glutinosus (Schaeff.: Fr.) Fr. – 1321 Piab, 1141 Piab, 1132 Pisy, Oct 2001, Sept 2003; frequent.

G. roseus (Nees: Fr.) Fr. – 1121 Pisy, Oct 2001, Sept 2003.

Hygrophoropsis aurantiaca (Wulfen: Fr.) Maire – 1321 Piab, 1121 Pisy, 1132 Pisy, Oct 2001, Sept 2003; frequent.

Leccinum aurantiacum (Bull.) Gray – 1321 Piab, 1132 Piab, 1132 Pisy, Oct 2001, Sept 2003.

L. holopus (Rostk.) Rauschert – 1132 Pisy, 1132 Piab, 1421 Bepu, 1412 Bepu, Oct 2001, Sept 2003.

L. populinum M. Korhonen – 1412 Bepu, Sinkarka, 11 Sept 2003, TAA 185656.

L. scabrum (Bull.: Fr.) Gray – 1121 Pisy, 1321 Piab, 1132 Pisy, 1312 Pisy, 1162 Tico, July 1998, Oct 2001, Sept 2003.

L. variicolor Watling – 1321 Piab, 1132 Piab, Mustametsa ots, 10 Sept 2003.

L. versipelle (Fr.) Snell – 1141 Piab, 1121 Pisy, 1132 Pisy, 214, 1321 Piab, July 1998, Oct 2001, Sept 2003; frequent.

L. vulpinum Watling – 1122 Pisy, Suured mäed, 5 Oct 2001.

Paxillus atrotomentosus (Batsch: Fr.) Fr. – on wood of *Picea abies*, 1132 Pisy, 1321 Piab, Männiku, Mustametsa ots, 9/10 Sept 2003.

P. filamentosus (Scop.) Fr. – 1321 Piab, 1412 Algl, Mustametsa ots, Suursadam, 5 Oct 2001, 12 Sept 2003.

P. involutus (Batsch : Fr.) Fr. – 1122 Pisy, 1121 Pisy, 1323 Pisy, 1312 Pisy, 1321 Piab, 1141 Piab, 1162 Tico, Oct 2001, Sept 2003; frequent.

Pisolithus arhizus (Scop.: Pers.) Rauschert – on sandy path, 511, 1121 Pisy, Oct 2001, May 2002, Sept 2003, TAA 165915, 165943, 182083, 182097, 185660; frequent; **rare.**

Pseudomerulius aureus (Fr.) Jülich – on wood of *Betula* sp., 1162 Tico, Oct 2001, June 2002.

Scleroderma citrinum Pers.: Pers. – on wood, 1321 Piab, 1412 Bepu, Mustametsa ots, Sinkarka, 5 Oct 2001, 11 Sept 2003.

Suillus bovinus (L.: Fr.) Kuntze – 1121 Pisy, 1323 Pisy, 1132 Pisy, 1122 Pisy, 511, Oct 2001, Sept 2003; frequent, at places numerous.

S. flavidus (Fr.: Fr.) C. Presl – 1412 Bepu, 1323 Pisy, Sinkarka, Kunilasoo, 6 Oct 2001, 10 Sept 2003.

S. granulatus (L.: Fr.) Roussel – 1121 Pisy, 1162 Tico, 1312 Pisy, July 1998, Oct 2001, Sept 2003.

S. luteus (L.: Fr.) Roussel – 1121 Pisy, 1162 Tico, 511, Oct 2001, Sept 2003; frequent, at places numerous.

S. variegatus (Sw.: Fr.) Kuntze – 1121 Pisy, 1323 Pisy, 1132 Piab, 1321 Piab, 1132 Pisy, 1412 Bepu, 511, Oct 2001, Sept 2003; frequent, at places numerous.

Xerocomus badius (Fr.) Kühner ex Gilb. – 1141 Piab, 1321 Piab, 214, 1162 Tico, Oct 2001, Sept 2003; frequent.

Xerocomus pascuus (Pers.) Krombh. – 1162 Tico, Taani kuninga aed, 6 Oct 2001, 11 Sept 2003, TAA 176112, 185648, 185654.

X. subtomentosus (L.: Fr.) Quél. – 1321 Piab, 1132 Pisy, 1121 Pisy, Oct 2001, Sept 2003.

**Agaricales**

Agaricus cf. dulcidulus ss. Moser – 1162 Quro, Taani kuninga aed, 4 July 1998, TAA 147945.

A. porphyrizon P.D. Orton – 1321 Piab, Mustametsa ots, 10 Sept 2003, TAA 185617.

A. silvaticus Schaeff. – 214, 1162 Tico, Lõunaküla, Taani kuninga aed, 9/11 Sept 2003.

A. sylvicola (Vittad.) Peck – 1321 Piab, 1141 Piab, 1162 Tico, 1312 Pisy, 1121 Pisy, Oct 2001, Sept 2003; frequent.

Agrocybe praecox (Pers.: Fr.) Fayod – on roadside, Suursadam, 30 May 2002, TAA 182071.

Amanita citrina (Schaeff.) Pers. var. alba (Gillet) E.-J. Gilbert – 1312 Pisy, 1121 Pisy, 1122 Pisy, 1132 Pisy, 1321 Piab, Oct 2001, Sept 2003.

A. citrina (Schaeff.) Pers. var. citrina – 1121 Pisy, 1132 Pisy, 1321 Piab, 1122 Pisy, 1162 Tico, 1141 Piab, 214, Oct 2001, Sept 2003; frequent, at places numerous.

A. fulva (Schaeff.) Fr. – 1421 Bepu, 1321 Piab, 214, Mustametsa ots, Lõunaküla, 5 Oct 2001, 10/11 Sept 2003.

A. muscaria (L.: Fr.) Hook. – 1121 Pisy, 1132 Piab, 1122 Pisy, 511, 1162 Tico, 1132 Pisy, Oct 2001, Sept 2003, frequent.

A. muscaria (L.: Fr.) Hook. var. areola Kalchbr. – 1321 Piab, 1121 Pisy, 214, 511, Sept 2003; frequent.

A. pantherina (DC.: Fr.) Krombh. – 1122 Pisy, 1312 Pisy, 1121 Pisy, 1132 Pisy, 1121 Pisy, 1132 Piab, 1162 Tico, 511, July 1998, Oct 2001, Sept 2003; frequent.

A. porphyria (Alb. & Schwein.: Fr.) Mladý – 1132 Pisy, 1141 Piab, 1321 Piab, 1162 Tico, Oct 2001, Sept 2003; frequent.

A. regalis (Fr.) Bertillon – 1321 Piab, Lõunaküla, 11 Sept 2003, TAA 185633.

A. rubescens (Pers.: Fr.) Gray – 1132 Pisy, 1132 Piab, 1321 Piab, Oct 2001, Sept 2003.

A. virosa (Lam.) Bertill. – 1321 Piab, Mustametsa ots, Lõunaküla, 5 Oct 2001, 11 Sept 2003.

Armillaria borealis Marxm. & Korhonen – on deciduous wood, 1132 Pisy, 1321 Piab, 1141 Piab, 1162 Tico, Mustametsa ots, Taani kuninga aed, 5/6 Oct 2001, 11 Sept 2003.

A. gallica Marxm. & Romagn. – on wood of *Salix* sp., 1321 Piab, 1141 Piab, Mustametsa ots, Taani kuninga aed, 5/6 Oct 2001, TAA 176084.

A. ostoyae (Romagn.) Herink – on wood of *Betula* sp., 1321 Piab, 1132 Pisy, 1162 Tico, 214, Oct 2001, Sept 2003; frequent, at places numerous.

Arrhenia spathulata (Fr.) Redhead – on moss, 1121 Pisy, Noodamajand, 4 Oct 2001, TAA 176058.

Bolbitius variicolor Atkinson – on horse dung, Virbi ots, 2/31 May 2002, TAA 176167, 182074; **new record.**

Calvatia excipuliformis (Pers.: Pers.) Perdeck – 1321 Piab, 1121 Pisy, 214, Oct 2001, Sept 2003.

Camarophyllopsis foetens (Phillips) Arnolds – 1321 Piab, Lõunaküla, 4 May 2002, TAA 176169; **new record.**

Cantharellula umbonata (J.F. Gmel.: Fr.) Singer – 1132 Pisy, 1122 Pisy, Kunilamägi, Sinkarka, 5/6 Oct 2001.

Clitocybe clavipes (Pers.: Fr.) P. Kumm. – 1162 Tico, 1321 Piab, 214, Oct 2001, Sept 2003, TAA 185588.

C. gibba (Pers.: Fr.) P. Kumm. – 1162 Quro, 214, July 1998, Sept 2003, TAA 147948.

C. metachroa (Fr.) P. Kumm. – 1122 Pisy, 1121 Pisy, 1321 Piab, 1312 Pisy, Oct 2001.

C. nebularis (Batsch: Fr.) P. Kumm. – 1321 Piab, 1122 Pisy, 1162 Tico, 1141 Piab, Oct 2001; frequent, at places numerous.

C. odora (Bull.: Fr.) P. Kumm. – 1321 Piab, 1132 Piab, 1141 Piab, Oct 2001, Sept 2003, TAA 185613; frequent.

C. phyllophila (Pers.: Fr.) P. Kumm. var. phyllophila – on debris, 1162 Tico, Taani kuninga aed, 6 Oct 2001, TAA 176131.

Clitopilus prunulus (Scop.: Fr.) P. Kumm. – 214, Lõunaküla, 9 Sept 2003.

Collybia cirrhata (I.H. Schum.) P. Kumm. – 1121 Pisy, 1321 Piab, Hülgekari ots, Mustametsa ots, 4/5 Oct 2001, 10 Sept 2003.

Coprinus atramentarius (Bull.: Fr.) Fr. – on roadside, Suursadam, 9 Sept 2003.

C. cinereus (Schaeff.: Fr.) Gray – on horse dung, Virbi ots, 2 May 2002, TAA 176166.

C. leiocephalus P.D. Orton – 1412 Algl, Taani kuninga aed, 6 Oct 2001, TAA 176123.

Cortinarius alboviolaceus (Pers.: Fr.) Fr. – 1122 Pisy, 1121 Bepe, 1421 Bepu, Kunilamägi, Mustametsa ots, 5 Oct 2001, 10 Sept 2003.

C. armillatus (Fr.: Fr.) Fr. – 1132 Piab, 1321 Piab, Mustametsa ots, Lõunaküla, 10/11 Sept 2003.

C. camphoratus (Fr.: Fr.) Fr. – 1321 Piab, 1132 Piab, Lõunaküla, Miiniladu, 11 Sept 2003, TAA 185632.

C. cf. cinnabarinus Fr. – 1162 Tico, Taani kuninga aed, 6 Oct 2001, TAA 176119.

C. cinnamomeoluteus P.D. Orton – 1121 Pisy, 1132 Pisy, Oct 2001.

C. cinnamomeus (L.: Fr.) Fr. – 1323 Pisy, Kunilasoo, 5 Oct 2001.

C. aff. helobius Romagn. – 1121 Pisy, Sinkarka, 6 Oct 2001, TAA 176143.

C. mucosus (Bull.) Kickx – 1121 Pisy, 1132 Piab, 511, Sept 2003.

C. muscigenus Peck – 1121 Pisy, 1321 Piab, Oct 2001, Sept 2003.

C. pholideus (Fr.: Fr.) Fr. – 1421 Bepu, 1321 Piab, Mustametsa ots, Lõunaküla, 10/11 Sept 2003.

C. sanguineus (Wulfen: Fr.) Fr. – 1321 Piab, 1141 Piab, Oct 2001, Sept 2003; frequent.

C. semisanguineus (Fr.) Gillet – 1122 Pisy, 1132 Pisy, 1323 Pisy, 1321 Piab, Oct 2001, Sept 2003; frequent.

C. stillatitius Fr. – 1321 Piab, Lõunaküla, 11 Sept 2003.

C. traganus Fr.: Fr. – 1321 Piab, Lõunaküla, 11 Sept 2003, TAA 185632.

Crepidotus calolepis (Fr.) P. Karst. – on wood of *Sorbus aucuparia*, Vallimägi, 9 Sept 2003.

C. versutus (Peck) Sacc. – on wood of *Betula* sp., 1412 Bepu, Sinkarka, 6 Oct 2001, TAA 176140.

Crinipellis scabella (Alb. & Schwein.: Fr.) Murrill – on grasses, 511, Virbi ots, Sinkarka, 5 Oct 2001, TAA 176146.

Cystoderma adnatifolium (Peck) Harmaja – 1321 Piab, Mustametsa ots, 5 Oct 2001, TAA 182056, 182057.

C. amianthinum (Scop.) Fayod – 1312 Pisy, 1121 Pisy, 1321 Piab, 1122 Pisy, Oct 2001, Sept 2003, TAA 182048, 182054, 182064; frequent.

C. carcharias (Pers.) Fayod – 1132 Pisy, 1121 Pisy, 1122 Pisy, 1321 Piab, 1162 Tico, Oct 2001, TAA 182050, 182053; frequent.

C. cinnabarinum (Alb. & Schwein.: Fr.) Fayod – 1132 Pisy, 1121 Pisy, 1141 Piab, Oct 2001, Sept 2003, TAA 182051, 182060, 182062.

C. granulosum (Batsch: Fr.) Fayod – 1141 Piab, 1321 Piab, 1132 Piab, Oct 2001, Sept 2003, TAA 182067.

C. jasonis (Cooke & Massee) Harmaja – 1132 Pisy, 1122 Pisy, Kunilamägi, 5 Oct 2001, TAA 182058, 182059.

Cystolepiota seminuda (Lasch) Bon – on fallen branches of deciduous trees, 1321 Piab, Mustametsa ots, 10 Sept 2003, TAA 185602.

Entoloma cetratum (Fr.: Fr.) M.M. Moser – 1121 Pisy, Sinkarka, 6 Oct 2001, TAA 176141.

E. conferendum (Britzelm.) Noordel. – 214, Lõunaküla, 9 Sept 2003, TAA 185572.

E. lividoalbum (Kühner & Romagn.) Kubička – 1321 Piab, Mustametsa ots, 10 Sept 2003, TAA 185612.

E. nidorosum (Fr.) Quél. – 1321 Piab, 214, Oct 2001, Sept 2003.

E. rhodopolium (Fr.: Fr.) P. Kumm. – 1162 Tico, 1321 Bepu, Taani kuninga aed, Sinkarka, 6 Oct 2001.

E. sericeum (Bull.: Fr.) Quél. – 511, Virbi ots, 10 Sept 2003.

E. turbidum (Fr.: Fr.) Quél. – 214, Lõunaküla, 9 Sept 2003.

Galerina marginata (Batsch) Kühner – on wood of *Picea abies* and *Salix* sp., 1132 Pisy, 1321 Piab, 1141 Piab, Suursadam, Taani kuninga aed, 4/6 Oct 2001.

G. paludosa (Fr.) Kühner – on *Sphagnum* sp., 1412 Bepu, June 1999, June 2002, TAA 175349, 182085, 182089.

G. pumila (Pers.: Fr.) Singer – on moss, 1121 Pisy, Sinkarka, 6 Oct 2001, TAA 176142.

Gymnopilus penetrans (Fr.: Fr.) Murrill – on wood, 1321 Piab, 1132 Pisy, Oct 2001, Sept 2003.

G. picreus (Pers.: Fr.) P. Karst. – on wood of *Pinus sylvestris*, 1162 Tico, Taani kuninga aed, 6 Oct 2001, TAA 176127.

Gymnopus acervatus (Fr.) Murrill – on wood, 1321 Piab, Lõunaküla, 11 Sept 2003, TAA 185628.

G. aquosus (Bull.: Fr.) Antonín & Noordel. – on *Sphagnum* sp., 1312 Bepe, 1162 Quro, 1412 Bepu, Virbi ots, Taani kuninga aed, 4 July 1998, 1 June 2002, TAA 147936, 182090.

Gymnopus confluens (Pers.) Antonín, Halling & Noordel. – 1312 Pisy, 1132 Pisy, 1421 Bepu, 1321 Piab, 1162 Tico, 214, July 1998, Oct 2001, Sept 2003.

G. dryophilus (Bull.) Murrill – 1321 Piab, 1162 Tico, Sept 2003.

G. peronatus (Bolton) Antonín, Halling & Noordel. – 1321 Piab, 1162 Tico, Oct 2001, Sept 2003.

Hebeloma crustuliniforme (Bull.) Quél. – 1132 Pisy, 1122 Pisy, 1321 Piab, 1162 Tico, 511, Oct 2001, Sept 2003; frequent.

H. cf. hiemale Bres. – 1132 Piab, 1321 Piab, 1132 Pisy, 1323 Pisy, 1421 Bepu, 1162 Tico, Sept 2003; frequent.

H. sinapizans (Paulet) Gillet – 1162 Tico, 1321 Piab, Taani kuninga aed, Mustametsa ots, 06 Oct 2001, 10 Sept 2003.

Hygrocybe coccinea (Schaeff.: Fr.) P. Kumm. – 1162 Tico, Taani kuninga aed, 6 Oct 2001, TAA 176130.

H. conica (Schaeff.: Fr.) P. Kumm. – 1162 Tico, Taani kuninga aed, 6 Oct 2001.

H. miniata (Fr.) P. Kumm. – 1321 Piab, Mustametsa ots, Suureliiva, 5 Oct 2001, TAA 176093, 176096.

Hygrophorus camarophyllus (Alb. & Schwein.: Fr.) Dumée, Grandjean & Maire – 1132 Piab, Kunilasoo, Lõunaküla, 5 Oct 2001, 11 Sept 2003.

H. erubescens (Fr.) Fr. – 1321 Piab, Suursadam, 12 Sept 2003, TAA 185629.

H. hedrychii (Velen.) K. Kult. – 1321 Piab, Mustametsa ots, 5 Oct 2001, TAA 176079.

H. olivaceoalbus (Fr.: Fr.) Fr. – 1321 Piab, Suureliiva, Mustametsa ots, 5 Oct 2001, 10 Sept 2003.

H. piceae Kühner – 1321 Piab, Mustametsa ots, Lõunaküla, 10/11 Sept 2003, TAA 185623, 185634.

Hypholoma capnoides (Fr.: Fr.) P. Kumm. – on wood, 1323 Pisy, 1132 Pisy, Kunilasoo, Miiniladu, 5 Oct 2001, 11 Sept 2003.

H. elongatum (Pers.: Fr.) Ricken – on moss, 1412 Bepu, Sinkarka, 6 Oct 2001, TAA 176136.

H. fasciculare (Huds.: Fr.) P. Kumm. – on wood of *Alnus* sp., 1321 Piab, 1132 Piab, 1162 Tico, 1412 Algl, Oct 2001, May 2002, Sept 2003, TAA 176171.

H. lateritium (Schaeff.: Fr.) J. Schröt. – on wood, 1132 Piab, Suured mäed, 5 Oct 2001.

H. myosotis (Fr.: Fr.) M. Lange – 1323 Pisy, Kunilasoo, 5 Oct 2001.

Inocybe geophylla (Fr.: Fr.) P. Kumm. var. geophylla – 1321 Piab, 1121 Bepe, Oct 2001.

I. geophylla (Fr.: Fr.) P. Kumm. var. lilacina Gillet – 1321 Piab, 1122 Pisy, 1121 Bepe, 1162 Tico, Oct 2001, Sept 2003, TAA 176062; frequent.

I. grammata Quél. ss. Kühner – 1321 Piab, Mustametsa ots, 10 Sept 2003, TAA 185609.

I. impexa (Lasch) Kuyper – on sand, Kunilamägi, 10 Sept 2003, TAA 185624.

I. lacera (Fr.: Fr.) P. Kumm. – on sand, Miiniladu, 11 Sept 2003.

I. lucifuga (Fr.: Fr.) P. Kumm. – 1121 Pisy, Hülgekari ots, 4 Oct 2001, TAA 176068.

I. mixtilis Britzelm. – 1132 Pisy, 1121 Pisy, Haldja, Noodamajand, 4 July 1998, 04 Oct 2001, TAA 147940, 176059.

I. posterula (Britzelm.) Sacc. – 1121 Pisy, Noodamajand, 4 Oct 2001, TAA 176055, 176060.

I. rimosa (Bull.: Fr.) P. Kumm. – 1162 Tico, Taani kuninga aed, 11 Sept 2003.

Kuehneromyces lignicola (Peck) Redhead – on remains of wood, Suursadam, 30 May 2002, TAA 182072; **rare.**

K. mutabilis (Schaeff.: Fr.) Singer & A.H. Sm. – on wood of *Tilia cordata* and *Corylus avellana*, 1321 Piab, 1162 Tico, 1412 Bepu, May 2002, Sept 2003, TAA 182075.

Laccaria amethystea (Bull.) Murrill – 1321 Piab, 1132 Piab, 1312 Pisy, 1121 Pisy, 1162 Tico, Oct 2001, Sept 2003, TAA 176092.

L. bicolor (Maire) P.D. Orton – 1121 Pisy, Mustametsa ots, Sinkarka, 5/6 Oct 2001, TAA 176081.

L. laccata var. pallidifolia (Peck) Peck – 511, 1421, 1132 Pisy, 1321 Piab, Oct 2001, Sept 2003, TAA 176097, 176101, 176105, 176137, 176139; frequent.

L. proxima (Boud.) Pat. – 1421 Bepu, 1132 Piab, 1321 Piab, Mustametsa ots, Lõunaküla, 10/11 Sept 2003, TAA 185606.

Lepiota alba (Bres.) Sacc. – 214, 1121 Pisy, Lõunaküla, Virbi ots, 9/10 Sept 2003, TAA 185590.

L. clypeolaria (Bull.: Fr.) P. Kumm. – 1321 Piab, 1121 Pisy, 1162 Tico, 1141 Piab, 214, Oct 2001, Sept 2003; frequent.

L. cristata (Bolton: Fr.) P. Kumm. – 1321 Piab, Mustametsa ots, 10 Sept 2003.

L. ventriosospora D.A. Reid – 1162 Tico, 1321 Piab, 1312 Pisy, Oct 2001, Sept 2003; frequent.

Lepista gilva (Pers.: Fr.) Roze – 1141 Piab, 1321 Piab, 1162 Tico, 214, Taani kuninga aed, Lõunaküla, 6 Oct 2001, 9/11 Sept 2003.

L. glaucocana (Bres.) Singer – 1321 Piab, Mustametsa ots, 10 Sept 2003.

L. nuda (Bull.: Fr.) Cooke – 1321 Piab, 1162 Tico, Mustametsa ots, Taani kuninga aed, 5/6 Oct 2001.

Leucoagaricus cretaceus (Bull.: Fr.) M.M. Moser – 511, Hülgekari ots, 4 Oct 2001, TAA 176064; **rare.**

Leucocortinarius bulbiger (Alb. & Schwein.: Fr.) Singer – 214, Lõunaküla, 9 Sept 2003.

Leucopaxillus candidus (Bres.) Singer – 1321 Piab, Mustametsa ots, 10 Sept 2003, TAA 185618.

Limacella glioderma (Fr.) Maire – 1321 Piab, 1162 Tico, Mustametsa ots, Taani kuninga aed, 5/6 Oct 2001, 10 Sept 2003.

L. illinita (Fr.: Fr.) Murrill – 1121 Pisy, 1321 Piab, 1312 Pisy, Noodamajand, Mustametsa ots, 4 Oct 2001, 10 Sept 2003, TAA 185611; **rare.**

Lycoperdon molle Pers.: Pers. – 1321 Piab, 1162 Tico, Kabelikari, Taani kuninga aed, 11 Sept 2003.

L. nigrescens Pers. – on rotten wood, 1321 Piab, Kabelikari, 9 Sept 2003.

L. perlatum Pers.: Pers. – 1321 Piab, 1121 Pisy, 1162 Tico, Oct 2001, Sept 2003; frequent.

L. pyriforme Schaeff.: Pers. – on wood of *Tilia cordata* and *Alnus* sp., 1321 Piab, 1162 Tico, Suureliiva, Taani kuninga aed, 5/6 Oct 2001.

Lyophyllum decastes (Fr.: Fr.) Singer – 1132 Pisy, Kunilamägi, 5 Oct 2001.

L. fumosum (Pers. sensu Fr.: Fr.) P.D. Orton – on burnt ground, 1132 Piab, Lõunaküla, Miiniladu, 11 Sept 2003, TAA 185640, 185641.

L. semitale (Fr.) Kühner – 1121 Pisy, Hülgekari ots, 4 Oct 2001, TAA 176066.

Macrolepiota mastoidea (Fr.) Singer – 214, Lõunaküla, Mustametsa ots, 9/10 Sept 2003, TAA 185591.

M. nympharum (Kalchbr.) Wasser – 1141 Piab, Taani kuninga aed, 6 Oct 2001, TAA 176114; **protected by law (Category II), Estonian Red Data Book.**

M. procera (Scop.: Fr.) Singer – 1321 Piab, 1132 Pisy, 1162 Tico, 1141 Pisy, 1312 Pisy, 1121 Pisy, Oct 2001, Sept 2003; frequent.

M. rhacodes (Vittad.) Singer – 1141 Piab, 214, 1162 Tico, Taani kuninga aed, Lõunaküla, 6 Oct 2001, 9/11 Sept 2003, TAA 185653.

Marasmius bulliardii Quél. – on needle debris, 1162 Quro, Taani kuninga aed, 4 July 1998, 26 June 1999, TAA 175348.

M. cohaerens (Pers.: Fr.) Cooke & Quél. – 1321 Piab, Mustametsa ots, 5 Oct 2001, TAA 176085, 176090.

M. epiphyllus (Pers.: Fr.) Fr. – on leaf debris of *Populus tremula*, 1321 Piab, 1141 Piab, Suursadam, Taani kuninga aed, 4/6 Oct 2001.

M. oreades (Bolton: Fr.) Fr. – 511, 1141 Piab, 214, Oct 2001, Sept 2003, TAA 176073.

M. scorodonius (Fr.: Fr.) Fr. – 1121 Pisy, 1132 Pisy, 1321 Piab, Oct 2001, Sept 2003.

Megacollybia platyphylla (Pers.: Fr.) Kotl. & Pouzar – 1321 Piab, 1312 Pisy, 1162 Quro, 1162 Tico, July 1998, Oct 2001, Sept 2003.

Melanophyllum echinatum (Roth: Fr.) Singer – on fallen branches of deciduous wood, 1162 Tico, 1321 Piab, Taani kuninga aed, Mustametsa ots, 06 Oct 2001, 10 Sept 2003, TAA 176111, 185603; **rare.**

Mycena acicula (Schaeff.) P. Kumm. – 1321 Piab, Mustametsa ots, 10 Sept 2003.

M. cinerella var. subviscida Kauffm. & A.H. Sm. – 1321 Piab, Mustametsa ots, 5 Oct 2001, TAA 176094b; **new record.**

M. epipterygia (Scop.: Fr.) Gray var. epipterygia – 1132 Pisy, 1321 Piab, 1121 Pisy, 1412 Bepu, Oct 2001, Sept 2003; frequent.

M. epipterygia (Scop.: Fr.) Gray var. viscosa (Maire) Ricken – 1321 Piab, 1141 Piab, Mustametsa ots, Taani kuninga aed, 5/6 Oct 2001.

M. filopes (Bull.: Fr.) P. Kumm. – 1121 Bepe, 1321 Piab, 1162 Tico, Oct 2001, Sept 2003.

M. galericulata (Scop.: Fr.) Gray – on wood of *Tilia cordata*, *Quercus robur*, *Salix* sp. and *Betula* sp., 1321 Piab, 1162 Tico, 1412 Bepu, July 1998, Oct 2001, Sept 2003, TAA 147946.

M. galopus (Pers.: Fr.) P. Kumm. – 1323 Pisy, 1421 Bepu, 1321 Bepu, Oct 2001, Sept 2003.

M. haematopus (Pers.: Fr.) P. Kumm. var. haematopus – on wood of *Tilia cordata*, 1162 Tico, Taani kuninga aed, 4 July 1998.

M. haematopus (Pers.: Fr.) P. Kumm. var. marginata J.E. Lange – on wood of *Corylus avellana* and *Betula* sp., 1321 Piab, 1162 Tico, Suursadam, Taani kuninga aed, 4/6 Oct 2001.

Mycena leptocephala (Pers.: Fr.) Gillet – 511, Sinkarka, 6 Oct 2001, TAA 176145.

M. macrocystidiata Singer – 1321 Piab, Mustametsa ots, 10 Sept 2003, TAA 185604.

M. megaspora Kauffm. – 1412 Bepu, 1421 Bepu, Sinkarka, Mustametsa ots, 6 Oct 2001, 10 Sept 2003, TAA 176138, 185607.

M. pura (Pers.: Fr.) P. Kumm. var. pura – 1121 Pisy, 1132 Pisy, 1321 Piab, 1162 Tico, 1141 Piab, 214, July 1998, Oct 2001, Sept 2003.

M. purpureofusca (Peck) Sacc. – on wood of *Picea abies*, 1321 Piab, Kabelikari, 9 Sept 2003, TAA 185576; **new record.**

M. sanquinolenta (Fr.) Quél. – on wood, 1162 Tico, 1321 Piab, Taani kuninga aed, Kabelikari, 26 June 1999, 9 Sept 2003, TAA 175347.

M. zephyrus (Fr.: Fr.) P. Kumm. – 1312 Pisy, 1121 Pisy, 1321 Piab, 1162 Tico, 214, Oct 2001, Sept 2003, TAA 176091,185582; frequent.

Naucoria escharoides (Fr.: Fr.) P. Kumm. – 1412 Bepu, Sinkarka, 6 Oct 2001, TAA 176134.

Panellus mitis (Pers.: Fr.) Singer – on wood of *Pinus sylvestris*, 1162 Tico, Taani kuninga aed, 6 Oct 2001.

P. ringens (Fr.) Romagn. – on wood of *Salix* sp., 1421, Taani kuninga aed, 2 May 2002, TAA 176165.

P. serotinus (Schrad.: Fr.) Kühner – on wood of *Quercus robur*, 1162 Tico, Taani kuninga aed, 6 Oct 2001.

Pholiota alnicola (Fr.) Singer – on wood of *Alnus* sp., *Betula* sp. and *Padus avium*, 1412 Algl, 1412 Bepu, 1162 Tico, 1412 Bepu, 214, Oct 2001, Sept 2003, TAA 176120.

Ph. astragalina (Fr.: Fr.) Singer – on wood of *Pinus sylvestris*, 1132 Pisy, Miiniladu, 11 Sept 2003.

Ph. gummosa (Lasch) Singer – on remains of wood, 1132 Pisy, Kunilamägi, 5 Oct 2001.

Ph. spumosa (Fr.) Singer – on remains of wood, 1122 Pisy, 1132 Piab, Kunilamägi, Miiniladu, 5 Oct 2001, 10/11 Sept 2003.

Ph. squarrosa (Weigel: Fr.) P. Kumm. – on *Tilia cordata* and *Betula* sp., 1162 Tico, 1132 Pisy, Taani kuninga aed, Sinkarka, 6 Oct 2001.

Ph. squarrosoides (Peck) Sacc. – on wood, 1321 Piab, Mustametsa ots, 5 Oct 2001, TAA 176095.

Pleurotus pulmonarius (Fr.: Fr.) Quél. – on wood, 1132 Piab, 214, 1162 Tico, Oct 2001, May 2002, Sept 2003, TAA 176106.

Pluteus cervinus (Schaeff.) P. Kumm. – on wood, 1132 Pisy, 1321 Piab, 1141 Piab, 1412 Algl, 1412 Bepu, 1162 Tico, 1162 Quro, July 1998, Oct 2001, Sept 2003, TAA 176124, 185657; frequent.

P. leoninus (Schaeff.: Fr.) P. Kumm. – on wood of *Betula* sp., 1132 Pisy, Kunilamägi, 10 Sept 2003.

P. plautus (Weinm.) Gillet – on wood of *Picea abies*, 1321 Piab, Kabelikari, 9 Sept 2003, TAA 185574.

P. salicinus (Pers.: Fr.) P. Kumm. – on wood, 1321 Piab, Mustametsa ots, 10 Sept 2003, TAA 185616.

Psathyrella piluliformis (Bull.: Fr.) P.D. Orton – on wood of *Betula* sp. and *Populus tremula*, 1321 Piab, 1132 Pisy, 1141 Piab, Mustametsa ots, Oct 2001, TAA 176087, 176098; **new record.**

P. prona (Fr.) Gillet – on roadside, 1321 Piab, Mustametsa ots, 31 May 2002, TAA 182076.

Psilocybe montana (Pers.: Fr.) P. Kumm. var. montana – on *Rhacomitrium canescens*, 1121 Pisy, Mustametsa ots, 5 Oct 2001, TAA 176082; **new record.**

Rhodocollybia butyracea (Bull.) Antonín, Halling & Noordel. f. asema – 1321 Piab, 1132 Piab, 1162 Tico, 1121 Pisy, Oct 2001, Sept 2003; frequent.

R. butyracea (Bull.) Antonín & Noordel. f. butyracea – 1132 Piab, 1321 Piab, Mustametsa ots, Lõunaküla, 10/11 Sept 2003.

R. maculata (Alb. & Schwein.: Fr.) Singer – 1122 Pisy, Taani kuninga aed, 12 Sept 2003.

R. prolixa (Hornem.) Antonín & Noordel. – 1321 Piab, Kabelikari, 9 Sept 2003, TAA 185580.

Rhodocybe nitellina (Fr.) Singer – 1321 Piab, Kabelikari, 9 Sept 2003, TAA 185575.

Rickenella fibula (Bull.: Fr.) Raithelh. – on moss, 1121 Pisy, 511, Noodamajand, Sinkarka, 4/6 Oct 2001.

Rozites caperatus (Pers.: Fr.) P. Karst. – 1122 Pisy, 1323 Pisy, 1132 Pisy, 1132 Piab, 1321 Piab, Oct 2001, Sept 2003; frequent.

Schizophyllum commune Fr. – on wood of *Betula* sp., 1321 Piab, Mustametsa ots, 31 May 2002.

Strobilurus esculentus (Wulfen: Fr.) Singer – on fallen cones of *Picea abies*, 1321 Piab, Mustametsa ots, 10 Sept 2003.

Strobilurus stephanocystis (Hora) Singer – on fallen cones of *Pinus sylvestris*, 511, Virbi ots, 2 May 2002, TAA 176168.

S. tenacellus (Pers.: Fr.) Singer – on fallen cones of *Pinus sylvestris*, 1162 Quro, Taani kuninga aed, 4 July 1998, TAA 147947.

Stropharia aeruginosa (Curtis: Fr.) Quél. – 1321 Piab, 1162 Tico, Oct 2001.

S. pseudocyanea (Desm.) Morg. – 1141 Piab, Taani kuninga aed, 6 Oct 2001, TAA 176115.

Tephrocybe mephitica (Fr.) M.M. Moser – 1141 Piab, Taani kuninga aed, 6 Oct 2001, TAA 176118.

T. palustris (Peck) Donk – on *Sphagnum* sp., 1412 Bepu, Sinkarka, 1 June 2002, 182092.

T. rancida (Fr.) Donk – 1321 Piab, 1162 Tico, Mustametsa ots, Taani kuninga aed, 5/6 Oct 2001.

Tricholoma albobrunneum (Pers.: Fr.) P. Kumm. – 511, 1121 Pisy, 1132 Pisy, Oct 2001, Sept 2003, TAA 176083, 185600; frequent, at places numerous.

T. arvernense Bon – 1121 Pisy, 1321 Piab, Oct 2001, Sept 2003, TAA 176051, 185636; **rare.**

T. atrosquamosum (Chev.) Sacc. – 511, Virbi ots, 10 Sept 2003, TAA 185598, 185599.

T. cingulatum (Almfelt ex Fr.: Fr.) Jacob. – 1321 Piab, Mustametsa ots, 5 Oct 2001, TAA 176080.

T. columbetta (Fr.) P. Kumm. – 1162 Tico, Taani kuninga aed, 6 Oct 2001, 11 Sept 2003; **rare.**

T. equestre (L.: Fr.) P. Kumm. – 1321 Piab, 1121 Pisy, 1132 Pisy, 1122 Pisy, 511, Oct 2001, Sept 2003, TAA 176069, 185659; frequent, at places numerous.

T. focale (Fr.) Ricken var. focale – 1121 Pisy, 1132 Pisy, Oct 2001, Sept 2003, TAA 176052, 176070; frequent, at places numerous.

T. frondosae Kalamees & Shtshukin – 1321 Piab, 1162 Tico, Mustametsa ots, Taani kuninga aed, 5/6 Oct 2001, TAA 176086, 176088.

T. fulvum (Bull.: Fr.) Sacc. – 214, 1162 Tico, Lõunaküla, Taani kuninga aed, 9/11 Sept 2003.

T. gausapatum (Fr.) Quél. – 1122 Pisy, Noodamajand, 4 Oct 2001, TAA 176061.

T. imbricatum (Fr.: Fr.) P. Kumm. – 1162 Tico, Taani kuninga aed, 6 Oct 2001.

T. inamoenum (Fr.: Fr.) Gillet – 1312 Pisy, 1141 Piab, 1321 Piab, Oct 2001, Sept 2003.

T. luridum (Schaeff.: Fr.) P. Kumm. – 1121 Pisy, 1132 Pisy, 1122 Pisy, Oct 2001, TAA 176057, 176109.

T. portentosum (Fr.) Quél. – 1121 Pisy, 1122 Pisy, 1132 Pisy, Oct 2001.

T. saponaceum (Fr.) P. Kumm. var. saponaceum – 1121 Pisy, 1132 Pisy, Noodamajand, Kunilamägi, 4/5 Oct 2001.

T. scalpturatum (Fr.) Quél. – 1321 Piab, Mustametsa ots, 5 Oct 2001, 10 Sept 2003.

T. sejunctum (Sow.: Fr.) Quél. – 1132 Pisy, Kunilamägi, 10 Sept 2003.

T. stans (Fr.) Sacc. ss. Gulden – 1132 Pisy, Kunilamägi, 5 Oct 2001, TAA 176099.

T. stiparophyllum (S. Lundell) P. Karst. – 1321 Piab, 1121 Bepe, 1162 Tico, 214, Oct 2001, Sept 2003.

T. sulphureum (Bull.: Fr.) P. Kumm. – 1162 Tico, Taani kuninga aed, 6 Oct 2001.

Tricholomopsis decora (Fr.) Singer – on wood, 1132 Pisy, Suursadam, 12 Sept 2003.

T. rutilans (Schaeff.: Fr.) Singer – on wood, 1312 Pisy, 1132 Pisy, Mustametsa ots, Miiniladu, 10/11 Sept 2003.

Tubaria furfuracea (Pers.: Fr.) Gillet ss. Gulden – 511, Virbi ots, 5 Oct 2001, TAA 176076.

Vascellum pratense (Pers.: Pers.) Kreisel – 511, 1321 Piab, Virbi ots, Kabelikari, 3 May 2002, 9 Sept 2003, TAA 176185.

Xeromphalina fellea Maire & Malençon – on wood, 1321 Piab, Mustametsa ots, 5 Oct 2001.

**Phallales**

Phallus impudicus L.: Fr. – 1162 Tico, Taani kuninga aed, 11 Sept 2003.

Ramaria flava (Schaeff.: Fr.) Quél. – Miiniladu, 11 Sept 2003.

R. stricta (Fr.) Quél. – 1321 Piab, Lõunaküla, 11 Sept 2003, TAA 185630.

**Russulales**

Auriscalpium vulgare Gray – on fallen cones of *Pinus sylvestris*, 1121 Pisy, 1162 Tico, Noodamajand, Taani kuninga aed, 4/6 Oct 2001.

Heterobasidion parviporum Niemelä & Korhonen – on wood of *Picea abies*, 1321 Piab, Mustametsa ots, 31 May 2002, TAA 185505.

Lactarius aquizonatus Kytövuori – 1132 Pisy, Kunilamägi, 10 Sept 2003, TAA 185626.

Lactarius aspideus (Fr.: Fr.) Fr. – 1421, Taani kuninga aed, 6 Oct 2001, TAA 176121; **rare.**

L. aurantiofulvus J. Blum ex Bon – 1162 Tico, Taani kuninga aed, 11 Sept 2003, TAA 185646.

L. camphoratus (Bull.) Fr. – 1321 Piab, 1132 Piab, 1323 Pisy, 1412 Bepu, Oct 2001, Sept 2003; frequent.

L. citriolens Pouzar – 1321 Piab, 1132 Piab, Mustametsa ots, Miiniladu, 10/11 Sept 2003.

L. deliciosus (L.: Fr.) Gray var. rubescens Schmitt – 1121 Pisy, 1122 Pisy, Oct 2001, Sept 2003.

L. deterrimus Gröger – 1141 Piab, 214, 1321 Piab, Oct 2001, Sept 2003.

L. flexuosus (Pers.: Fr.) Gray – 1162 Tico, Taani kuninga aed, 11 Sept 2003, TAA 185650.

L. cf. fulvissimus Romagn. – 1162 Tico, Taani kuninga aed, 6 Oct 2001, TAA 176110; **rare.**

L. glyciosmus (Fr.: Fr.) Fr. – 1122 Pisy, 1412 Bepu, Suured mäed, Sinkarka, 5/6 Oct 2001.

L. helvus (Fr.) Fr. – 1323 Pisy, 1421 Bepu, Kunilasoo, Mustametsa ots, 5 Oct 2001, 10 Sept 2003.

L. lacunarum Romagn. ex Hora – 1412 Bepu, Sinkarka, 6 Oct 2001, 11 Sept 2003, TAA 176133, 185655.

L. mammosus (Fr. ex Weinm.) Fr. – 1321 Piab, Lõunaküla, 11 Sept 2003.

L. mitissimus (Fr.) Fr. – 1321 Piab, 1312 Pisy, Mustametsa ots, Lõunaküla, 5 Oct 2001, 10/11 Sept 2003.

L. musteus Fr. – 1132 Pisy, Kunilamägi, 5 Oct 2001.

L. necator (J.F. Gmel.: Fr.) P. Karst. – 1121 Pisy, 1321 Piab, 1312 Pisy, 1132 Pisy, Oct 2001, Sept 2003.

L. obscuratus (Lasch) Fr. var. obscuratus – 1412 Algl, Männiku, 9 Sept 2003, TAA 185595.

L. obscuratus (Lasch) Fr. var. radiatus (J.E. Lange) Romagn. – 1412 Algl, Männiku, 9 Sept 2003, TAA 185596.

L. aff. pubescens (Schrad.) Fr. – 1121 Pisy, Mustametsa ots, 5 Oct 2001.

L. pubescens (Schrad.) Fr. – 1321 Piab, 1132 Piab, 1312 Pisy, 1121 Pisy, Mustametsa ots, Miiniladu, 5 Oct 2001, 10/11 Sept 2003.

L. rufus (Scop.: Fr.) Fr. – 1121 Pisy, 1122 Pisy, 1132 Pisy, 1323 Pisy, 1132 Piab, 1321 Piab, 511, July 1998, Oct 2001, Sept 2003; frequent, at places numerous.

L. scrobiculatus (Scop.: Fr.) Fr. – 1321 Piab, Mustametsa ots, 10 Sept 2003.

L. tabidus Fr. – 1321 Piab, 1321 Bepu, 1312 Pisy, 1162 Tico, Oct 2001, Sept 2003, TAA 185579; frequent.

L. torminosus (Schaeff.: Fr.) Gray – 1312 Pisy, 1121 Pisy, 1321 Piab, 1132 Piab, 1162 Tico, 214, Oct 2001, Sept 2003; frequent.

L. trivialis (Fr.: Fr.) Fr. – 1312 Pisy, 1121 Pisy, 214, 1321 Piab, Oct 2001, Sept 2003; frequent.

L. vietus (Fr.: Fr.) Fr. – 1321 Piab, 1132 Piab, 1323 Pisy, 1122 Pisy, 1421 Bepu, 1412 Bepu, 214, Oct 2001, Sept 2003, TAA 176102, 176132; frequent.

Lentinellus flabelliformis (Bolton: Fr.) S. Ito – on deciduous wood, 1321 Piab, Mustametsa ots, 10 Sept 2003, TAA 185619.

L. cf. ursinus (Fr.: Fr.) Kühner – on deciduous wood, 1412 Algl, Taani kuninga aed, 6 Oct 2001, TAA 176125.

Russula acrifolia Romagn. – 1312 Pisy, 1321 Piab, Mustametsa ots, Lõunaküla, 10/11 Sept 2003.

R. adusta (Pers.: Fr.) Fr. – 1132 Pisy, Suured mäed, Sinkarka, 5/6 Oct 2001.

R. aeruginea Lindblad – 1121 Pisy, 1321 Piab, 1162 Tico, July 1998, Oct 2001, Sept 2003; frequent.

R. aurea Pers. – 1162 Tico, Taani kuninga aed, 6 Oct 2001.

R. betularum Horak – 1321 Piab, Mustametsa ots, 10 Sept 2003.

R. chloroides (Krombh.) Bres. – 1162 Tico, 214, Taani kuninga aed, Lõunaküla, 6 Oct 2001, 9/11 Sept 2003.

R. claroflava Grove – 1321 Piab, Lõunaküla, 11 Sept 2003.

R. consobrina (Fr.: Fr.) Fr. – 214, 1321 Piab, Lõunaküla, 9/11 Sept 2003.

R. decolorans (Fr.: Fr.) Fr. – 1132 Pisy, 1132 Piab, 1122 Pisy, 214, 1321 Piab, Oct 2001, Sept 2003; frequent.

R. delica Fr. – 1162 Tico, 214, Taani kuninga aed, Lõunaküla, 6 Oct 2001, 9 Sept 2003.

R. drimeia Cooke – 1121 Pisy, Sinkarka, 6 Oct 2001, TAA 176148.

R. emetica (Schaeff.: Fr.) Pers. – 1323 Pisy, 1132 Pisy, 1132 Piab, 1321 Piab, Oct 2001, Sept 2003; frequent.

Russula favrei M.M. Moser – 214, 1321 Piab, Lõunaküla, 9 Sept 2003.

R. foetens Pers.: Fr. – 1132 Pisy, Männiku, 9 Sept 2003.

R. aff. fragilis (Pers.: Fr.) Fr. – 1421 Bepu, Mustametsa ots, 10 Sept 2003, TAA 185608.

R. ochroleuca (Pers.) Fr. – 1321 Piab, 1132 Piab, 214, 1323 Pisy, 1162 Tico, Sept 2003; frequent.

R. paludosa Britzelm. – 1323 Pisy, 1132 Pisy, 1321 Piab, Oct 2001, Sept 2003.

R. queletii coll. – 214, 1162 Tico, Lõunaküla, Taani kuninga aed, 9/11 Sept 2003.

R. rhodopoda Zvára – 1132 Pisy, Männiku, Virbi ots, 9/10 Sept 2003.

R. sanguinaria (Schum.) S. Rauschert – 1162 Tico, Taani kuninga aed, 6 Oct 2001, 11 Sept 2003.

R. turci Bres. – 1321 Piab, Lõunaküla, 11 Sept 2003.

R. vesca Fr. – 1312 Pisy, 1122 Pisy, 1121 Pisy, 1132 Pisy, 1132 Piab, July 1998, Oct 2001, Sept 2003; frequent.

R. vinosa Lindblad – 1321 Piab, 1132 Piab, Kabelikari, Mustametsa ots, 9/10 Sept 2003.

R. xerampelina (Schaeff.) Fr. – 1122 Pisy, 1121 Pisy, 1321 Piab, Oct 2001, Sept 2003.

Scytinostroma portentosum (Berk. & M.A. Curtis) Donk – on wood of *Quercus robur*, 1162 Tico, Taani kuninga aed, 6 Oct 2001, TAA 165936.

Stereum hirsutum (Willd.: Fr.) Gray – on wood, 1421 Bepu, Suursadam, 30 May 2002.

S. rugosum (Pers.: Fr.) Fr. – on wood of *Betula* sp., 1162 Tico, Taani kuninga aed, 1 June 2002, TAA 182084.

Vesiculomyces citrinus (Pers.) Hagstr. – on wood of *Pinus sylvestris*, 1121 Pisy, Suursadam, 4 Oct 2001, TAA 165902.

## PROTOZOA

## MYXOMYCOTA

### Echinosteliales

Clastoderma debaryanum A. Blytt – on wood of *Picea abies*, 1321 Piab, Mustametsa ots, 5 Oct 2001, TAA 165921, 165919; **rare.**

### Liceales

Cribraria cancellata (Batsch) Nann.-Bremek. – on wood of *Quercus robur*, 1162 Tico, Taani kuninga aed, 6 Oct 2001, TAA 165938.

C. rufa (Roth) Rostaf. – on wood of *Pinus sylvestris*, Suursadam, 4 Oct 2001, TAA 165901.

Enteridium lycoperdon (Bull.) M.L. Farr – on wood of *Betula* sp., Sinkarka, 1 June 2002.

Lycogala epidendrum (L.) Fr. – on wood, 1162 Quro, Taani kuninga aed, 6 Oct 2001, 1 June 2002.

Tubifera ferruginosa J.F. Gmel. – on wood of *Salix* sp., 1321 Piab, Mustametsa ots, 5 Oct 2001.

### Physarales

Diderma aff. globosum Pers. – on grass litter of *Menyanthes trifoliata*, 1412 Bepu, Sinkarka, 6 Oct 2001, TAA 165942, 165943.

Didymium melanospermum (Pers.) T. Macbr. – on wood of *Salix* sp. and *Pinus sylvestris*, Suursadam, Mustametsa ots, 4/5 Oct 2001, TAA 165903, 165918.

D. squamulosum (Alb. & Schwein.) Fr. – on grasses, 511, Virbi ots, 5 Oct 2001, TAA 165912.

Fuligo septica (L.) F.H. Wigg. – on wood of *Pinus sylvestris*, Suursadam, Taani kuninga aed, 4/6 Oct 2001.

Physarum nutans Pers. – on wood of *Populus tremula*, 1321 Piab, Mustametsa ots, 5 Oct 2001, TAA 165916.

### Stemonitales

Comatricha ellae Härk. – on wood of *Pinus sylvestris*, Suursadam, Taani kuninga aed, 4/6 Oct 2001, TAA 165905, 165940.

C. nigra (Pers.) J.Schröt. – on wood of *Picea abies* and *Quercus robur*, 1162 Tico, Taani kuninga aed, 1 June 2002, TAA 165950, 165937.

Lamproderma columbinum (Pers.) Rostaf. – on wood of *Picea abies*, 1321 Piab, Mustametsa ots, 5 Oct 2001, TAA 165920.

Symphytocarpus impexus Ing & Nann.-Bremek. – on wood of *Quercus robur*, 1162 Tico, Taani kuninga aed, 6 Oct 2001, TAA 165936.

**Trichiales**

ARCYRIA INCARNATA (Pers.) Pers. – on wood of *Betula* sp., 1162 Tico, Taani kuninga aed, 1 June 2002, TAA 165948, 165949.

A. MAJOR (G. Lister) Ing – on wood of *Sorbus aucuparia*, 1162 Tico, Taani kuninga aed, 6 Oct 2001, TAA 165934.

ARCYRIA POMIFORMIS (Leers) Rostaf. – on wood of *Pinus sylvestris*, Suursadam, 4 Oct 2001, TAA 165905.

METATRICHIA VESPARIUM (Batsch) Nann.-Bremek. – on wood of *Betula* sp., 1321 Piab, Mustametsa ots, 5 Oct 2001, TAA 165922.

TRICHIA AFFINIS de Bary – on wood of *Quercus robur*, 1162 Tico, Taani kuninga aed, 6 Oct 2001, TAA 165935, 165939.

T. CONTORTA (Ditmar) Rostaf. – 1162 Tico, Taani kuninga aed, 6 Oct 2001, TAA 165930.

T. PERSIMILIS P. Karst. – on wood, 1321 Piab, Mustametsa ots, 31 May 2002.

T. SCABRA Rostaf. – on wood of *Betula* sp., 1321 Piab, Mustametsa ots, 31 May 2002, TAA 165947.

T. VARIA (Pers.) Pers. – on wood of *Sorbus aucuparia*, 1162 Tico, Taani kuninga aed, 6 Oct 2001, TAA 165926.

## RESULTS

The mycobiota of seventeen different site types were studied.

Broad-leaved Aegopodium fresh boreo-nemoral lime and oak forests occupy the first place as concerns species diversity. Characteristic species for these forest types on the island are *Xerocomus pascuus, Hebeloma sinapizans, Tricholoma sulphureum, Russula aurea* and *Lactarius* cf. *fulvissimus;* the last-mentioned species was most numerous in October 2002. Of rare species in Estonia, there were represented *Melanophyllum echinatum, Tricholoma columbetta* and *Lactarius* cf. *fulvissimus.*

In the diversity of fungus species, most similar to the above-regarded broad-leaved forests are *Polytrichum-Vaccinium myrtillus* poor paludified spruce forests. A large number of fruit bodies were produced by *Hygrophorus hedrychii* growing in enormous groups of hundreds of fruit bodies. In these spruce forests, frequent were also *Cantharellus tubiformis, Paxillus involutus, Clitocybe nebularis, Rhodocollybia butyracea* var. *asema, Tricholoma stiparophyllum, T. frondosae, Entoloma nidorosum*, *Cortinarius sanguineus*, *Inocybe geophylla* and *Lactarius tabidus.* Of rare to Estonia fungi in this forest type were represented *Sarcosoma globosum* (protected by law, Estonian Red Data book), *Marasmius cohaerens, Psathyrella piluliformis*, *Lentinus suavissimus*, and *Camarophyllopsis foetens* (new to Estonia).

Most wide-spread in Naissaar are *Cladina* and *Calluna* boreal heath, *Vaccinium myrtillus* and *Vaccinium vitis-idaea* dry boreal and *Oxalis-Vaccinium myrtillus* fresh boreal pine forests, there also occur *Vaccinium myrtillus* and *Oxalis-Vaccinium myrtillus* spruce forests. These forest types are quite similar in species composition but poor in fungus species. *Cantharellus cibarius, Boletus edulis, Chroogomphus rutilus, Hygrophoropsis aurantiaca, Paxillus involutus, Suillus bovinus*, *S. luteus*, *S. variegatus*, *Mycena epipterygia* var. *epipterygia, Tricholoma albobrunneum*, *T. equestre*, *T. focale*, *T. luridum*, *T. portentosum, Amanita citrina* var. *citrina*, *A. muscaria*, *A. pantherina, Rozites caperatus, Lactarius deliciosus* var. *rubescens, L. rufus, Russula vesca* are frequent and often represented with large numbers of fruit bodies in *Cladina*, *Calluna* and *Vaccinium myrtillus* boreal heath pine forests. In the *Vaccinium myrtillus* spruce forests, *Cantharellus tubiformis* was encountered in large numbers at some places. In the *Oxalis-Vaccinium myrtillus* forest type, two species of parasol mushrooms, *Macralepiota procera* and *M. rhacodes*, are frequent. Of rare Estonian fungi in this forest site type were recorded *Tricholoma arvernense,* the moss parasite *Arrhenia spathulata*, *Pisolithus arhizus*, and *M. nympharum* protected by law (Category II) and included in the Estonian Red Data Book. A new species for Estonia, the moss parasite *Psilocybe montana* var. *montana* was collected in the *Cladina* boreal heath pine forest.

*Vaccinium uliginosum* poor paludified pine forests are a little richer in species composition. Typical and often numerous in this forest type are: *Lactarius rufus, L. helvus, Russula paludosa, R. emetica, Suillus variegatus, Laccaria laccata* var. *pallidifolia*, *Cantharellus aurora* and *C. tubiformis*.

Mixotrophic bog and *Calla* minerotrophic mobile water swamp forests on the island are usually rather poor in fungus species. In the latter forest type *Leccinum holopus* is a quite frequent species, at places, there also occur *Suillus flavidus, Lactarius lacunarum*, *Laccaria laccata* var. *pallidifolia* and under alder trees, *Naucoria escharoides*. A rare species in Estonia, *Lactarius aspideus,* was recorded in mixotrophic bog willow shrub. In the *Calla* alder grove, *Pholiota alnicola* was recorded in large numbers on alder wood.

On the coastal dunes, there were few fungi in the years regarded. *Crinipellis scabella*, growing on grass litter, *Marasmius oreades* and *Vascellum pratense* were recorded in remarkable numbers at places.

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# Estimation of fungal geome size: comparison of image cytometry and photometric cytometry

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**Abstract:** Besides photometric cytometry (PC), fluorescence microscopy combined with computerised image analysis, i.e. image cytometry (IC), offers an alternative tool for assessing genome size. These techniques allow direct visualization of hyphae and simultaneous measurement of nuclear fluorescence intensity. We developed a simple method for quantitative evaluation of nuclear DNA in fungi using DAPI-IC. The intensity of signals from individual nuclei was quantitatively measured in digitized images. In agreement with the results of parallel PC experiments, this simple IC performed on fruitbodies or on pure culture preparations enables to detect the amount of nuclear DNA in fungal cells. This result validates IC as an alternative to PC in such experiments.

**Kokkuvõte:** Seene genoomi suuruse määramine: pildianalüüsi ja fotomeetriise tsütomeetria võrdlus.

Genoomi suuruse määramise meetodiks klassikalise tsütofotomeetria (PC) kõrval on fluorestsents-mikroskoopia kombineerituna kompuuter-pildianalüüsiga (IC). See meetod võimaldab mõõta hüüfituumade fluorestsentsi intensiivsust *in situ*. Töös esitatakse lihtne meetod tuuma DNA-sisalduse kvantitatiivseks määramiseks DAPI-IC. Digitaliseeritud pildil mõõdeti igast tuumast tulevate signaalide intensiivsust kvantitatiivselt. Paralleelsete PC eksperimentide tulemused kinnitasid, et see lihtne IC meetod võimaldab viljakeha või puhaskultuuri preparaatidest kindlaks teha tuuma DNA-sisaldust ja ta on kasutatav alternatiivse meetodina.

## INTRODUCTION

The study of genome size variation is important from a number of practical and theoretical perspectives. Nuclear DNA content in an unreplicated haploid chromosome complement (1C-value) is a key diversity character with many uses (Bennett & Leitch, 1998, 2005, for terminology see Greilhuber et al., 2005). Processes inducing quantum or doubling series variation in genome size are common. These abrupt shifts have significant effects on phenotypic attributes at both cellular and organism levels and may play an important role in evolution (Gregory & Hebert, 1999). The questions of the C-value enigma transcend taxonomic boundaries, and increased communication is therefore urged among those who study genome size evolution, whether in plants, animals or other organisms (Gregory, 2005 a). Databases of plant and animal genome size are growing rapidly (Gregory, 2005b; Bennett & Leitch, 2004). To date, comparatively few data are available for the genome size of fungi. The 1C-values in fungi range from 6.5 Mbp (*Pneumocystis carinii* f. sp. *muris*, Birren et al., 2002) to 795 Mbp (*Scutellospora castanea*, Hijri & Sanders, 2005) (see Kullman et al., 2005, http://www.zbi.ee/fungal-genomesize/).

In providing quantitative data of nuclear DNA for the purpose of fungal taxonomy, microspectrophotometry and microfluorometry (cytofluorometry) have played an important role (see for a review Kullman, 2000). These cytometric methods of determination of genome size consist in the analysis of nuclear DNA molecules *in situ* after quantitative staining, and comparative evaluation of the data of different species. By means of these methods it is possible to measure relative DNA amount in the nucleus: the ratio of the result of the measurement of the studied organism to that of the standard organism is calculated.

Fluorometry relies on quantitative staining of DNA with fluorochromes. The amount of DNA is estimated from the amount of emitted light measured with a microscope-photometer or with a flow cytometer* (FC; Dolezhel, 1997; Dolezhel et al., 1998; Kullman, 2000; Saar & Kullman, 2000). A classical fluorometric method which has been used mostly in mycology (see

review Kullman, 2000) involves measurement of intensity with instruments combining a microscope and a photometer. The photometer can now be replaced with an image analysis system which grabs images from the microscope via a digital camera and calculates intensity or optical density from the grey values of the pixels in the nucleus (for a review see Vidal, 1997; Hardie et al., 2002). The classical method is referred to as photometric cytometry (PC) in contrast to computer-based image cytometry (IC) (Vilhar et al., 2001).

Comparison has shown that using Feulgen staining, FC and IC as well as PC and IC, provide a similar efficacy of DNA quantification (Borgiani et al., 1994; Vilhar et al., 2001). In measurement of plant and animal genome size, the Feulgen image analysis has met an ever wider application. This method is also used in plant pathology (Volgmayr & Greilhuber, 1998; Rincones et al., 2003).

Employing PC for measurement of fungal nuclear DNA, mostly fluorochrome DAPI has been used for estimation of the ploidy level (Bresinsky et al., 1987a, b; Wittmann-Meixner, 1989; Wittmann-Meixner & Bresinsky, 1989; Whittaker et al., 1991; Wittmann-Meixner et al., 1989; Weber & Bresinsky, 1992; Weber, 1992; Bresinsky & Wittmann-Bresinsky, 1995; Bresinsky et al., 1999; Kullman, 2000, 2002 a, b). DAPI is a small water-soluble fluorescent molecule with extremely high avidity and specificity for DNA, preferentially binding to the A-T rich regions of DNA. A comparative study of the DAPI dye and the intercalating dyes revealed a higher fluorescence intensity and resolution of the former (Otto & Tsou, 1985). DAPI staining is less affected by the state of chromatin condensation compared with staining with other fluorochromes (Shapiro, 1995). Comparing the Feulgen image analysis and DAPI image analysis, Volkova (2005) reported higher image resolution in the case of DAPI staining. DAPI is also widely used in current plant FC for ploidy analysis.

IC has only rarely been used in mycology (Rincones et al., 2003; Volkova, 2005). Moreover, published data provide no evidence that IC with DAPI staining yields results comparable to the results obtained with PC. Most PC studies report only relative DNA values, while usually no attempt has been made to present the value of absolute DNA content values in fungi.

Important steps in measurement of nuclear DNA content in fungi are standardized procedures for DNA staining and measurement, as well as the choice of the standard species. The aim of the present study was to compare PC and IC on the basis of the nuclei stained with the fluorochrome.

## MATERIAL AND METHODS

### Experimental design

Nuclear DNA content in 5 fungal species was measured in two laboratories with IC and PC, respectively, using DAPI staining. Also, two IC, the software Image-Pro Plus 4.5 and the software Image J 1.34f, were used to study the same slides of 8 specimens (from 6 species).

Two calibration standards, *Trichophaea hemisphaerioides* (TFC 97-71) 23.3 Mbp (Kullman, 2000) and the species *Neottiella rutilans* 530 Mbp (Kullman, 2002a), and the prophase/telophase method were applied for fungal cytometry. The genome size of the other specimens was estimated in relation to the standards.

Measured fluorescence intensity is proportional to DNA content in the nucleus. When measuring nuclei in the haplophase, a distribution curve is obtained whose first maximum, indicating the nuclei with unreplicated chromosomes in the G0/G1 phase of the cell cycle, corresponds to genome size. The resulting fluorescence histograms can be analysed for calculating the difference in nuclear DNA content between the specimens. By including the internal standard, relative DNA content is converted to the absolute amount. The genome size of an unknown specimen is obtained by dividing the mean relative DNA content of the unknown G0/G1 population of nuclei by the mean of the standard G0/G1 population of nuclei and by multiplying the result by the genome size of the standard. DNA content is expressed in megabase pairs of nucleotides (Mbp) (NB 1 pg = 978 Mbp (see Dolezhel et al., 2003).

When the genome size of *T. hemisphaerioides*, obtained in Kullman (2000), is 23.3 Mpb and the mean value of the same species, measured in arbitrary units (a.u.) by Weber (1992), is 54.4, then 1 a.u.= 0.43 Mbp. In this case also the genome size of the other species studied by

Weber (1992) was recalculated in Mpb (Kullman, 2000; Kullman et al., 2005) and used in this study.

**Material**

Herbarized material: *Anthracobia melaloma* (Velen.) Svrček, Russia, near Krasnoyarsk, on the ground, 9 Oct. 1955, M.I. Beglyanova, N 87, TAA188381; *Melastiza chateri* (W.G. Sm.) Boud, Sweden, Overkalix, on the ground, B. Kullman, TAA157958; *Neottiella* sp. nov., Tuva, Ak-Dovurak, on the ground among moss, 2 Aug.1972, A. Raitviir & B. Kullman, TAA62474; *Neottiella* sp. nov., Tuva, Kozoelon, on the ground, 18 Aug.1972, A. Raitviir & B. Kullman, TAA62740; *Neottiella rutilans* (Fr.) Dennis. Finland, Kilbisjärvi, on the ground, 26 Aug. 1998, B. Kullman, TAA157947; *Neottiella rutilans*. Russia, Primorsk Terr., Habarovsk Distr., Kedrovaja-Pad, on the ground among the moss, 8 Aug.1957, E. Z. Koval, P-137, TAA188382; *Neottiella vivida (Nyl.) Dennis* Norway, Sogn & Fjordene, Sogntal, Haukåsen airport, on the ground, 8 Sep. 2000, B. Kullman, TAA179520; *Ramsbottomia crechqueraultii* (P. Crouan & H. Crouan) Benkert & T. Schumach., Finland, Robinsalmi, on the ground, 27.Aug. 1998. B. Kullman, TAA157951; *Octospora humosa* (Fr.) Dennis, Finland, Karesuvanto, on the ground among moss, 27 Aug. 8. 1998, B. Kullman, TAA 157953.

Fixed material: Fruit bodies of *Neottiella rutilans* (Fr.) Dennis, Finland, Kilpisjärvi, Sana, 25 Aug. 1998, A. Jakobson, TAA 135730 and *Octospora humosa* (Fr.) Dennis, Finland, Kontolanrahka, Rahanlevon mäki, 21 Sep. 1993 on the burnt ground among moss, 67489:2692, Jakobson, TAA 135658.

Pure culture: *Peziza lobulata* (Velen.) Svrček, Estonia, Tartumaa Co., Nõo Comm., Peedu, on fire site, 3 Sep. 2001, B. Kullman (TAA 179671), *Trichophaea hemisphaerioides* (Mounton) Graddon (TFC 97-71 from TAA 147708) as a reference specimen (Kullman, 2000).

**Procedures and proposed methods**

**PC**

For staining nuclei, the material was squeezed between the slide and the cover-slip and subjected to DAPI staining as described in Weber (1992). The relative DNA content of nuclei was measured by cytofluorometry at the Institute of Botany, Regensburg University, using a Zeiss UNIVERSAL photomicroscope, equipped with an epifluorescence illuminator III RS, and a Zeiss microscope photometer 03, as used routinely in the same laboratory by Bresinsky et al. (1987b), Wittmann-Meixner (1989), Weber (1992) and Büttner (1999) and others.

**IC**

Staining Protocol

A slice of a fruitbody or a hypha of a pure culture were fixed in Carnoy's solution (ethanol: chloroform:ice acetic acid, 6:3:1, by vol.) (Romeis, 1968) and stored at 4° C until used, or at least for 1 h.

To stain DNA, the fixed material was slightly dried on filter paper and incubated with 0.5% Pepsin pH 1.8 for 7 min at room temperature by slow shaking. Next, the fourfold volume of 4',6-diamidino-2-phenylindole (DAPI: Molecular Probes Inc.) at 2µg $ml^{-1}$ TRIS buffer was added, and the sample was incubated for 45 min by slow shaking. Then the slices were placed in a drop of glycerin on glass slides, minced and rinsed gently with a shaving blade and squashed under the cover slips. The slides were stored at -20° C until study. For one experiment, the slides of all specimens were prepared and analysed during one measurement session.

Processing with Image Pro Plus

DNA image cytometry with the *Image Pro Plus* 4.5 (IPP) (manufactured by Media Cybernetics, USA) software package was performed at Rostock University.

The system for DAPI-DNA IC consists of a Olympus IX70 fluorescence microscope with 360 nm excitation and 460 nm emission filters, a Hamamatsu colour Chilled 3CCD camera with an adapter and a colour monitor, and an IBM Pentium I - compatible personal computer. Hyphal nuclei were observed under 40x and 20x Olypmus LCPlan FL objectives and the images of the nuclei in the areas with low background noise were saved on the hard disk of the computer as TIFF files. Image-Pro Plus 4.5 was used to grab and process the images with local background determination: i.e. the nucleus was segmented determining the light intensity of the reference background from the narrow zone surrounding the nucleus using

the cursor (Figs.1-3). Only a few nuclei in the centre of the image were measured because of the uneven illumination of the field of view. A rounded AOI (area of interest) with a stable size was used for selecting each nucleus separately throughout one measurement session. A total of 30-50 nuclei per slide were measured. If the parameter Integrated Optical Density (IOD) is selected with the Automatic Bright Objects option of the count/size command, then IOD is equal to Integrated Intensity of the nucleus to be measured. Mass = integrated intensity = sum of pixels. Concentration = mass / area = mean intensity = average intensity. See the following web pages which explain intensity measurement and provide a few tools for it http://www.aecom.yu.edu/aif/analysis_tools/intensity.htm; http://rsb.info.nih.gov/nih-image/about.html.

Proposed method

Image processing protocol, selection of the parameters and data collection:

Menu Process – Color Channel – Extract: Color Model – RGB, Generate channel – B–OK.

Menu Measure – Calibration, select Intensity: click New, Free Form, Options: Image, define a 3x3 neighborhood template, use the cursor as crosshairs to determine the Current Value of light intensity of the background for calibrating the input value – OK, select Change to calibrate 0 intensity for the y axis, Calibration always positive – OK.

Menu Edit New AOI – Select Ellipse AOI for measuring a nucleus – OK.

Menu Edit – AOI: Add AOI with appropriate size, Save. Use this setting throughout one measurement session.

Menu Measure – Count /Size, select Automatic Bright Objects, Measure Objects, Accumulate Counts, Display objects.

Menu Measure – Data Collector – Layout: Count Size – appropriate selection is: IOD, Area, Density mean, Density min, Density max (for Automatic Bright Objects, Density = Intensity and IOD = Area x Density mean = Integrated Intensity, equal to area x average intensity); – Data List – Collect Now after Count in Count /Size menu; – Export – Select Excel (DDE) – Export Now.

Image processing with ImageJ

DNA image cytometry with the *ImageJ* 1.34f software package for Windows was performed at the Estonian Agricultural University. *ImageJ* is a public domain image analysis program which was developed at the National Institutes of Health (http://rsb.info.nih.gov/ij; http://rsb.info.nih.gov/ij/docs/pgfs/ImageJ.pdf. The photos grabbed with *Image Pro* are also analysed with *ImageJ* (Tables 1 and 2).

Proposed method

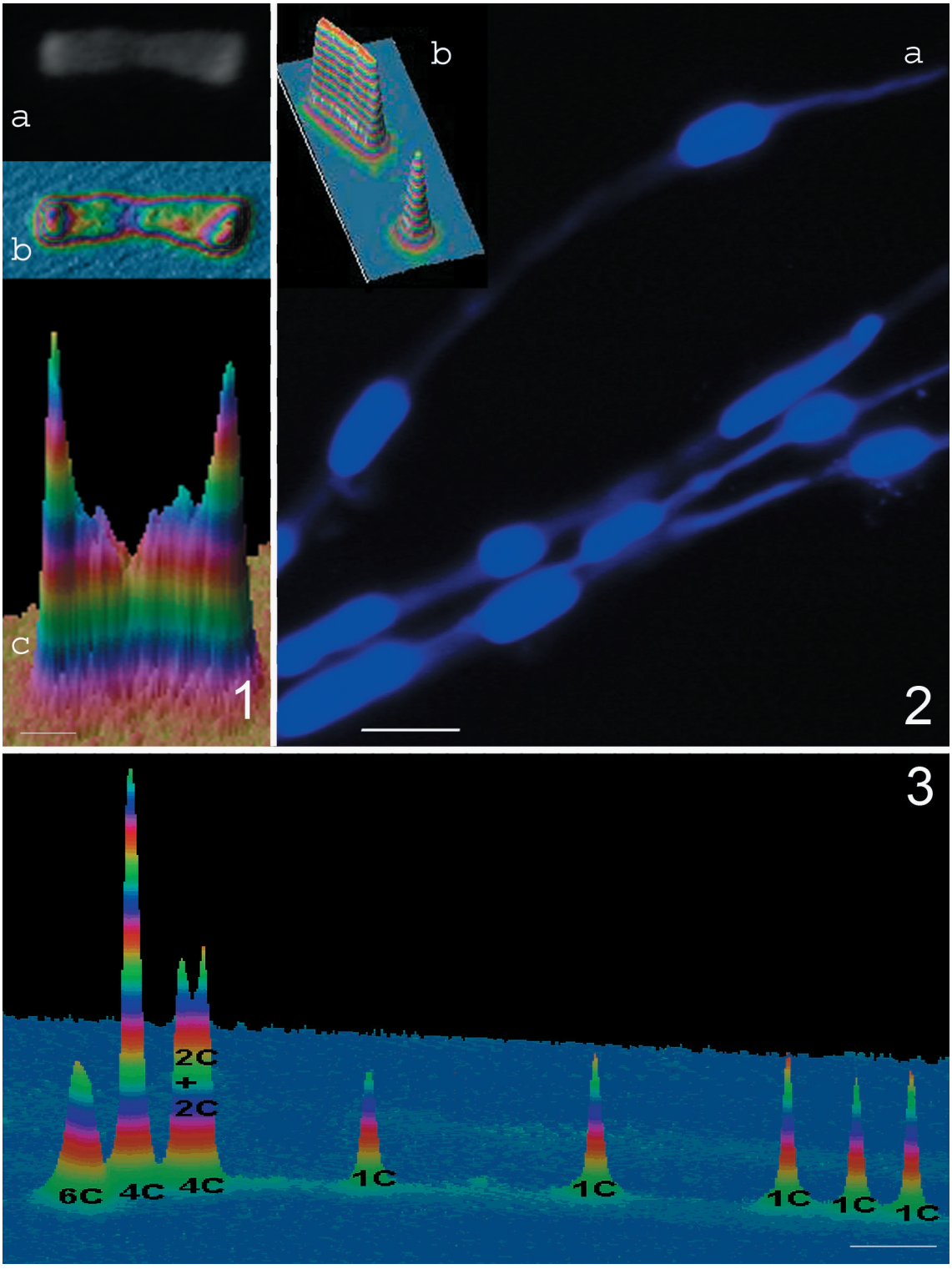
Operations. Select File – Import – Image sequence from the menu to open a stored image as a stack.

Image Processing. Image – Type – 8-bit converts the image into 256 shades of grey. On this scale 0 = pure black and 255 = pure white.

**Fig. 1.** Closed mitosis in a cell of a fruitbody of *Neottiella vivida* TAA 179520. DNA is concentrated into brightly stained poles. a – a photo of a DAPI-stained nucleus; b and c – analysis with Image PRO. The y axis denotes fluorescence intensity. The volume of the cone is proportional to DNA content in the nucleus. Bar = 5 μm.

**Fig. 2.** Haploid nuclei of *Neottiella vivida* TAA 179520 stained with DAPI. The nuclei appear as diffuse blue ovals: a – endopolyploid nuclei of paraphyses; b – unequal haploidization of the endopolyploid nucleus analysed with Image PRO (ratio of DNA content 1:7). Bar = 10 μm.

**Fig. 3.** Relative nuclear DNA content in the hyphae of a pure culture of *Peziza lobulata* TAA179671. The ultimate nucleus has higher growth potential compared with its sister nucleus. Replication in the nucleus of the top cell is faster than division, while the posterior nuclei can be divided without replication and stop at the 1C value. As a result, there arise endopolyploidization (in the apical cells) and haploidization (in the posterior cells). C – the C-value which corresponds to genome size. Bar = 5 μm.


a
b
c
1
b
a
2
3
2C
+
2C
6C
4C
4C
1C
1C
1C
1C
1C

Next, Image – Type – 32-bit allows to see the nuclei more precisely.

Process – Smooth makes the background more homogeneous.

Each nucleus is measured separately. Surround a nucleus with a perimeter. This can be done with an oval area selection tool (ROI – region of interest) and the Wand Tool (see below). The status bar below the toolbar gives the intensity value of a pixel under the cursor. Using this, to cover all nuclear fluorescence, oval selection was done so that the minimal pixel value for it was close to the background value. In this case the diameter of the oval area is ca 2 x larger than the diameter of the visible nucleus.

Wand Tool. Go to Image – Adjust – Threshold. Select the Set Threshold Levels menu button to adjust threshold level to the background pixel value near the nucleus. In the binary image the red areas indicate the nuclei and the black portions indicate the background. This tool automatically finds the edge of a nucleus and traces its shape. It works best with high contrast images and can be used with caution for small fungal nuclei.

Use Analyse – Set Measurements to select parameters such as Area and pixels Mean, pixels Min & pixels Max Grey Value and Integrated Density.

Go to Analyse – Measure. Using Oval Selection, the data window will show the area of oval selection and its pixel brightness values. Using Oval Selection with Wand Tool, the data window will show the area of the outlined nucleus and its pixel brightness values. Integrated Density = Total_mass of nucleus = (raw_mean)*area of outlined ROI. The minimum pixel value in this case is larger than the background pixel value. Unlike Image PRO, Image J can not automatically subtract background noise and subtraction should be done separately. One can calculate total_mass = (raw_mean – background_mean)*area (http://www.aecom.yu.edu/aif/analysis_tools/edge_intensity/m1.htm).

The Process – Smooth has made the background sufficiently homogenous so that the background pixel brightness values of the area of Oval Selection = raw_min, and then total_mass of nucleus = (raw_mean – raw_min)*area of Oval Selection.

In both cases, with Image Pro and Image J, the data were automatically collected and then transported and stored in an EXCEL table. A frequency histogram and descriptive statistics were obtained for each data set with the softwares EXCEL and R.

For detailed comparison, the same nuclei of *Neottiella vivida* TAA179520 were measured with different IC methods (Table 1). Calculation of the nuclear DNA Mbp values was based on the calibration of the sample against the corresponding standard nuclei, using the 1C value of 530 Mbp as the equivalent of the average Integrated Intensity the G1 nuclei of the *Neottiella rutilans* (Kullman, 2002). For comparison of methods PC and IC, the G1 nuclei from the fruitbody of *N. rutilnas* TAA157947 were used as the internal standard (Table 2).

## RESULTS

### Comparison of IC methods on the basis of 17 nuclei

The estimates of DNA content for the 17 nuclei of the fruitbody the *Neottiella vivida* TAA 179520 for the software packages Image Pro and Image J, respectively, are shown in Table 1. The analysed photos were made with an 40x objective (Figs. 1–2).

Differences in the measurements of nuclear DNA content with different IC methods were investigated using regression analysis. One of the IC methods (the Image Pro software) was employed as the reference method and the other two methods were compared to this. A linear regression line depicting the correlation between the Image PRO (outlined AOI) method and the other two IC methods was plotted (Fig. 4A and 4B). The regression equation for the Image J (outlined ROI) method was $y = 1.00x + 3.59$ ($R^2 = 0.998$. P-value $< 0.0001$) and for the Image J (oval ROI) method $y = 0.931x + 6.84$ ($R^2 = 0.995$. P-value $< 0.0001$). The point representing the calibration standard nucleus set at 100% for all measurements, was excluded from regression analysis. The method of linear regression analysis has been used previously for inter-method comparison of C-value measurements (Dolezhel et al., 1998, Johnston et a., 1999 and Vihar et al., 2001) Both regression lines indicated high correlation between the three studied IC methods.

**Table 1.** Nuclear DNA content of 17 nuclei in the fruitbody of *Neottiella vivida* TAA179520 measured with three IC methods. ImageJ (oval ROI) using Oval Selection without a threshold, where nuclear intensity = (mean-min)*area oval ROI; ImageJ (outlined ROI) and Image PRO (outlined AOI) using segmentaton of nuclei against the background, where integral intensity = mean*area of outlined AOI or AOI, respectively. The 10th nucleus was used as the calibration standard and set at 100% for all measurements (DNA value 76 in a.u.). The nuclei are ordered beginning from the smallest DNA content to the largest nuclear DNA content.

| | Image J (oval ROI) | | | | | Image J (oval ROI) | Image J (outlined ROI) | Image PRO (outlined AOI) |
|---|---|---|---|---|---|---|---|---|
| No | area in pixels | mean pixel value | min pixel value | max pixel value | (mean-min)*area | (mean-min)*area | integral intensity | integral intensity |
| 1 | 1020 | 16 | 5 | 60 | 11118 | 22 | 21 | 19 |
| 2 | 1556 | 12 | 4 | 37 | 13070 | 25 | 23 | 22 |
| 3 | 1664 | 17 | 5 | 56 | 20134 | 39 | 41 | 40 |
| 4 | 3120 | 12 | 4 | 37 | 24024 | 47 | 46 | 45 |
| 5 | 1664 | 20 | 5 | 80 | 26125 | 51 | 54 | 49 |
| 6 | 1664 | 21 | 4 | 60 | 27622 | 53 | 56 | 53 |
| 7 | 3052 | 13 | 4 | 41 | 28689 | 56 | 56 | 54 |
| 8 | 2279 | 22 | 5 | 77 | 39199 | 76 | 80 | 73 |
| 9 | 1807 | 27 | 5 | 86 | 39212 | 76 | 76 | 76 |
| 10 | 4014 | 19 | 4 | 86 | 59407 | 115 | 115 | 108 |
| 11 | 4653 | 20 | 4 | 85 | 73517 | 142 | 143 | 130 |
| 12 | 2602 | 32 | 5 | 86 | 69473 | 135 | 145 | 137 |
| 13 | 3746 | 26 | 5 | 86 | 81663 | 158 | 167 | 158 |
| 14 | 3772 | 26 | 4 | 86 | 84493 | 164 | 170 | 169 |
| 15 | 3772 | 28 | 4 | 86 | 90905 | 176 | 182 | 180 |
| 16 | 4326 | 33 | 5 | 87 | 124589 | 241 | 260 | 260 |
| 17 | 5734 | 26 | 4 | 78 | 125001 | 242 | 261 | 257 |

IC was used in two ways: measurement of the outlined nuclei in thresholded images, which is typical of IC (Fig. 4A), and measurement of Oval Selection (containing a nucleus) in non-thresholded images according to the measurement principle used in the classical method, PC (Fig.4B).

In the first case, IC is used to process images with determination of the local background, i.e. the light intensity of the reference background is determined and the nuclei are segmented.

The ImagePro and ImageJ software packages can measure nuclei in thresholded images. They work by scanning the selection until finding the edge of a nucleus. They then outline the nuclei using a threshold and measure their integral intensity. If threshold level is checked, only thresholded pixels are included in measurement calculations. The problem is to find an appropriate threshold level for accurate segmentation of nuclei. We suggest not using an auto-threshold. Threshold level can be determined, using the mouse cursor, from a blank zone surrounding the nucleus, where the pixel values are close to the light intensity of the background.

Although the ImagePro and ImageJ software packages calculate the integral intensity of the outlined nuclei in the same way (the mean pixel value of the outlined nucleus is multiplied by its area), the results can be different. Caution: if the background pixel values are relatively high, then the integral intensity of the outlined nuclei, calculated with the Image J software package, may be not correct. Image Pro with set zero threshold level on the intensity scale is more precise, while in the case of the Image J software package, threshold pixel intensity values include

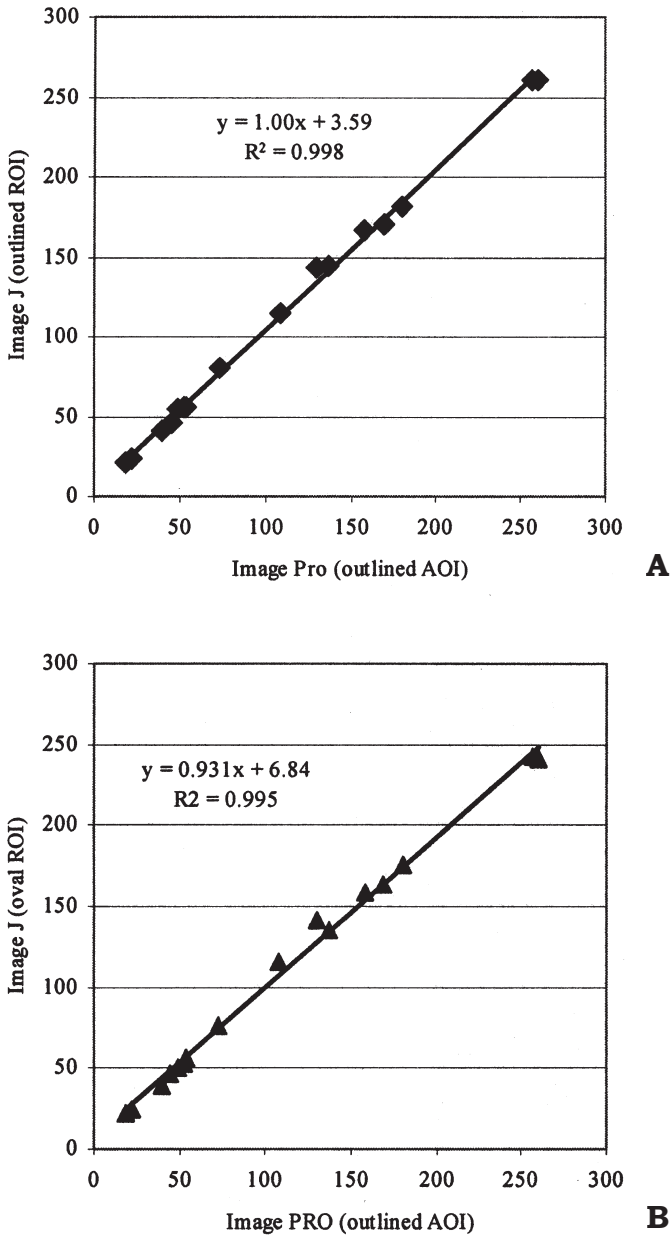



**Fig. 4.** Comparison of the nuclear DNA content estimates measured with three IC methods – ImagePro (outlined AOI), ImageJ (outlined ROI) using segmentaton of nuclei against the background, and ImageJ (oval ROI) using Oval Selection without a threshold. Image Pro (outlined AOI) – nuclear intensity = mean*area outlined AOI, was used as the reference method to which the other two methods were compared. A – Image J, nuclear intensity = (mean)*area outlined ROI); B - Image J, nuclear intensity = (mean-min)* area oval ROI. The DNA content of te mixoploid nuclei of the fruitbody *Neottiella vivida* TAA 179520 is expressed in arbitrary units. Some of the nuclei are overlighted (see in text). A 40x objective was used.

also background pixel intensity values (see Methods and also http://www.aecom.yu.edu/aif/analysis_tools/edge_intensity/m1.htm). The threshold level for Image J (outlined ROI) analysis throughout the measurement of a stack was selected to be the mean threshold level for Image Pro analysis. In this case the regression lines indicate high correlation between both methods, however, the nuclear DNA content obtained with Image J (outlined ROI) is slightly larger (Fig 4A).

In the second case, with the Image J (oval ROI) method, pixel intensities of Oval Selection (ROI) are used: nuclear intensity = (mean – min) *areaROI, where the selected area is larger than the nucleus so that the 'min' of ROI pixel values is by one unit larger than the background pixel intensity values (see methods). The diameter of ROI can be ca 2 times as large as the diameter of the nucleus to gather all nuclear fluorescence. The regression lines indicate high correlation between this method and Image PRO (outlined AOI), however, the variance of the nuclear DNA content obtained with this method is slightly lower. Hence one can obtain smaller differences in genome size between different species.

In conclusion, all three studied IC methods, ImagePro and ImageJ (measurement of the outlined nuclei in thresholded images) as well as ImageJ (measurement of Oval Selection) yielded comparable results (Fig. 4). At the same time, the most suitable and powerful method is Image PRO.

**Comparison of IC and PC methods on the basis of eight specimens.**

The estimates of the C-values for 8 specimens (from 6 species) on the basis of the herbarized (IC) or fixed material (PC) are shown in Table 2

**Table 2.** DNA C-values measured with IC and PC. The two IC methods, ImageJ (oval ROI) and Image Pro (outlined AOI), are employed. For IC, the 7th specimen of *N. rutilans* was used as the internal standard set at 100% for all measurements made by the authors (C-value 530 in Mbp). The IC methods were used to analyse the same slides for the following specimens: 1- *Anthracobia melaloma* TAA188381, 2 – *Melastiza chateri* TAA157958, 3 – *Neottiella* sp. nov. TAA62474, 4 – *Neottiella* sp. nov. TAA62740, 5 – *Ramsbottomia crechqueraultii* TAA157951, 6 – *Octospora humosa* TAA157953, 7 – *Neottiella rutilans* TAA157947, 8 – *Neottiella rutilans* TAA188382 (The analyzed photos were made with a 20x objective). The PC method was employed by the authors as well as by Weber (1992) but for analysing different specimens from the species studied here and using different internal standards (see the text). Using PC, the author analysed the following specimens: 6 – *Octospora humosa* TAA 135658, 7, 8 – *Neottiella rutilans* 135730. The specimens are ordered beginning from the lowest C-value to the highest C-value. C-values in Mbp ± CV%.

| | **IC** | | **PC** | |
|---|---|---|---|---|
| Species | Image J (oval ROI) | Image Pro (outlined AOI) | Present study | Weber 1992 |
| 1. A. melaloma | 15 ± 25% (20) | 11 ± 22% (30) | | 18 ± 10% |
| 2. M. chateri | 15 ± 23% (6) | 13 ± 20% (12) | | 15 ± 10% |
| 3. Neottiella sp. | 19 ± 17% (23) | 19 ± 11% (21) | | |
| 4. Neottiella sp. | 19 ± 18% (13) | 22 ± 13% (17) | | |
| 5. R. rechqueraultii | 20 ± 28% (11) | 27 ± 28% 13) | | 25 ± 13% |
| 6. O. humosa | 187 ± 16% (52) | 265 ± 25% (52) | 165 ± 10% | 155 ± 11% |
| 7. N. rutilans | 530 ± 18% (25) | 530 ± 13% (28) | 530 ± 6% | 417 ± 8% |
| 8. N. rutilans | 561 ± 16% (10) | 580 ± 17% (5) | 530 ± 6% | 417 ± 8% |

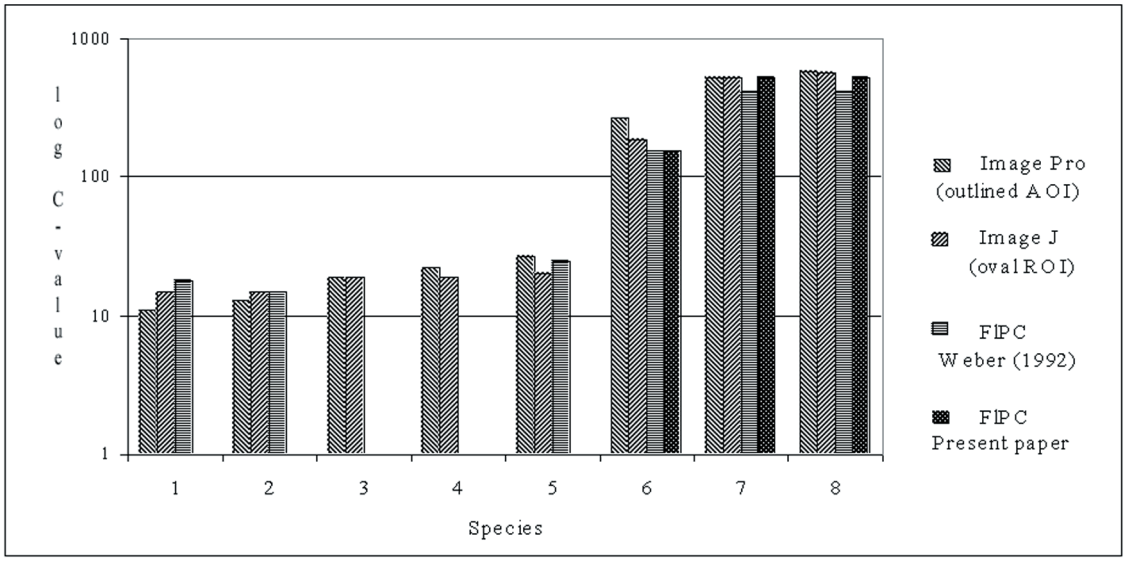



**Fig. 5.** Variation of measurement of nuclear DNA content (in Mbp) within eight specimens. The legend as shown in Table 2. The specimens are ordered from the lowest C- value (left) to the highest C-value (right). On the y – axis measurements of nuclear DNA content are transformed logarithmically. C-values in Mbp.

and Fig. 5 for the software package Image Pro and for Image J, respectively, as well as for PC as measured by the author and by Weber (1992), respectively. The two IC methods were employed for analysis of the same slides of the studied specimens. *N. rutilans* (7th specimen in Table 2) was used as the internal standard (C-value 530 in Mbp.) set at 100% for all measurements performed by the authors. However, Weber (1992) used other specimens from the species analysed in this study and used other internal standards (Kullman et al., 2005).

Differences in the measurement of the C-values with the use of different methods were investigated with regression analysis (Fig. 6). For this purpose, one of the IC methods (the Image Pro software) was used as the reference method and the other methods were compared to this. The point representing the internal standard was excluded from regression analysis.

The linear regression line showing the correlation between the Image PRO (outlined AOI) method and the Image J (oval ROI) method and the PC method used measured by Weber (1992) was plotted (Fig. 6A and 6B). The regression equation for the Image J (outlined ROI) method was $y = 0.94x – 5.75$ ($R^2 = 0.985$. P-value < 0.0001. ) and for the PC method, used by Weber, was $y = 0.73x + 0.36$ ($R^2 = 0.987$. P-value < 0.0001).

All regression lines indicate high correlation between the three studied methods. The highest correlation was obtained between the methods used by Weber 1992 (PC) and Image J (oval ROI), where $y=1.33x –10.87$ ($R^2 = 1.00$. P-value < 0.0001), although different specimens of the studied species were used. This can indicate the stability of the C-value of a species, besides the fact that these two methods have similar principles for calculation of relative DNA content (Fig. 6C).

## DISCUSSION

In this study, we developed a simple method for fungal genome size measurement with DAPI-IC. DAPI staining reveals the state of the DNA at different stages of the cell cycle (Figs. 1–3). When nuclei undergo division, DNA condenses into brightly staining poles – the characteristic closed mitosis / amitose shapes (Fig. 1). During the rest of the cell cycle, the nucleus appears as a diffuse blue oval (Fig. 2a.).

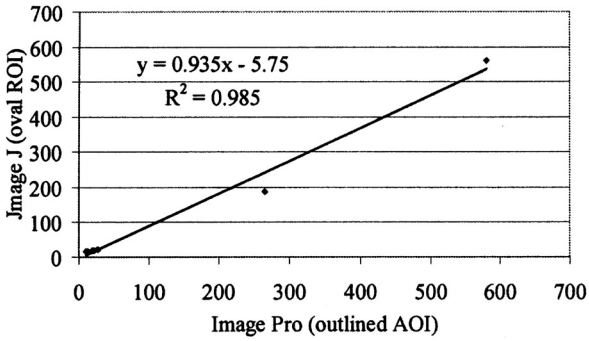



**Fig. 6A.** Comparison of the two IC methods, ImageJ (oval ROI) and Image Pro (outlined AOI).

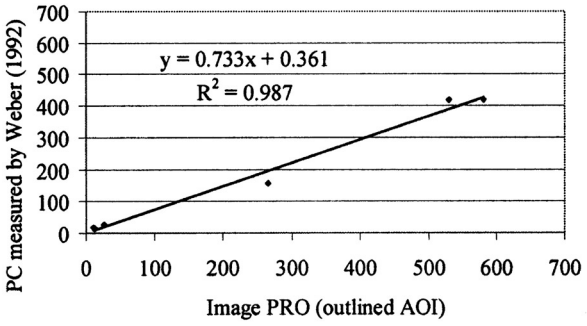



**Fig. 6B.** Comparison of IC (Image Pro) and PC methods.

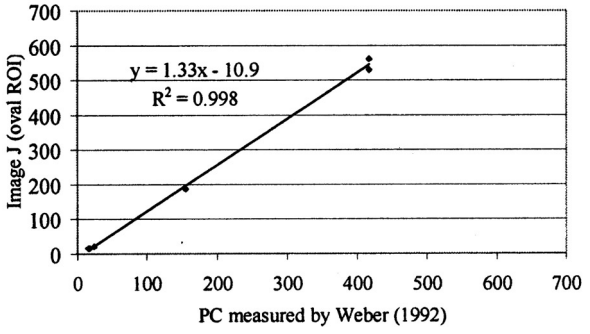



**Fig. 6C.** Comparison of PC and IC (Image J) methods.

**Fig. 6.** Comparison of the IC and PC methods on the basis of measurements is presented in Table 2.

Using Blue (RGB) colour space as well as a threshold segmentation technique by selection of the proper parameters, available in the software tool of Image-Pro Plus 4.5 and Image J 1.34f, quantitative measurement of cytomorphological images become possible.

With A-T preference, DAPI provides an expression for estimation of DNA content in a special case, i.e. it is appropriate for studying differences in nuclear DNA content within a specimen (study of endopolyploidy) and within a group with stable GC/ AT content. In fungi differences in GC/ AT content among closely related species, genera and families and often even among orders are largely similar (Wittmann-Meixner, 1989). For calculation of absolute DNA content standard species should be used which are taxonomically close to the species whose DNA content is unknown.

Both PC and IC of cytomorphological slides allow to measure nuclei in situ. To establish the C-value, it is appropriate to measure DNA content from developing asci or basidia. To find out which peak on the DNA content histogram corresponds to the 1C value, we measured nuclei after the first meiotic division. The C-value of these nuclei is exactly 2. The DNA content of all other nuclei can be more or less equivalent to the product of the 1C-values expressed in integers. When paraphyse nuclei are used, which are mostly 1G nuclei, one should avoid enodopolyploid nuclei (in the tip of the paraphyse, Fig. 2) for calculation of 1C-value (Kullman, 2002a). In principle, the genome size of the nuclei in ascogenous hyphae can be stable, however, due to the ongoing mitotic cycle it is difficult to establish 1G nuclei. In an old ascomycete culture, DNA content estimation of nuclei in hyphae can be different due do aneuploidy or endopolyploidy (data about *Peziza* sp., not shown in this paper).

Measurement of the C-value is also justified immediately after spore germination. However, it should be borne in mind that in the hyphal tip, in the course of apical growth, mitotic DNA replication is not followed by the division of nucleus, which leads to endopolyploidy. The ultimate nucleus has the higher potential to grow compared with its sister nucleus. As a result, the posterior nuclei in the hyphae complete division and stop at the 1C value, owing to which they can be used for measurement of genome size in

ascomycetes (Fig. 3). As in ascomycetes, nuclear division in basidiomycetes is usually initiated at the hyphal tip, however in basidiomycetes mitosis is additionally initiated in the central region of the apical compartment. The distal region is unaffected by mitotic activity and the nuclei remain there in 2C condition (Valla, 1984; Bresinsky et al., 1987b). The non-dividing telophase nuclei may fuse (Bresinsky et al., 1987b); endodiploid (2x) nuclei arise in old hyphae through endomitosis (endoreplication) (Wittmann-Meixner, 1989). Diploidization and tetraploidization, but also fusions of heterokarions, are found in basidiomycete cultures. Haploidization (meiotic process !?) of these nuclei can occur before development of basidia starts (Fischer, 1987). Heterokaryosis through anastomosis and parasexuality (leading to diploidization and subsequently to haploidization) can also play a role in the lability of nuclear DNA content in hyphae.

The data about heteroploidy studied with the use of chromosome counting are controversial (Tolmsoff, 1983). Employing electrophoretic karyotyping, it has been found that intraspecific variation in both chromosome number and size is a rule rather than an exception for many species (Beadle, 2003). At the same time, using cytofluorometric investigation of various fungi, Bresinsky et al. (1987b) demonstrated stability of the relative DNA content of nuclei among different strains and varieties; there are however, significant differences between species within a genus and between genera within an order. Correlation between relative nuclear DNA content, chromosome number and ploidy levels in several fungal divisions was tested by Wittmann-Meixner et al. (1989). Based on cytological studies of developing asci of *Magnoporthe grisea* (Leung & Williams, 1987; Yaegashi & Hebert, 1976), consensus has been reached to the effect that the haploid number of *M. grisea* chromosomes is stable – and was determined to be six.

When measuring complete nuclear DNA content, both IC and PC, are ± free from error as compared to chromosome counting due to small chromosomes beyond microscope resolution. Further, using the method of electrophoretic karyotyping numerous chromosomes of the same size and/or many large (larger than 8 Mb) can not be resolved (Beadle et al., 2003).

To verify the linearity of measurement one can use nuclei in the cell cycle. The ratio of the G2 to the G1 nuclei must be equal to 2. Vidal (1997) recommended to use, as internal control for 1C, low variation of the readings of nuclear DNA content for the nuclei falling within the same C-value class in one sample, and low proportionality error (4C/2C or 2C/1C ratio for one sample close to 2.00).

In case the above ratio is not 2, one reason can be instable illumination; therefore the current stabilizer is recommended. Also 3D studies with IC are required to check if nuclei are overlighted or not. A projection with the shape of a severed cone indicates overlighted nuclei. The measured integral intensity of the nucleus in this case is lower because the intensity of some pixels exceeds the maximum grey scale value used in IC.

Thus a careful evaluation is needed in each case, while IC is useful in testing which cells could be employed for estimation of the C-value.

Regarding preparation for DNA measurement caution should be taken in setting fixation time (Greilhuber et al., 2005). Ten-year old herbarized material is more appropriate for measurement of nuclear DNA content than the material that has been fixed with Carnoy for some years, even in the refrigerator, as was seen in comparative measurements (not shown in this paper). Study of the material that has been fixed with Carnoy for different time periods can also yield erroneous results.

For comparison of different IC methods, we used identical nuclei from one specimen TAA159520 (Table 1, Fig. 4) and for comparison of IC and PC methods, we used different specimens from one species (Table 2, Figs. 5-6). In one specimen of *N. rutilans* TAA 179520, we measured nuclei with different nuclear DNA contents which correspond to endopolyploidy and aneuploidy (Table 1; Fig. 2). Unequal haploidization of nuclei was seen in paraphyse nuclei (Fig. 2b, ratio 1:7). At the same time, genome size of the species remained stable (Table 2; Fig.5).

The results of this study demonstrate that IC is comparable to PC. We showed that IC provides reliable and reproducible results over a range of different C-values in fungal species. Thus we recommend this method to be considered as an alternative to PC in measurement of fungal nuclear DNA content.

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# A checklist of Lithuanian hyaloscyphaceous fungi (Ascomycetes)

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**Abstract:** 109 species belonging to 28 genera of the hyaloscyphaceous fungi are listed. 30 species are reported as new for Lithuania.

**Kokkuvõte:** Leedu harjastiksikuliste (kottseened) nimestik.

Esitatakse andmed 28 perekonda kuuluva 109 harjastiksikulise (Hyaloscyphaceae) esinemise kohta Leedus. 30 liiki on esmasleiud Leedust.

## INTRODUCTION

Hyaloscyphaceous fungi have tiny sessile or stalked apothecia, build up of usually light-coloured excipulum composed of prismatic or angular cells, and their receptacle is covered by hairs of different shapes and structure. Except some important parasites of coniferous trees in the genus *Lachnellula*, the majority of species are fruiting as saprotrophs on various plant remnants, *e.g.* decaying wood and bark, stems and leaves of herbs, grasses, rushes, reeds, sedges, ferns, canes of *Rubus*, fallen leaves, needles and cones of trees. The scope and taxonomy of these inoperculate discomycetes have significantly changed during last three decades (Raitviir, 2004). Substantial number of unknown species were described not only from Europe and North America, but also from Asia, Australia and South America.

Only 3 hyaloscyphaceous species, namely *Capitotricha bicolor*, *Lachnellula willkommii* and *Lachnum virgineum*, were known in Lithuania up to the middle of the 20th century (Kutorga, 1990). During the field trips arranged in different parts of Lithuania in 1965–1966, the second author collected 83 specimens (all preserved in TAA) representing 35 species of the hyaloscyphaceous fungi. This material was used to publish a new taxon, *Clavidisculum caricis* Raitv. (= *Cistella caricis* (Raitv.) Raitv.) (Raitviir, 1970). Significant progress has been made on the investigation of diversity and distribution of these fungi since 1987. A number of species have been added to the previously known genera, and many genera and species formerly unknown to Lithuania have been reported (Kutorga, 1989a, 1989b, 1991, 1996, 2002; Iršenaite & Kutorga, 2001; Iršenaite, 2003; Kutorga & Raitviir, 2003). Lithuanian specimens of the genus *Hyaloscypha* and allied genera collected by A. Raitviir and preserved in TAA were reassessed by Huhtinen (1990).

A total of Lithuanian collections reached about 750 in 2004. Most them are preserved in the Herbarium of Institute of Botany, Vilnius (BILAS). Other collections were deposited in the Herbaria of Vilnius University (WI) and Institute of Zoology and Botany, Tartu (TAA). Collected specimens have been studied microscopically and identified in close cooperation of both authors. The aim of present study was to summarise the data on diversity and distribution of the Lithuanian hyaloscyphaceous fungi, and to reassess taxonomy and nomenclature of taxa treated.

109 species belonging to 28 genera of the hyaloscyphaceous fungi have been recorded in Lithuania. 30 species marked with an asterisk (*) are reported for the first time in Lithuania. The most common species are *Belonidium ciliare*, *Capitotricha bicolor*, *Hyaloscypha albohyalina*, *Lachnum pudibundum*, *L. virgineum*, *Olla*

*millepunctata*, *Psilachnum chrysostigmum*, *Trichopeziza leucophaea* and *T. sulphurea*. 37 species are known in Lithuania from a single collection.

The list of taxa is arranged in alphabetic order following taxonomical concept of hyaloscyphaceous fungi proposed by Raitviir (2004).

## LIST OF SPECIES

### HYALOSCHYPHACEAE NANNF.

CALYCELLINA Höhn.

Calycellina alniella (Nyl.) Baral
Rather common on fallen female cones of *Alnus glutinosa* and *A. incana* from September till October. Known from 8 localities in Klaipeda, Plunge, Taurage and Trakai districts, and in Neringa. Lit.: Kutorga (1989a, 1989b, 1991, 1996, 2002, as *Pezizella alniella* (Nyl.) Dennis).

C. ochracea (Grelet & Crozals) Dennis
Rare on decaying wood of *Quercus robur* and unidentified deciduous tree from August to September. Known from 3 localities in Kedainiai, Lazdijai and Vilnius districts. Lit.: Iršenaite (2003).

C. populina (Fuckel) Höhn.
Rather common on fallen leaves and petioles of *Betula* sp., *Populus tremula* and *Quercus robur* from August to October. Known from 5 localities in Kedainiai, Pakruojis and Taurage districts. Lit.: Iršenaite & Kutorga (2001), Iršenaite (2003), Kutorga & Raitviir (2003).

C. punctata (Fr.) Lowen & Dumont, Syn.: *Calycellina punctiformis* (Grev.) Höhn., *Phialina puberula* (Lasch) Höhn.
Common on fallen leaves and acorns of *Quercus robur* and unidentified deciduous tree from August to October. Known from 19 localities in Jonava, Kedainiai, Klaipeda, Plunge, Šakiai, Šilute, Taurage, Trakai, Vilkaviškis and Vilnius districts. Lit.: Kutorga (1991, 1996), Iršenaite & Kutorga (2001), Iršenaite (2003), Kutorga & Raitviir (2003).

CALYCINA Nees ex Gray

Calycina conorum (Rehm) Baral
Known from a 2 localities: on fallen cones of *Pinus sylvestris*, Neringa, 29 IV 1989; on fallen fruit cupules of *Aesculus hippocastanum*, Klaipeda district, 16 IX 1994. Lit.: Kutorga (1989a, 1991, as *Pezizella chionea* (Fr.) Dennis).

C. herbarum (Pers.) Gray
Common on dead stems of *Aegopodium podagraria*, *Artemisia vulgaris*, *Eupatorium cannabinum*, *Phragmites australis*, *Urtica dioica* (mostly) and some unidentified herbaceous plants from July till November. Known from 24 localities in Ignalina, Kaunas, Kedainiai, Marijampole, Mazeikiai, Moletai, Plunge, Šakiai, Šiauliai, Šilute, Trakai and Vilnius districts, and in Neringa. Lit.: Kutorga (1989a, 1989b, 1991, as *Hymenoscyphus herbarum* (Pers.) Dennis).

*C. vulgaris (Fr.) Baral
Known from a single locality on bark of *Betula* sp., Mazeikiai district, 27 IX 1989.

CILIOLARINA Svrček

*Ciliolarina laetifica Huhtinen
Known from a single locality on wooden plank, Kaunas district, 13 X 1991.

*C. neglecta Huhtinen
Known from a single locality on fallen bark of unidentified tree and on pyrenomycete ascomata, Kedainiai district, 30 VIII 2000.

CISTELLA Quél.

Cistella aconiti (Rehm) Raitv. & Järv
Known from 2 localities: on dead stems of *Urtica dioica*, Taurage district, 12 V 1999; on dead stems of *Heracleum sosnovskyi*, Ignalina district, 07 VIII 2003. Lit.: Kutorga & Raitviir (2003).

C. acuum (Alb. & Schwein.) Svrček
Rare on fallen needles of *Picea abies* and *Pinus sylvestris* from April to August. Known from 3 localities in Šakiai district, and in Neringa. Lit.: Kutorga (1989a, 1991).

C. caricis (Raitv.) Raitv.
Rather common on dead stems and leaves of *Carex* spp., *Scirpus sylvaticus* and *Typha latifolia* from May to September. Known from 4 localities in Plunge, Šakiai, Šilute and Taurage districts. Lit.: Raitviir (1970, as *Clavidisculum caricis* Raitv.). The holotype (TAA-44252) of this species was collected in Lithuania in 1966.

*Cistella fugiens (Buckn.) Matheis
Known from 2 localities on dead stems of *Ammophila arenaria* in Neringa, 19 IX 2003 and 20 IX 2003.

*C. geelmuydenii Nannf.
Collected twice in a single locality on dead wood of *Picea abies*, Trakai district, 10 IX 2003 and 07 IX 2004.

*C. granulosella (P. Karst.) Nannf.
Known from a single locality on dead deciduous wood and stromata of *Hypoxylon*. sp., Kedainiai district, 31 V 2000.

C. grevillei (Berk.) Raschle
Common on dead stems of *Heracleum sosnovskyi*, *Urtica dioica* and some unidentified herbaceous plants from May to August. Known from 11 localities in Ignalina, Klaipeda, Šakiai, Šilute and Taurage districts. Lit.: Kutorga (1991, 2002).

C. hungarica (Rehm) Raitv.
Common on dead stems of *Aegopodium podagraria*, *Filipendula ulmaria*, *Heracleum sosnovskyi*, *Heracleum* sp., *Polygonatum odoratum*, *Reynoutria sachalinensis* and *Urtica dioica* from May to August. Known from 15 localities in Ignalina, Kedainiai, Plunge, Šilute, Švencionys, Trakai and Vilnius districts. Lit.: Kutorga (1991).

*C. perparvula (P. Karst.) Nannf.
Known from a single locality on decaying bark of deciduous tree, Kedainiai district, 01 VI 2000.

HAMATOCANTHOSCYPHA Svrček

Hamatocanthoscypha laricionis (Velen.) Svrček
Rather common on fallen cones and needles of *Larix* sp. and *Picea abies* from August to October. Known from 8 localities in Taurage, Trakai and Vilnius districts, and in Neringa. Lit.: Kutorga (1989a, 1991, 2002, as *Hyaloscypha strobilicola* Huhtinen), Kutorga & Raitviir (2003**)**.

HYALOPEZIZA Fuckel

*Hyalopeziza raripila (Höhn.) Huhtinen
Known from a single locality on dead stems of *Heracleum sosnovskyi*, Ignalina district, 30 VII 2003.

H. trichodea (W. Phillips & Plowr.) Raitv.
Known from 2 localities: on fallen needles of *Pinus sylvestris*, Šakiai district, 12 VIII 1989; on fallen needles of *Pinus sylvestris,* Mazeikiai district, 26 IX 1989. Lit.: Kutorga (1991).

HYALOSCYPHA Boud.

Hyaloscypha albohyalina (P. Karst.) Boud.
Common on decaying wood of *Alnus glutinosa*, *Betula* sp., *Corylus avellana*, *Fagus sylvatica*, *Fraxinus excelsior*, *Pinus sylvestris*, *Quercus robur*, unidentified deciduous trees, fallen cones of *Larix* sp. and *Picea abies*, and dead canes of *Rubus idaeus* from May to October. Known from 24 localities in Jonava, Jurbarkas, Kedainiai, Mazeikiai, Plunge, Taurage, Trakai and Zarasai districts, and in Neringa. Lit.: Kutorga (1989a, 1991, as *Hyaloscypha lectissima* (P. Karst.) Raitv., 2002).

H. aureliella (Nyl.) Huhtinen
Rather common on decaying wood of *Picea abies* and *Pinus sylvestris* from March to October. Known from 8 localities in Ignalina, Trakai, Varena and Vilnius districts, and in Neringa. Lit.: Huhtinen (1990).

H. daedaleae Velen.
Common on decaying wood of *Quercus robur* from July to September. Known from 10 localities in Alytus, Ignalina, Kedainiai, Prienai and Vilnius districts. Lit.: Huhtinen (1990), Iršenaite (2003).

H. fuckelii Nannf.
Rather common on decaying wood of *Fraxinus excelsior*, *Pinus sylvestris*, *Populus tremula*, unidentified deciduous tree and wooden chips from May to September. Known from 5 localities in Alytus, Kedainiai and Šilute districts, and in Neringa. Lit.: (Huhtinen, 1990).

H. herbarum Velen.
Known from 2 localities: on fallen leaf of *Betula* sp., Jurbarkas district, 08 VI 1987; on dead stems of *Phragmites australis*, Taurage district, 27 IX 2000. Lit.: Kutorga (2002).

H. hyalina (Pers.) Boud.
was listed in several publications by E. Kutorga (1989a, 1989b, 1991). The re-examination of the specimens showed that they belong to different species of the genus *Hyaloscypha*.

*****Hyaloscypha paludicola (Huhtinen) Raitv.
Known from a single locality on dead stems of *Heracleum sosnovskyi*, Vilnius district, 21 VII 2003.

H. priapi Velen.
Known from 2 localities: on decaying wood of *Quercus robur*, Alytus district, 12 VII 1966; on decaying wood of *Alnus incana*, Plunge district, 26 IX 1988. Lit.: Huhtinen (1990).

*H. quercicola (Velen.) Huhtinen
Known from 2 localities: on decaying wood of *Quercus robur,* Vilnius district, 17 VIII 2001; on decaying wood of *Tilia cordata*, Kedainiai district, 03 X 2002.

H. tigillaris (P. Karst.) Raitv.
was listed in the work by E. Kutorga (1991). This specimen has been reidentified as *Hyaloscypha albohyalina*.

H. vitreola (P. Karst.) Boud.
Rare on decaying wood of *Quercus robur*, unidentified deciduous trees and bushes from June to September. Known from 4 localities in Alytus, Kedainiai and Vilnius districts. Lit.: Huhtinen (1990).

MICROSCYPHA Syd. & P. Syd.

*Microscypha arenula (Fr.) Svrček
Known from a single locality on dead leaves of *Pteridium aquilinum*, Telšiai district, 17 VII 1966.

OLLA Velen.

Olla millepunctata (Lib.) Svrček
Syn.: *Hyalopeziza millepunctata* (Lib.) Raitv., *Unguicularia millepunctata* (Lib.) Dennis
Very common on decaying wood of *Alnus glutinosa*, *Fraxinus excelsior*, *Picea abies*, unidentified deciduous trees, dead canes of *Rubus idaeus*, dead stems of *Artemisia vulgaris*, *Cirsium palustre*, *Filipendula ulmaria* and a plant of the Apiaceae from April to September. Known from 21 localities in Ignalina, Kedainiai, Marijampole, Plunge, Šakiai, Šiauliai, Šilute, Taurage and Trakai districts, and in Neringa. Lit.: Kutorga (1989b, as *Unguicularia scrupulosa* (P. Karst.) Höhn., 1991, 2002).

*O. transiens (Höhn.) Baral
Known from a single locality on decaying cut wood of unidentified tree, Ukmerge district, 25 IX 1997.

PHIALINA Höhn.
Phialina carpinacea (Velen.) Raitv. & R. Galán
Known from a single locality on fallen leaves of *Alnus glutinosa*, Taurage district, 01 IX 2000. Lit.: Kutorga & Raitviir (2003).

Ph. lachnobrachya (Desm.) Raitv.
Common on fallen leaves of *Alnus glutinosa*, *A. incana*, *Betula* sp. and *Quercus robur* (mostly), and fruit-wings of *Acer platanoides* from August to October. Known from 13 localities in Ignalina, Jonava, Kedainiai, Mazeikiai, Plunge, Šakiai, Taurage and Trakai districts. Lit.: Kutorga (1989b, as Setoscypha lachnobrachya (Desm.) Svrček, 1991, as Phialoscypha lachnobrachya (Desm.) Raitv., 1996, as Hyaloscypha lachnobrachya (Desm.) Nannf., 2002), Iršenaite & Kutorga (2001), Iršenaite (2003).

Ph. ulmariae (Lasch) Dennis
Rare on dead stems of *Filipendula ulmaria* from May to July. Known from 3 localities in Kaunas, Plunge and Šilute districts. Lit.: Huhtinen (1990), Kutorga (1991, as *Calycellina ulmaria* (Lasch) Korf).

PSILACHNUM Höhn.

*Psilachnum acutum (Velen.) Svrček
Known from a single locality on dead stems of *Scirpus sylvaticus*, Šilute district, 12 V 1990.

P. asemum (W. Phillips) Dennis
Known from a single locality on dead stems of *Phragmites australis*, Plunge district, 26 IX 1988. Lit.: Kutorga (1991).

P. chrysostigmum (Fr.) Raitv.
Very common on fronds of *Athyrium filix-femina*, *Dryopteris filix-mas* and *Pteridium aquilinum* from April to October. Known from 42 localities in Alytus, Ignalina, Jonava, Jurbarkas, Kedainiai, Mazeikiai, Moletai, Plunge, Šakiai, Šiauliai, Šilute, Taurage, Telšiai, Trakai, Varena and Vilnius districts, and in Neringa. Lit.: Kutorga (1989a, 1991, 1996, as *Pezizella chrysostigma* (Fr.) Sacc.).

*****Psilachnum crinellum (Ellis & Everh.) Dennis
Known from a single locality on dead stems of *Calammophila baltica*, Neringa, 20 IX 2003.

P. inquilinum (P. Karst.) Dennis
Rather common on dead stems of *Equisetum arvense*, *E. fluviatile*, *E. pratense* and *E. sylvaticum* from May to October. Known from 8 localities in Anykščiai, Kedainiai, Klaipeda, Taurage, Trakai and Šilute districts. Lit.: Kutorga (1991, 2002).

P. lanceolato-paraphysatum (Rehm) Dennis
Rare on dead stems of *Aegopodium podagraria* (?), *Filipendula ulmaria* and *Rumex* sp. from June to July. Known from 3 localities in Taurage and Trakai districts, and in Neringa. Lit.: Raitviir (1988).

P. lateritio-album (P. Karst.) Höhn.
Rare on dead stems and leaves of *Carex cespitosa*, unidentified sedge of the *Cyperaceae*, *Typha latifolia* from May to September. Known from 3 localities in Šilute and Vilnius districts, and in Neringa. Lit.: Raitviir (1988).

*P. lupini (Svrček) Raitv.
Known from a single locality on dead stems of *Centaurea scabiosa* and unidentified plant of the Apiaceae, Trakai district, 08 VI 2004.

UNGUICULELLA Höhn.

*Unguiculella eurotioides (P. Karst.) Nannf.
Known from 2 localities: on dead stems of *Heracleum sosnovskyi*, Vilnius district, 21 VII 2003; on dead stems of *Heracleum sosnovskyi*, Ignalina district, 07 VIII 2003.

URCEOLELLA Boud.

Urceolella carestiana (Rabenh.) Dennis
On dead petioles of *Athyrium filix-femina* and *Dryopteris filix-mas* from April to June. Known from 4 localities in Šilute district, and in Neringa. Lit.: Kutorga (1991, as *Hyalopeziza carestiana* (Rabenh.) Raitv.).

U. crispula (P. Karst.) Boud.
Rather rare on dead stems of *Heracleum sosnovskyi*, *Typhoides arundinacea* and unidentified plant of the Apiaceae from June to September. Known from 5 localities in Ignalina, Kretinga, Mazeikiai, Trakai and Vilnius districts. Lit.: Kutorga (1991, as *Hyalopeziza crispula* (P. Karst.) Raitv.).

U. graddonii Raitv. & Galán
Known from a single locality on fallen leaves of *Betula* sp., Mazeikiai district, 27 IX 1989. Lit.: Kutorga (1991, as *Hyalopeziza salicicola* (Raschle) Raitv.).

**LACHNACEAE (NANNF.) RAITV.**

ALBOTRICHA Raitv.

Albotricha acutipila (P. Karst.) Raitv.
Rather common on dead stems of *Ammophila arenaria*, *Calamagrostis arundinacea*, *Phragmites australis* and unidentified grass of the Poaceae from May to October. Known from 9 localities in Plunge, Šilute, Taurage, Trakai and Zarasai districts, and in Neringa. Lit.: Kutorga (1989a, 1991, 2002).

A. albotestacea (Desm.) Raitv.
Rather common on dead stems of *Calamagrostis* sp., *Phragmites australis* and unidentified grass of the Poaceae from June to September. Known from 5 localities in Jurbarkas, Plunge, Šilute and Trakai districts, and in Neringa. Lit.: Kutorga (1991).

*A. ammophilae Dennis & Spooner
Known from a single locality on dead stems of *Ammophila arenaria*, Neringa, 19 IX 2003.

A. miniata (Kanouse) Raitv.
Known from a single locality on dead petioles of *Pteridium aquilinum*, Neringa, 28 IV 1989. Lit.: Kutorga (1991, as *Albotricha washingtonensis* (Dennis) Raitv.).

BRUNNIPILA Baral

*Brunnipila calyculiformis (Schumach. : Fr.) Baral
Known from a single locality on decaying wood of *Corylus avellana*, Vilnius district, 25 VI 2001.

B. cannabina (Rehm) Raitv. & Järv
Known from a single locality on dead stems of *Urtica dioica,* Plunge district, 08 VI 1989. Lit.: Kutorga (1991, as *Lachnum cannabinum* Rehm).

Brunnipila clandestina (Bull. : Fr.) Baral
Common on dead canes of *Rubus* spp. from April to September. Known from 19 localities in Ignalina, Klaipeda, Mazeikiai, Plunge, Taurage, Telšiai, Trakai, Šakiai, Šilute, Švencioniai, Vilnius and Zarasai districts, and in Neringa. Lit.: Kutorga (1989a, 1991, 1996, 2002, as *Lachnum clandestinum* (Bull. : Fr.) P. Karst.).

B. fuscescens (Pers. : Fr.) Baral
Known from 2 localities: on fallen fruits and leaves of *Fagus sylvatica*, Jurbarkas district, 12 V 1999; on fallen leaves of *Carpinus betulus*, Alytus district, 08 V 2001. Lit.: Kutorga (2002, as *Lachnum fuscescens* (Pers. : Fr.) P. Karst.).

B. palearum (Desm.) Baral
Rare on dead stems of *Elymus caninus*, *Poa* sp. and unidentified grasses from May to June. Known from 4 localities in Anykščiai, Jurbarkas, Šilute and Trakai districts. Lit.: Kutorga (1991, as *Lachnum palearum* (Desm.) Raitv.).

CAPITOTRICHA (Raitv.) Baral

Capitotricha bicolor (Bull. : Fr.) Baral
Very common on dead wood and bark of still attached and fallen twigs and branches of *Betula* sp., *Corylus avellana* and *Quercus robur* (mostly) from February to June (dried apothecia persist up to September). Known from 21 localities in Alytus, Anykščiai, Jonava, Jurbarkas, Kaunas, Kedainiai, Mazeikiai, Trakai, Vilkaviškis, Vilnius and Zarasai districts. Lit.: Kutorga (1991), Iršenaite (2003), both as *Lachnum bicolor* (Bull. : Fr.) P. Karst.

C. rubi (Bres.) Baral
Rare on dead canes of *Rubus* spp. from June to September. Known from 4 localities in Mazeikiai, Moletai and Telšiai districts, and in Neringa. Lit.: Kutorga (1991, as *Lachnum rubi* (Bres.) Raitv.).

DASYSCYPHELLA Tranzschel

Dasyscyphella crystallina (Fuckel) Raitv.
Rather common on dead wood of *Quercus robur* and unidentified deciduous tree from May to September. Known from 7 localities in Alytus, Šakiai, Šilute, Trakai and Vilnius districts. Lit.: Kutorga (1991).

*D. montana (Fuckel) Raitv.
Known from 2 localities: on dead wood of deciduous tree, Vilnius district, 02 IX 1987; on dead wood of deciduous tree, Trakai district, 04 IX 1987.

D. nivea (R. Hedw. : Fr.) Raitv.
Common on decaying wood and bark of *Fraxinus excelsior* and *Quercus robur* (mostly) from June to September. Known from 10 localities in Kedainiai, Lazdijai, Utena and Vilnius districts. Lit.: Iršenaite (2003).

FUSCOLACHNUM J.H. Haines

Fuscolachnum dumorum (Roberge ex Desm.) J.H. Haines
Known from a single locality on dead leaf of *Rubus idaeus*, Plunge district, 08 VI 1989. Lit.: Kutorga (1991, as *Lachnum dumorum* (Roberge ex Desm.) Huhtinen).

F. pteridis (Alb. & Schwein. : Fr.) J.H. Haines
Rare on dead fronds of *Pteridium aquilinum* from June to July. Known from 3 localities in Jurbarkas, Plunge and Šilute districts. Lit.: Kutorga (1991, as *Lachnum pteridis* (Alb. & Schwein. : Fr.) anon. ined.).

INCRUCIPULUM Mont. & Durieu

Incrucipulum capitatum (Peck) Baral
Syn.: *Lachnum capitatum* (Peck) Raitv.
Rare on fallen leaves of *Quercus robur* from June to July. Known from 3 localities in Lazdijai, Šilute and Telšiai districts. Lit.: Kutorga (1991), Iršenaite & Kutorga (2001), Iršenaite (2003).

I. ciliare (Schrad. : Fr.) Baral
Syn.: *Lachnum ciliare* (Schrad. : Fr.) Rehm
Very common on fallen leaves of *Betula* sp. and *Quercus robur* (mostly), and female cones of *Alnus incana* from July to October. Known from 32 localities in Alytus, Ignalina, Jonava, Kaunas, Kedainiai, Klaipeda, Kretinga, Marijampole, Mazeikiai, Pakruojis, Plunge, Prienai, Šakiai, Šilute, Taurage and Vilnius districts, and in Neringa. Lit.: Kutorga (1989a, 1989b, 1991, 1996, 2002), Iršenaite & Kutorga (2001), Iršenaite (2003).

LACHNELLULA P. Karst.

Lachnellula calyciformis (Fr.) Dharne
Known from 2 localities: on fallen cone of *Pinus sylvestris*, Neringa, 28 IV 1989; on bark of fallen *Picea abies* twigs, Vilnius district, 20 IV 1998. Lit.: Kutorga (1991).

*L. calycina Sacc.
Known from 2 localities: on woody outgrows with a resin exudates around wounds of *Picea abies* living trunks, Trakai district, 06 V 2004, 08 VI 2004; Jonava district, 02 IX 2004.

*L. occidentalis (G.G. Hahn & Ayers) Dharne
Known from a single locality on twigs of *Larix* sp., Neringa, 12 VIII 1991.

L. pseudofarinacea (P. Crouan & H. Crouan) Dennis
Known from 2 localities: on twigs of *Pinus sylvestris*, Palanga, 03 VIII 1987; on twigs of *Pinus sylvestris*, Neringa, 29 IV 1989. Lit.: Kutorga (1991).

L. subtilissima (Cooke) Dennis
Known from a single locality on bark of *Pinus sylvestris* twig, Neringa, 26 IV 1989. Lit.: Kutorga (1989a, 1991).

L. willkommii (Hartig) Dennis
Common on dead, still attached and fallen twigs of *Larix* spp. from April to August. Known from 10 localities in Anykščiai, Jurbarkas, Kaunas, Kedainiai, Šilute and Vilnius districts, and in Neringa. Lit.: Kutorga (1989a, 1990, 1991).

LACHNUM Retz.

Lachnum apalum (Berk. & Broome) Nannf.
Known from a single locality on dead stems of *Juncus* sp., Šakiai district, 11 VIII 1989. Lit.: Kutorga (1991).

L. brevipilosum Baral
Common on decaying wood of twigs and branches of *Alnus glutinosa, A. incana, Betula* sp., *Carpinus betulus* (?), *Corylus avellana, Padus avium* and some other unidentified trees, and old plywood from June to December. Known from 10 localities in Jonava, Kedainiai, Klaipeda, Marijampole, Šalcininkai, Švencionys and Utena districts. Lit.: Kutorga (1996), Iršenaite (2003).

L. charretii Raitv. & Guy Garcia
Known from a single locality on fallen leaf of *Fagus sylvatica*, Jurbarkas district, 12 V 1999. Lit.: Kutorga & Raitviir (2003).

L. clavigerum (Svrček) Raitv.
Known from a single locality on dead stems of *Filipendula ulmaria*, Taurage district, 12 V 1999. Lit.: Kutorga (2002).

L. coeruleo-album Rehm
Known from a single locality on dead stems of *Eriophorum vaginatum*, Taurage district, 01 IX 2000. Lit.: Kutorga & Raitviir (2003).

L. controversum (Cooke) Rehm
Common on dead stems and leaves of *Calamagrostis arundinacea* and *Phragmites australis* (mostly) from April to September. Known from 16 localities in Mazeikiai, Plunge, Šilute, Taurage, Trakai, Ukmerge and Zarasai districts, and in Neringa. Lit.: Kutorga (1989a, 1991, 2002).

L. diminutum (Roberge) Rehm
Known from a single locality on dead stems of *Juncus* sp., Šilute district, 21 VII 1988. Lit.: Kutorga (1991).

L. elongatisporum Baral
Rare on dead stems of *Ammophila arenaria*, *Calammophila baltica* and unidentified grass from June to September. Known from 4 localities in Plunge district, and in Neringa. Lit.: Kutorga (1991).

L. imbecille P. Karst.
Rare on dead stems and leaves of *Eriophorum vaginatum* and *Typha latifolia* from July to September. Known from 3 localities in Ignalina, Plunge and Taurage districts (Kutorga, 1991, 2002, as L*achnum eriophori* (Quél.) Rehm, Kutorga & Raitviir, 2003).

*L. impudicum Baral
Known from a single locality on fallen female cones of *Alnus incana*, Pakruojis district, 12 IX 1991.

L. ledi (Raitv.) Raitv.
Known from a single locality on dead leaves of *Andromeda polifolia*, Taurage district, 01 IX 2000. Lit.: Kutorga & Raitviir (2003).

*Lachnum microsporum Velen.
Known from a single locality on dead leaves of *Vaccinium myrtillus* in *Pinus-Quercus* mixed forest, Šilute district, 21 VI 1965.
Notes: This species is very similar to *L. rhytismatis* but differs from it in asci arising from simple septa.

L. nudipes (Fuckel) Nannf.
Common on dead stems of *Epilobium roseum*, *Filipendula ulmaria* (mostly) and some other unidentified herbaceous plants, and dead canes of *Rubus idaeus* from April to August. Known from 17 localities in Ignalina, Kedainiai, Klaipeda, Marijampole, Plunge, Šilute and Taurage districts, and in Neringa. Lit.: Kutorga (1989a, 1991).

L. pudibundum (Quél.) Schröt.
Very common on decaying wood and bark of *Alnus glutinosa*, *Betula* sp., *Corylus avellana*, *Frangula alnus*, *Fraxinus excelsior*, *Salix* sp., some other unidentified deciduous and coniferous trees, and fallen husk of fruit of *Aesculus hippocastan*um from May to September. Known from 24 localities in Anykšciai, Jurbarkas, Kedainiai, Klaipeda, Marijampole, Mazeikiai, Plunge, Šakiai, Šilute, Taurage and Vilnius districts, and in Neringa. Lit.: Kutorga (1989a, 1989b, 1991, 2002).

L. pulverulentum (Lib.) P. Karst.
Known from 2 localities: on fallen needles of *Pinus sylvestris*, Ignalina district, 08 07 1966; on fallen needles of *Pinus sylvestris*, Šakiai district, 12 08 1989. Lit.: Kutorga (1991).

L. pygmaeum (Fr.) Bres.
Known from a single locality on decaying wood of unidentified deciduous tree, Šilute district, 21 VII 1988. Lit.: Kutorga (1991).

L. rhodoleucum (Sacc.) Rehm
Rare on dead stems and leaves of *Calamagrostis arundinacea*, *Carex* spp. and *Scirpus sylvatica* from July to September. Known from 4 localities in Alytus, Jurbarkas and Trakai districts, and in Neringa. Lit.: Kutorga (1989a, 1991).

L. rhytismatis (W. Phillips) Nannf.
Common on fallen leaves of *Quercus robur,* more rarely *Tilia cordata* from May to July. Known from 9 localities in Jonava, Plunge, Šakiai, Šilute, Taurage and Vilnius districts. Lit.: Kutorga (1991, 2002), Iršenaite & Kutorga (2001).

L. roridum (Wallr.) Rehm
Known from a single locality on dead canes of *Rubus idaeus*, Jurbarkas district, 07 VI 1987. Lit.: Kutorga (1991).

L. salicariae (Rehm) Raitv.
Rare on dead stems of *Lythrum salicaria* and some other unidentified herbaceous plants in August. Known from 4 localities in Šakiai district, and in Neringa and in Palanga. Lit.: Kutorga (1989a, 1991).

*L. trapeziforme Velen.
Known from a single locality on fallen leaves of *Alnus glutinos*a, Plunge district, 26 IX 1988. Lit.: Kutorga (1989b, 1991) as *Lachnum soppittii* (Massee) Raitv.

L. subauratum (Ellis) Raitv.
Known from a single locality on fallen leaf of *Betula* sp., Taurage district, 11 V 1999. Lit.: Kutorga & Raitviir (2003).

L. tenuissimum (Quél.) Raitv.
Common on dead stems and leaves of *Calamagrostis arundinacea*, *Calammophila baltica*, *Carex* sp., *Juncus* sp., *Molinia caerulea*, *Phragmites australis* and some other unidentified grasses of the Poaceae from June to September. Known from 14 localities in Alytus, Birzai, Klaipeda, Plunge, Taurage, Šilute, Varena and Vilnius districts, and in Neringa. Lit.: Kutorga (1989a, 1991, 2002).

L. virgineum (Batsch : Fr.) P. Karst.
Very common on decaying wood and bark of *Alnus glutinosa*, *Betula* spp., *Fagus sylvatica*, *Fraxinus excelsior*, *Corylus avellana*, *Picea abies*, *Populus tremula*, *Quercus robur*, *Q. rubra*, *Sorbus aucuparia* and some other unidentified deciduous and coniferous trees, rotting wooden planks, fallen female cones of *Alnus glutinosa* and *A. incana*, fallen fruits of *Fagus sylvatica*, fallen leaves of *Quercus robur* and *Q. rubra*, dead canes of *Rubus* spp., dead stems of *Artemisia vulgaris* and *Phragmites australis* from April to October.

Known from 74 localities in Alytus, Jonava, Jurbarkas, Kedainiai, Klaipeda, Kretinga, Marijampole, Mazeikiai, Plunge, Šiauliai, Šilute, Taurage, Trakai, Utena, Vilkaviškis, Vilnius and Zarasai districts, and in Neringa. Lit.: Kutorga (1989a, 1989b, 1991, 1996, 2002), Iršenaite & Kutorga (2001), Iršenaite (2003).

LASIOBELONIUM Ellis & Everh.

*Lasiobelonium corticale (Pers. : Fr.) Raitv.
Rare on decaying wood and bark of *Populus tremula* from February to August. Known from 2 localities in Širvintai district.

*L. variegatum (Fuckel) Raitv.
Rare on decaying wood of *Fraxinus excelsior*, *Quercus robur*, *Salix* sp. from May to October. Known from 4 localities in Kedainiai, Šakiai and Vilnius districts.

PROLIFERODISCUS J.H. Haines & Dumont

*Proliferodiscus pulveraceus (Alb. & Schwein. : Fr.) Baral
Known from a single locality on decaying wood of deciduous tree branch, Kedainiai district, 03 V 2001.

TRICHOPEZIZA Fuckel

*Trichopeziza leucophaea (Pers.) Rehm
Very common on dead stems of *Aegopodium podagraria*, *Artemisia vulgaris*, *Filipendula ulmaria*, *Geum* sp., *Heracleum sosnovskyi*, *Heracleum* sp., *Ranunculus* sp., *Reynoutria sachalinensis* and *Urtica dioica*, and petioles of *Dryopteris filix-mas* from May to August. Known from 20 localities in Ignalina, Kedainiai, Taurage, Trakai and Vilnius districts.

T. mollissima (Lasch) Fuckel
Common on dead stems of *Aegopodium podagraria*, *Arctium* sp., *Artemisia vulgaris*, *Heracleum sosnovskyi*, *Rumex* sp., *Urtica dioica*, unidentified plants of the Apiaceae and other Dicotyledones, and petioles of *Dryopteris filix-mas* from April to August. Known from 17 localities in Ignalina, Jurbarkas, Kaunas, Kedainiai, Kretinga, Trakai and Vilnius districts, and in Neringa. Lit.: Kutorga (1989a, 1991, as *Belonidium mollissimum* (Lasch) Raitv.).

T. sulphurea (Pers. : Fr.) Fuckel
Very common on dead stems of *Aegopodium podagraria*, *Cirsium* sp., *Filipendula ulmaria*, *Phragmites australis*, *Rumex* sp. and *Urtica dioica* (mostly) from July to October. Known from 25 localities in Ignalina, Kedainiai, Mazeikiai, Moletai, Šakiai, Šiauliai, Šilute, Taurage, Trakai and Vilnius districts, and in Neringa. Lit.: Kutorga (1989a, 1991, as *Belonidium sulphureum* (Lasch) Raitv.; 2002).

TRICHOPEZIZELLA Raitv.

*Trichopezizella barbata (Kunze) Raitv.
Known from a single locality on dead twigs of *Lonicera xylosteum*, Ukmerge district, 25 V 2005.

T. nidulus (Kunze) Raitv.
Common on dead stems of *Filipendula ulmaria* and *Polygonatum odoratum* (mostly) from May to June. Known from 11 localities in Ignalina, Kedainiai, Šilute and Taurage districts. Lit.: Kutorga (1991, 2002).

**APPENDIX: ARACHNOPEZIZOIDEAE**

The taxonomic position of this group is not solved yet. For this reason we list the species of Arachnopezizoideae as an appendix to Hyaloscyphaceae and Lachnaceae.

ARACHNOPEZIZA Fuckel

Arachnopeziza aurata Fuckel
Rare on decaying wood and bark of *Betula* sp., *Corylus avellana* and unidentified deciduous tree from May to September. Known from 3 localities in Kedainiai, Taurage and Vilnius districts. Lit.: Kutorga (2002).

A. aurelia (Pers.) Fuckel
Known from a single locality on fallen fruit cupules of *Quercus rubra*, Jurbarkas district, 12 V 1999. Lit.: Iršenaite & Kutorga (2001), Kutorga (2002).

*A .variepilosa (Galán & Raitv.) Huhtinen
Known from a single locality on decaying wood of *Picea abies*, Trakai district, 09 VI 2004.

ERIOPEZIA (Sacc.) Rehm

ERIOPEZIA CAESIA (Pers. : Fr.) Rehm
Common on decaying wood of *Quercus robur* (mostly) and *Corylus avellan*a from June to October. Known from 10 localities in Alytus, Jonava, Kedainiai, Prienai, Utena and Vilnius districts. Lit.: Iršenaite (2003).

POLYDESMIA Boud.

POLYDESMIA PRUINOSA (Gerd. ex Berk. & Broome) Boud.
Common on old pyrenomycete stromata and basidiomata of *Fomes fomentarius*, decaying wood of *Alnus glutinosa*, *Betula* sp., *Corylus avellana* and *Quercus robur* from August to October. Known from 12 localities in Ignalina, Kedainiai, Klaipeda, Švencionys and Vilnius districts, and in Neringa. Lit.: Kutorga (1989b, 1996), Iršenaite (2003).

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# Hypogeous fungi collected in Estonia in 1989 and 1999

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**Abstract:** A list of twelve hypogeous fungal species is a result of forays during X Congress of European Mycologists (August 1989, Tallinn) and XIV Symposium of Baltic Mycologists and Lichenologists (September 1999, Järvselja). Collected fungi belong to genera: *Elaphomyces, Balsamia, Tuber, Rhizopogon, Hymenogaster* and *Cenococcum* (sclerotia). Short taxonomical characteristics of 11species with some remarks to their distribution are presented in the paper.

**Kokkuvõte:** Eestist 1989. ja 1999. a. kogutud maa-alused seened.

12 maa-aluse seeneliigi nimestik on X Euroopa Mükoloogide Kongressi (Tallinn, august 1989) ja XIV Balti Mükoloogide ja Lihhenoloogide Sümpoosiumi (Järvselja, september 1999) ekskursioonide tulemus. Kogutud seened kuuluvad perekondadesse *Elaphomyces, Balsamia, Tuber, Rhizopogon, Hymenogaster* ja *Cenococcum* (sklerootsiumid). Artiklis esitatakse 11 liigi lühikirjeldused koos märkustega nende leviku kohta.

## INTRODUCTION

Hypogeous fungi have been a matter of increasing interest of mycologists and amateurs in recent years. According to contemporary literature they belong to Ascomycotina and Basidiomycotina.

Hypogeous fungi form an important ecological group of ectomycorrhizal symbionts of forest trees. Their occurrence is limited by distribution of their green partner. Climatic and geobotanical conditions in Estonia provide to expect the species of hypogeous fungi typical to temperate and subboreal climatic zones. A list of 11 species found in Estonia compose quite good sample of hypogeous fungi collected there.

The results presented in the paper are based on fresh material and field observations made by author during her forays in programme of two international meetings organized by Estonian mycologists. Owing to laboratory facilities it was possible to examine fresh collections microscopically. The analysis has been continued in laboratory at the University of Lódz using Nikon-Eclipse 600 microscope according to methods described by Lawrynowicz (1988), Pegler et al. (1993), Martin (1996) and Montecchi & Sarasini (2000). The general distribution is consulted with the paper by Lawrynowicz (1989, 1990). The nomenclature and systematic arrangement is after Trappe (1979) and Kirk et al. (2001).

All collected specimens are deposited at the Herbarium Univeristatis Lodziensis (LOD).

## RESULTS

Among collected hypogeous species, nine represented Ascomycotina (including *Cenococcum* – anamorphic ascomycota) and two Basidiomycotina.

### ASCOMYCOTINA

### Elaphomycetales

### Elaphomycetaceae

ELAPHOMYCES ANTHRACINUS Vittad., Monographia Tuberacearum: 66, pl. III fig. 8 (1831).

Ascomata subglobose to pyriform, 5–10 mm diam., hard, carbonaceous, dark brown to black, minutely warted or almost smooth, on the surface covered with adpressed, matted, dark brown or occasionally blue-gray or green-gray hyphae. Cortex 220 µm thick, dark brown or blackish, carbonised and mostly opaque in thin section. Crust poorly developed or lacking. Odour not distinctive. Peridium 1–2 mm thick, whitish or pale grey, composed of interwoven, septate, often branching hyphae. Gleba whitish or greyish, at first cottony, at maturity filled with a powdery black mass of spores. Dissepimenta early disappearing. Glebal hyphae narrow, branched, sometimes encrusted. Asci 50–55 µm diam., globose, usually 8–spored, thin-walled, evanescent. Ascospores 16–20 µm diam., globose, hyaline at first, thick–walled, becoming blackish-brown and almost opaque at maturity, smooth or with slightly cracked episporium.

Distribution in Europe: In Central and Western Europe. Occuring in lowlands and low tectonic forelands.

Specimens examined: Põlvamaa Co., Saesaare, under *Corylus avellana* in *Picea abies* forest. Only one complete fruit-body and three other in small parts in soil in a place destroyed by animals. 6.09.1999, coll. M. Lawrynowicz.

Elaphomyces asperulus Vittad., Monographia Tuberacearum: 69 (1831).

Ascomata globose, somewhat depressed, 1–4 cm diam. soft, becoming hard when dry, ochraceous, dull brown, chestnut-coloured when old, paler in herbarium materials. Warts of the cortex short, obtuse, exceptionally acute in depressed part of the fruit-body, 0.1-0.15 mm across. Odour slight, becoming strong, unpleasant when decaying. Peridium white to greyish pink, soft, homogenous in section, not marbled, variable in thickness, 2-5 mm, thicker in young fruit-body, becoming thinner with age. Crust distinct, easly separating from the fruitbody. Gleba at first marbled with greyish pink dissepimenta separating groups of asci forming dark brown gleba. At the maturity of spores dissepimenta disappear.

Asci 40-60 µm diam. globose or subglobose, 6–8 spored. Ascospores globose, dark brown becoming black at maturity 28-35 µm diam., ornamented with warts up to 2 µm high, coalescent in groups.

Distribution in Europe: Occuring abundantly and frequently in the Cental, Eastern and Northern Europe. In the Southern part mostly in mountains.

Specimens examined: Põlvamaa Co., Saesaare, in *Picea abies* forest, between roots of tree, mature fruit-bodies but several old in decaying stage. Common in spruce forests. Accompanied by sclerotia of *Cenococcum geophilum* Fr., 6.09.1999, coll. M. Lawrynowicz.

Elaphomyces granulatus Fr. Syst. Mycol. 3: 58 (1829).

Ascomata subglobose or globose, 1–2 cm diam., firm, leathery, becoming hard when dry, dull yellowish-brown, bright when fresh, densely covered with fine warts. Warts polygonal, pyramidal 0.1–0.25 mm across. Odour at first slight, unpleasant when old. Cortex yellowish-brown, 200–300 µm thick including warts, composed of agglutinated, thick-walled hyphae 3–5 µm diam. Peridium white, uniform in appearance, not marbled, variable in thickness, 0.5–1.5 mm thick, composed of hyaline or pale yellowish, closely interwoven hyphae 3–6 µm diam. Gleba stuffed with ascogenous hyphae, pinkish-buff, at maturity developing into a powdery mass of blackish-brown spores. Dissepimenta disappearing at maturity of spores. Asci 35–45 x 30–40 µm, subglobose, thin-walled, evanescent, 6–8-spored. Ascospores 25–35 µm diam. globose, at first hyaline, becoming blackish-brown and virtually opaque in transmitted light at maturity, ornamented with spines ca 3 µm high.

Distribution in Europe: The species frequently found in the Central Europe, Great Britan and Southern Scandinavia in lowlands and low mountain sites.

Specimens examined: Tartumaa Co., Vääbnasaare and Apnasaare near Ahunapalu, in mixed forest of *Betula pendula, Picea abies* and *Quercus robur*. In soil under *Betula pendula*, 7.09.1999, coll. M. Lawrynowicz.

Elaphomyces muricatus Fr., Syst. Mycol. 3: 59 (1829).

Ascomata globose or subglobose, 10–30 diam., firm, leathery, hard when dry. Cortex yellowish brown, yellow when fresh, ochraceous, orange-brown, darker and duller with age, covered with warts. Warts conical, 250–400 µm diam., 300–400 µm high. Odour slight, more distinctive with age. Cortex up to ca 500 µm thick including warts, separated from peridium only when decaying. Peridium variable in colour, distinctly marbled throughout thick-walled hyphae of paler colour; 1–2.5 mm thick or even up to 5 mm when young, thinning upon pression of developing gleba. Gleba comprising hyaline, loosely woven hyphae, ascogenous areas delimited by white or pinkish dissepimenta. At maturity filled with a powdery mass at first brown than blackish, finally black spores. Asci globose or subglobose, thin-walked, (4)5–6 spored, 35–45 x 30–45 µm. Ascospores 22–28 µm diam., globose, at first hyaline, becoming dark brown to blackish, covered with closely spaced blunt spines 2–4 µm high irregularly arranged into groups (blocks).

Distribution in Europe: Common in the Central and Northern Europe in lowland, upland and of low mountain sites. A typical deciduous forest species of the nemoral zone.

Specimens examined: Põlvamaa Co., Saesaare, in a tree stand consisting of *Betula pendula* and *Picea abies*. In soil between roots of *Betula pendula*, sometimes partly epigeous, 6.09.1999, coll. M. Lawrynowic.

**Pezizales**

**Balsamiaceae**

Balsamia platyspora Berk. & Broome, Ann. Mag. Nat. Hist. ser. 1, 13: 358 (1844).

Ascomata globose to subglobose, often somewhat flattened and irregular. 5–15 mm diam., reddish–brown, verrucose; warts small, rounded to pyramidal, 200–300 µm across, 100–200 µm high. Odour initially slight, becoming strong and unpleasant. Peridium pseudoparenchymatous, 80–100 µm thick, composed of subangular cells. Gleba whitish to pale yellow, marbled with chambers conspicuous in fresh fruitbodies as irregular, angular to sinuous in form, obscured in dried material. Gleba composed of interwoven, thin–walled, septate hyphae 3–6 µm diam. becoming pulpy when old. Asci 60–80 x 30–40 µm, 8-spored, thin-walled, broadly ellipsoid-fusoid, non-amyloid, shortly stipitate, distributed throughout the glebal tissue. Ascospores 22–28 x 13–16 µm, ellipsoid, hyaline, usually with a single large guttule and numerous smaller ones.

Distribution in Europe: Widely distributed from Moscow (Mikhailovskoe) to the British Isles and from Oslo to Southern France (Apt), but not often. Although the most common species of *Balsamia*, it is rarely noted, occuring only in some years and some places.

In Estonia: Pärnumaa Co., Mihkli forest, under *Quercus robur, Corylus avellana, Acer platanoides* in soil covered with *Aegopodium podagraria, Viola* sp., *Lathyrus vernus, Stellaria nemorum, Rubus saxatilis, Geum rivale.* Ca 50% of covering by herbal layer. In soil a lot of "tunnels" – underground ways of small rodents. Growing together with *Tuber rufum* and *Hymenogaster tener*, 28.08.1989. coll. M. Lawrynowicz.

**Tuberaceae**

Tuber rufum Pico, Melethemata inauguralia de fungorum generatione et propagatione: 80 (1788).

Ascomata subglobose to irregular, 5–10 mm diam., dingy white to yellowish, finally reddish–brown or rufous, glabrous, smooth or commonly minutely warted, or cracked when exposed towards soil surface. Odour at first none, finally unpleasant. Peridium 250–400 µm thick, white to pale yellowish, pigmented near the surface, easily separating from gleba. Gleba initially whitish, becoming greyish-yellow to pale gray-brown, marbled with conspicuous, broad, dark brown and whitish or pale orange, veins radiating from the base of the fruitbody. Asci 60–90 x 40–70 µm pyriform or clavate, sometimes subglobose, always with a short stalk, walls thin or somewhat thickened, (1)2–5(6) – spored. Ascospores 20–35 x 18–25 µm, excluding ornament, ellipsoid to ovate-ellipsoid, spiny, initially hyaline, yellowish-brown at maturity. Spines up to 4 µm long.

Distribution in Europe: Collected in all Europe, especially in regions with a temperate or submediterranean climate. Both in lowlands and uplands.

Specimens examined: Pärnumaa Co., Mihkli, Kalli, in mixed forests. In Mihkli with *Balsamia platyspora* and *Hymenogaster tener*. In Kalli in vicinity of *T. puberulum* and *T. maculatum* (see description of habitat), 28-29.08.1989, coll. M. Lawrynowicz.

Tuber maculatum Vittad., Monographia Tuberacearum p. 45, pl. III fig. 16 (1831).

Ascomata 8–12 mm diam., subglobose or irregular and lobed, smooth or minutely pruinose, at first snow white becoming pale yellow-brown, usually with brown or reddish-brown patches. Odour slight, stronger but unpleasant at maturity. Peridium 300–400 µm thick, composed of agglutinated, hyaline or pale yellowish, thick-walled, septate hyphae. Gleba initially white, becoming pale greyish-brown to yellowish-brown, sometimes with a violaceous tinge, marbled with branching, white veins arising from various points on the peridium. Asci 70–100 x 50–70 µm subglobose, or ovate, thin-walled, usually sessile, 1–4-spored. Ascospores globose to broadly ellipsoid, 25–35 x 20–32 µm, ornamented with a regular reticulum with meshes 5–7 µm wide, 3–5 meshes across width of spore; spores initially hyaline, becoming dark yellowish-brown at maturity.

Distribution in Europe: Numerous localities in Central and Northern Europe. In Southern part of Europe rather in mountain sites.

Specimens examined: Pärnumaa Co., Kalli, in mixed forest consisting of *Quercus robur, Populus tremula, Picea abies, Corylus avellana.* In 30% covered by herbar layer: A*egopodium podagraria, Hepatica nobilis, Paris quadrifolia, Viola* sp., *Rubus saxatilis*, small, ca 4 years old exemplars of *Quercus robur* and *Padus avium.* Growing together with *T. puberulum*, 29.08.1989, coll. M. Lawrynowicz.

Tuber puberulum Berk. & Broome in Ann. Mag. Nat. Hist. 18: 81(1846).

Ascomata globose or subglobose 0.5–1 cm diam., initially white to cream-coloured, becoming yellowish-brown or grayish brown or discolouring purplish red on bruising, puberulent, with a velvety appearance when fresh, lacking warts, firm, solid. Odour slight, pleasant at maturity. Peridium 150–180 µm thick, pseudoparenchymatous, composed of small cells mostly 10–15 µm diam., with somewhat thickened, yellowish–brown walls, darker towards the surface covered with setose hairs. Hairs abundant, 60–110 µm long, 4.5–9 µm diam. at the base, acute at the apex, 1–4-septate, 0.8–1,5 µm thick. Gleba solid, initially whitish, becoming pale brown to yellowish-brown, to brown when dried, with irregular whitish veins radiating from the base and also arising from various points in the periphery, giving the gleba a marbled appearance. Asci 80–100 x 66–95 µm, subglobose or broadly ellipsoid, sessile, with thin or slightly thickened walls, 1–4-spored. Ascospores 30–50 x 26–46 µm ornamented with a regular reticulum, 5-8 meshes across width of spore, globose or very broadly ellipsoid, at first hyaline, becoming yellowish-brown to reddish-brown at maturity.

Distribution in Europe: Distributed in Central and Eeastern Europe, a lowland species of the nemoral zone of temperate climate.

Specimens examined: Pärnumaa Co., Kalli, in mixed forest. Growing together with *T. maculatum* (See description of habitat), 29.08.1989, coll. M. Lawrynowicz.

Tuber rapaeodorum Tul. & C. Tul. in Ann. Sci. Nat., Bot. ser. II, 19: 380 (1843).

Ascomata 0.5–12 mm diam., subglobose or sometimes lobed or irregular, dingy white to yellow or yellowish-brown, sometimes with a reddish tinge, smooth or minutely papillate, finely puberulent, at least when young. Odour initially slight, finally strong, resembling turnip. Peridium up to 250 µm thick, comprising a narrow inner layer 40–60 µm thick of interwoven, agglutinated, hyaline or pale yellowish hyphae and an outermost pseudoparenchymatous layer 100–150 µm thick, composed of subangular cells. Gleba initially white, becoming creamy gray or greyish yellow, often with a carneous tinge, finally purple, marbled with white, veins arising from various points of the peridium. Asci 60–90 x 50–60 µm, subglobose or ovate, thin walled, sessile or shortly stalked, 1–4-spored. Ascospores 22–48 (–52) x 16–33 µm depending on number spores in ascus, ellipsoid, at first hyaline, becoming yellow-brown at maturity, ornamented with a regular reticulum, meshes 5–10 µm wide.

Distribution in Europe: Widespreaded in all Europe in lowlands.

Specimens examined: Tartumaa Co., Järvselja, near buildings beloging to Forestry Service, under *Tilia cordata, Corylus avellana* and *Padus serotina*. Herbal layer ca 30% of covering mostly by *Aegopodium podagraria*. In humus together with *Hymenogaster tener*, 5.09.1999, coll. M. Lawrynowicz.

## BASIDIOMYCOTINA

### Boletales

### Rhizopogonaceae

Rhizopogon luteolus Fr. apud Fr. & Nordholm, Symb. Gasterom. 1: 5 (1817), emend.
Tul. et C. Tul. in Giorn. bot. ital., ann. 1, 2(1): 57 (1844).

Gasterocarps 1–3 cm diam., globose to irregularly ellipsoid, basally or laterally covered with numerous, fine rhizomorphs first the some colour as peridium, blacken on drying. Peridium simple, 0.5 mm thick and tough, initially white when young becoming yellow to olivaceous brown with age, finally cracking, covered with numerous fine, tawny fibrils. Gleba whitish yellow in young fruit-bodies to olive, becoming dark olive or brown when old. Chambers minute, 0.1–0.3 mm diam., round to labyrinthoid, filled with olivaceous brown spores. Tramal plates whitish-yellowish, 100–200 µm thick, giving the gleba a marbled appearance, composed of narrow, filamentous hyphae, 2.5–6 µm diam., with a gelatinized, refractive wall and a narrow lumen; peridial context well developed, similar in structure. Odour fruity in young fresh fruitbodies, pleasant. Spores 8 x 2.5–3 µm,

truncate, at the base oblong ellipsoid, with a subtruncated base, pale olivaceous, with a smooth, thickened wall, with biguttulate contents. Basidia clavate to cylindrical 23–30 x 8–9 µm, with four to six, short apical sterigmata. Subhymenial layer 13–20 µm thick, pseudoparenchymatous. Peridiopellis a repent epicutis, up to 70 µm thick.

Distribution in Europe: Widespreaded in coniferous forests on sundy soils as ectomycorrhizal species of *Pinus sylvestris*.

Specimens examined: Pärnumaa Co., Lemme, in coniferous forest dominated by *Pinus sylvestris*. Fruitbodies subepigeously situated in sandy soil, 27.08.1989, coll. A.E. Kovalenko & A. Strid.

**Cortinariales**

**Hymenogasteraceae**

HYMENOGASTER TENER Berk. & Broome in Ann. Mag. Nat. Hist. ser. 1, 13: 349 (1844).

Gasterocarps 0.5–1 cm diam., irregularly globose, with a white rhizomorphs. Peridium 100-200 µm thick, initially white, after bruising turning soon brownish, silky, smooth. Gleba white when young, becoming pale pinkish, finally greyish brown, soft; chambers fairly narrow sterile base pronounced in young specimens, white; columella visible as fine strands radiating from base. Tramal plates 30–40 µm thick; composed of inflated, thin–walled hyphae, 2–11 µm diam. Odour undistinct. Spores 15–20 x 8–12 µm, yellowish brown, citriform with a small mucronate apex, smooth, thick–walled, with hyaline myxosporium fragmenting into irregular patches. Basidia 23–28 x 6–8 µm, clavate, bisporic. Subhymenial layer pseudoparenchymatous. Peridiopellis a fairly thick epicutis of agglutinated, thin–walled hyphae, 2–6 µm diam.

Distribution in Europe: Fairly common species in humus of deciduous and coniferous trees in forests of all Europe. Often together with other hypogeous species.

Specimens examined: Pärnumaa Co., Mihkli, in mixed forest, in humus, together with *Balasamia platyspora* and *Tuber rufum*, 28.08.1989, coll. M. Lawrynowicz. Tartumaa Co., Järvselja, in mixed forest, in humus, in the vicinity of *T. rapaeodorum* site (see description of habitat), 5.09.1999, coll. M. Lawrynowicz.

## FINAL REMARKS

*Elaphomycetales* was represented by very common *E. asperulus* and fairly common *E. granulatus* as well as *E. muricatus*. But *E. anthracinus* belongs to rare species in Europe.

The most interesting from chorological and ecological point of views seem to be occurrence of *Tuberales: Balsamia platyspora* and four species of *Tuber: T. rufum, T. puberulum* and fairly rare in Europe *T. maculatum* and *T. rapaeodorum*.

Two species of Basidiomycotina: *Rhizopogon luteolus* and *Hymenogaster tener* are easy to discover, but taking into account habitats conditions it is possible to expect also another species of these genera.

## ACKNOWLEDGEMENTS

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# New data on distribution and basidiospore variation in *Hydnochaete* and *Hymenochaete* (Hymenomycetes)

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**Abstract:** New data on distribution and some additional data on variability of basidiomata and basidiospores of fourteen species of the genera *Hydnochaete* and *Hymenochaete* are given.

**Kokkuvõte:** Uusi andmeid Hydnochaete ja Hymenochaete liikide levikust ja eoste varieeruvusest.

Esitatakse uusi levikuandmeid neljateist liigi kohta ja nende eoste suuruse ja kuju statistilisi mõõteandmeid.

## INTRODUCTION

During my study on taxonomy of hymenochaetoid fungi (1960–2006), many specimens were studied by me in the herbaria of BPI, K, LSUM, NY, PRM, S, as well as numerous collections sent by my friends and colleagues. Data on North America were published by the author of this paper earlier (Parmasto, 2001) and data on some rare and poorly known species a year ago (Parmasto, 2005). In this survey, unpublished data on distribution of several species in inadequately studied regions, and data on the variation of their spore size will be given.

## METHODS

Basidiomata are described using the colour names by Rayner (1970); colour notations are given according to the Munsell Book of Color (1976; abbreviation: M) and Kornerup & Wanscher (1967; abbreviation: K & W). For basidiospore statistics, if not mentioned otherwise, 25 randomly taken spores were measured in each specimen with the aid of a Sony CCD Video Camera attached to a Nikon Labophot 2 microscope and analysed by Global Lab Image (Data Translation Inc.) software. Length, width and *Q* value of spores have been characterized by the 90%-expected tolerance limits of the specimen means in four species (Parmasto & Parmasto, 1987: 109–111). Descriptions given for some species below are based on new collections and types only. Usually only new additional data are presented, not complete descriptions. Herbarium acronyms are after Holmgren, Holmgren & Barnett (1990). Data on distribution of species are arranged using Brummitt's (2001) geographical scheme for recording plant distributions.

## TAXONOMY

HYDNOCHAETE OLIVACEA (Schwein.: Fr.) Banker, Mycologia 6 (5): 234 (1914).

CARIBBEAN: Jamaica, Portland Parish, Green Hills, 18 Jul 1968 B. Lowy JA-826 (LSUM).

HYMENOCHAETE ATTENUATA (Lév.) Lév., Ann. Sci. Nat., Bot. III 5: 152 (1846).

INDO-CHINA: Thailand, Cangwat Chiang Mai, Doit Suthep, 1300–1600 m, 18/24 Feb 1979 L. Ryvarden 18025 (O).

HYMENOCHAETE CERVINA Berk. & M.A. Curtis, J. Linn. Soc., Bot. 10: 334 (1868).

CARIBBEAN: Jamaica, Korf et al. (NY; det. G.A. Escobar as *H. corrugata).* WESTERN SOUTH AMERICA: Colombia, Dept. Magdalena, Sierra Nevada de Santa Marta, San Lorenzo, 2200 m, 17 Jun 1978 K.P. Dumont et al. 8771 (NY; det. Escobar as *H. corrugata*); Peru, Prov. Convencion (BPI 278239). BRAZIL SOUTHEAST: Niterói, Dec 1947 E.J.H. Corner (E 60192); Rio Grande do Sul, C. Cirne Lima 6 (BPI 277673, ex MO 171292). SOUTHERN SOUTH AMERICA: Uruguay, Dep. Florida, Rincon del Yi, on *Eucalyptus globulus*, Sep 1926 Herter (NY).

HYMENOCHAETE CINNAMOMEA (Pers.: Fr.) Bres., Atti Accad. Sci., Lett. Arti Agiati III 3 (1): 110 (1897).

INDO-CHINA: Thailand, Cangwat Lamphun, Doi Inthanond, 2200–2590 m, 17 Feb 1979 L. Ryvarden 17625, 17627, 17663 (O). NORTHERN

South America: Venezuela, Gran Sabana, Esta. Bolivar, 24 Feb 2000 T. Iturriaga 72411 (O 42345). Western South America: Colombia, Depart. Cundinamarca, W of Bogota, 2650 m, 3 Jun 1978 K.P. Dumont et al. 8534 (NY); Ecuador, Prov. Pichincha, western slope of Mt. Antisana, 4200 m, 27–28 Jan 1983 L. Brako 5018 (NY). Brazil West-Central: Mato Grosso, Campo Grande, 25 Mar 1948 E.J.H. Corner (E 60198). Australia: H. Lepp 1907 (CANB).

*H. cinnamomea* is a widespread species found on all continents. 90%-expected tolerance limits of the specimen spore means are 4.81–6.38 x 2.16–2.74 µm; *Q* = 1.91–2.68. Mean size and mean *Q* value of spores:

| | | |
|---|---|---|
| 4.53 x 2.37 | 2.05 | Azerbaijan, TAA 90036 |
| 4.93 x 2.54 | 1.94 | Russia, North Caucasus, TAA 63448 |
| 4.95 x 2.47 | 2.00 | Caucasus, Georgia, TAA 15244 |
| 4.96 x 2.52 | 1.97 | Estonia, TAA 14927 |
| 4.97 x 2.43 | 1.91 | India, BPI 348657 |
| 5.00 x 2.28 | 2.19 | USA, BPI 278604 |
| 5.04 x 2.55 | 1.98 | Argentina, BAFC 30254 |
| 5.26 x 2.35 | 2.24 | USA, Maryland, CFMR (FP 104279) |
| 5.29 x 2.40 | 2.20 | New Zealand, BPI 277536 |
| 5.31 x 2.28 | 2.33 | USA, Florida, CFMR (HHB 9623) |
| 5.32 x 2.11 | 2.52 | USA, Maryland, CFMR (HHB 7949) |
| 5.34 x 2.60 | 2.05 | USA, BPI 278607 |
| 5.41 x 2.43 | 2.23 | USA, Vermont, BPI 278960 |
| 5.45 x 2.43 | 2.24 | USA, BPI 278611 |
| 5.45 x 2.34 | 2.33 | USA. Michigan, CFMR (HHB 11978) |
| 5.52 x 2.59 | 2.14 | Chile, Raj. 10933 |
| 5.54 x 2.48 | 2.23 | USA, New York, BPI 278602 |
| 5.55 x 2.80 | 1.99 | Thailand, O 17627 |
| 5.57 x 2.06 | 2.70 | USA, Mississippi, CFMR (FP 110163) |
| 5.57 x 2.76 | 2.02 | Thailand, O 17625 |
| 5.70 x 2.34 | 2.44 | USA, Tennessee, TAA 151324 |
| 5. 72 x 2.44 | 2.35 | Azores, K Spooner 1384 |
| 5.73 x 2.27 | 2.52 | Russia, North Caucasus, TAA 19774 |
| 5.73 x 2.41 | 2.38 | USA, Tennessee, CFMR (HHB 3933) |
| 5.74 x 2.28 | 2.52 | Russian Far East, TAA 104663 |
| 5.80 x 2.45 | 2.37 | USA, New York, NY 56099 |
| 5.86 x 2.32 | 2.52 | Caucasus, Chechnya, TAA 107822 |
| 5.87 x 2.79 | 2.11 | Colombia, NY 8534 |
| 5.91 x 2.78 | 2.13 | Thailand, O 17663 |
| 5.95 x 2.34 | 2.54 | Italy, BPI 277733 |
| 5.97 x 2.38 | 2.50 | Macedonia, Karadelev 00/1532 |
| 6.02 x 2.32 | 2.60 | Russian Far East, TAA 104663 |
| 6.05 x 2.51 | 2.41 | Australia, CANB Lepp 1907 |
| 6.10 x 2.59 | 2.36 | Turkmenistan, TAA 55587 |
| 6.13 x 2.72 | 2.26 | USA, Michigan, CFMR (HHB 10326) |
| 6.16 x 2.54 | 2.42 | USA, N. Carolina, CFMR (HHB 2937) |
| 6.19 x 2.65 | 2.34 | Macedonia, Karadelev 98/1739 |
| 6.21 x 2.48 | 2.51 | Estonia, TAA 154484 |
| 6.74 x 2.42 | 2.79 | Estonia, TAA 164845 |

Hymenochaete corrugata (Fr.: Fr.) Lév., Ann. Sci. Nat. III 5: 152 (1846).

New localities in **South America**. Caribbean: Puerto Rico, Rio Pudras, 29 Mar 1919 P.R. Earle 239 (NY). Northern South America: Guyana, Kartabo Point, Mazaruni River, in dense forest at sea level, [on bamboo,] Mar 1924 W.A. Murrill (NY). Western South America: Colombia, Dpto. Cundinamarca, E. Jardines de Paz, 28 Jun 1974 K.P. Dumont et al. 16 (NY).

**Rem**. The species is common in broad-leaved forests of Europe and North America, but known from only a few localities in Central and South America, e.g. Costa Rica, Jamaica, Puerto Rico, Argentina, Brazil, Ecuador and Uruguay. The colour of basidiomata is variable and depends on the season of collecting. The Guyana collection mentioned above is different from other specimens studied by me in possessing light Smoke Grey coloured hymenium (M: 7.5 YR 8/2; K & W: 5 B 1) and light fulvous arachnoid margin (7.5 YR 6/8; K & W: 5 C 7). Its setae are not numerous, short and thick, (35–)40–50(–55) x (9–)10–15(–18) µm

but fit within the *mean* range of setae (37–67 x 7–12 µm) found in the 33 specimens from the Great Smoky Mts. (USA) and studied by me. The basidiospores are relatively long (see the Table below). The very pale colour may be due to the thinness of the basidiome (100–150 µm) because of its growing on a smooth bamboo stem.

90%-expected tolerance limits of the specimen spore means are 4.68–6.12 x 1.50–2.17 µm; *Q* = 2.50–3.64. Mean spore size and mean *Q* value of *H. corrugata:*

| | | |
|---|---|---|
| 4.68 x 1.72 | 2.71 | USA, Virginia, CFMR 10674 |
| 4.95 x 1.73 | 2.86 | USA, N. Carolina, TAA 151006 |
| 4.99 x 1.82 | 2.74 | USA, N. Carolina, TAA 151456 |
| 5.02 x 1.78 | 2.82 | USA, N. Carolina, CFMR (HHB 2885) |
| 5.04 x 1.78 | 2.84 | USA, N. Carolina, CFMR (HHB 2778) |
| 5.11 x 1.66 | 3.08 | USA, N. Carolina, TAA 151067 |
| 5.24 x 1.85 | 2.83 | USA, N. Carolina, TAA 151026 |
| 5.21 x 2.00 | 2.61 | USA, N. Carolina, TAA 151299 |
| 5.26 x 1.54 | 3.42 | USA, N. Carolina, TAA 151026 |
| 5.29 x 1.57 | 3.37 | Russian Far East, TAA 107479 |
| 5.38 x 1.70 | 3.17 | USA, N. Carolina, TAA 151495 |
| 5.38 x 2.02 | 2.66 | USA, Tennessee, TAA 151335 |
| 5.39 x 1.67 | 3.24 | USA, Tennessee, TAA 151366 |
| 5.43 x 1.94 | 2.79 | USA, N. Carolina, TAA 151082 |
| 5.47 x 1.94 | 2.82 | USA, Tennessee, TAA 151242 |
| 5.50 x 1.91 | 2.87 | USA, Tennessee, TAA 151246 |
| 5.51 x 1.84 | 2.99 | USA, N. Carolina, TAA 151124 |
| 5.53 x 1.60 | 3.45 | USA, N. Carolina, TAA 151067 |
| 5.61 x 1.80 | 3.13 | USA, N Carolina, TAA 151016 |
| 5.65 x 1.72 | 3.29 | USA, N. Carolina, TAA 151029 |
| 5.67 x 1.80 | 3.15 | USA, CFMR (HHB 38199 |
| 5.74 x 2.46 | 2.33 | Costa Rica, O 109 |
| 5.77 x 1.63 | 3.54 | USA, N. Carolina, CFMR (HHB 2546) |
| 5.81 x 1.81 | 3.20 | USA, N. Carolina, TAA 151006 |
| 5.92 x 2.01 | 2.95 | USA, Massachusets, BPI 277961 |
| 6.04 x 1.71 | 3.53 | USA, N. Carolina, TAA 151047 |
| 6.25 x 1.85 | 3.38 | USA, N. Carolina, TAA 151134 |
| 6.53 x 2.01 | 3.25 | USA, Mississippi, CFMR (HHB 13041) |
| 6.54 x 1.89 | 3.46 | USA, N. Carolina, TAA 151129 |
| 6.70 x 2.30 | 2.91 | Guyana, NY Murrill Mar 1924 |
| 6.73 x 1.80 | 3.74 | USA, N. Carolina, TAA 151057 |

HYMENOCHAETE DAMICORNIS (Link) Lév., Ann. Sci. Nat. Bot. III 5: 151 (1846).

NORTHERN SOUTH AMERICA: Venezuela, Territorio Amazonas, Rio Guainia, E of Maroa, 130 m, on rotten sticks on ground, 3 Jul 1959 J.J. Wurdack & L.S. Addelry 43302 (NY). WESTERN SOUTH AMERICA: Peru, Dpto. Loreto, outskirts of Iquitos, Rio Nanay, 31 Oct 1958 B. Lowy 407P (LSUM); near Iquitos, Yagua Indian Reservation, 21 Nov 1972 B. Lowy (LSUM); 12 km E of La Peca, 29 Jun 1978 P.J. Barbour (LSUM). BRAZIL NORTH: Amazonia, km 39 N of Rio Branco, 13 Oct 1980 B. Lowy et al. (LSUM 684BR); 5 km NW of Rio Branco, 21 Oct 1980 B. Lowy et al. (LSUM 830BR and 838 BR). BRAZIL WEST-CENTRAL: Mato Grosso, Chavantina, 27 Jan and 1 Feb 1968 E.J.H. Corner (E 60195, 60191). BRAZIL SOUTHEAST: Sao Paulo, Parque do Estado, 1969, B.V. Skvortzov (LSUM 2088, 2114, 3093); 15 Feb 1969, 12 Jan 1970, 4 Feb 1971, 15 May 1971 and 10 Feb 1972 B.V. Skvortzov 1133, 13, 1444, 196 and 665 (LSUM 1623, 1962, 2380, 1476 and 3092); 28 Jan 1966 and 8 Feb 1966, B. Lowy 775BR and 1474 BR (LSUM /SP 92598 and LSUM 3100/SP 91582); Sao Paulo, Este Experimental, Ubatuba, 29 Jan 1966 B. Lowy 1270BR (LSUM 3094/SP 91881). SOUTHERN SOUTH AMERICA: ARGENTINA NORTHEAST: Misiones, Puerto Iguazu, on wood and humus in subtropical forest, 12 Apr 1957 R. Singer M 964 (K).

90%-expected tolerance limits of the specimen means are 5.00–6.10 x 3.95–4.65 µm; *Q* = 1.15–1.45. Spore variation of Mexican

specimens is given in Parmasto, 2001: 148–149. New data:

| | | |
|---|---|---|
| 5.04 x 4.28 | 1.18 | Brazil, SP193617; spores mostly damaged |
| 5.29 x 4.29 | 1.23 | Brazil, SP 193921; spores unnumerous |
| 5.37 x 4.26 | 1.26 | Brazil, NY, Rodriges et al. 195 |
| 5.46 x 4.53 | 1.21 | Brazil, SP 193369 |
| 5.55 x 4.28 | 1.30 | Brazil, SP 177453 |
| 5.61 x 4.12 | 1.36 | Argentina, K Singer M964 |
| 5.63 x 4.01 | 1.40 | Brazil, SP 177756 |
| 5.63 x 4.09 | 1.38 | Venezuela, NY Wurdack & Adderly 43302 |
| 5.79 x 4.52 | 1.28 | Brazil, SP 194247; spores few |
| 6.11 x 4.45 | 1.37 | Brazil, LSUM Skvortzov 13 |

Hymenochaete epichlora (Berk. & M.A. Curtis) Cooke, Grevillea 8: 147 (1880).

Central America: Belize, La Democracia, Birds Without Borders Nature Trail, 28 Sep 2002 P.J. Roberts B22 (K(M) 106661). SOUTH AMERICA. Brazil (1256 BR).

Mean spore size and mean *Q* value of *H. epichlora:*

| | | |
|---|---|---|
| 3.85 x 2.17 | 1.77 | Brazil, BR 1256 |
| 4.02 x 2.20 | 1.83 | Belize, K(M) Roberts B22 |

Hymenochaete leonina Berk. & M.A. Curtis, J. Linn. Soc. Bot. 10 (46): 334 (1868).

In addition to the localities indicated in Léger, 1998 (p. 176), collected also in Colombia, French Guyana and Kenya (several collections in NY, not studied by me). - Northern South America: Venezuela, Roraima, Boa Vista, Boca da Mata, 29 Nov 1977 I. Araujo et al. 78.404 (NY). Western South America: Bolivia: El Sena, Rio Madre de Deos (BPI 278878). Brazil North: Amazonas, Mantaus, Sep and 2 Nov 1948 E.J.H. Corner (E 60193, 60190); Roraima, Boa Vista, Boca da Mata, 29 Nov 1977 I. Araujo et al. 78.404 (NY). Brazil Southeast: San Paulo, Parque do Estado, 5 Nov 1968, 20 Aug 1969 and 9 Oct 1969 B.V. Skvortzov (LSUM 2357, 1896, 2167).

Spore variation of some specimens is given in Parmasto, 2001: 157. Additional data:

| | | |
|---|---|---|
| 4.20 x 2.26 | 1.86 | India, TAA 103310 |
| 4.60 x 2.03 | 2.28 | Brazil, NY 78.404 |
| 4.65 x 2.16 | 2.15 | Brazil, LSUM 2357 |
| 4.75 x 2.06 | 2.31 | Venezuela, O 42247 |
| 5.26 x 2.03 | 2.60 | Venezuela, O 42342 |

Hymenochaete luteobadia (Fr.) Höhn. & Litsch., Sitzungsber. K. Akad. Wiss. Wien, Math.-nat. Kl. 116: 754 (1907).

**Type studied**. *Thelephora kunzei* (Hook.) Massee: Surinam (BPI 278215, ex Herb. Bresadola, "orig.").

West-Central Tropical Africa: Congo ("Belgian Congo"), Oct and Nov 1920 Vanderyst (BPI 330049*, 329926, 329927; Lloyd Herb. 33768, 19661, 19662); Congo, Kisantu, Hyac Vanderyst (BPI 330051*, Lloyd Herb. 33767). East Tropical Africa, Kenya: Mombasa (BPI 278228, ex K); Tanzania: Tanganyika, 1920 Maitland (BPI 329929, Lloyd Herb. 19659). South Tropical Africa: Angola, J. Grossweiler (BPI 330048*, 330050*, 330052*, Lloyd Herb. 33766, 33765, 33764); Angola, Port W. Africa, J. Grossweiler (BPI 330046*, Lloyd Herb. 6465). Southern Africa: Natal, Durban, P. van der Bijl (BPI 278234; BPI 330047*, Lloyd Herb. 33763). All African **specimens indicated with an asterisk *** are identified by C.G. Lloyd as *H. tenuissima* (= *H. rheicolor*). – China: Hainan, Tan-hsien, 27 Nov 1934 S.Q. Deng 6952 (BPI 278323). Central America: Belize, Cayo, Mountain Pine Ridge, 3 Oct 2002 P.J. Roberts B111 (K(M) 106674); Panama Canal Zone (BPI 278241). Northern South America: Venezuela, Caracas, 11 Oct 1947 E.J.H. Corner (E 60201). Western South America: Colombia, 16 Jan 1976 K.P. Dumont et al. 2781 (NY); Peru, Dpto. Loreto, in Amazon river offshore Iquitos harbor, Padre Isla, 29 Oct 1958 B. Lowy (LSUM 454P). Brazil North: Roraima, 18 Nov 1977 I. Araujo et al. 77.576 (NY). [Roraima,] Ilha de Maracá, Primary forest, on dead wood, 18 Jun Ð 3 Jul 1986 B. Lowy et al. 1799R (LSUM); Estado Amazonas, vicinity of Km 200, Manaus Ð Itacoatiara road, 19 Nov 1965 B. Lowy 821BR (LSUM 3099/SP 91800); Amazonas, Manaous, 14 Jun and June 1947 E.J.H. Corner (E 60199, 60197). Brazil Northeast: Bahia, C. Torrend (BPI 330063, Lloyd Herb. 33740, identified by C.G. Lloyd as *H. tenuissima* (= *H. rheicolor*)). Brazil West-Central: Caixas, Anna Brockes (BPI 329928, Lloyd Herb. 19660); D. F., Parque do Municipio de Gama, 24 Jul 1965 B. Lowy 164B (LSUM 3103/SP 92387). Brazil Southeast: Estado Guanabara,

Mata da Tijuca, 4 Apr 1966 B. Lowy 1030BR (LSUM 3106/SP 92198); Niterói, 7 Mar 1948 E.J.H. Corner (E 60200).

One of the important characters of this species has not been clearly described until now. The hyphidia have light brown thickened walls, conical tips, and are very numerous in the frequently sterile hymenium. In South America, only *H. rheicolor* has similar basidiomata but may easily be distinguished by soft, pliable pilei without cortex (dark line under tomentum).

Almost all specimens seen in herbaria are sterile; spores have been found in two specimens:

| | | |
|---|---|---|
| 4.14 x 2.17 | 1.91 | Belize, K(M) 106674 |
| 4.56 x 2.26 | 2.02 | Mexico, XAL 20791 |

Hymenochaete pinnatifida Burt, Ann. Missouri Bot. Gard. 5: 355 (1918).

Central America: Belize, Cayo, Mountain Pine Ridge, 4 Oct 2002 P.J. Roberts B148 (K(M) 106675); Guatemala, Dto. Sololá, Cerro Panajachel, 13 Jul 1963 B. Lowy 4323 (LSUM). Western South America: Peru, Dpto. Loreto, outskirts of Iquitos, Rio Nanay, 28 Oct 1958 B. Lowy 391P (LSUM). Brazil North: Amazonas, km 175 south of Manaus on Porto Velho road, Roadside woods, 16 Sep 1980 B. Lowy et al. 179BR (NY).

Mean spore size and mean *Q* value of the only specimen which has spores is:

| | | |
|---|---|---|
| 4.52 x 2.42 | 1.86 | Peru, LSUM 391P |

The spores are broader in the Peruvian collection than in the North American specimens, which have 90%-expected tolerance limits of the specimen means 4.57–6.20 x 1.70–2.35 µm; *Q* = 2.25–3.10.

Hymenochaete rheicolor (Mont.) Lév., Ann. Sci. Nat. III 5: 151 (1846).

Eastern Asia: Taiwan ("Formosa"), Kaukau, S. Kusano 1909 (BPI 277602, NY 61352). Malesia, Malaya: Malay Peninsula, State of Pahang, 13 Sep 1923 R.E. Holltum (BPI 330082, Lloyd Herb. 33760). Malesia, Jawa: Samarang, van Leeuwen (BPI 330084, Lloyd Herb. 33772); Korthals (BPI 277607, from the Bresadola Herbarium). Caribbean: Cuba (PRM 903277). Western South America: Peru, Dpto. Junin, Road to Pichita Caluga–San Ramon, Jul 1958 Albrizzio & Vqalcarcel 230P (LSUM). Brazil Northeast: Bahia, C. Torrend (BPI 330063, 330069, Lloyd Herb. 33741, 33742). Brazil Southeast: San Paulo, Parque do Estado, 4 Oct 1969 B.V. Skvortzov 1793, 2059 (LSUM). Southern South America, Chile North: Santiago, M.R. Espinosa (BPI 330072, Lloyd Herb. 33758). Southwestern Pacific: Tonga (BPI 277606).

In addition to the countries, mentioned by Léger (1998) and Parmasto (2001), collections have also been seen from Panama (BPI 278533, 278552, 278554, 278557, 278580, 278582), Venezuela (incl. Amazonas, Orinoco) (NY) and St. Kitts (Leeward Is.) (BPI, NY).

All specimens collected from Africa and identified as *H. tenuissima* (= *H. rheicolor*) by C.G. Lloyd (BPI, Lloyd Herb.) belong to *H. luteobadia*. There are no reliable data on occurrence of *H. rheicolor* in Africa.

Spore size and mean *Q* value of *H. rheicolor* has been described by Parmasto & Gilbertson (2006); some additional data are given below:

| | | |
|---|---|---|
| 4.89 x 2.21 | 2.21 | Cuba , PRM 903277 |
| 5.19 x 2.20 | 2.36 | India, BPI 1100811 |
| 5.41 x 2.34 | 2.31 | Cuba, PRM 903263 |

Hymenochaete tabacina (Sowerby: Fr.) Lév., Ann. Sci. Nat. Bot. III 5: 145 (1846).

The species is rare in South America. Two specimens from Colombia where it has not yet been reported, were studied by me:

Western South America: Colombia, Dpto. Cundinamarca, E. Jardines de Paz, El Bosque de Tibabita, 28 Jun 1974 K.P. Dumont et al. 64 (NY); Dpto. Cundinamarca, 7 km from Bogotá, elev. 10 000 ft, 4 Aug 1976 K.P. Dumont et al. 5492 (NY).

This species has quite variable spores from short cylindrical to cylindric-allantoid (cf. Léger, 1998: 274). New Zealand and Australian specimens have longer spores than most other collections; their basidiomata are effused or with only slightly reflexed margins. As is commonly found, most of the Australasian collections are without any basidiospores. Others have a small number, usually heavily damaged by bacteria. Nevertheless, we have made some measurements; the results are given in the table below. 90%-expected tolerance limits of the mean spore size are 4.11–6.63 x 1.47–2.24 µm; Q = 2.40–3.40. Coefficient of variation of mean spore length of specimens is 13.8, of spore width it is 12.1, and of *Q* V = 10.1; these values are considerably higher than usual in Hymenomycetes (Parmasto & Parmasto, 1987).

Nevertheless, there is no distinct spore size limit between Australasian and other specimens. If further studies find additional differences, the Australasian specimens may be distinguished as a subspecies of *H. tabacina*. Because we did not see any good specimens with abundant and undamaged basidiospores that would serve as a good quality holotype, we did not take this step.

In Europe, f. *rhododendri* Rehm has been described as a "variety strongly different from the normal fruitbodies" (Pilát, 1930: 110). However, Gerhold (1999: 23) did not find differences in the macroscopical characteristics. Neither did I observe differences in basidiospore measurements of this form. It appears to be a synonym. In the table below, specimens collected on Rhododendron spp. are indicated with an asterisc *****.

Mean spore size and mean *Q* value of *H. tabacina:*

| | | |
|---|---|---|
| 4.55 x 1.59 | 2.85 | USA, Alaska, CFMR (HHB 13058) |
| 4.56 x 1.75 | 2.60 | * Austria, TAA 189307 |
| 4.58 x 1.70 | 2.69 | * Austria, TAA 189306 |
| 4.59 x 1.62 | 2.84 | Russia, Ural Mts., TAA 90305 |
| 4.66 x 1.64 | 2.86 | Russian Far East, TAA 104682 |
| 4.68 x 1.52 | 3.07 | * Russia, Sakhalin Is., TAA 102555 |
| 4.70 x 1.67 | 2.82 | USA, N. Carolina, TAA 151510 |
| 4.70 x 1.80 | 2.61 | USA, N. Carolina, TAA 151521 |
| 4.80 x 1.65 | 2.91 | Russia, Altai Mts., TAA 92555 |
| 4.80 x 1.92 | 2.50 | Macedonia, TAA Karadelev 98/1752 |
| 4.81 x 2.00 | 2.44 | Russia, Tatarstan, TAA 100818 |
| 4.82 x 1.62 | 3.00 | Estonia, TAA 101511 |
| 4.82 x 1.68 | 2.87 | * Russian Far East, TAA 101577 |
| 4.86 x 1.57 | 3.11 | Russia, Perm Reg., TAA 104247 |
| 4.86 x 1.72 | 2.82 | Austria, GZU 18380 |
| 4.95 x 2.02 | 2.46 | Russia, TAA 104247 |
| 4.96 x 1.75 | 2.84 | Macedonia, MK 98/ 1724 |
| 4.99 x 2.01 | 2.49 | Norway, TAA 184043 |
| 5.00 x 1.92 | 2.61 | Finland, TAA 126678 |
| 5.02 x 1.80 | 2.79 | Finland, Lapland, TAA 162162 |
| 5.04 x 1.73 | 2.92 | Russia, N. Caucasus, TAA 53234 |
| 5.12 x 1.98 | 2.58 | USA, Tennessee, TAA 151197 |
| 5.19 x 1.90 | 2.74 | USA, N. Carolina, TAA 151484 |
| 5.20 x 1.66 | 3.16 | Estonia, TAA 115589 |
| 5.21 x 2.01 | 2.60 | USA, N. Carolina, CFMR (HHB 2570) |
| 5.28 x 1.83 | 2.89 | Estonia, TAA 101511 |
| 5.29 x 1.79 | 2.95 | USA, New York, CFMR (Larsen 1) |
| 5.35 x 1.76 | 3.04 | Russian Far East, Sakhalin Is., TAA 47261 |
| 5.59 x 1.74 | 3.22 | Sweden, UPS 10248 |
| 5.67 x 1.91 | 2.96 | USA, Maryland, TAA 105527 |
| 5.98 x 1.76 | 3.40 | USA, Maryland, BPI 279227 |
| 6.09 x 2.09 | 2.91 | New Zealand, PDD 16995 |
| 6.10 x 2.00 | 3.04 | Estonia, TAA 180975 |
| 6.11 x 2.20 | 2.79 | Australia, PDD 7165 |
| 6.12 x 1.94 | 3.15 | New Zealand, PDD 16955 |
| 6.26 x 1.79 | 3.50 | New Zealand, PDD 7159 |
| 6.39 x 2.10 | 3.04 | Colombia, NY, Dumont 5492 |
| 6.50 x 1.82 | 3.57 | USA, Montana, BPI 279481 |
| 6.53 x 1.84 | 3.56 | New Zealand, PDD 16955 |
| 6.67 x 2.60 | 2.57 | Byelorussia, MSK 5197 |
| 6.84 x 2.41 | 2.84 | New Zealand, PDD 7165 |
| 7.33 x 2.20 | 3.35 | New Zealand, PDD 16522 |

Hymenochaete tenuis Peck, Ann. Rep. N. Y. St. Mus. Nat. Hist. 40: 57 (1887).

Caribbean: Trinidad, Cumuto, 23 Jun 1961 A.L. Welden 2124 (BPI 348561; det. F. Reeves as *H. multisetae* Burt).

Hymenochaete villosa (Lév.) Bres., Hedwigia 51: 323 (1912).

China: Hainan, Chang-kiang, 12 Nov 1934 S.Q. Deng 6371 (BPI 278876). Indo-China: Thailand, Cangwat Chiang Mai, Doit Suthep, 1300–1600 m, 18/24 Feb 1979 L. Ryvarden 17720 (O). Malesia, Malaya: Malay Peninsula, 23 Jan 1920 M. Noor (BPI 330078, Lloyd Herb. 33761; det. C.G. Lloyd as *H. tenuissima* Berk.).

Most of the specimens of this fungus that we studied are sterile; in several cases, a few unripe and several damaged (by bacteria?) basidiospores can be seen. This *Hymenochaete* species has the smallest spores in this genus.

Mean spore size and mean *Q* value of *H. villosa:*

| | | |
|---|---|---|
| 3.17 x 1.91 | 1.66 | New Zealand, PDD 7152 |
| 3.50 x 1.84 | 1.91 | New Zealand, PDD 7964 |
| 3.68 x 1.78 | 2.07 | New Zealand, PDD 7966 |
| 4.07 x 2.00 | 2.03 | India, TAA 103327 |
| 4.23 x 2.03 | 2.08 | Taiwan, TNMF Wu 980536 |

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# *Dichochaete, Hydnochaete* and *Hymenochaete* (Hymenochaetales, Hymenomycetes) in Costa Rica

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**Abstract:** Data on distribution of 25 species of the genera *Dichochaete, Hydnochaete* and *Hymenochaete* are given.

**Kokkuvõte**: Eoslavaseente perekonnad *Dichochaete, Hydnochaete* ja *Hymenochaete* Costa Ricas.

## INTRODUCTION

The biota of the hymenochaetoid genera *Dichochaete, Hydnochaete* and *Hymenochaete* of Central America is scarcely known. Léger in his world monograph of the genus *Hymenochaete* (1998) indicates four species found in Panama, no species from Nicaragua and only few from Costa Rica. Ryvarden (1982) did not indicate any species of Hydnochaete from this region.

No species were indicated from Costa Rica by Burt (1918) in his survey of North American *Hymenochaete* species. Reeves and Welden (1967) mentioned one species (*Dichochaete setosa*); Escobar (1978) gave localities of eight species of *Hymenochaete* and *D. setosa* found in Costa Rica in his unpublished monograph. Ryvarden (1985) listed among the localities of *H. damicornis* also Costa Rica; Léger studied for his World monograph of the genus *Hymenochaete* specimens of *D. ceratophora, H. adusta* and *H. lenta*, collected in this country. Parmasto (2000, 2001) described a new species, *H. reticulata* found in Costa Rica, and indicated two localities of *H. escobarii*. Altogether, thirteen species of the genus *Hymenochaete* and two of *Dichochaete* have been found until this study in Costa Rica. Eight of these are also listed in the National Biodiversity Institute herbarium database in Santo Domingo de Heredia (http://www.inbio.ac.cr)

## MATERIALS AND METHODS

Irene Lindblad, Kristine Haugerud (Oslo), Karl Henrik Larsson (Göteborg) and Urmas Kõljalg (Tartu) have collected hymenochaetoid fungi in Costa Rica in 1996, 1997, 1999 and 2004. These collections are deposited in INB, O and G, their duplicates in TAA. In addition, the author of this paper studied herbarium specimens in BPI and NY in 1998 and 1999. The specimens are identified by E. Parmasto (EP), if not indicated otherwise.

Herbarium acronyms are after Holmgren, Holmgren & Barnett (1990). Colour notations of the basidiomata are given using the books by Munsell, 1976 (M) and Kornerup & Wanscher, 1973 (K & W). Only some very rare species are shortly described in this paper.

## RESULTS

25 species of the genera *Dichochaete, Hydnochaete* and *Hymenochaete* have been found in Costa Rica including *H. sordida*, found until this only once in 1925 (in Argentina), and *H. reticulata*, found only in Costa Rica. The number of species is quite high when compared with the biota of the same fungal group well studied in North America (28 species in USA, Canada, Greenland and temperate Mexico; Parmasto, 2001) or in Brazil (29; Gibertoni et al., 2003). As in all tropical and subtropical countries studied, the number of rare species is high and of common species low in Costa Rica (*Hymenochaete damicornis, H. escobarii, H. pinnatifida, H. rheicolor*).

### List of species

Dichochaete ceratophora (Job) Parmasto. Syn.: *Hymenochaete alabastrina* Escobar ex Léger, 1990
Heredia Prov., near Puerto Viejo (Léger, 1998: 53).

Dichochaete setosa (Sw.) Parmasto. Syn.: *Hymenochaete aspera* Berk. & M.A. Curtis, 1868
Northern slopes of Volcán Orosí (Escobar, 1978: 44); Puntarenas, Coto Brus, Sabalito, Zona Protectora Tablas, Camino a Cotoncito, 3 Nov 2004 U. Kõljalg (TAA 187022, 187029); Zona Protectora Tabas, Las Alturas, 4 Nov 2004 U. Kõljalg (TAA 187039).

Hydnochaete peroxydata (Berk. & M.A. Curtis) Dennis
Puntarenas, Coto Brunx, Parque La Amistad Sn. Vito, J. Carranga 257-97, det. L. Ryvarden (O; Parmasto, 2005).

Hymenochaete adusta Bres. Syn.: *H. cacao* (Berk.) Berk., 1868
Heredia Prov., Cerro Centro de Zurqui, leg. C.W. Dodge et al. 69933, was identified as H. berkeleyana (Léger, 1998: 81).

H. anomala Burt
Guanacaste Prov., Santa Rosa National Park, 300 m, on deciduous wood, 2 July 1997 I. Lindblad 3274 (O, TAA 171352).
Cystidia are better developed in this specimen than in many others studied by me; setae sparse, 25–40(–42) x 3.8–5 µm, some with bifurcate base. Basidiome partly 2–3-layered, with thin hyphal layer between setal strata. Spores are few, 3.2–4.2 x 1.8–2.2 µm; mean size of 17 spores measured: 3.69 x 2.03 µm, Q = 1.82.

H. cinnamomea (Pers.) Bres.
Guanacaste Prov., Santa Rosa National Park, alt. 300 m, on deciduous wood, 17 Jan 1997 I. Lindblad 2463-B (TAA 151354).

H. contiformis G. Cunn.
San José de Montana, 12 June 1972 A.L. Welden 4363 (Escobar, 1978: 62).

H. corrugata (Fr.) Lév.
Rio Pudras, 29 Mar 1919 P.R. Earle (NY); Las Tablas Protector Zone, Sendero e. Higueron central, alt. 1450 m, on dead deciduous wood, 24 June 1999 K. Haugerud 109 (TAA 173592).

H. crustacea Escobar ex Léger
Chimoco Trail, above Monteverde, 8 Jan 1973 A.L. Welden 3278, holotype (Escobar, 1978: 77).

H. damicornis (Link) Lév.
Puerto Viejo, 10–11 Aug 1965 D.E. Stone; Northern slopes of Volcán Orosí, 18 Jan 1968 A.L. Welden 2896; near Tuis, above Platanillo, 12 June 1970 A.L. Welden 3061, 3063; same locality, 14 June 1972 A.L. Welden 4362 (Escobar, 1978: 84); Costa Rica (Ryvarden, 1985: 538); San Jose Prov., Guayabillos, 2160–2180 m (BPI); San José, Dota, Copey, San Gerardo–Dota, La Querbrada Salida Trail, 9 Nov 2004 U. Kõljalg (TAA 187093); San Gerardo–Dota, Los Robles Trail, 11 Nov 2004 U. Kõljalg (TAA 187111).

H. epichlora (Berk. & M.A. Curtis) Cooke
San José, Dota, Copney, San Gerardo-Dota, La Quebrada Salida trail, 9 Nov 2004 U. Kõljalg 187095 (TAA).
Basidiomata with crowded fusiform setae 45–60 x 6–8 µm and only some few spores attached to setal tips, 3.3–4 x 2.2–8 µm.

H. escobarii Léger
Las Tablas Protector Zone, 24 Jun 1999 K. Hagerud 121 (O, TAA) and Rio Grande, Luquillo Mts., 18 Jun 1996 K.-H. Larsson 9024 (G, TAA; Parmasto, 2001: 151); Puntarenas, Coto Brus, Sabalito, Zona Protectora Tablas, Finca Cafrosa, El Tajo, 6 Nov 2004 U. Kõljalg (TAA 187061, 187065); Zona Protectora Tablas, Camino a Cotoncito, 3 Nov 2004 U. Kõljalg (TAA 187023, 187031).

H. legeri Parmasto
Las Tablas Protector Zone, Sendero el. Higueron central, 1450 m, on dead deciduous wood, 24 June 1999 K. Haugerud 119 (O, TAA 171350).
The species has been found earlier in Hawaii, India and Azores (Parmasto & Gilbertson, 2006); Costa Rican specimen differs from the other collections by its slightly smaller spores 5.4–6.4 (–7) x 2.0–2.7µm; setae are acute, (70–)80–100 (–110) x 8–12 µm, with heavily conically encrusted apex. A similar and possibly related species *H. americana* Greslebin & Parmasto found in Tierra del Fuego (Argentina) and in the Arizona State of USA has similar setae but spores are larger, (7.0–)7.5–9.2(–9.5) x 2.5–3(–3.2) µm, and thin hyphal layer and cortex are present in the basidiome (Parmasto, 2000).

H. lenta Escobar ex Léger
Woods below Volcán Poas, 21 Jan 1968 A.L. Welden 2957, holotype (Escobar, 1978: 113; Léger, 1998: 174).

Hymenochaete luteobadia (Fr.) Höhn. & Litsch.
Northern slopes of Volcán Orosí, 18 Jan 1968 A.L. Welden 2893; Guanacaste, lower slopes of Volcán Orosí, 19 Jan 1968 A.L. Welden 2927 (Escobar, 1978: 127); Guanacaste Prov., Santa Rosa National Park, alt. 300 m, on dead deciduous wood, 21 May 1997 I. Lindblad 2806 (TAA 171345); Costa Rica (locality unknown): BPI 278233, 278238 (BPI).

H. pinnatifida Burt
Las Tabas Protector Zone, Sendero el. Higueron central, alt. 1450 m, 24 June 1999 K. Haugerud 106 (TAA 173592); Puntarenas, Coto Brus, Sabalito, Zona Protectora Tablas, La Neblina, 5 Nov 2004 U. Kõljalg (TAA 187050); La Selva Biological Station, Heredia, on dead deciduous wood, 4–6 July 1999 K. Haugerud 174, 178, 179, 193 (TAA 171349, 171348, 151358, 151355).

H. raunkiaeri Bres.
Costa Rica, La Selva Biological Station, Heredia, on dead deciduous wood, 5 Jul 1999 K. Hagerud 176 (O, TAA 151356; Parmasto, 2005: 158).

H. reticulata Parmasto
Turrialba, 28 Jul 1964 B. Lowy (LSU; Parmasto, 2000: 64).

H. rhabarbarina (Berk.) Cooke
Guanacaste Prov., Guanacaste National Park, Cacao, alt. 1000 m, on dead deciduous wood, 20 Jan 1997 I. Lindblad 2493 (TAA 171347).

H. rheicolor (Mont.) Lév. – Syn.: *H. sallei* Berk. & M.A. Curtis
Nine localities (Escobar, 1978: 182); Las Tablas Protector Zone, Sendero e. Higueron central, alt. 1450 m, on dead deciduous wood, 24 June 1999 K. Haugerud 111 and 131, det. L. Ryvarden and EP (TAA 173593, 173589); Turrialba, Cartago, 500–600 m, Sep 1984 L.D. Gómez 24351 (Museo Naci. Costa Rica, Herb. Nacional San Jose).

H. rubiginosa (Dicks.) Lév.
Costa Rica (Escobar, 1978; Léger, 1998: 243). Obviously, a very rare species in S. America; in American herbaria, several specimens collected in this region have been misidentified as *H. rubiginosa*.

H. sordida Speg.
Guanacaste Prov., Santa Rosa National Park, 300 m, on dead deciduous wood, 1 Jul 1997 I. Lindblad 3261 (O; TAA 171353).
Basidiomata effuse, 100–200 µm thick, greyish brown (M: 5 YR 5.5/3 or 5/4; K & W: 6 D 3 to 6 D 4, Café-au-lait). Cortex in some places hardly distinguishable, thin; hyphae of the hyphal layer loosely interwoven, with thickened brownish walls, branched, septate, 2.5–3.5 µm in diam; setae 35–55(–65) x 4.5–7(–8) µm, without hyphal sheaths; basidia 20–25 x 4–5 µm, with 4 thin sterigmata; spores short-cylindric or elongated-ellipsoid, with one side flattened, 4.2–5.5 x (2.0–)2.2–2.7 µm (mean size of 24 spores: 4.73 x 2.40 µm; length/width quotient Q = 1.97). In hymenium, subhymenium and hyphal layer numerous conglomerates of crystals 5–10 µm in diam and scattered conglomerates of resinous matter up to 20(–30) µm in diam.
Only type specimen of this species has been found earlier (in Central Argentina).

H. tabacina (Sowerby) Lév.
Prov. of Alajuela, La Palma de San Ramón, 12 Nov 1929 A.M. Brenes 183; Puerto Viejo, 16 Aug 1965 D.E. Stone (Escobar, 1978: 192). No specimens from Costa Rica have been seen by us in NY or BPI.

H. tenuis Peck. – Syn.: *H. multisetae* Burt
La Selva O.T.S. Station, near Puerto Viejo, 6 Jan 1974 A.L. Welden 3408 (Escobar, 1978: 141).

H. unicolor Berk. & M.A. Curtis
Guanacaste Prov., Cacao, alt. 1000 m, on a dead deciduous tree, 1997 I. Lindblad 2568 (O, identified as *H. ungulata* Burt; cf. Lindblad & Ryvarden, 1999: 344).

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# Two new parasitic ascomycetes on *Aesculus hippocastanum* in Estonia

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**Abstract:** In the fall of 2005 a powdery mildew fungus, *Erysiphe flexuosa*, was found for the first time on the leaves of common horse chestnut trees at several locations in Estonia. Native in North America, this powdery mildew has quickly spread in Europe since the end of the 1990s. Study of the material from the Russian Far East showed the single report of this species outside these two continents to be very doubtful. Some of the Estonian specimens also contained the *Phyllosticta anamorph* of *Guignardia aesculi*, another ascomycete that has extensively spread in Europe during recent decades, but not yet reported from here. *Septoria aesculicola*, with only two earlier records from Estonia, occurred together with the powdery mildew at most of the locations studied.

**Kokkuvõte:** Kaks Eestile uut parasiitset mikroseent hobukastanil.

Jahukasteseen *Erysiphe flexuosa* leiti esmakordselt Eestis 2005 a sügisel. Seent leiti hariliku hobukastani lehtedelt neljast Eesti maakonnast. See Põhja-Ameerikast pärit jahukasteseen on alates 1999 a Euroopas kiirelt levinud. Teated *E. flexuosa* esinemisest väljaspool mainitud maailmajagusid tuginesid ühele leiule Venemaa Kaug-Idast. Vastava herbaarmaterjali uurimine ei võimaldanud määrangut kinnitada. Mõnel pool Eestis esines hobukastani lehtedel ka *Guignardia aesculi* anamorf *Phyllosticta sphaeropsoidea*. Tegemist on teise Euroopas ekspansiivse kottseenega, mille esinemist Eestis pole siiani märgitud. *Septoria aesculicola*, mida oli seni Eestist mainitud vaid kahel korral, esines koos jahukastega enamikes selle leiukohtades.

Recent decades have brought along an increase in the number of plant-pathogenic fungi establishing themselves in areas outside their native distribution. The invasion of new regions and even of continents, dependent on long-distance dispersal of such pathogens, is nowadays greatly enhanced by international trade and migration. A special case is represented by the colonization of plants introduced to a particular region. In Estonia, powdery mildews (Erysiphales, Ascomycota) represent the group of plant-pathogenic fungi most exhaustively studied in this regard. In long-term research on the powdery mildews on trees and shrubs introduced to the Tallinn Botanical Garden, Karis (2002) provides data on the occurrence of 27 species on 136 host taxa. Although some of these imported hosts have carried along powdery mildews new to Estonia, data suggest that the majority of their parasites have probably been transferred from native hosts.

The most recent invasions of new powdery mildews that have become very common in Estonia include *Erysiphe* (=*Microsphaera*) *vanbruntiana* var. *sambuci-racemosa*e (U. Braun) U. Braun & S. Takam. on *Sambucus racemosa* L. (Normet, 1986) and *Erysiphe* =*Microsphaera*) *palczewskii* (Jacz.) U. Braun & S. Takam. on *Caragana arborescens* Lam. (Karis & Normet, 1999). These two powdery mildews have been considered to be introduced from Asia to Europe, where they have spread quickly since late the 1970s (Braun, 1995; Wolczanska & Mulenko, 2003). Karis (2002) and Karis & Normet (1999), however, provide evidence that only *E. vanbruntiana* var. *vanbruntiana* occurs in the Russian Far East and Siberia, thus disproving the theory of Asian origin of *E. vanbruntiana* var. *sambuci-racemosae*. They showed only the latter variety to occur on the introduced *S. racemosa* ssp. *sibirica* (Nakai) Hara and ssp. *pubens* (Michx.) Hult. in Estonia, although both subspecies are parasitized by *E. vanbruntiana* var. *vanbruntiana* within their native ranges of distribution. In the 1990s, the North American *Erysiphe* (=*Microsphaera*) *syringae* Schwein. appeared here on *Syringa vulgaris* L. (Karis & Normet, 1999), becoming rather common (Karis, 2002).

In the fall of 2005, the author, together with Günter Arnold, visiting from Weimar, Germany, noted a greyish-white mycelium, suggesting a powdery mildew, on the leaves of a common horse chestnut (*Aesculus hippocastanum* L.) tree in Tartu. Thus far, no powdery mildews had been

reported on trees from this genus in Estonia (Karis, 1987; Järva et al., 1998). Microscopic examination in the lab revealed the fungus to be *Erysiphe flexuosa* (Peck) U. Braun & S. Takam. (Fig. 1). Subsequently, several other localities were checked for the presence of this new powdery mildew. *Erysiphe flexuosa* occurred on the majority of the common horse chestnut trees examined in Tartu, and in south-central Estonia as well as in Tallinn on the northern coast of the country. During the inspection, leaves of some trees exhibited effused brown blotches, to 6 cm long, with yellow margins and often numerous dark pycnidia on the upper side of the leaves (Fig. 2). These appeared to belong to the anamorph (*Phyllosticta sphaeropsoidea* Ellis & Everh.) of *Guignardia aesculi* (Peck) Stewart, an ascomycete that has extensively spread in Europe during the recent decades (Hudson, 1987), but has not yet been recorded in Estonia. Another pycnidial anamorph, *Septoria aesculicola* (Fr.) Sacc., only twice reported from Estonia (Järva & Parmasto, 1980), occurred together with *E. flexuosa* in most of the studied specimens. *Septoria aesculicola* can easily be distinguished from the anamorph of *G. aesculi* by forming on the leaves of the host small dark spots with the central part turning light with time; in each spot only one or a few pycnidia are seated (Fig. 3a). In contrast to the ellipsoidal aseptate conidia of *G. aesculi* (Fig. 2b), the conidia of *S. aesculicola* are filiform and 3-septate (Fig. 3b).

*Erysiphe flexuosa* is a common parasite of horse chestnut species in North America (Braun, 1987). Its first appearance in Europe was in Germany in 1999 (Ale-Agha et al., 2000). Following that, it appeared in many countries in central and southern Europe (Austria, the Czech Republic, Croatia, France, Hungary, Poland, Slovakia, Switzerland; Ale-Agha et al., 2000; Zimmermannova-Pastircakova et al., 2002; Kiss et al., 2004) as well as in Great Britain (Ing & Spooner, 2002), Ukraine (Heluta & Voityuk, 2004), Lithuania (Grigaliunaite et al, 2004) and Finland (Huhtinen, pers. comm.).

The only record of *E. flexuosa* outside North America and Europe is from *A. hippocastanum* at the Botanical Garden near Vladivostok, in the Far East of Russia (Bunkina, 1978, 1991). The morphological description by Bunkina (1991) indicates that tips of the numerous equatorial appendages on cleistothecia are either simple or branched. Based on this feature, Karis (1995) suggested that this specimen belongs to *Sawadaea bicornis* (Wallr.) Mijabe, the powdery mildew of maples (Acer). This species occurs in different regions of mainly the northern hemisphere, being common in the Russian Far East (Karis, 1995, 2002), and has been reported to be able to occasionally infect *A. hippocastanum* (Braun, 1987, 1995). While visiting the Vladivostok Botanical Garden in September 1983, Karis (pers. comm.) did not, however, find any powdery mildews on horse chestnut trees.

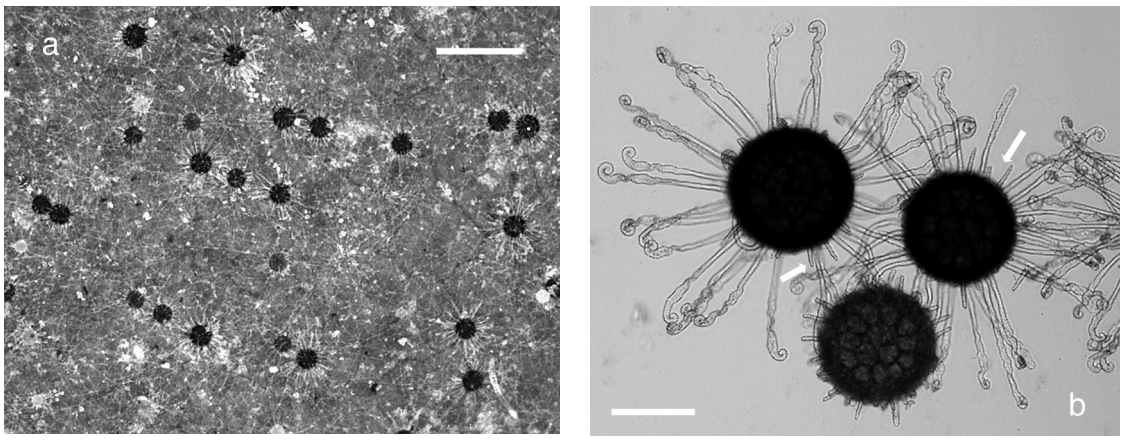


**Fig. 1.** Ascomata of *Erysiphe flexuosa*. **a.** View at the upper side of a leaf of *A. hippocastanum*. **b.** Chasmothecia with two type of appendages; arrows pointing to short straight appendages located among the long appendages with undulate upper parts and coiled tips. a – TAA(M) 170994, b – TAA(M) 170983. Scale bars: a = 0.5 mm, b = 100 µm.

Bunkina's specimen from September of 1976 is preserved at the herbarium of the Far East State University (Vladivostok). Part of this collection was examined by the author as well as by Uwe Braun (Halle, Germany). It revealed scanty mycelium and scattered chasmothecia on the upper side of horse chestnut leaves. The only more or less mature ascomata belonged to *Phyllactinia guttata* (Wallr. : Fr.) Lév. that differs from *E. flexuosa* and *S. bicornis* by having much larger ascomata, asci and ascospores as well as lanceolate appendages with bulbose basal swelling and 2-spored asci. While these singly placed ascomata were not associated with the mycelium, one of the few ascomata located among the mycelium had no appendages but contained 8-spored asci. The mycelium revealed no trace of conidiophores or conidia. Neither did we observe hyphae with lobed appressoria that would indicate the possible presence of *E. flexuosa*. Therefore, the scarce powdery mildew on the horse chestnut tree from the Russian Far East cannot be unambiguously identified and should be excluded from the lists of records of *E. flexuosa*.

Differences in interpreting the unique feature of two types of appendages (Fig. 1b) in the powdery mildew species on horse chestnuts have determined its generic placement. Although it was originally described as *Uncinula flexuosa* Peck, Braun (1981) transferred this species to the genus *Uncinuliella* R. Y. Zheng & G. Q Chen, which he later synonymized with Uncinula Lév. (Braun, 1995). Recent advances in molecular systematics and the assessment of anamorph characters in the Erysiphales have settled the species in *Erysiphe* (Braun & Takamatsu, 2000).

The microscopic characteristics of Estonian specimens of *E. flexuosa* match well those in the literature. The majority of the collections contain well-developed mycelium disappearing with age and profuse ascomata (Fig 1a). Chasmothecia often appear more abundant on the lower surface of the leaves; on some leaves, the colonies are circular rather than irregularly effused. Remarkably, in TAA(M) 170980, the colonies of *E. flexuosa* on the upper side of leaves are exclusively associated with sterile brown lesions, probably caused by *G. aesculi*.

Examination of the age and the distance between infected trees revealed no preferences in pathogen invasion. At two locations, old, uninfected horse chestnut trees grew approximately 300 m from young infected trees. In a park in Tartu, as well as in Puhja, a healthy tree was growing next to a severely infected tree. Such preliminary observations, revealing the sporadic occurrence of *E. flexuosa* on *A. hippocastanum*, suggest that the powdery mildew most probably reached Estonia not many years before its discovery here in 2005. Its distribution and frequency are not yet comparable to those of the rust *Melampsoridium hiratsukanum* S. Ito that has caused an epidemic on *Alnus incana* (L.) Moench in Estonia since 1996 (Põldmaa, 1997).

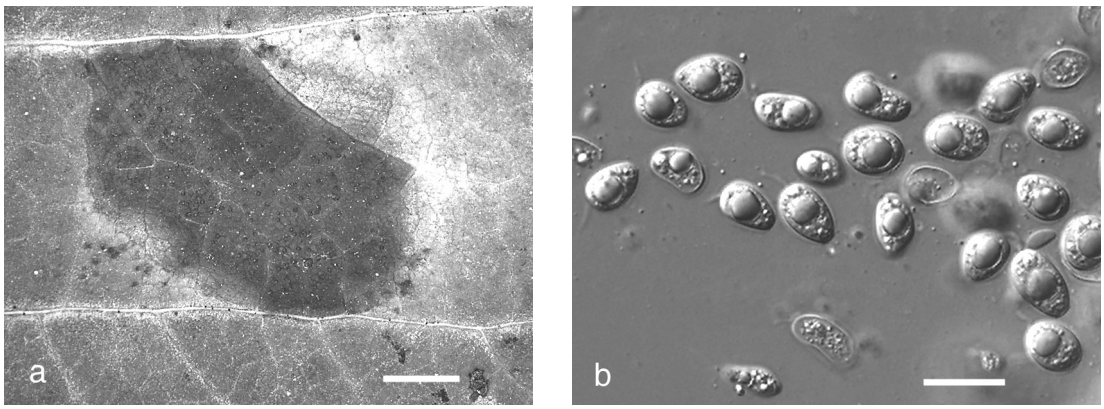


**Fig. 2.** *Phyllosticta* anamorph of *Guignardia aesculi*. **a.** Dark blotch with light margins and numerous dark pycnidia on the upper side of a leaf of *A. hippocastanum*. **b.** Conidia. a – TAA(M) 170990, b – TAA(M) 170993. Scale bars: a = 0.25 mm, b = 20 µm.

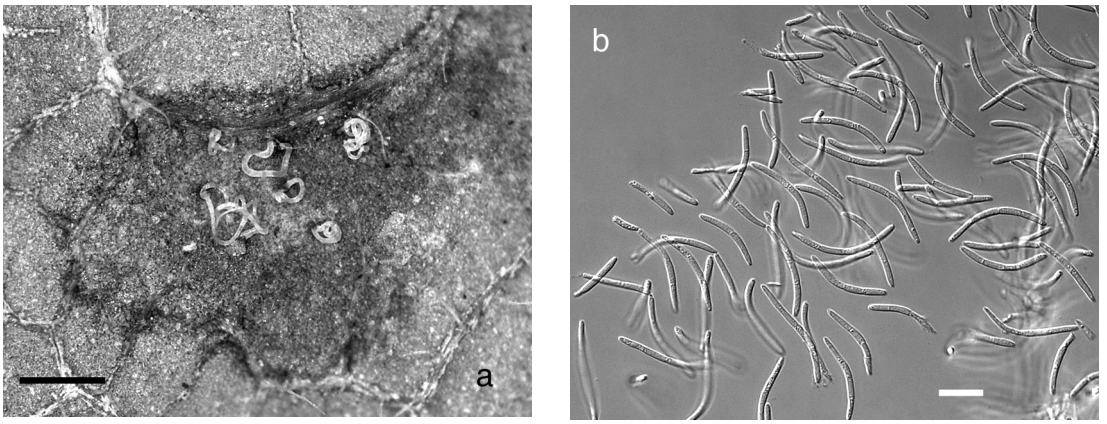


**Fig. 3.** *Septoria aesculicola*, TAA(M) 170997. **a.** Dark lesion on the underside of a leaf of *A. hippocastanum* with immersed pycnidia and extruded masses of conidia. **b.** 3-septate conidia. Scale bars: a = 0.5 mm, b = 20 µm.

The time of emergence and extent of spread of *Guignardia aesculi* in Estonia, are, however, unkown. *Septoria aesculicola* (Fr.) Sacc., on the contrary, seems to be quite abundant and widespread in Estonia, despite the scarce records on it in the literature. Its first citation by Dietrich (1856): "not rarely on leaves of horse chestnut" has been followed by a single record from North Estonia (Põldmaa, 1967). It is noteworthy that concurrently one more pest of horse chestnut trees, the moth *Cameraria ohridella* Deschka & Dimic, is rapidly expanding its distribution range in Europe though negatively interacting with *G. aesculi* (Gilbert et al., 2003). Although not yet discovered in Estonia, it has recently reached Latvia (Jürivete, pers. comm.).

While *E. flexuosa* grows exclusively on species of *Aesculus*, in Europe trees of this genus occasionally serve as hosts of other powdery mildews: *Erysiphe* (*Microsphaera*) *alphitoides* (Griffon & Maubl.) U. Braun & S. Takam., *Phyllactinia guttata* and *Sawadaea bicornis* (Braun, 1987, 1995; Karis, 1995). Although all these species occur in Estonia, none of them has been found on horse chestnuts here. Leaves of a horse chestnut tree from a private garden in Tartu (TAA(M) 170997), however, revealed among the chasmothecia of *E. flexuosa* many those of *P. guttata*. As in the specimen from the Russian Far East, the ascomata were exclusively attached to the upper surface of the leaves, but without any trace of associated mycelium. This suggests wind-blown origin of the ascomata of *P. guttata* in these specimens, while generally they are hypophyllous in this species.

The specimens examined (all collected in October 2005 by the author if not indicated otherwise); [1] marks the presence of *G. aesculi* and [2] *S. aesculicola*:

On *Aesculus hippocastanum*:

Harjumaa Co., Tallinn (leg. T. Ploompuu) : Nõmme, TAA(M) 170999; Kadriorg, TAA(M) 171000, TAA(M) 171001. Tartumaa Co., Tartu: Raadi cemetery, TAA(M) 170975; Tähtvere, TAA(M) 170978[2]; Karlova, TAA(M) 170979[1], 170980[1?,2]; Räni, TAA(M) 170994[2]; Tammelinn, TAA(M) 170997[2]. Puhja, TAA(M) 170981[2]. Viljandimaa Co., Viljandi, TAA(M) 170982[2]; Õisu, TAA(M) 170983, Kõpu, TAA(M) 170993[1]. Pärnumaa Co., Lodja, TAA(M) 170990[1].

On *Aesculus* x *carnea* Hayne:

Harjumaa Co., Tallinn: Kadriorg, leg. T. Ploompuu, TAA(M) 171002.

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am indebted to Harry Karis for sharing his observations on powdery mildews, to Tõnu Ploompuu for collecting material from Tallinn, and to Urmas Jürivete (all three from Tallinn) for the information on the distribution of the leafminer. Mall Vaasma (Tartu) is thanked for her kind assistance.

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# A list of Pezizales and Thelebolales of Latvia

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**Abstract:** A list of Pezizales and Thelebolales of Latvia comprising 139 species is provided. A new genus of the Pyronemataceae *Smarodsia* with a new species *Smarodsia stollii* and another new species *Cheilymenia tervetensis* are described.

**Kokkuvõte**: Seltside Pezizales ja Thelebolales Lätist leitud liikide nimestik.

Esitatakse 139 liigist koosnev Läti Pezizales ja Thelebolales liikide nimestik. Kirjeldatakse sugukonna Pyronemataceae uus perekond *Smarodsia* uue liigiga *Smarodsia stollii* ja samuti uus liik *Cheilymenia tervetensis.*

## INTRODUCTION

Operculate discomycetes – Pezizales – are widely present in Latvian nature. This fungal group has been, however, not studied in detail in Latvia. Bucholtz (1900, 1902, 1908) has published data on hypogeous species of this group. Stoll (1913–1939, 1931) has collected some fragmentary data on operculate discomycetes. In the second half of the 20th century E. Vimba has more or less systematically collected operculate discomycetes. These collections are deposited in the herbarium of the University of Latvia (RIG). A small number of collection collected by A. Raitviir is deposited in the Mycological Herbarium of the Estonian Agricultural University (TAA). If the collector's name is indicated for cited specimens then the RIG-collections are collected by E. Vimba and TAA collections by A. Raitviir.

Some data on the distribution of operculate discomycetes have been published by Vimba (1970) and Vimba & Raitviir (1970), more fragmentary data are included in the papers by Kupffer (1931), Skuja (1936), Pučko (1954), Smarods (1956), Lūkins (1967, 1968, 1981) and Kalamees & Vimba (1985). Data on coprophilous Pezizales and Thelebolales in Latvia are included in the monograph by Prochorov (2004) who has listed 22 species as identified by him from Latvian collections.

The present paper intends to summarize published and unpublished herbarium data. All previous published data are compiled by E. Vimba. He has also preliminarily identified many collections. A. Raitviir has verified these identifications and identified the remaining collections, and also critically checked the watercolour plates of discomycetes by Stoll (1913-1939) which provide interesting data on some rare species.

The authors have followed the classification of Ascomycetes by Eriksson (2005) and included in the list in addition to Pezizales also Thelebolales because this small group of coprophilous species, now placed in Leotiomycetes, is still collected and studied together with coprophilous Pezizales.

The total number of species of Pezizales and Thelebolales found in Latvia is 139. The taxonomic diversity by families is presented in Tab. 1. Three species, *Otidea onotica, Peziza ammophila* and *Sarcosoma globosum* are protected by the Law.

**Table 1.** Number of genera and species by families of Pezizales and Thelebolales in Latvia

| Family | Number of genera | Number of species |
|---|---|---|
| Pezizaceae | 4 | 19 |
| Ascobolaceae | 3 | 11 |
| Helvellaceae | 2 | 11 |
| Discinaceae | 3 | 6 |
| Rhizinaceae | 1 | 1 |
| Morchellaceae | 3 | 9 |
| Tuberaceae | 2 | 5 |
| Pyronemataceae | 30 | 66 |
| Sarcoscyphaceae | 2 | 2 |
| Sarcosomataceae | 3 | 3 |
| Thelebolaceae | 3 | 6 |
| In total | 55 | 139 |

**Pezizaceae**

Iodophanus carneus (Pers.: Fr.) Korf – Reported from Latvia by Prochorov (2004).

Pachyphloeus melanoxanthus (Berk.) Tul. & C. Tul. – Very rare in deciduous forests. Riga County, Bulduri, (Bucholtz, 1900); Riga County, Kemeri (Bucholtz, 1907: "9.VIII 1907 im Park von Kemmern unter einem Haselstrauch. Die Oberflšche des Fruchtkörpers war gelb und warzig."; Skuja, 1936; Pučko, 1954).

Peziza ammophila Durieu & Mont. – Uncommon on dunes. Riga County, Mangali, 04.11.1964. coll. A. Piter,ns (RIG-3752); Talsi County, Kolka, 16.08.1995 (RIG-7783), 16.08.1995.(RIG-7784), 20.08.1995 (RIG-7785), 23.07.1996 (RIG-8196), 07.07.1998, coll. D.Meiere (RIG-6040) Liepaja County, Jurmalciems, 22.09.1995, coll. B.Laime (RIG-7837); Riga County, Lilaste, 29.09.2001, coll. A.Opmanis (RIG-6001). Reported from Riga County, Garciems (Stoll, 1931, Skuja, 1936) as *Geopyxis ammophila* (Mont. et Dur.) Sacc.) and Peterupe (Stoll, 1913–1939).

P. ampliata Pers.: Fr. – Very rare. Valmiera County, Mazsalaca, on rotting wood, 03.03.1963 (RIG-2687), (Vimba & Raitviir, 1970).

P. atrovinosa Cooke & W.R. Gerard – Very rare. Madona County, Kalsnava, experimental station, on seedlings of *Thuja* sp, 29.05.1980 (RIG-4765).

P. badia Pers.: Fr. – Not uncommon but rarely collected in coniferous forests on the soil in autumn.

P. brunneoatra Desm. – Very rare. Riga County, Riga, on the soil, 13.07.2004 (RIG-6427).

P. domiciliana Cooke – Very rare. Dobele County, Tervete, on rich soil, 27.08.1984 (RIG-6381).

P. echinispora P. Karst. – Not rare in forests on burnt ground . Valmiera County, Mazsalaca, 20.08.1962 (RIG-3753); (Vimba & Raitviir, 1970); Jelgava County, Cena, coll. G.Aldermane, 1968: (Vimba & Raitviir, 1970); Dobele County, Tervete, 29.07.1961 (RIG-3754); (Vimba & Raitviir, 1970); Saldus County, Lasupe, 25.10.1970 (RIG-6433).

P. fimeti (Fuckel) Seaver – Reported from Latvia by Prochorov (2004).

P. lobulata (Velen.) Svrček – Common on sterile soil, especially on burnt ground among *Funaria hygrometrica*.

P. michelii (Boud.) Dennis – Very rare. Riga County, Kemeri, on rich soil, 23.07.1962 (RIG-3755), (Vimba & Raitviir, 1970).

P. micropus Pers.: Fr. – Very rare. Riga County, Riga, on wood debris, 27.06.2004 (RIG-6368).

P. repanda Pers.: Fr. – Rare on rich soil. Valmiera County, Mazsalaca, 07.08.1966 (RIG-3680), Vimba & Raitviir, 1970; Riga County, Riga, 07.10.2001, coll. B.Vimba (RIG-6059); Riga County, Olaine: Davji, 03.06.2001, coll. A.Piterans, (RIG-6058); Ogre County, Suntazi, 18.06.1955 (RIG-726), (Vimba & Raitviir, 1970).

P. vacinii (Velen.) Svrček – Very rare. Madona County, Cesvaine, on burnt ground, 19.07.1972 (RIG-6389).
Note: This species which is easily recognizable by its unique spore ornamentation of high pyramidal ridges or high truncate spines is a very rare one. It has been reported from less than 10 localities in Czech Republic, England (Moravec & Spooner, 1998), Germany (Benkert, 1991) and Norway (Hansen & Knudsen, 2000). Now the range of distribution of this carbophilous species is extended to Latvia.

P. varia Hedw (syn.: *Peziza cerea* Bull.: Fr., *P. muralis* Sowerby) – Fairly common on debris of the wood, on peat, plaster covering timber, sometimes in wet cellars.

P. vesiculosa Bull.: Fr. – Rare. Riga County, Olaine, on rich soil, 13.11.1961 (RIG-2314), (Vimba & Raitviir, 1970); Riga County, Riga, on sacks of substrata for cultivating *Pleurotus ostreatus*, 01.1996, coll. V.Vavere (RIG-7919).

P. violacea Pers.: Fr.– Rare. Dobele County, Tervete, on burnt ground, 25.06.1977 (RIG-6431).

Plicaria trachycarpa (Curr.) Boud. – Very rare. Cesis County, Zvartas iezis, on burnt ground, 11.10.1959 (RIG-1230), (Vimba, 1970, sub *Plicariella trachycarpa* Rehm).

**Ascobolaceae**

Ascobolus carbonarius P. Karst. – Very rare. Tukums County, Smarde, on a fireplace, 30.06.1962 (RIG-3741), (Vimba & Raitviir, 1970).

A. furfuraceus Pers. – Common on cow dung but rarely collected.: Talsi County, Slitere, 30.09.1980 (RIG-5157), Riga County, Sigulda, 06.10.1974 (RIG-4808); Riga County, Dole, 25.07.1962 (RIG-6383); also reported by Prochorov (2004).

A. glaber Fr. – Very rare. Dobele County, Tervete, on cow dung, 09.08.1961 (RIG-2455), Vimba & Raitviir, 1970.

A. immersus Pers.: Fr. – Reported from Latvia by Prochorov (2004).

A. michaudii Boud. – Very rare. Talsi County, Dundaga (Rakupe), on elk dung, 24.08.1982 (RIG-5401).

A. minutus Boud. – Reported from Latvia by Prochorov (2004).

A. sacchariferus Brumm. – Rare. Talsi County, Slitere, 1988. (RIG-6829); also reported from Latvia by Prochorov (2004).

Saccobolus depauperatus (Berk. & Broome) E.C. Hansen – Reported from Latvia by Prochorov (2004).

S. versicolor (P. Karst.) P. Karst. – Reported from Latvia by Prochorov (2004).

Thecotheus cinereus (H. Crouan & P. Crouan) Chenant. – Reported from Latvia by Prochorov (2004).
Note: The Latvian collection is growing on bare soil which is more rare substrate than twigs and wood in water for this species.

T. rivicola (Vacek) Kimbr. & Pfister – Very rare. Talsi County, Vidale, on sandy wet soil, 09.06.1972 (RIG-6396).

**Helvellaceae**

Balsamia platyspora Berk. & Broome – Very rare. Dobele County, Tervete, in soil under oak trees, 03.07.1983 (RIG-7625).

Helvella. acetabulum (Fr.) Quél. – Common on the ground in forests, especially on forest roads and other places in late spring.

H. albella Quél. – Very rare, Riga County, Mangalsala, on the soil, 09.1986, coll. I. Lodzina (RIG-6426).

H. atra König – Not common on the soil among grass in the forests. Limbazi County, Mernieki, 03.09.1973 (RIG-3989). Reported also by Skuja (1954) and Pučko (1954).

H. bulbosa (Hedw.: Fr.) Kreisel (syn.: *H. macropus* (Pers.: Fr.) P. Karst.) – Common on the ground in the forests.

H. crispa Scop: Fr. – Common in mixed and deciduous forests among grass especially late in the summer.

H. elastica Bull.: Fr. – Very common in mixed forests late in the summer and autumn. Pučko (1954) reported it as *Helvella pulla* Holmsk.

H. ephippium Lév. – Very rare. Riga County, Sala, on sandy soil in pine forest. 10. 1972 (RIG-4796).

H. lacunosa Afzel.: Fr. – Common in the mixed forests in the autumn.

H. leucomelaeana (Pers.) Nannf. – Very rare. Riga County, Sigulda 25.05.1928, on sandy soil under Salix by the river Gauja (Stoll, 1913-1939 as *Otidea cochleata*).
Note: The second author has examined the original watercolour plate by Stoll (no. 2028/407.828) and found that the external view of apothecium, uniguttulate spore, 20/11,5 µm and collecting time leave no doubt that Stoll has been misled by accidentally asymmetrical apothecia.

H. stevensii Peck – Very rare. Dobele County, Tervete, on sandy soil in forest, 17.07.1970.(RIG-4799).

**Discinaceae**

Discina gigas (Krombh.) Eckblad (syn.: *Gyromitra gigas* (Krombh.) Rehm) - Rare in mixed forests. Riga County, Sigulda, Vimba (1974); Dobele County, Tervete, 12.05.1974 (RIG-3972); Liepaja County, Mazgramzda, 27.05.1972 (RIG-3819).

D. perlata (Fr.) Fr. - Common on the ground in spring.

Gyromitra ambigua (P. Karst.) Harmaja – Very rare. Riga County,. Henselshof = Ropazi?, 25. 09 1932 (Stoll, 1913-1939 as *Helvella infula*).
Note: Stoll's excellent watercolour (original plate no. 2028/407.828 which shows deep violaceous stipe and provided spore size 22–24/9.5–11.5 µm leave no doubt that his collection represents *G. ambigua*.

G. esculenta (Pers.) Fr. – Very common on sandy soil in dry pine forests in the spring.

G. infula (Schaeff.) Quél. – Common on ground and decaying wood in forests in late summer and autumn.

Hydnotrya tulasnei Berk. & Broome – Rare in deciduous and coniferous forests. Riga County, Krimulda (Bucholtz, 1905; Skuja, 1936; Pučko, 1954); Ogre County, Inikile, 25.07.1984 (RIG-s.n.); Talsi County, Kolka, 13.07.1996, coll. D.Vimba (RIG-8248).

**Rhizinaceae**

Rhizina undulata Fr. (syn.: *R. inflata* Schaeff.) – Very common on burnt areas.

**Morchellaceae**

Disciotis venosa (Fr.) Boud. – Common on the ground in the spring.

Morchella conica Pers.: Fr. – Fairly common in mixed forest in the spring.

M. crassipes (Vent.) Pers. – Rare on the ground among grasses in mixed forests. Riga County, Kemeri, 1927, (Stoll, 1913-1939; Skuja, 1936); Jelgava County, Klive, 1939 (Stoll, 1913-1939).

M. deliciosa Fr. – Very rare. Riga County, Riga, in the Botanical garden of the University of Latvia together with cultivated *Sempervivum* sp., 10.05.1972 (RIG-3809).

M. elata Fr. – Fairly common on sandy soil in mixed and deciduous forests, parks and gardens in spring and early summer.

M. esculenta (L.: Fr.) Pers. – Common on the soil in deciduous forests, parks and gardens in spring.

M. semilibera DC.: Fr (syn.: *Morchella rimosipes* DC.: Fr.; *Morchella hybrida* (Sowerby) Boud.) – Not rare on rich soil in deciduous forests, parks and gardens, from spring to early summer. Pučko (1954), Vimba & Raitviir (1970) as *M. hybrida*.

Verpa bohemica (Krombh.) J. Schröt (syn.: *Ptychoverpa bohemica* (Krombh.)Boud.).– Very common on rich soil in deciduous and mixed forests in spring.

V. conica (O. Müller: Fr.) Sowerby (syn.: *V. digitaliformis* Pers.) – Not rare on the ground in deciduous forests and bushes in the spring.

**Tuberaceae**

Choiromyces venosus (Fr.) Th. Fr (syn.: *Ch. meandriformis* Vittad.) – Very rare. Riga County, Bulduri (Bucholtz, 1900).

Tuber dryophilum Tul. & C. Tul. – Very rare. Dobele County, Tervete, 14.07.1982. (RIG-6405).

T. maculatum Vittad. – Very rare, Bauska County, Brunava, in deciduous forest, 25.08.1980, coll. R. Steinberga (RIG-6402).

T. rapaeodorum Tul. & C. Tul. – Very rare. Dobele County, Tervete, under oak trees, 03.07.1983. (RIG-7626).

T. rufum Pico ex Fr. – Very rare. Riga County, Riga, 1981 ( oral information by E. Kalnina).

**Excluded species:**
*Tuber brumale* Vitt. – Pučko (1954) has included this species in his key to Latvian fungi although already Bucholtz (1902) has strongly doubted if the species has ever been found in Russian Empire and Skuja (1936) has said that existing old

data have not been confirmed. Pučko has probably misenterpreted Friebe (1805: 397, no 348: Essbare Trüffel. Tuber Gulsorum (*Lycoperdon Tuber*). Die Trüffeln sind inwending weiss und haben einen knoblauchartigen Geruch.) who has evidently described not Tuber brumale.

**Pyronemataceae**

Aleuria aurantia (Fr.) Fuckel – Very common on sandy soil in autumn.

Anthracobia macrocystis (Cooke) Boud. – Very rare. Dobele County, Tervete, on burnt ground, 13.06.1990 (RIG-6408).

A. maurilabra (Cooke) Boud. – Rare on fireplaces. Talsi County, Vidale, 09.06.1972 (RIG--5153); Riga County, Sigulda, 31.05.1974 (RIG-5152); Aizkraukle County, Skriveri, 09.07.1972 (RIG-5154).

A. melaloma (Fr.) Boud. – Fairly common on fireplaces but rarely collected. Cesis County, Zvartas iezis, 11.10.1959. (RIG-1232),Vimba & Raitviir (1970), Vimba, (1970); Limbazi County, Vitrupe, 10.10.1971 (RIG-6412); Talsi County, Vidale, 09.06.1972 (RIG-6413).

Ascodesmis sphaerospora W. Obrist – Reported from Latvia by Prochorov (2004).

Byssonectria cartilagineum (Kanouse & Smith) Pfister – Very rare. Ogre County, Ikskile, 12.04.1973, coll. M.Mengote (RIG-3923).
Note: This collection comprises young apothecia having spores only within asci where they measure only 14-18 µm long.

B. terrestris (Alb. & Schwein.: Fr.) Pfister (syn.: *Inermisia aggregata* (Berk. & Broome) Svrček; *Inermisia buchsii* (Henn.) J. Moravec) – Common on dung and plant debris from early spring to early summer.

Caloscypha fulgens (Fr.) Boud. – Rare on the ground in the forests. Riga County, Sigulda, 02.05.1977 (RIG-4453), Riga County, Riga, 23.04.1983. coll. B.Vimba (RIG- 5256), Dobele County, Tervete, 12.05.1981 (RIG-5464); Riga County, Sigulda, 02.05.1977, coll. B.Vimba (RIG-4453).

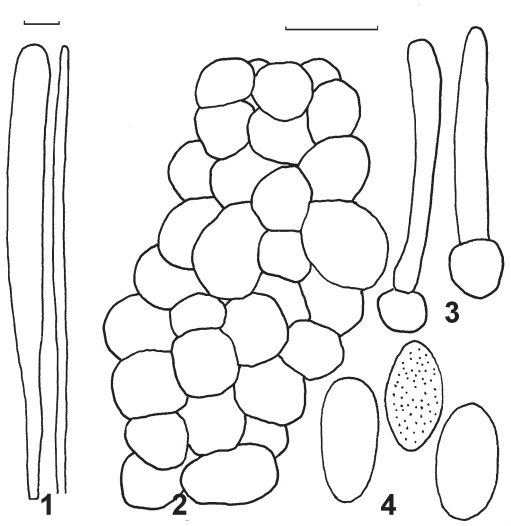
Cheilymenia crucipila (Cooke & Phill.) LeGal – Very rare. Ogre County, Ogresgals, on forest road, 10.07.1961 (RIG-3743), Vimba & Raitviir (1970).

Ch. fimicola (De Not. & Bagl.) Dennis (syn.: *Cheilymenia coprinaria* (Cooke) Boud.) – Reported from Latvia by Prochorov (2004) as *C. coprinaria*.

Ch. granulata (Bull.) J. Moravec (Syn.*Coprobia granulata* (Fr.) Boud. – Very common on cow dung.

Ch. stercorea (Fr.) Boud. – Common on cow and elk dung but rarely collected. Gulbene County, Tirza, 20.09.1958 (RIG-561), Plavinas, 21.07.1961 (RIG-3744), Vimba (1970).

**Cheilymenia tervetensis Raitv. & Vimba species nova Figs. 1–4**.
*Cheilymenia stercoraria (Velen.) J. Moravec similis, sed sporis minoribus 12–16 x 6–8 µm et habitatione terrestri differt.*
Etymology: referring to the type locality of the species.
Apothecia 2–5 mm in diameter, sessile, shallow cup-shaped to saucer-shaped, disc deep orange to reddish orange, receptacle somewhat paler than the disc, externally smooth. Ectal excipulum pale ochraceous brown in section, of textura globulosa, cells thin-walled to firm-walled with hyaline to pale ochraceous walls, 7–12 µm wide. There are groups of darker pigmented ochraceous-brown cells on the outer surface of the ectal excipulum. Hairs extremely scanty, present as up to 30 µm long hyaline outgrowths from the outermost cells but. Asci aporhynchous, cylindrical, 160-180 x 8–11 µm, apically not bluing in MLZ, 8-spored. Ascospores ellipsoid, 14–16 x 7–8 µm in KOH, 12–14 x 6–7 in CB, very finely punctate, without inclusions, perisporium loosening when heated in lactic acid. Paraphyses cylindrical, straight, apically not swollen, up to 2 µm wide, filled with numerous small orange drops.
On bare sandy soil.
Specimen examined: Latvia, Dobele County, Tervete, on bare soil sparsely covered by mosses between a fireplace and forest road, 23.08. 2005, coll. A. Raitviir & E. Vimba (Holotype TAA(M) 190025).




**Figs. 1–4.** *Cheilymenia tervetensis*. 1 – ascus and paraphysis; 2 – ectal excipulum; 3 – two hairs; 4 – spores. Bars = 20 μm.

Notes: This species belongs to the section *Micropilosae* Moravec of the genus *Cheilymenia* Boud. which is characterized by extremely rudimentary hairs, sparse hair-like outgrowths from outermost cells of ectal excipulum. Until the present study the section has been monotypic comprising the only species *C. stercoraria* (Velen.) J. Moravec. It is a coprophilous species with reddish hymenium and broadly ellipsoid spores. *C. tervetensis* is macroscopically quite similar to *C. stercoraria* but is strictly terrestrial growing on sandy soil, has much smaller cells of ectal excipulum and more narrow ellipsoid spores covered with finer punctate ornamentation than irregulary warted spores of *C. stercoraria*. It was growing between a fireplace and forest road, but outside of burnt zone together with some apothecia of Trichophaea hybrida on sandy soil covered by a few mosses and cannot be considered as a carbofilous species.

Cheilymenia theleboloides (Alb. & Schwein.: Fr.) Boud. – Reported from Latvia by Prochorov (2004).

Ch. vitellina (Fr.) Dennis – Very rare: Madona County, Laudona, on damp road in forest, 14.07.1970 (RIG-5158).

Coprotus dextrinoideus Kimbr., Luck-Allen & Cain – Reported from Latvia by Prochorov (2004).

C. luteus Kimbr., Kimbr., Luck-Allen & Cain – Reported from Latvia by Prochorov (2004).

C. glaucellus (Rehm) Kimbr. – Very rare. Valmiera County, Mazsalaca, on elk dung, 14.08.1964 (RIG-3742).

Genea hispidula Berk. & Broome ex Tul.& C. Tul. – Very rare. Riga County, Turaida, in a Devonian sandstone cave, 10.10.1983, coll. J. Smalinskis (RIG-7627).

Geopora arenicola (Lév.) Kers. ( syn.: *Sepultaria arenicola* (Lév.) Kunze, *Geopora arenosa* (Fuckel) S. Ahmad) – Not rare, especially on coastal dunes in autumn, rarely out of this zone.

Geopyxis carbonaria (Alb. & Schwein.) Rehm – Very common on fireplaces.

Humaria aurantia (Clem.) Häffner, Benkert & Krisai– Very rare. Dobele County, Tervete, on the soil, 03.07.1983, det. R. Dougoud, (RIG-6495).
Note: This beautiful species with ochraceous yellow to orange hymenium is evidently a very rare one. Häffner & al. (1994) list only 9 localities, one from North America, others from France, Germany, Switzerland, Austria and. India. In Latvia this species is evidently a relict of Atlantic Climatic Period.

H. hemisphaerica (F.H. Wigg.: Fr.) Fuckel – Very common in forests on decaying wood in the soil.

Hydnocystis piligera Tul. & C. Tul.– Very rare. Riga County, In vicinity of Riga, autumn 1903 (Bucholtz, 1904).

Lasiobolus cuniculi Velen. – Reported from Latvia by Prochorov (2004).

L. intermedius J.L. Bezerra & Kimbr. – Uncommon on elk dung. Talsi County, Slitere, without date (RIG-6827), 18.06.1980 (RIG-7061), 11.07.1989.(RIG- 8336). Also reported from Latvia by Prochorov (2004).

L. macrotrichus Rea – Very rare. Talsi County, Slitere, on elk dung, without date (RIG-6828), 04.06.1988.(RIG-8337).

Lasiobolus equinus (O.F. Müll.) P. Karst (syn.: *L. papillatus* (Pers.: Fr.) Sacc., *L. ciliatus* (J.C. Schmidt) Boud.) – Reported from Latvia by Prochorov (2004).

Marcelleina atroviolacea (Delile ex De Seynes) Brumm. – Very rare. Ogre County, Ogre, 24.06.1972 (RIG-5442).

Melastiza cornubiensis (Berk. & Broome) J. Moravec (syn. *M. chateri* (Wm.G. Sm.) Boud. Riga County, Riga Stoll, 1913–1939 (1923) ( sub *Lachnea miniata* Fuck.).

M. flavorubens (Rehm) Pfister & Korf – Very rare on rich soil in forests, Talsi County, Ives parkas, 17.08.1988, coll. B.Vimba (RIG-6380).

Nannfeldtiella guldeniae (Svrček) Svrček (syn.: *N. aggregata* Eckblad, *Pseudombrophila tetraspora* Harmaja, *P. aggregata* (Eckblad) Harmaja) – Not common on subiculum of *Byssonectria terrestris* in spring or early summer. Riga County, Suzi, 30.03.1975, coll. A.Piterans (RIG- 4207): Riga County, Lozmetejkalns, 26.04.1970 (RIG-4824).

Neottiella hetieri Boud. – Very rare. Dobele County, Tervete, on burnt place among *Funaria hygrometrica*, 08.05.1989, coll. B.Vimba (RIG-6384).

N. rutilans (Fr.) Dennis – Rare on sandy soil among moss. Riga County, Priedaine, 1934 (Stoll, 1913-1939, as *Aleuria rutilans* Fr.); Tukums County, Lepstes, 06.09.1986 (RIG-6392).

N. vivida (Nyl.) Dennis – Rare. Preili County, Jaunaglona, on moss of the genus *Polytrichum*, 17.09.1966 (RIG-3681), Vimba & Raitviir (1970).

Octospora leucoloma Hedw.: Fr. – Very rare. Dobele County, Tervete, among grass on the soil in pine forest, 02.11.1974 (RIG-6397).

O. roxheimii Dennis & Itzerott – Very rare. Ogre County, Ciemupe, on burnt ground among moss, 27.10.1952 (RIG-1265).

Otidea alutacea (Pers.: Fr.) Massee – Rare on soil in woods. Riga County, Riga, 07.09.1986, coll. B.Vimba (RIG-8322); Cesis County, Ieriki, 07.09.2001. (RIG-5972).

O. bufonia (Pers.: Fr.) Boud. – Uncommon on the ground under coniferous and deciduous tress, from summer to autumn.

O. concinna (Pers.: Fr.) Sacc. – Rare on rich soil in deciduous and mixed forests. Talsi County, Skede, 14.09.1972 (RIG-4814); Madona County, Kuldiga County, Edole, 15.08.1988, coll. U. Susko (RIG-8314); Dobele County, Tervete, 06.08.1972 (RIG-4825).

O. felina (Pers.) Bres. – Fairly rare on the ground in woods. Aizkraukle County, Koknese, Stoll (1913–1939) as *Otidea alutacea*; Aizkraukle County, Aizkraukle, 19.08.1995, coll. Digne Pilate (RIG-6375); Talsi County, Skede, 20.08.1978 (RIG-5446); Madona County, Cesvaine, 19.07.1972 (RIG-4826); Dobele County, Tervete, 21.08.1988 (RIG-6690).

O. grandis (Pers.) Rehm – Very rare in coniferous forests on calcareous soil. Riga County, Babite, 05.07.2004, coll. L.Vulfa (RIG-6428).

O. leporina (Batsch: Fr.) Fuckel – Fairly common among mosses in coniferous forests, autumn.

O. onotica (Pers.: Fr.) Fuckel – Uncommon in rich soil in mixed and deciduous forests among mosses and other plants.

O. smithii Kanouse – Very rare on rich soil. Tukums County, Milzkalne, 06.09.1981 (RIG-5501, 5502).

Pulvinula carbonaria (Fuckel) Boud. – Very rare. Talsi County, Slitere, on burnt ground, 13.10.1971 (RIG-5447).

P. constellatio (Berk. & Broome) Boud. – Rare in sandy soil. Dobele County, Tervete, 21.08.1961 (RIG-3759), Vimba & Raitviir (1970); 18.08.1970 (RIG-5511).

Pulvinula convexella (P. Karst.) Pfister – Rare. Ogre County, Ogre, on sandy soil, 31.07.1977 (RIG-5448).

P. laeterubra (Rehm) Pfister – Very rare, Tukums County, Milzkalne, on snady soil, 31.08.1985, coll. B.Vimba (RIG-6382).

Pyronema confluens (Pers.) Tul. & C. Tul (syn.: *P. omphalodes* (Bull.) Fuckel – Fairly common on burnt ground. already in one week after fire.

Scutellinia olivascens (Cooke) Kuntze (syn. *S. ampullacea* (L.: Fr.) Lambotte) – Very rare, Talsi County, Slitere (Kalamees & Vimba, 1985).

S. parvispora J. Moravec – Very rare. Cesis County, Drabesi, on wet soil, 10.08.1996, coll. anonymus (RIG-6416).

S. pseudoumbrarum J. Moravec – Very rare. Limbazi County, Stiene, 16.07.2004 (RIG-6417).

S. scutellata (L.: Fr.) Lambotte – Very common on decaying wood on wet ground and among mosses.

S. setosa (Nees: Fr.) O. Kuntze – Very rare. Valmiera County, Vaidava, 22.09.1994, coll. I. Avota (RIG-6434).

S. trechispora (Berk. & Broome) Lambotte – Very rare. Tukums County, Kandava, Cuzu purvs, 17.09.1987 (RIG-6411).

**Smarodsia Raitv. & Vimba gen. nov.**

*Genus pyronematacearum Kotlabaea Svrcek similis sed in sporis distincte guttulatis et pilis setiformibus crassiter tunicatis differt.*

Typus generis: *Smarodsia stollii* Raitv. & Vimba

Apothecia terrestrial, minute, broadly sessile, discoid to saucer-shaped, disc pale yellowish to pale ochraceous or orange-yellowish, receptacle concolorous with the disc, externally smooth. Ectal excipulum of hyaline, large-celled textura globulosa. The cells of outer layers have thick, refracting walls. Hairs scanty, hyaline, aseptate, firm-walled to thick-walled, cylindrical to conical, obtusely rounded, rarely almost pointed, straight to slightly flexuous, arising superficially from a basal cell. Asci pleurorhynchous, cylindrical, apically not bluing in MLZ, at first 8-spored but 4-spored at maturity in type species. Ascospores ellipsoid-fusoid, containing 2 big, more rarely 1 big or 1 big and several small lipid globules, sometimes with numerous small globules or granulose cytoplasma, spore wall without changes when heated in lactic acid. Paraphyses apically clavate, filled with numerous small yellowish drops in CB.

Etymology: named in the honour of Latvian mycologist J. Smarods.

**Smarodsia stollii Raitv. & Vimba species nova Figs. 5–8**

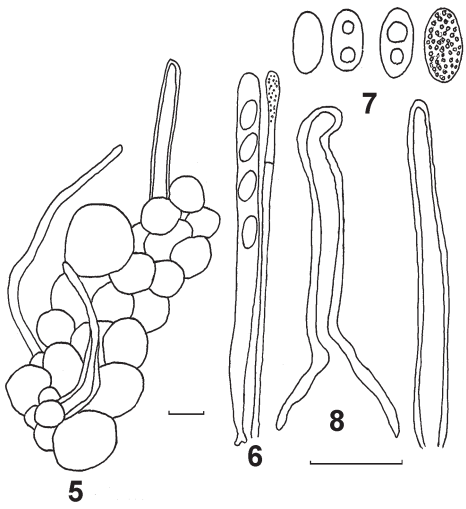
*Apothecia sessilia discoidea, pallide lutea usque ad pallide ochracea vel aurantiaco lutea, 1–1.5 mm in diametro. Exipulum ectale ex textura globulosa, cellulis hyalinis, 15–30 µm in diametro. Pili sparsi, hyalini, cylindracei usque ad conici, tenuiter tunicati usque ad crassiter tunicati, 45–75 x 5–8 µm. Asci uncinati, cylindracei, 160–190 x 10–12 µm, primo octospori, maturitatem quadrospori. Sporae ellipsoideo-fusoideae, 17–20 x 9–10 µm in KOH, 15.5–17 x 7–8.5 µm in CB, bi- vel uniguttulate vel minute multiguttulatae. Paraphyses apicibus clavatis ad 6.5 µm latis minute luteoguttulatis.*

*Ad terram argillaceo-arenosam crescit.*

Etymology: Named in the honour of Latvian mycologist F.E. Stoll.

Apothecia 1–1.5 mm in diameter, broadly sessile, discoid to saucer-shaped, disc pale yellowish to pale ochraceous or orange-yellowish receptacle concolorous with the disc, externally smooth. Ectal excipulum of hyaline textura globulosa, cells 15–30 µm wide. The cells of outer layers have thick refracting walls. Hairs scanty, hyaline, aseptate, firm-walled to thick-walled, cylindrical to conical, obtusely rounded, rarely almost pointed, straight to slightly flexuous, arising superficially from a basal cell, 45–75 x 5–8 µm. Asci pleurorhynchous, cylindrical, 160–190 x 10–12 µm, apically not bluing in MLZ, at first 8-spored but 4-spored at maturity. Ascospores ellipsoid-fusoid, 17–20 x 9–10 µm in KOH, 15.5–17 x 7–8.5 µm in CB, containing 2 big, more rarely 1 big or 1 big and several small lipid globules, sometimes with numerous small globules or granulose cytoplasma, spore wall without changes when heated in lactic acid. Paraphyses apically clavate, up to 6.5 µm wide, filled with numerous small yellowish drops in CB.

On bare clayish sandy soil.
Specimen studied: Latvia, Talsi County, Dundaga, on mud on the road, coll. E. Vimba 18.07.1984 (RIG-6493) Holotype.
Notes: This small fungus has a rather unusual combination of characters and cannot be placed in any existing genus of the Pyronemataceae. It differs from *Cheilymenia* in spores with walls not changed in boiling lactic acid, and containing lipid globules. It cannot be placed in *Leucoscypha* because its paraphyses contain carotenoids and the nuclei of spores do not stain in acetocarmine (observed by R. Dougoud). It seems to be most close to *Kotlabaea* having some spores with very similar "spumose" contents but many spores contain distinct lipid globules when fully mature, and the aseptate thick-walled hairs and thick walled outer excipular cells are strongly deviant from Kotlabaea. J. Moravec (pers. comm.) has told us that it is very probably an undescribed taxon and Dougoud (pers. comm.) has informed me that in Pezizales thick-walled aseptate hairs can be found only in *Lasiobolus* which is naturally ruled out. For these reasons we have described our fungus as a new species of a new genus.




**Figs. 5–8.** *Smarodsia stollii.* 5 – ectal excipulum with hairs; 6 – ascus with 4 mature spores and paraphysis; 7 – spores; 8 – two hairs. Bars = 20 μm.

Sphaerosporella brunnea (Alb. & Schwein.) Svrček & Kubička (syn. *Sphaerospora brunnea* (Alb. & Schwein.) anon.) – Very rare. Riga County, Lielupe, on burnt ground, 22.07.1968 (RIG-3671), Vimba & Raitviir (1970).

Tarzetta cupularis (L.: Fr.) Lambotte – Rare on sandy, sometimes rich, soil. Valmiera County, Mazsalaca, 07.07.1964 (RIG-3760) (Vimba & Raitviir, 1970 sub *Pustularia cupularis* (Fr.) Fuckel); Riga County, Riga, 1926, (Stoll, 1913-1939 sub *Geopyxis cupularis*); Ogre County, Ogre, 07.09.1980, coll. B.Vimba (RIG-6387); Talsi County, Slitere, 25.05.1875 (RIG-6393).

Tricharina cretea (Cooke) K.S. Thind & Waraitch – Very rare on sandy soil. Riga County, Skukisi, 03.06.1972 (RIG-5438).

T. gilva (Boud. ex Cooke) Eckblad – Not rare on sandy soil or on burnt ground.

T. ochroleuca (Bres.) Eckblad – Very rare. Riga County, Skukisi, 03.06.1972 (RIG-6386).

T. praecox (P. Karst.) Dennis – Very rare. 13/29 Riga County, Skukishi, on sandy soil, 03.06.1972(RIG-5436).

Trichophaea hybrida (Sow.) T. Schumach. (syn.: T. gregaria (Rehm) Boud.) – Rare. Madona County, Vesetnieki, 11.08.1977, coll. A. Abolina (RIG-7053); Dobele County, Tervete, 23.08.2005 (TAA s.n.).

T. woolhopeia (Cooke & W. Phillips) Boud. – Not rare on rich mull. Talsi County, Slitere, 1983, coll. I. Parmasto (TAA s.n.), Kalamees & Vimba (1985); Talsi County, Dundaga, 29.09.1980 (RIG-5525); Riga County, Riga, 19.09.1979 (RIG-4833).

Trichophaeopsis bicuspis (Boud.) Korf & Erb (syn. *Tricophaea bicuspis* (Boud.) Boud.) – Very rare. Tukums County, Jaunplavas, on elk dung (RIG-6830); without locality, 06.10.1984 (RIG-8338).

**Sarcoscyphaceae**

Pithya cupressina (Pers.: Fr.) Fuckel – Riga County, Salaspils, National Botanical Garden, on twigs and needles of *Chamaecyparis lawsoniana*

(RIG-5716), *Juniperus x pfitzeriana* (RIG-5708)), *Juniperus sabina* (RIG-5706, 5717), *Juniperus virginiana* (RIG-5704), 07.1998.

SARCOSCYPHA AUSTRIACA (Beck) Boud. – Very common on fallen sticks of *Alnus* spp., *Betula* spp. and *Corylus avellana* early in the spring.

**Excluded species:**
*Sarcoscypha coccinea* (Scop.: Fr.) Lambotte (syn. *Plectania coccinea* (Scop.: Fr.)Fuckel). The authors have not seen any collection of true *S. coccinea* from Latvia. For this reason this species is excluded from the list.

**Sarcosomataceae**

PSEUDOPLECTANIA NIGRELLA (Pers.: Fr.) Fuckel – Very common the ground among needle debris in coniferous forests.

SARCOSOMA GLOBOSUM (Schmidel: Fr.) Casp.– Very rare in coniferous forests in deep moss early spring. Tukums County, Putninu Forest near Tukums (Skuja, 1936); Tukums County, Tume, near Tukums, 10.05.2000 (RIG-5880); Valka County, Vijciems, 11.06.2005, coll. V. Lārmanis (RIG-6496).

URNULA CRATERIUM (Schwein.: Fr.) Fr. – Uncommon on buried sticks among debris in the spring.

**Thelebolaceae**

ASCOZONUS CUNICULARIS (Boud.) Boud. – Reported from Latvia by Prochorov (2004).

A. WOOLHOPENSIS (Renny) Boud. – Reported from Latvia by Prochorov (2004).

THELEBOLUS MICROSPORUS (Berk. & Broome) Kimbr. – Reported from Latvia by Prochorov (2004).

T. POLYSPORUS (P. Karst.) Otani & Kanzawa – Reported from Latvia by Prochorov (2004).

T. STERCOREUS Tode: Fr. – Reported from Latvia by Prochorov (2004).

TRICHOBOLUS SPHAEROSPORUS Kimbr. – Reported from Latvia by Prochorov (2004).

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Folia Cryptog. Estonica, Fasc. 42: 103-111 (2006)

# NEW ESTONIAN RECORDS

## Pezizales (Ascomycetes)

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GEOPORA FOLIACEA (Schaeff.) S. Ahmad – Hiiumaa Co., Käina Comm., Kassari peninsula, Käina-Kassari Landscape Reserv, Sääre tirp, (58° 46,5'N, 22° 48,5'E), on ground, 17 Sept 2001 B. Kullman, det. B. Kullman (TAA 179754, TAA 179755, TAA 179778).

PEZIZA LIVIDULA W. Phillips. – Jõgevamaa Co., Jõgeva Comm., Endla Nature Reserve, near Mustjõgi river (58° 52'N, 26° 13'E), on peat soil, 3 Sept 2005 B. Kullman, det. B. Kullman & H. Tamm (TAA 192221). Ascospores 17.2–19.7×9–9.8 µm.

RAMSBOTTOMIA CRECHQUERAULTII (P. Crouan & H. Crouan) Benkert & T. Schumach. – Tartumaa Co., Nõo Comm., Peedu, (58° 14,0'N, 26° 28,5'E), on wet soil alongside of rail in forest, 3 Sept 2001, B. Kullman, det. B. Kullman (TAA 179675).

TRICHOPHAEA VARIORNATA Korf & W.Y. Zhuang – Hiiumaa Co., Käina-Kassari Landscape Reserv, Sääre tirp, (58° 46,5'N, 22° 48,5'E), on ground, 17 Sept 2001 B. Kullman, det. B. Kullman (TAA 179779).

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## New lichens and lichenicolous fungi

**Ave Suija[1], Inga Jüriado[2], Ede Leppik[2] & Tiina Randlane[2]**

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Twelve species and one variety of lichens and lichenicolous fungi are reported for the first time for Estonia. Cited material is deposited either in lichenological herbarium of University of Tartu (TU) or in herbarium of Eurouniversity (ICEB). Abbreviations of distribution regions and frequency classes follow Randlane & Saag (1999). Lichenicolous fungi are indicated with #.

BACIDIA VERMIFERA (Nyl.) Th. Fr. – SE: Valgamaa, Taheva comm., Koikküla (57°41'N 26°17'E), on *Betula* sp., 10 Sep 1986, leg. A. Pärn, det. A. Suija (TU). Freq.: rr.

EPILICHEN SCABROSUS (Ach.) Clem. [syn. *Buellia scabrosa* (Ach.) A. Massal.] – SE: Põlvamaa, Lutepää (57°55'N 27°42'E), sand dunes with sparse pine trees and open patches of sand, on thallus of *Baeomyces* and on sand, 27 Apr 1991, leg. and det. T. Ahti & T. Randlane (TU). Freq.: rr. – The fungus starts as a parasite on *Baeomyces*, later it becomes an autonomous lichen (Santesson et al., 2004).

LECANORA OROSTHEA (Ach.) Ach. – WIs: Hiiumaa, Vohilaid islet (58°55'N 23°02'E), on granite, 6 July 2005, leg. A. Suija & M. Nõmm No. 742, det. A. Suija & L. Saag (TU). Freq.: rr. – The specimen contains usnic acid and zeorin (TLC).

Lecidea fuscoatra (L.) Ach. var. grisella (Flörke) Nyl. – NW: Läänemaa, Kaseküla alvar (58°37'N 23°38'E), on granite boulder, 10 Aug 1991, leg. & det. T. Randlane (TU). Freq.: rr. – The main variety of *Lecidea fuscoatra* is rather frequent in Estonia and has been reported from all regions; var. *grisella* differs from it by the pale brown or almost grey thallus and dark grey (not black) apothecia.

Leucocarpia dictyospora (Orange) R. Sant. in Kalb & Hafellner [syn. *Macentina dictyospora* Orange] – SE: Valgamaa, Taheva comm., in the forest at the Koiva wooded meadow (57°41'21"N 26°11'16"E), on *Quercus robur*, 4 Sep 2005, leg. & det. E. Leppik (TU). Freq.: rr. – *Leucocarpia dictyospora* differs from the other species of the genus in its submuriform ascospores while the others have transversely septate ascospores. The species is recorded from several countries in Europe, and also from North-America, but is still rather poorly known. *L. dictyospora* prefers high humidity, low radiation conditions and bark with high pH. It grows on trunk bases of *Quercus* (Longán & Gómez-Bolea, 1998) and dead wood of *Betula* (Santesson et al., 2004) as well as on decaying thallus of *Peltigera* (Martinez & Hafellner, 1998), old *Fomes fomentarius* (Santesson et al., 2004) and plant debris (Dietrich, 1991).

# Lichenopeltella coppinsii Earland-Bennett & D. Hawksw. – WIs: Hiiumaa, Vohilaid islet, eastern part of the islet (58°55'N 23°02'E), on *Verrucaria muralis* growing on limestone shingle, 6 July 2005, leg. A. Suija & M. Nõmm No. 730, det. A. Suija (TU). Freq.: rr. – This species which grows on *Verrucaria muralis* is rarely recorded in Europe, known only from the British Isles (Earland-Bennett & Hawksworth, 1999) and Germany (Triebel & Scholz, 2001). There is another *Lichenopeltella* species restricted to aquatic *Verrucaria* species, *L. hydrophila* (Santesson, 2001). Following the species descriptions, both species share many similar characters i.e. lack of setae around ostiole, more or less similar size of ascomata, ascospores and individual cells of ascomatal plates, setulae of ascopores lie mainly on the sides of ascospores, etc. The main difference between these two *Lichenopeltella* species, besides their host preferences, is the width of asci: 8.5–13 µm in *L. hydrophila* and 14.5–16 µm in *L. coppinsii*.

Micarea erratica (Körb.) Hertel, Rambold & Pietschm. – NW: Tallinn, Landscape sanctuary "Mustamäe-Nõmme" (59°23'17''N 24°37'30"E), on pebbles, 25 Sep 2005, leg. L. Martin, det. A. Suija (ICEB). Freq.: rr.

# Monodictys epilepraria Kukwa & Diederich – WIs: Hiiumaa, Vohilaid islet, mixed forest with *Picea abies* and *Betula pendula* in the central part of the islet (58°55'N 23°02'E), on *Lepraria* sp. growing on *Betula pendula*, 6 July 2005, leg. A. Suija & M. Nõmm No. 755, det. A. Suija (TU). Freq.: rr. – *Monodictys epilepraria* has been described only recently by Kukwa & Diederich (2005), but reported already from several European countries. *Monodictys cellulosa*, saprotrophic fungus which facultatively grows on various sterile lichens (incl. *Lepraria*), has larger conidia than *M. epilepraria*.

# Phaeospora peltigericola D. Hawksw. – WIs: Hiiumaa, Sääre, alvar (58°58'N 22°55'E), on *Peltigera aphthosa* growing on ground, 12 Aug 1993, leg. H. Trass, det. A. Suija (TU). Freq.: rr.

# Phoma cytospora (Vouaux) D. Hawksw. – SE: Põlvamaa, Kõlleste comm., c. 1 km in North direction from Palojärv (58°05'36"N 26°55'3"E), spruce forest, on *Hypogymnia physodes* growing on *Picea abies,* 12 Apr 2005, leg. T. Tõrra, det. A. Suija (TU). Freq.: rr. – The specimen of *Hypogymnia physodes* is additionally infected with *Tremella hypogymniae*.

# Phoma lobariae Diederich & Etayo – NW: Läänemaa, Hanila comm., Puhtu broad leaved forest (58°34'N 23°33'E), on *Lobaria pulmonaria* growing on the trunk of *Tilia cordata*, 31 July 1966, leg. L. Kannuke No. 69741, det. A. Suija (TU). Freq.: rr.

Protothelenella corrosa (Körb.) H. Mayrhofer & Poelt – NE: Jõgevamaa, Halliku forestry, forest square 426/1 (58°39'N 26°51'E), dry boreal pine forest, on granite stone, 9 Sep 2004, leg. I. Jüriado No. 72-3, det. A. Suija (TU). Freq.: rr. – The only saxicolous species of the genus *Protothelenella* prefers to grow in shaded habitats with rather high humidity (Mayrhofer & Poelt, 1985). Therefore the most likely habitats to find this species are at the vicinity of streams, in old quarries, etc.

Strigula stigmatella (Ach.) R. C. Harris – NW: Harjumaa, Suurupi, broad leaved clint forest, on *Fraxinus excelsior* (59°27,68"N 24°22,59"E), 29 Aug 2002, leg. & det. I. Jüriado No. 23SR1yld (TU). Freq.: rr.

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We would like to thank curators of H and S for sending us comparison material, Christine Keller (Switzerland) for verification of *Strigula stigmatella,* Martin Kukwa (Poland) for the reference sample of *Monodictys epilepraria,* and Lauri Saag for identification of lichen substances in *Lecanora orosthea*. Thanks are also due to Ljudmilla Martin who provided us with her unidentified *Micarea* specimen.

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# Genus *Xylographa* in Estonia

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The treatment of the genus *Xylographa* in the recent guidebook of Estonian microlichens (Randlane & Saag, 2004) appeared to be not correct. All fertile specimens of *Xylographa* in the lichenological herbarium of University of Tartu (TU) were re-identified and, as a result, *X. trunciseda* should be excluded from the list of Estonian lichens, and *X. opegraphella* is reported as new to the country. Hereby the according chapter of the guidebook of Estonian microlichens [including description of the genus, key to the species and descriptions of the species; diagnostic characters (DC) listed separately] is presented – to correct the mistakes and to introduce the form and the essence of this national guidebook to the international audience.

Precise distributional data are provided for very rare (1–2 localities) and rare (3–5 localities) taxa. Abbreviations of distribution regions follow Randlane & Saag (1999). All listed specimens are deposited in TU.

## Genus XYLOGRAPHA (Fr.) Fr. (1836)

**Thallus** crustose, usually thin or immersed, occasionally rather thick or almost verrucose; sometimes with **soralia** or goniocysts. **Photobiont** chlorococcoid.

**Fruiting bodies** apthecia, round or usually elongate (lirelliform), rarely branched; often aligned with the grain of the wood; pale to dark brown. Disc plane; thalline exciple absent; true exciple thin or becoming unclear with age. Epithecium brown; exciple brown in the outer part; hymenium colourless, I+ blue; hypothecium colourless. Paraphyses simple or sparingly branched or anastomosed, with brown apices. **Asci** 8-spored, clavate to almost cylindrical, with distinct tholus, without ocular chamber, *Trapelia*-type. **Ascospores** 1-celled, colourless (sometimes becoming brown when old); elliptic to narrowly elliptic. **Pycnidia** globose, dark brown, more or less immersed. **Pycnidiospores** falcate, colourless.

**Secondary compounds:** usually absent or containing stictic and norstictic acids; unidentified lichen substances may also be present.

**Inhabit** wood, rarely bark of coniferous trees. Distributed in Europe and North America.

**Species:** 6 in the world, 3 in Estonia.

**Systematically** the genus belongs to ordo *Agyriales*, fam. *Agyriaceae*; phylogenetically close (of local lichen genera) to *Ptychographa*, *Trapelia* and *Trapeliopsis*. Two latter genera are easily distinguished by their round apothecia; species of *Ptychographa* have also lirelliform apothecia but these are black with dark hypthecium.

**DC of the genus:** thallus crustose, thin; fruting bodies lirelliform apothecia, elongate, aligned with the grain of the wood, brown; thalline exciple absent, true exciple present, thin; outer part of exciple brown, hypothecium colourless; ascospores 1-celled, colourless (brown when old); inhabit mainly wood.

**Literature:** Brodo, 1992; Foucard, 2001; Laundon, 1963.

1 Soralia present..... *X. vitiligo*
– Soralia absent..... 2
2 Apothecia elongate, often branched into y-shape; ascospores narrowly elliptic (9–13 × 3–5 µm). Thallus K+ red (norstictic acid)... ..... *X. opegraphella*
– Apothecia elongate to linear, not branched; ascospores elliptic, bigger (11–17 × 5–8 µm). Thallus K± yellow (stictic acid), rarely K+ red (norstictic acid) ..... *X. parallela*

### Xylographa opegraphella Nyl. ex Rothr.

**Thallus** crustose, superficial and thin or rather thick to almost verrucose; whitish or greenish grey.

**Apothecia** numerous, small, elongate, often branched into y-shape, with distinct true exciple; brown to dark brown. **Ascospores** narrowly elliptic, 9–13 × 3–5 µm.

**Secondary compounds:** thallus contains norstictic, rarely stictic acid. Thallus K+ red, C–, Pd+ yellow/orange.

**Inhabits** wood, most often old lignum at seashores. **Distributed** in Europe (Finland, Sweden – on the coast of the Baltic Sea) and North America. **In Estonia** – NW: Harjumaa, Padise comm., Keibu sand dunes (59°15'N 23°45'E), on lignum of *Pinus* at seashore, 26 Sept 1997, leg. I. Jüriado; Harjumaa, peninsula of Juminda (59°39'N 25°30'E), on driftwood at seashore, 19 June 2001, leg. E. Nilson; Harjumaa, Island Mohni (59°40'N 25°48'E), on driftwood at seashore, 17 Aug 2002, leg. E. Nilson; Läänemaa, Island Osmussaar, northern coast (59°18'N 23°23'E), on wood, 28 July 1993, leg. I. Jüriado & T. Randlane. **Freq.:** rare.

**DC of the species:** thallus thin or thick and verrucose crust; apothecia lirelliform, elongate, often branched into y-shape; ascospores narrowly elliptic, 9–13 × 3–5 µm; thallus K+ red (norstictic acid); inhabits old lignum at seashores.

### Xylographa parallela (Ach.:Fr.) Fr.

*X. abietina* (Pers.) Zahlbr., *X. rubescens* Räsänen

**Thallus** immersed, visible only as a light or grey stain, sometimes with small (∅ –40 µm) brown granules (goniocysts).

**Apothecia** elongate to linear, unbranched, semi-immersed to superficial; 0.3–1.7(–2.7) × 0.1–0.3 mm; dark brown to almost black. True exciple thin, disappering with age, concolorous with disc or paler. **Ascospores** elliptic, relatively large, 11–17 × 5–8 µm. Pycnidia frequent but inconspicuous, resembling large goniocysts.

**Secondary compounds:** thallus contains stictic acid and traces of other members of the complex, exceptionally norstictic acid present; lichen substances may also be absent. Thallus K± yellow, rarely + red, C–, Pd± yellow/orange.

**Inhabits** undecayed wood, especially lignum of conifers. **Distributed** in northern hemisphere in the zone of coniferous forests. **In Estonia** – SE: Põlvamaa, Taevaskoja (58°06'N 27°02'E), on old lignum, 2 July 1961, leg. H. Trass. **Freq.:** very rare.

**Remarks:** *X. parallela* is easily distinguished from *X. opegraphella* by its elliptic (not narrowly elliptic) ascospores with width 5–8 µm. Specimens which have apothecia and ascospores similar to *X. parallela* but still contain norstictic acid, have earlier been treated as a separate species (*X. rubescens*). Today this chemical difference is not considered essential.

**X. TRUNCISEDA** (Th. Fr.) Minks ex Redinger which have been reported earlier as a member of Estonian lichen flora (Randlane & Saag, 1999; Randlane & Saag, 2004) is a misidentification. This species is characterized by small roundish to elongate apothecia of orange-brown colour and elliptic ascospores of smaller dimensions (9–13 × 4.5–6.5 µm).

**DC of the species:** thallus immersed, light grey, sometimes with small brown granules; apothecia lirelliform, elongate to linear, unbranched, 0.3–2.7 × 0.1–0.3 mm; ascospores elliptic, 11–17 × 5–8 µm; thallus K± yellow (stictic acid); inhabits old wood of conifers.

**XYLOGRAPHA VITILIGO (Ach) J. R. Laundon**

**Thallus** immersed, pale grey, without brown goniocysts. **Soralia** erumpent, discrete, roundish to elliptic, 0.2–1 ×0.2–0.4 mm, more or less flat; brown, dark grey or indigo, yellowish or green when abraded but even then containing a few dark soredia.

**Apothecia** present or usually absent, broadly elliptic to linear, superficial; 0.3–1 × 0.2–0.4 mm; disk flat, pale to dark brown. True exciple thin, concolorous with disc or paler. **Ascospores** elliptic, 10–14(–16) × 4–7 µm.

**Secondary compounds:** tallus contains stictic acid and traces of other members of the complex, incl. norstictic acid. Soralia K+ yellow, C–, Pd+ yellow/orange.

**Inhabits** undecayed wood, especially of conifers. **Distributed** in boreal zone of thenorthern hemisphere and in mountains. **In Estonia** – NW: Läänemaa, Kaseküla; WIs: Saaremaa, Muhu, Kõinastu. **Freq.:** rather rare.

**Remarks:** differs from other species of the genus by the presence of soralia; when sterile, may be mixed up with the other sorediate taxa, e.g. *Buellia grieseovirens* but is recognized by the dark colour of soralia and colour tests.

**DC of the species:** thallus immersed, without brown goniocysts but with soralia; soralia discrete, roundish to elliptic, brown or dark grey; apothecia present or absent, lirelliform; soralia K+ yellow, Pd + yellow/orange (stictic acid); inhabits old wood of conifers.

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# Liverworts and mosses.

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Nineteen species (eight hepatics and eleven mosses) new for Estonian bryoflora have been registered since the last additions (Vellak et al., 2001). The list includes newly found species as well as species identified from earlier herbarium specimens. Today the list of Estonian bryophytes contains 556 species. For every new species the Estonian name, the collecting data and the location of the voucher specimen are given in this paper. Six of the newly registered species (*Cephaloziella elachista, Lophozia ascendens, Lophozia laxa, Bryum subelegans, Dicranella humilis* and *Schistidium papillosum)* belong to the Red Data Book of European Bryophytes (ECCB, 1995) and one (*Lophozia perssonii*) has already been granted national protection status in Estonia.

The majority of the new species are very small (*Cephaloziella* p.p.), difficult to identify

(*Bryum* p.p.), rare also in neighboring countries (*Lophozia* p.p.), or on the border of their distribution area (*Rhytidiadelphus loreus)*.

In addition to newly recorded species, voucher specimens for *Schistidium crassipilum* Blom (müür-lõhistanukas) and *Schistidium confusum* Blom (petlik lõhistanukas) are now in Estonian herbaria (TAM, TU). Earlier they were recorded for Estonia from the Mikutowizc' herbarium in Stockholm by H. H. Blom (1995).

**HEPATICAE**

Calypogeia azurea Stotler & Crotz – sinakas kottsammal – 1st loc.: Tartu Co., Emajõe-Suursoo Nature Protection Area, Kantsi village, birch fen forest, on a decaying log, 3 Aug 2005. leg./det. K. Vellak, N. Ingerpuu (TU).

Earlier several different *Calypogeia* species were treated as a collective species *Calypogeia trichomanis* auct. (Stotler & Crotz, 1983). This synonym was formerly included in the list of Estonian hepatics (Laasimer, 1953), but not included later as *C. azurea*, since no voucher specimen was found. It was impossible to identify *C. azurea* from old herbarium specimens, since the bluish oil bodies, the best character for the identification of the species, degrade over time. The species is widespread in Europe, but missing from Finland.

Cephaloziella elachista (Gottsche & Rabenh.) Schiffn. – õrn niidiksammal – 1st loc.: Lääne Co., Suursoo Nature Reserve, Nõmmraba bog, north from Veskijärv, Aug 2004. leg./det. T. Ploompuu (TU); 2nd loc.: Lääne Co., south-western part of Suursoo, Linnuraba bog, among other bryophytes, 31 July 2003. leg. K. Leek, det. T. Ploompuu (TU); 3rd loc.: Tartu Co., Emajõe-Suursoo Nature Protection Area, between Kikassaare and Kastre villages, ca 1 km west from Ahja river, in a fen, on peatmosses, 5 Sep 2005. leg./det. N. Ingerpuu (TU).

The species is redlisted in whole Europe (ECCB, 1995), Sweden, Finland, and several other European countries (Hallingbäck, 1998). Occurs very rare in Latvia (Ābolina, 2002). It has sub-oceanic distribution and it grows among peatmosses in mires (Damsholt, 2002).

C. spinigera (Lindb.) Jørg. – kannus-niidiksammal – 1st loc.: Rapla Co., Keava bog, on a hummock, July 2002. leg. T. Ploompuu, det. N. Ingerpuu (TU); 2nd loc.: Võru Co., Kellamäe bog, Aug 2004. leg./det. T. Ploompuu (TU).

The species has northern sub-oceanic distribution. It is rather common in the Nordic countries (Damsholt, 2002), but occurs very rare in Latvia (Ābolina, 2002) and is not found from Lithuania (Naujalis et al., 1995; Jukoniene, 1996).

Lophozia ascendens (Warnst.) R.M. Schust. – pisi-lõhiksammal – 1st loc.: Rapla Co., Raikküla, Sõerutse alvar forest, on a log, 14 July 2004. leg./det. N. Ingerpuu (TU); 2nd loc.: Rapla Co., north-east from Rapla, on a spruce log, 13 July 2004. leg./det. N. Ingerpuu (TU).

The species is redlisted in whole Europe (ECCB 1995), Sweden, Finland and several other European countries (Hallingbäck, 1998). It is rare in Latvia (Ābolina, 2002) and is not found from Lithuania (Naujalis et al., 1995; Jukoniene, 1996). Occurs mainly on large spruce logs in moist forests (Hallingbäck, 1998). The distribution is boreal-montane (Damsholt, 2002).

L. laxa (Lindb.) Grolle – raba-lõhiksammal – 1st loc.: Harju Co., Lahemaa National Park, north-west from Loksa, Aabla bog, between peatmosses, 4 Aug 2004. leg. K. Leek, det. N. Ingerpuu (TU).

The species is redlisted in whole Europe (ECCB, 1995), Sweden, Finland and several other European countries (Hallingbäck, 1998). Not found from Latvia and Lithuania (Ābolina, 2002; Naujalis et al., 1995; Jukoniene, 1996). It has northern sub-oceanic distribution and grows in wet parts of peatbogs (Damsholt, 2002).

L. perssonii H. Buch & S. W. Arnell – Perssoni lõhiksammal – 1st loc.: Pärnu Co., sandstone escarpment "Tori Põrgu", on a moist outcrop, 4 Aug 2003. leg./det. H. J. During (TAA, TU).

The species is included in the red lists of Nordic countries (Sweden, Finland and Norway) due to its vulnerability to overgrowing of habitats and increasing pressure of tourism (Hallingbäck, 1998). For the same reasons it is protected by law in Estonia since 2004 (Riigi Teataja, 2004). Occurs as a pioneer species on open calcareous substrate (Hallingbäck, 1998).

Riccia beyrichiana Lehm. – Beyrichi riktsia – 1st loc.: Saare Co., Saaremaa Is., Loode Oak Forest Landscape Reserve, western part of alvar, 13 Sep 2004. leg. M. Leis, det. N. Ingerpuu (TU).

The species has wide distribution, but is concerned as vulnerable in Finland (Rassi et al., 2001) and is absent from Latvia and Lithuania (Ābolina, 2002; Naujalis et al., 1995; Jukoniene, 1996).

Scapania nemorea (L.) Grolle – saluskapaania – 1st loc.: Rapla Co., north from Jalase Village, in an alvar forest, on a granite stone, 18 June 2005. leg. S. Ingerpuu, det. N. Ingerpuu (TU).

Having western-temperate distribution, this species is rather common in Europe (Damsholt, 2002), but is near threatened in Finland (Rassi et al., 2001), redlisted in Latvia (Ābolina, 1994) and absent from Lithuania (Naujalis et al., 1995; Jukoniene, 1996).

**BRYOPHYTA**

Bryum badium (Brid.) Schimp. – ruske pungsammal – 1st loc.: Hiiu Co., Hiiumaa Islets Landscape Reserve, Hanikatsi Islet, Rootsimaa alvar, in a *Juniperus* shrubbery on ground, 9 June 2001. leg./det. (March 2002) L. Kannukene (TAM); 2nd loc.: Hiiu Co., Hiiumaa Landscape Reserve, Hanikatsi Islet, SW-coast, on a coastal ridge, 9 June 2001. leg./det. (March 2002) L. Kannukene (TAM); 3rd loc.: Valga Co., northern part of Palupera sand quarry, on bank of a pond, 12 Aug 2005. leg./det. M. Leis (TU).

The distribution of this species is still unclear since it has been treated as a variety of *B. caespiticium* Hedw. (Nyholm, 1993).

B. bicolor Dicks. – kahevärviline pungsammal – 1st loc.: Harju Co., Pakri Landscape Reserve, Suur-Pakri Is., on a moist *Sesleria* alvar meadow, 12 Aug 1998, leg./det. (11 May 2005) L. Kannukene (TAM).

The species has circumpolar distribution with sub-mediterranean – sub-atlantic character in Europe (Boros, 1968). It grows on bare sandy or gravely, preferably basic soil (Nyholm, 1993).

B. elegans Nees – peen pungsammal – 1st loc.: Hiiu Co., Hiiumaa Islets Landscape Reserve, Öakse Islet, in a *Juniperus* shrubbery, 26 Aug 2001. leg./det. L. Kannukene (TAM); 2nd loc.: Hiiu Co., Hiiumaa Islets Landscape Reserve, Palgirahu Islet, 27 July 2001. leg./det. (28 Mar 2002) L. Kannukene (TAM); 3rd loc.: Saare Co., Saaremaa Is., Loode Oak Forest Landscape Reserve, western part of alvar, on shingle, 15 Sep 2004. leg. M. Leis, det. L. Kannukene (TU); 4th loc.: Tartu Co., Emajõe-Suursoo Nature Protection Area, on a sandy meadow at Liivanina, 10 Sep 2005. leg. N. Ingerpuu, K. Vellak, det. N. Ingerpuu (TU); 5th loc.: Harju Co., Aegna Is., western part of the island, on a coastal meadow, 12 July 2005. leg./det. L. Kannukene (TAM).

The species has circumpolar distribution and it grows on open alkaline soils (Zolotov, 2000).

B. subelegans Kindb. – väike pungsammal – 1st loc.: Saare Co., Vilsandi Nature Park, Harilaid Peninsula, 21 June 1959. leg. J. Kaasik, det. (23 May 2005) L. Kannukene (TAM); 2nd loc.: Hiiu Co., Kadakalaid Islet, in a *Juniperus* shrubbery, on ground, 7 June 1999, leg./det. (11 Oct 2005) L. Kannukene (TAM).

The name of *B. subelegans* was mentioned first time for Estonia in 1994 (Ingerpuu et al., 1994), as a higher rank synonym of *B. capillare* var. *flaccidum.* At present three separate species are distinguished instead of earlier collective species (Nyholm, 1993). For this study all herbaria specimens labelled with these synonyms were re-checked and only one specimens of *B. subelegans* was found. All other 52 specimens were identified as *B. flaccidum.* The species is endemic for Europe and Macaronesia (ECCB 1995), rather rare in northern Europe and grows on basic rocks and old ruins (Nyholm, 1993).

Dicranella humilis Ruthe – madal kaksikhambake – 1st loc.: Tartu Co., Tartu, on the coast of River Emajõgi, 28 June 1988. leg. T. Rasso, det. (26 Oct 2004) M. Leis, L. Kannukene (TU).

The species is redlisted in whole Europe (ECCB, 1995), Sweden and Finland (Hallingbäck, 1998; Rassi et al., 2001), is not found from Latvia (Ābolina, 2002). It grows on moist soil near waterbodies (Hallingbäck, 1998).

Eurhynchium striatum (Schreb. ex Hedw.) Schimp. – kurd-salusammal – 1st loc.: Viljandi Co., Õisu, on stones on a river bank, 17 June

1996. leg./det. (9 Sep 2004) M. Leis (TU, TAM); 2nd loc.: Harju Co., Pakri Landscape Reserve, Pakri Peninsula, on foot of Leetse kint, on a shaded limestone outcrop, 5 May 1994. leg/det. (8 June 2005) L. Kannukene (TAM).

Common in southern part of Europe, but redlisted in Finland (Rassi et al., 2001), occurs rare in Lithuania (Jukoniene, 2003) and fairly rare in Latvia (Ābolina, 2002). It grows on tree bases and stones in forests (Ignatov & Ignatova, 2003).

OXYSTEGUS TENUIROSTRIS (Hook. & Tayl.) A.J.E. Sm. – liiv-kräsusammal – 1st loc.: Pärnu Co., sandstone escarpment "Tori Põrgu", on a sandstone outcrop, 4 Aug 2003. leg./det. H. J. During (TU).

Widely distributed in boreal region on shaded siliceous rocks and tree bases (Nyholm, 1989). The species is absent from Lithuania, in Latvia redlisted as extinct species (Ābolina, 1994), in Finland as near threatened (Rassi et al., 2001).

PSEUDOCROSSIDIUM REVOLUTUM (Brid.) Zander – mugul-ripssammal – 1st loc.: Saare Co., Saaremaa Is., Loode Oak Forest Landscape Reserve, southern part of alvar, on shingle, 13 Sep 2004. leg./det. M. Leis (TU).

The species occurs in Europe, North-Africa and Middle-Asia, but is redlisted in Sweden (Hallingbäck, 1998), and not found from Finland, Latvia and Lithuania (Ulvinen et al., 2002; Ābolina, 2002; Naujalis et al., 1995; Jukoniene, 1996). It grows on calcareous soil or rocks (Hallingbäck, 1998).

RACOMITRIUM SUDETICUM (Funck) Bruch & Schimp. – sudeedi härmik – 1st loc.: Harju Co., Naissaar Nature Park, deciduous forest, on an erratic boulder, 10 Aug 1993. leg./det. (9 June 2005) L. Kannukene (TAM).

It is distributed in Eurasia and North America, including Arctic, and occurs on siliceous boulders and rocks (Ignatov & Ignatova, 2003).

RHYTIDIADELPHUS LOREUS (Hedw.) Warnst. – nõtke käharik – 1st loc.: Hiiu Co., Hiiumaa Is., Kõpu Peninsula, Kriipsuränk Reservation, in an old coniferous forest, on ground and boulders, 16 Oct 2004. leg./det. N. Ingerpuu, K. Vellak (TU, TAA, TAM); 2nd loc.: Saare Co., Saaremaa Is., Merise, in a coniferous alvar forest, on ground, 22 July 2005. leg./det. K. Vellak (TU).

Widespread in southern and western Europe, more sparsely distributed towards north and lacking in the east from Estonia (Ignatov & Afonina, 1992). Redlisted in Lithuania (Anonimos, 2003) and is not found in Latvia (Ābolina, 2002).

SCHISTIDIUM PAPILLOSUM Culm. – näsa-lõhistanukas – 1st loc.: Harju Co., Pakri Landscape Reserve, Väike-Pakri Is., in an aspen grove, on an erratic boulder, 27 May 1997, leg./det. (29 Sep 2005) L. Kannukene; 2nd loc.: Hiiu Co., Hiiumaa Is., Sarve Landscape Reserve, Aruküla alvar, on an erratic boulder, 25 July 1998. leg./det. (12 Oct 2005) L. Kannukene (TAM).

The species has circumpolar distribution and is the most widespread species of the *Schistidium apocarpum*-complex. The species occurs on siliceous as well as calcareous rocks (Blom, 1995). Nevertheless it is included to the European Red Data Book (ECCB, 1995).

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