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NOTES ON PERENNIPORIACEAE

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ANNOTATIONES
DE PERENNIPORIACEAE

Redactore

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The genus *Perenniporia* Murrill uniting white-rot di- or trimitic polypores is elaborated for boreal zone of Russia. Its possible closest relatives are the genera *Haploporus* Bondartsev et Singer and *Ganoderma* P. Karst. The latter genera are characterized by exceptionally peculiar structure of a spore wall why their spores are often classified as *hemitectospores*, or *ganoder-moid* spores. The first chapter of this book is devoted to the studies in these peculiar spores. In second chapter, eight *Perenniporia* species are described and illustrated, two of them as new. The descriptions of two closely related species, *Haploporus suaveolens* (L.: Fr.) Donk and *Trametes ljubarskyi* Pilát, are also given; probably, they will be combined into *Perenniporia* in the near future.

Под ред. В. А. Спирина

Книга представляет критико-таксономическую обработку рода *Perenniporia* Murrill бореальной зоны России. Род *Perenniporia* объединяет трутовые грибы с димитической или тримитической гифальной системой, характеризующиеся толстостенными декстриноидными спорами, близкими по структуре к спорам *Haploporus* Bondartsev et Singer и *Ganoderma* P. Karst. (т. н. гемитектоспоры). Первая глава книги посвящена изучению общих особенностей спородермы гемитектоспор. Во второй главе приведена обработка родов *Perenniporia* и *Haploporus* бореальной зоны России. 2 вида описаны как новые для науки.

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FOREWORD

Old-growth boreal forests reveal an exceptional diversity of wood-inhabiting macromycetes, in particular, the polypores and corticioid fungi. Extensive study of these groups started in Nordic countries and adjacent parts of Russia in the end of 20th century and allowed to describe numerous new species and to solve some problems in fungal taxonomy.

The genus *Perenniporia* Murrill unites white-rot di- or trimitic polypores having thick-walled, often dextrinoid spores. Its possible closest relatives are the genera *Haploporus* Bondartsev et Singer and *Ganoderma* P. Karst. These genera are characterized by exceptionally peculiar structure of a spore wall why their spores are often classified as *hemitectospores*, or *ganodermoid* spores. The first chapter of this book is devoted to the studies in these peculiar spores, as well as some chemical features of a spore wall, i. e. amyloid, dextrinoid, and cyanopilous reactions. The main trends in spore evolution are also considered.

In second chapter, eight *Perenniporia* species are described and illustrated, two of them as new. The descriptions of two closely related species, *Haploporus suaveolens* (L.: Fr.) Donk and *Trametes ljubarskyi* Pilát, are also given; probably, they must be combined into *Perenniporia* later.

Acknowledgements. The authors are very grateful to Prof. Tuomo Niemelä (Helsinki University, Finland) for his generous help and numerous works on fungal taxonomy provided at our disposal. Prof. Solomon Wasser (Haifa University, Israel) and Dr. Alexander Krakhmalny (Kholodny Botanical Institute, Kiev, Ukraine) supported the study of a spore wall structure of the *Ganoderma* species (described in Chapter 1). Dr. Alexander Shirokov (Lobachevsky State University, Nizhny Novgorod, Russia) generously helped in field work and provided the descriptions of forest types (used in Chapter 2). Prof. Margarita Bondartseva (Komarov Botanical Institute, St. Petersburg, Russia) encouraged us to the studies in polypore taxonomy.

I. V. ZMITROVICH, V. F. MALYSHEVA

Chapter 1

The hemitectospores: structural and taxonomic aspects

1.1. Retrospection. The hemitectospores, i. e. the spores with perforated exine (called also as *ganodermoid spores*), attracted attention of mycologists already since the end of 19th century. Karsten (1881) established a new genus *Ganoderma* P. Karst. for *Polyporus lucidus* W. Curtis: Fr., and characterized this taxon by laccate upper surface and ovoid-ellipsoid yellowish-brown spores of "warty" appearance. In spite of Karsten's opinion, Atkinson (1908a) stated that the spore wall of *Ganoderma* is hyaline and smooth but perforated by brown or yellowish-brown finger-like outgrowths of the "spore content". However, he noted: "due to a certain age of the spore wall, when its consistency is less firm than at other times, the spore wall collapses to a certain extent and there is a tendency for the hyaline part of the wall to collapse between these dark areas, thus giving a roughened or slightly echinulate appearance to the spore" (Atkinson, 1908b).

White (1919) was the first who stressed two-layered structure of ganodermoid spore wall. He wrote that "basidiospore strats out with a hyaline wall and then that later within this outer thin walled basidiospore a rough-coated thick and yellow walled endospore is formed. The spore 'wall' in one sense then is accordingly double. As the endospore is more shortly elliptical than the original basidiospore, the tip of the latter is not occupied, and this hyaline tip being thin walled and without supporting contents usually collapses. This gives to the mature spore the 'truncated' appearance so invariably noted."(op. cit.). White's conclusions were verified by Coleman (1927), who used sulfuric acid to dissolve an "episporium" and bare an echinulate "endosporium". (We treat both names in a commas because they seem to be outdated. Nowadays there would be correct to say 'perine' when inconspicuous remnant of sterigmatic wall is meant; an underlying heterogeneous stratum named as 'exine' is roughly synonymous to 'episporium').
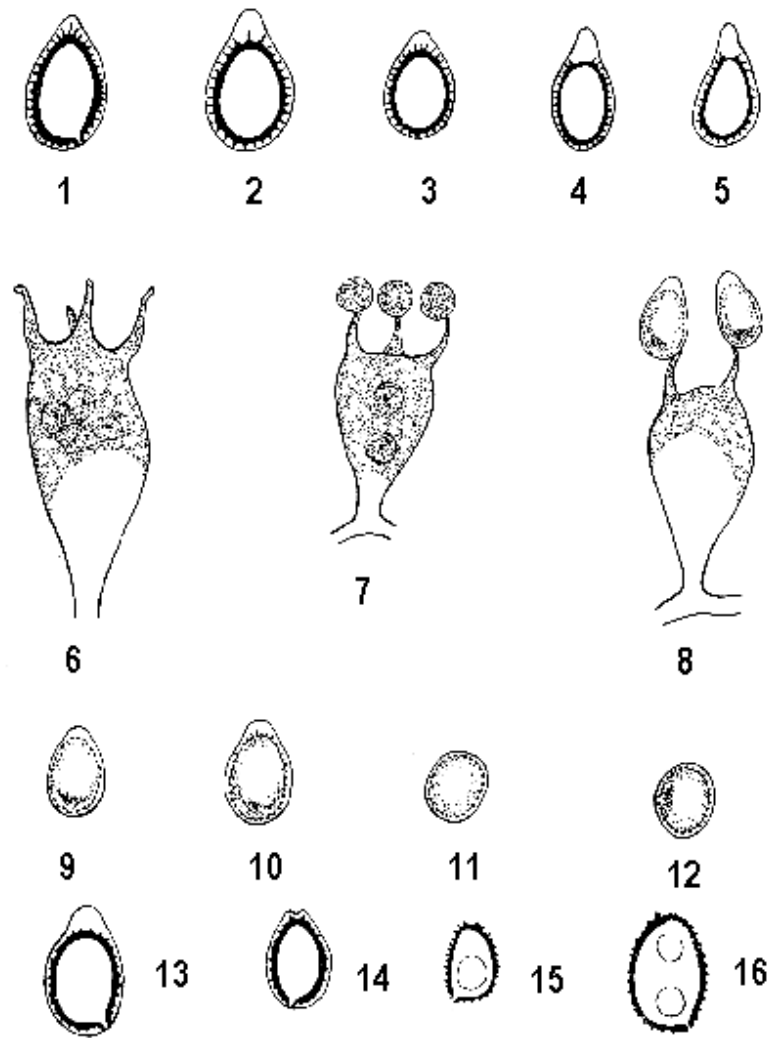
Fig. 1. Spore structure and sporogenesis in *Ganoderma* species according to Coleman (1927): *1* — basidiospore of *Ganoderma tsugae* Murrill in longitudinal section, *2* — basidiospore of *G. lobatum* Schwein. in longitudinal section, *3* — basidiospore of *G. applanatum* (Pers.) Pat. in longitudinal section, *4* — basidiospore of *G. australe* (Fr.) Pat. in longitudinal section, *5* — basidiospore of *G. lionettii* Roll. in longitudinal section, *6—8* — basidium of *G. applanatum*, showing first stages of basidiospore formation, *9* — longitudinal section of basidiospore of *G. applanatum* detached from the sterigma, *10—12* — longitudinal section of basidiospore of *G. applanatum*, showing endospore granules fused into continuous wall, *13—14* — basidiospores of *G. applanatum*, showing chitin reaction of the endospore, *15* — basidiospore of *G. applanatum* of longitudinal section after having been heated in 20% H_2SO_4 which has completely dissolved the epispore, *16* — basidiospore of *G. tornatum* of longitudinal section after having been heated in 20% H_2SO_4, giving same result as shown in (*15*).

This researcher tried to identify a chemistry of "episporium" (= fibrillar-crystalline [pectinous] matter of a spore wall) and ornamented "endosporium" (= refracting granular-fibrillar [chitinous] skeletal structure). Moreover, Coleman demonstrated that the ganodermoid spores are *apically* truncate, and showed the location of a germ pore (Fig. 1).

The work of Coleman became classical, and his ideas (both true and erroneous) persist till now. His main mistake was a statement that the surface of ganodermoid spore is smooth. A progress towards knowledge of true nature of ganodermoid spores was caused by development of microscopic techniques. The first TEM pictures were not successful because all structures have been fractured and chaotic; however, they allowed to make three-dimensional reconstruction of a ganodermoid spore (Furtado, 1962). Its appearance clearly showed that the 'endosporium' shape is reflected in 'exosporium'; so, this latter natively is not smooth (Fig. 2; see also Pegler, Young, 1973; Adaskaveg, Gilbertson, 1986; and Zhao, 1989). To confirm this fact, we proposed to make some SEM pictures of the spores of *Ganoderma resinaceum* Boud. in Pat., *G. applanatum* (Pers.) Pat., and *G. lucidum* (W. Curtis: Fr.) P. Karst. (results are shown in Table 3; this works were supported by Prof. S. Wasser [Haifa, Israel] and Dr. A. Krakhmalny [Kiev, Ukraine]).
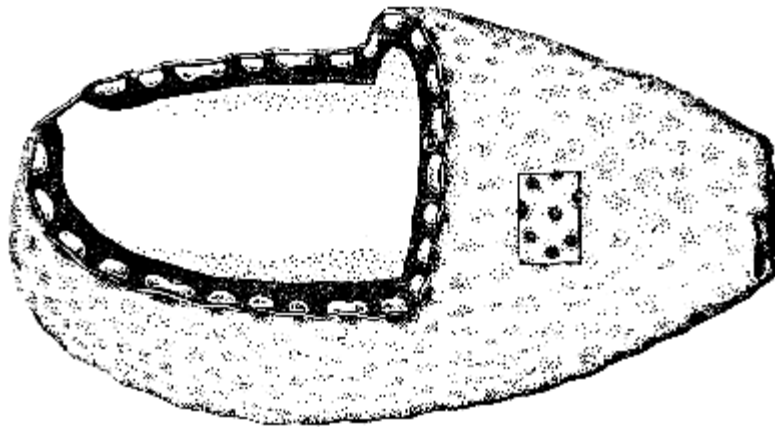

Fig. 2. Tridimensional conception of *Ganoderma* spore wall by Furtado (1962).

As seen, the spore surface is varying from weakly *verrucose* to reticulately *tuberculose*, alike in *Heterobasidion* or even *Lactarius* species (for an explanation of the terms 'verrucose' and 'tuberculose', see below).
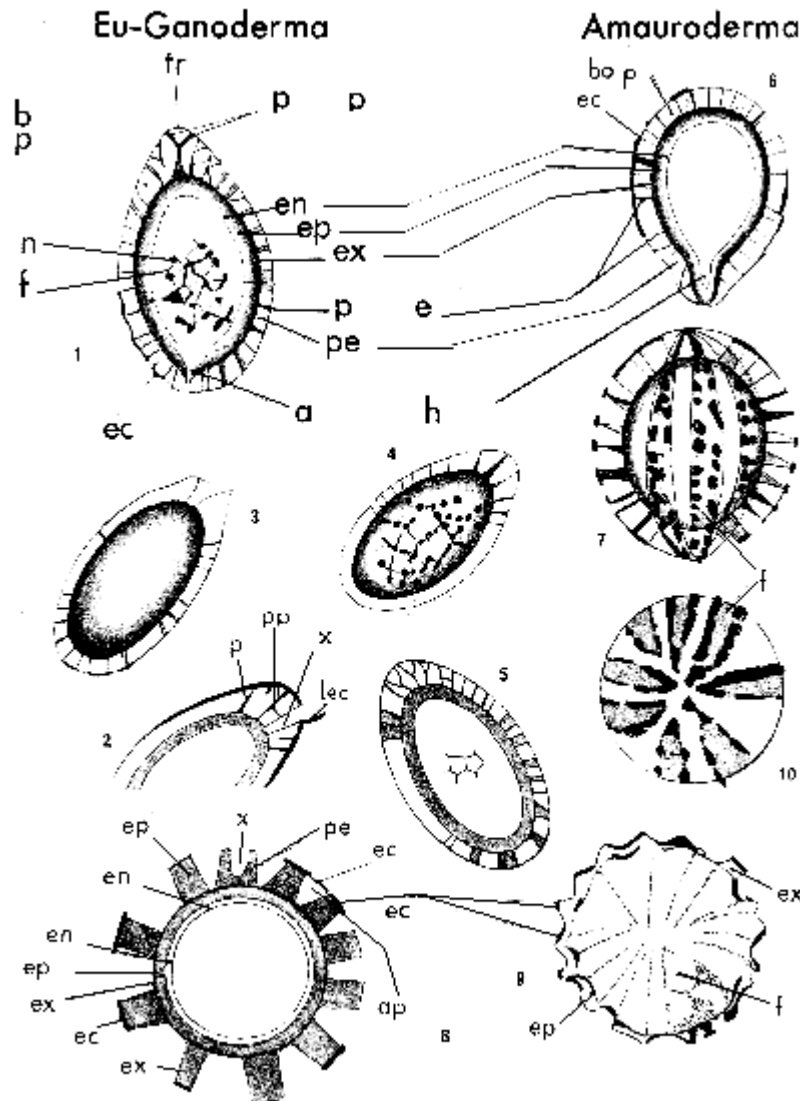
Fig. 3. Interpretation of fine structure of the *Ganoderma* spore wall by Heim (1962): *1* — elements of sporoderm structure (*en* — endospore, *ep* — epispore, *ex* — exospore, *pe* — exosporic pilars, *pp* — polar exosporic pillars, *ect* — ectospore, *tr* — truncature, *ah* — hilar appendage), *2* — free perisporic alveoles (lec), *3—5* — details of ornamentation, *6—10* — same structures in '*Amauroderma' longipes* (Lév.) Lloyd ex Wakef. n.v.p.: *7* — tridimensional spore conception, *8* — transverse spore section, *9* — surface hologram reconstruction, *10* — general view.

Heim (1962) observed the ganodermoid spores in LM and TEM, and stressed the differences of *Ganoderma* ('*Eu-Ganoderma*' sensu Heim) from *Amauroderma* Murrill. He also classified the terms referring to architectonics of ganodermoid spore (Fig. 3).

In the middle of 20th century, the spores of some other higher basidiomycetes were studied, too. A remarkable study of the spores of agaric *Fayodia bisphaerigera* (J. E. Lange) Singer was undertaken by Locquin (1943). He proposed a method of differential staining to reveal a spore surface and tectum structure. To dissolve a glucan matrix and bare an ornamentation, Locquin used strong nitric acid; then glucan matter was stained by Melzer's reagent, cellular content and ornamentation — by aniline dyes. As a result, Locquin depicted a spore shape of *F. bisphaerigera* which (as seen in Fig. 4) is typical *hemitectospore* (this term was proposed by him).
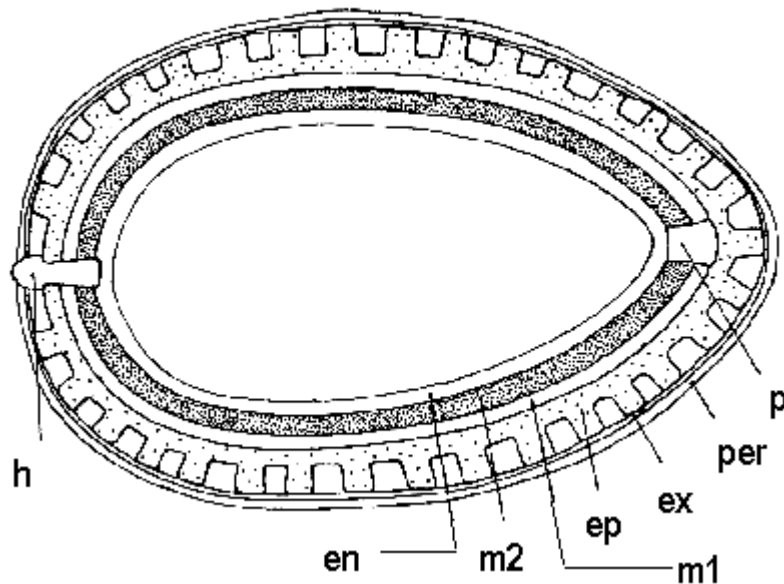
Fig. 4. Hemitectospore wall structure according to Locquin (1943) and Gäumann (1964): *per* — perispore, *ex* — exospore, *ep* — epispore, *en* — endospore, *m1* and *m2* — mesospore strates, *p* — germ pore, *h* — hilum.

At the same time, Singer (1947) enounced an opinion that the agaric genus *Crepidotus* and its allies are characterized by "falsely echinulate" or *ganodermoid* spores. He described a new family *Crepidotaceae* (S. Imai) Singer (1951) some years after, basing this solution mainly on spore characters. Pegler and Young (1972) and Nordstein (1990) rejected this concept and showed externally tuberculate (i. e. *Cortinarius*-like, not ganodermoid) spore structure of *Crepidotaceae*.

A general overview of hemitectosporic taxa was made by Locquin in his fundamental work "Mycologie générale et structurale" (1984), where

they were separated within the subclass *Fayodiomycetidae.* More detailed division of this subclass may be presented as following:

FAYODIAMYCETIDAE Locq., 1981 (n. v. p.)
    CALOSTOMATALES Locq., 1981 (n. v. p.)
Calostomataceae Fischer, 1900
    VELIGASTRALES Locq., 1981 (n. v. p.)
Veligastraceae Locq., 1981 (n. v. p.).
    WAKEFIELDIALES Locq., 1981 (n. v. p.)
Wakefieldiaceae Locq., 1981 (n. v. p.)
    CRIBBEALES Locq., 1981 (n. v. p.)
Cribbeaceae Singer, 1963
    LEUCOGASTRALES Fogel, 1979
Leucogastraceae Moreau ex Fogel, 1979
    STROBILOMYCETALES (E. Gilb.) Locq., 1981 (n. v. p.)
Strobilomycetaceae E. Gilb., 1931
    BATTAREALES Locq., 1981 (n. v. p.)
Battareaceae Corda, 1838
Favileaceae Locq., 1981 (n. v. p.)
    FAYODIALES Locq., 1981 (n. v. p.)
Fayodiaceae Locq., 1981 (n. v. p.)
    GANODERMATALES Jülich, 1982
Ganodermataceae (Donk) Donk, 1948
    CREPIDOTALES Locq., 1981 (n. v. p.)
Crepidotaceae (S. Imai) Singer, 1951.

Superficially, the system of Locquin looks highly bizarre. At once his division is well thought-out, and "sporocentrical approach" sometimes could be productive, especially in groups, characterized by well-developed spore ornamentation (Zmitrovich, 2004). However, some data, appeared during last twenty years, allow to make other conclusions. Before their exposure, we fix upon methodical problems of the sporoderm study and also make an explanation of some controversial terms.

1.2. Structures and diagnostics. The spore represents a dormant stage of the fungus life cycle. An independence from exogeneous sources causes their common habitual feature, i. e. compact form with a total surface coming to S = 2.199 (Aleev, 1986). Another main feature of fungal spore is the presence of impenetrable (more precisely, selectively penetrable) protective structure — the sporoderm (= integument, = spore wall).
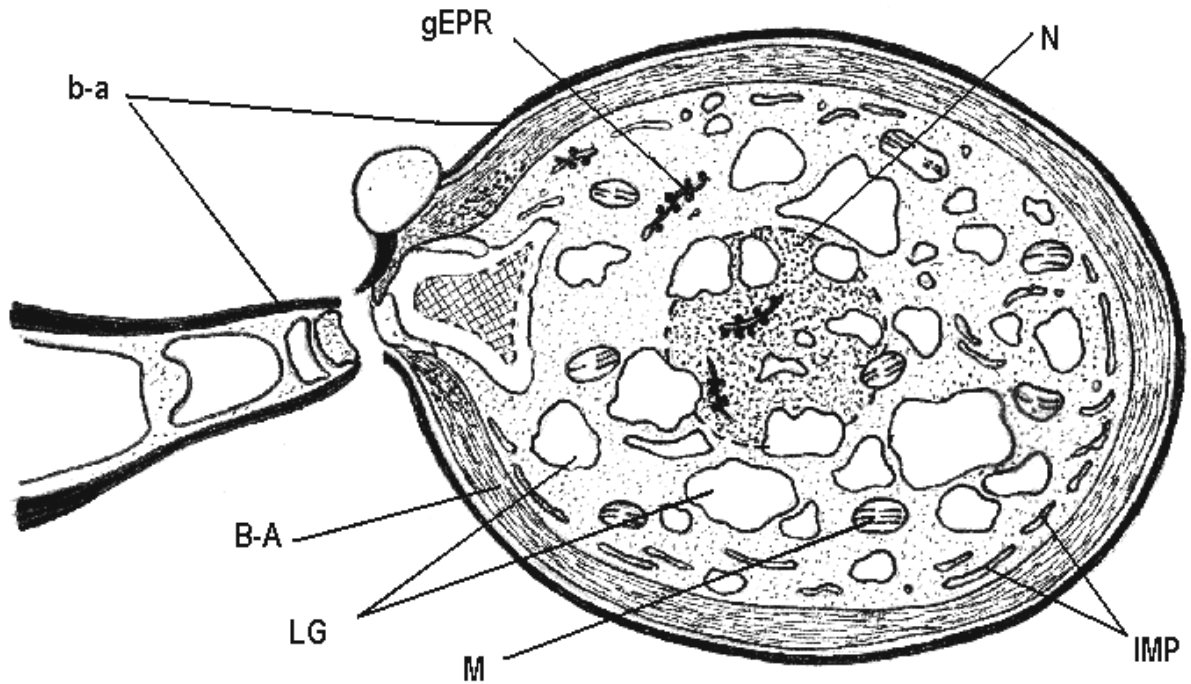
Fig 5. Basidiospore cytology overview: *b-a* — sterigmatic wall remnants (perine), *B-A* — core spore wall (exine), *N* — nucleus, *M* — mitochondria, *gEPR* — granulare endoplasmic reticulum, *IMP* — intrasporal membrane plaques, *LG* — lipid granules (drawing by Vera Malysheva according to conception by Oláh, Reisinger, 1981).

The basidiospore initials start to develop within basidia during postmeiotic mitoses on an holoblastic way. The components of basidial cytoplasm migrate into the sporoid bodies, and when the maturing process evolving, the dissimilative processes in a cytoplasm slow down. So, mature basidiospore appears as filled by the lipid granules, the reduced spheric mitochondria (so-called promitochondria), and free (or rarely associated with EPR) ribosomes (Fig. 5). Both material of a basidial wall and products of cytoplasmic EPR participate in the sporoderm formation. The EPR packets unload a various material to the surface area, in particular, the mixture of 1.3÷1.6 β-glucans and α-glucans. Among them (depending on prevalence of molecules with a certain branching pattern) the fragments as amylopectin, amylose, amylodextrins, or even glycogen (Chadefaud, 1960), may be identified. The glucans play a double role within sporoderm. Carrying out an amorphous wall matrix, they are structural substances associated with chitin fibrills. On the other hand, they are reserve substances, used during spore germination (Oliviera, Zangan, 1981).

Accumulating in cytoplasm, the metabolic inhibitors (1-dimethyl-propanol, isovalerianate) and storage substances (lipids, glycogen, treha-

lose) will be used during germination as high-speed donators of glucose → glucose-6-phosphate, PEP, ethanol, malate. It conducts to increase the restored forms of NADPH, NADH and ATP in a crate.

A spore germination is stimulated by temperature increasing (Cotter, 1981) and humidity, as well as pH descending (Locquin, 1984). The trigger role belongs to cAMP, activated by heat and acid shocks. This substance starts a cascade of reactions towards the ribonucleases and tripsinogen activation. The large contribution to protoplast activation is brought by trehalase enzyme, which attacks an inactive form of stored diol-trehalose. Simultaneously with a glucose clearing, the hydrolase and oxydase enzymatic systems are starting, the ribosomes are activating and the ATP synthesis beginning (so-called 'spheric growth' phase according to Bartnicki-Garcia, 1968). This phase corresponds to an isodiametric inflation of the spore (due to expense of active [endosmotic] water absorption). The dominating role in this process belongs to the colloid systems of both cytoplasm and sporoderm. In the last one, an enzymatic splitting of disulfuruic connections between glycoproteides is beginning, what conducts to the strate re-differentiation, the matrix gelatinization and the mobilisation of wall-stored substances as prolin, alanin, and glucans for a cytoplasmic needs.

After an achievement of these conditions, the protoplast passes to a premitotic state. There is a beginning of mitochondrial extension. At the same time, the ribosomes become more distinct (especially in perinuclear area), whereas the endoplasmic reticulum gives a set of membrane packets. Initially amorphous and TEM indistiguishible ribonucleoproteide transforms to basophilic paranuclear bodies (SPB, or MTOC). In a germ pore region, the cytoskeleton fibrillar rods are pulled. These fibrills implant a cytoplasmic microtubular system. Such formation, as well as a sporoplasm polarisation, mark a start of the pushing of germinating tube through the germ pore and further hyphal processing.

The stable sporoderm structure in dormant spore has a large taxonomical importance, therefore, there would be urgent to concretize our knowledge of its features.

First of all, both LM, and TEM researches show clear heterogeneity of the sporoderm, i. e. its multilayered nature (Table 1).

From these structures, the exine (mostly tectocorium) has main diagnostic value. It may be perforated in hemitectopores, ornamented in russuloid and gomphoid spores, etc. When developed, the perine only covers outer tectonic structures of exine. It is necessary to say that the different descriptions of exine morphology are conditioned by some artifacts inevitably constrained by microscopic technique. A minimizing of optical arti-

facts is possible due to use of various chemical reagents from which Melzer's reagent and Cresyl (Toluidin) Blue are especially interesting for us.

A colour reaction with Melzer's reagent (i. e. Iodine-starch reaction) becomes apparent if amorphous glucan matrix of a spore wall absorbed Iodine. However, depending on the structure of a spore wall, reaction may be varying. When the amylose fragments are dominating, a bluish staining is observed; a dominance of amylopectins is displayed by violet colouration, while reddish-brown colour reaction indicates a presence of amylodextrins (glycogen).

Table 1

The stratification of the basidiomycetes sporoderm according to transmission electron microscopy (Oláh et al., 1977) and light microscopy (Locquin, 1984)

TEM strates	**LM reconstruction**
Parietal subcytoplasmic structure 'C'	Intine: endocorium mesocorium
Core spore wall 'B-A'	Exine: epicorium: sclerosporium scutellosporium episporium leptosporium tectocorium: tectosporium parasporium ixosporium
Sterigmatic wall remnants 'b-a'	Perine: myxocorium: perisporium ectosporium

For a long time Iodine-starch reaction remained a riddle for chemists. They contented themselves with a supposition of the "Iodine-starch complex" formation, and only recently the convincing explanations were given. Here we briefly summarize them.

The "Iodine-starch complex" belongs to the substance class named as *acclusion compounds* and placed between two other classes — solid intrusion solutions and true chemical compounds. The inclusion compound appears when one chemical substance (in our case — Iodine) penetrates into the cavities of the other (for example, between "axes" and "branches" of glucan components — amylopectin and glycogen, see Fig. 6).
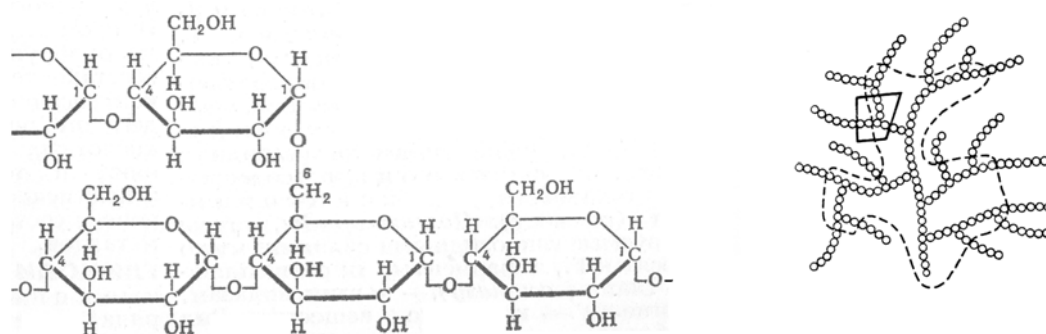

Fig. 6. The ramified chain of fungal glucan: dashed line shows the amylodextrin fragment.

The Iodine molecules fasten into glucan structure due to electrostatic powers. Unlike true chemical compounds, the Iodine atoms are not fixed strictly within glucan structure and form a long chain in which every Iodine atom is combined with the neighbour by one electron. The colour of Iodine chain is conditioned by length of cavity, and varying from bluish (cavity long) to brownish (cavity short).

Iodine forms analogous compounds together with barbiturates, coumarins and flavons. The electron transfers provide the Iodine-organic complexes with a stability:

$$donator + I_2 = [donator\ I]^+ + I^-$$
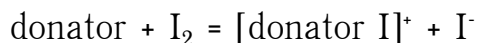
Therefore Iodine is commonly used in reactions, being a component of an organic-inorganic complex — Melzer's reagent.[1] An intensity of reaction descends after heating, and increases when preparation is cooled and the nitrites of alkaline metals are added.

Colour variation is depended on glucan concentration in a spore wall, and has taxonomic significance. At the same time, an evaluation of colour reactions is subject to any voluntarism. In our opinion, a sporoderm staining in Melzer's reagent may be well described with: 1) reaction to prevailed glucan fragments; 2) degree of colour intensity (ranged according to three-pointed

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[1] The Melzer's reagent is commonly prepared from 0.5 g Iodine, 1.5 g KI, 100 g water, and 22 g chlorale hydrate (see, for example, Ryvarden, Gilbertson, 1993).

scale); and 3) colour designation according to colour scale (the colour scale of J. H. Petersen, 1996 — see Table 2).

<div align="right">Table 2</div>

A scale of sporoderm reactions in Melzer's reagent
(colours designated according to J. H. Petersen, 1996)

Widespread term	Gradation proposed	Reference to colour plate	Selected examples
seemingly amyloid	'amylose'(+)	pale mouse gray (P 53) to light vinaceous grey (P 59)	*Porpomyces cremeus, Amylocorticiellum sinuosum, Heterobasidion annosum*
weakly amyloid	'amylose'+	ash-gray (P 55)	*Amylocorticiellum molle, Fayodia bisphaerigera* (outer 'sphere'), *Megalocystidium luridum, Mycena pura, Gloeocystidiellum porosum*
amyloid	'amylose'++	bluish grey (P 57) to dark bluish grey (P 56)	*Lactarius plumbeus* (crests), *Bondarzewia mesenterica* (crests), *Clavicorona pyxidata, Dentipellis dissita, Hericium coralloides*
strongly amyloid, =amylodextrinoid	'amylopectin'+++	vinaceous-grey (P 58) to greyish violet (P 44)	*Dentipellis fragilis* (selected specimens), *Leucopaxillus amarus*
weakly dextrinoid	amylodextrins+	cinnamon-buff (P 14) to olivaceous buff (P 16)	*Perenniporia medulla-panis, Haploporus suaveolens, 'Trametes' ljubarskyi*
dextrinoid[2]	amylodextrins++	yellowish-brown (P 9)	*Serpula mollusca, Parmastomyces mollissimus*
strongly dextrinoid	amylodextrins+++	orange-brown (P 7)	*Serpula panuoides, Perenniporia robiniophila, Leucopaxillus albissimus*

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[2] E. Parmasto in some papers used the term "pseudoamyloid" which approximately corresponds with "dextrinoid" of other authors. However, in "Conspectus systematis *Corticiacearum*" (Parmasto, 1968) he applies this term to any colourings, distinguished from dark blue including "weakly amyloid" in *Plicatura* and some *Leucogyrophana* species.

So, Melzer's reagent allows to show the peculiarities of fibrillar-crystalline sporoderm matrix, and precludes (to some degree) the artifacts caused by minute structure of exine. However, this stuff does not reveal a shape of sporoderm surface (both outer and inner) because it has no affinity with denser hydrophobic matter of a sporoderm (lipoid and protein concretions). Therefore, its use provides a little support to understand, either we deal with 'hemitectosporous' artifact, or with true perforated spore wall.

Toluidin blue (Fig. 7) aids to detect a granular matter and reconstruct a shape of spore surface (Locquin, 1945; R. H. Petersen, 1968, 1988).
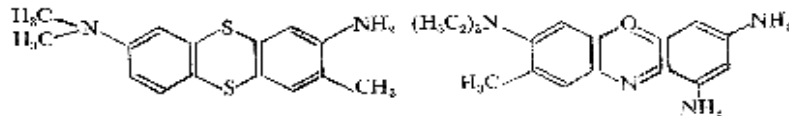
Fig. 7. Molecules of toluidin (left) and cresyl (right) blue.

Due to its free NH_2— group, this medium easily reacts with "acide" fragments of many lipoid and protein substances. In many cases, TB is very effective dye: it stains other matters, retaining its own colour. It is useful to morphological studies, since it colours the superficial chondroproteins of a sporoderm. When reacting with simpler stuffs, TB causes red or rosy colouration: then a *metachromatic* structure is told. Usually, this is a reaction with lipid inclusions in cytoplasm, or with surfaces of small organells. For example, a metachromatic reaction is highly characteristic for the spores of the *Hyphoderma* species, or the agaric *Lepiota pseudoasperula*, which are rich of acidic lipids. Melzer's reagent and TB use is enough to study a sporoderm morphology.

Also it is necessary to consider the terms applied to descriptions of sporoderm ornamentation. In our opinion, a scale of Locquin (1984) is most acceptable. This scale applies for quantity proportion of width (d) and height (h) of ornamentation elements. So, a spore surface may be regarded as *granulose* (h ≈ d/2), *rugulose* (d > 2h), *verrucose* (h ≤ d), *tuberculose* (h > d), *punctate* (h < d/2), *echinulate* (h > 2d), *acuminate* (d/2 > h < 2d).

A special theme of this chapter is the study of tectocorium in hymenomycetous fungi of which the spores were classified as 'ganodermoid' from time to time, i. e. in Locquin's 'orders' *Fayodiales*, *Ganodermatales*, *Crepidotales*, and *Strobilomycetales*.

'FAYODIALES'. In this group, a classical object was studied — there are the spores *Fayodia bisphaerigera* (J. E. Lange) Singer (Fig. 8). IKI-reaction shows 'amylose'+ tectocorium as a grayish outline around the chitin pilars. In this medium the pilars look like echinulate ornamentation and smooth perine shades away. TB makes a smooth perine perceptible, and pilars demonstrate moderate cyanophilous reaction. So, we deal with typical hemitectospores.
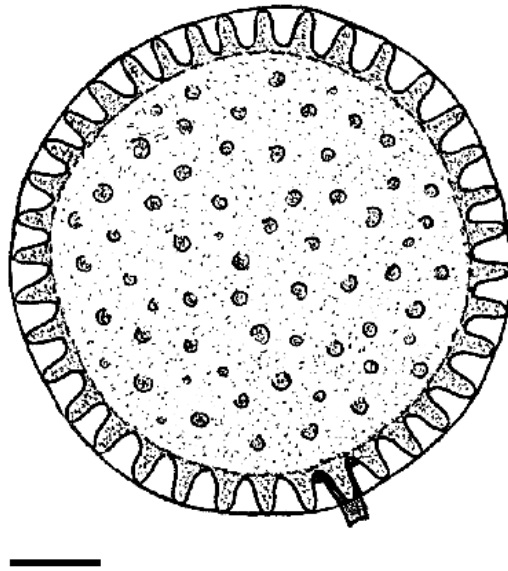

Fig. 8. Basidiospore of *Fayodia bisphaerigera* (LE 8722). Scale bar = 2 μm (drawing by Vera Malysheva).

'GANODERMATALES'. Because the spores of *Ganoderma* and *Amauroderma* species were entirely studied by LM (see above), here we try to concern a spore structure of some taxa discussed by mycologists as closely related to *Ganodermataceae* (Knudsen, 1995), i. e. *Heterobasidion*, *Haploporus* and *Perenniporia*.
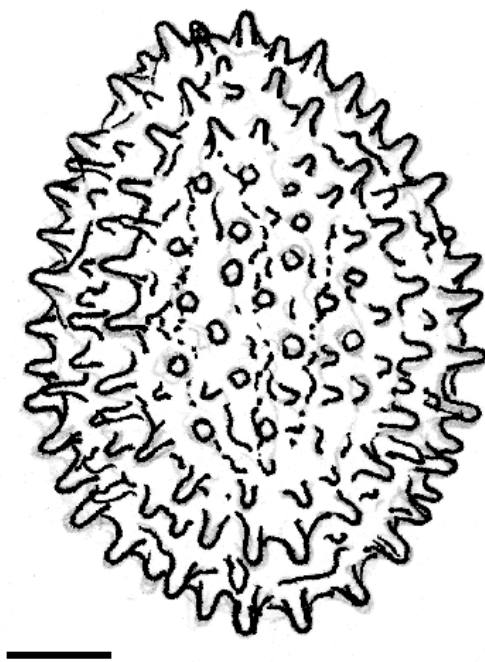
Fig. 9. Basidiospore of *Heterobasidion annosum*: conception of surface. Scale bar = 1 μm (drawing by Vera Malysheva).

Heterobasidion annosum (Fr.) Bref. (Fig. 9). IKI-reaction shows punctate, subinvisible outline staining as 'amylose'(+) to 'amylose'+. TB reveals more perceptible ornamentation which really is varying from verrucose to echinulate. So, there are no hemitectospores; in a case of *Heterobasidion*, we deal with spores having echinulate exine enveloped by strongly reduced perine. Exine develops the folds seen between tubercles as reticle or crests (see SEM in Stalpers, 1996). A glucan matrix is bluish in Melzer's reagent, and observed between perine and dense tectocorium. This spore structure is characteristic for many species of the *Russulales*.

Haploporus suaveolens (L.: Fr.) Donk (Fig. 10). IKI-reaction shows subverrucose to almost smooth outline ('amylose'(+) to amylodextrins+). TB-reaction bares the heterogeneity of a spore wall, which consisting of acyanophilous fibrillar-crystalline and cyanophilous granular matters. Granules (probably, homologous to the pilars of *Fayodia* and *Ganoderma*) compose an exine (up to 1 μm thick) freely fitted by thin uniformly cyanophilous perine. So, the spore surface seems to be granulose, resembling those of many *Ganoderma* species (compare SEM in Table 3 and SEM in Niemelä, 1971, or Blanchette, 1997). Therefore, the spores of *H. suaveolens* must be considered as peculiar hemitectospores.
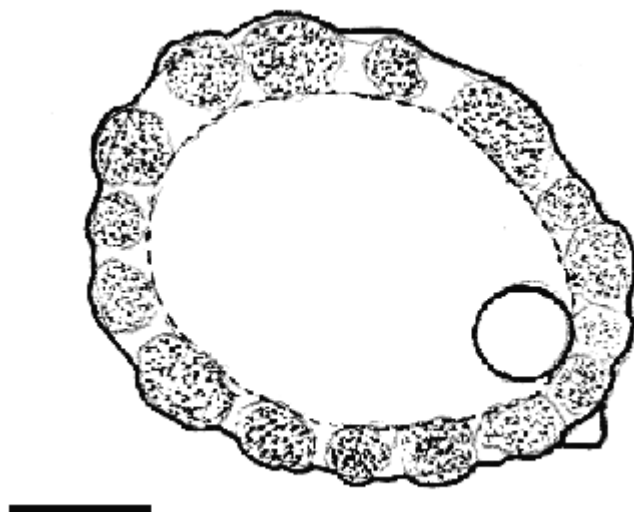
Fig. 10. Basidiospore of *Haploporus suaveolens* (LE 28149). Scale bar = 1 μm (drawing by Vera Malysheva).

'*Trametes*' *ljubarskyi* Pilát (Fig. 11). IKI-reaction displays 'amylodextrins+' outline of the same width as in preceding species; however, it is smooth. TB colours a spore wall evenly (a colouration of perine is slight clearer). The spores are reminiscent of those of *Perenniporia robiniophila* (Murrill) Ryvarden (Fig. 12) which differs in having more intensive IKI-reaction (amylodextrins+++). So, the spores of both '*Trametes*' *ljubarskyi* and *Perenniporia robiniophila* are not true hemitectospores, though they retain some features of the ganodermoid spores: there are more or less expressive dextrinoid reaction and irregularly thickened exine. Analogous species pairs with ornamented/not ornamented spores could be seen in the next 'order'.

'CREPIDOTALES'. *Crepidotus variabilis* (Pers.: Fr.) P. Kumm. (Fig. 13). IKI-reaction shows 'amylose'(+) ganodermoid outline with numerous "pilars". The regularly thickened cyanophilous wall with abundant tuberculose protuberances is seen in TB. Therefore, it causes an artifact of hemitectosporous shape.

Crepidotus mollis (Schaeff.: Fr.) Staude (Fig. 14). IKI-reaction stains thick spore wall superficially (perine 'amylodextrins+'). TB-reaction reveals evenly thickened cyanophilous wall.
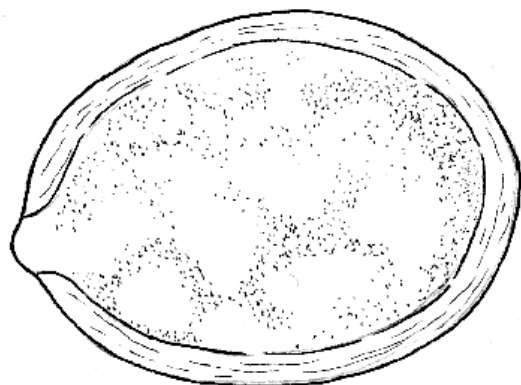
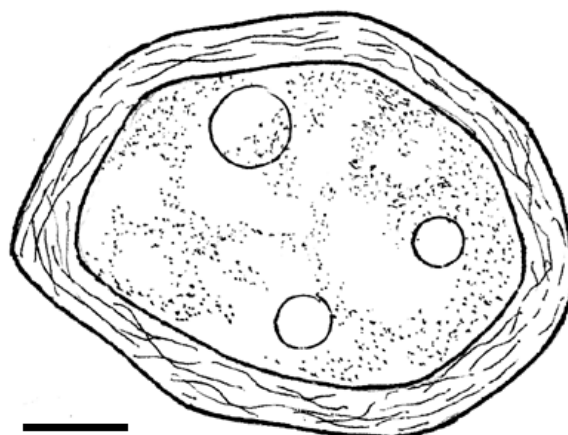**Fig. 11.** Basidiospore of '*Trametes*' *ljubarskyi* (LE 19475). Scale bar = 0.8 μm.

Fig. 12. Basidiospore of *Perenniporia robiniophila* (LE). Scale bar = 1 μm.

(Drawings by Vera Malysheva)

Spores of other *Crepidotus* species are either tuberculose-verrucose-punctate, or smooth (see Pegler, Young, 1972); so, the '*Crepidotales*' is not a hemitectosporous group.
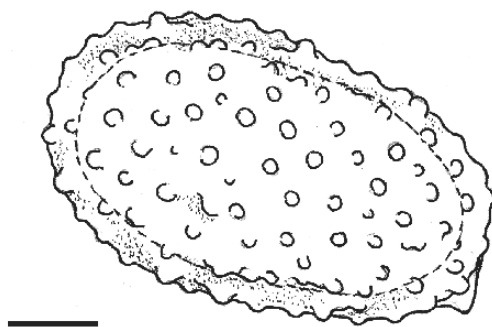

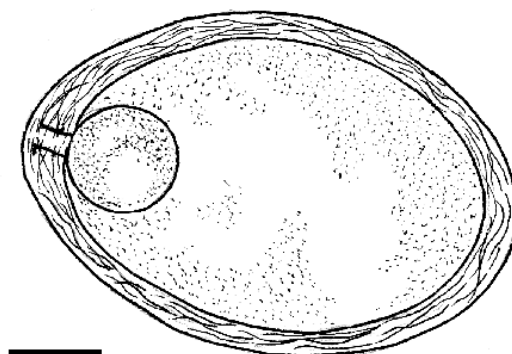**Fig. 13.** Basidiospore of *Crepidotus variabilis* (LE 12523). Scale bar = 1 μm.

Fig. 14. Basidiospore of *Crepidotus mollis* (LE 208141). Scale bar = 1.5 μm.

(Drawings by Vera Malysheva)

'STROBILOMYCETALES'. *Strobilomyces strobilaceus* (Scop.) Berk. IKI-reaction entirely stains a sporoderm ('amylose'+) and makes the artifacts of numerous "pilars" and "pores".
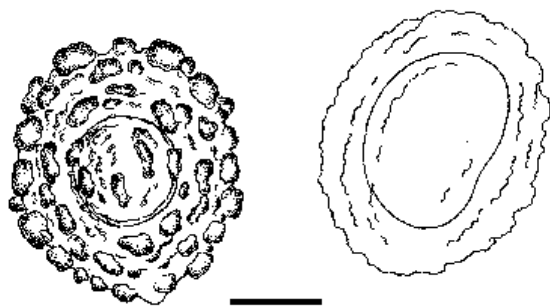
Fig. 15. Basidiospores of *Strobilomyces strobilaceus* (LE). Scale bar = 2 μm (drawing by Vera Malysheva).

TB-reaction (Fig. 15) is very intensive and displays strongly tuberculose surface. However, an ornamentation may be varying from typical tuberculate to almost smooth in the same microscopic mount. Moreover, some tubercles bear cap-like structures sometimes fusing together. This phenomenon will be discussed below; here we only mention that this pattern increases a hemitectospore artifact. The tubercles of *S. strobilaceus* represent a modified exine as well as in aforementioned species. The perine covers lower layer entirely and tightly; so, the spores of *S. strobilaceus* have the same structure as tuberculate ones of the 'Crepidotales'.

1.3. Tracing the thread of hemitectospore diversity through the taxonomy context. The trends of spore diversification are controversially interpreted till now. Of course, there is very difficult to detect any leading factor affected their morphogeny. It is evident a presence of tubercles, crests, spines, or reticular formations must be regarded as apomorphic condition because these structures improve aerodynamic and adhesive spore characteristics (Frazier, Glaser, 1979). However, whether these structures appeared from originally thin sporoderm, or produced by degraded thick-walled spores, is vague.

After the study of hemitectospores and thick-walled non-perforated spores, we incline to the second viewpoint. Evidently, an original — protective — function of the spores causes a development of its thickened impenetrable tectum. Thick-walled spores are characteristic for many archaic homobasidiomycetes groups (*Cantharellales*, *Gomphales*, *Boletales*), and represent, probably, a plesiomorphic stage. At the same time, as noted by Coleman (1927), their main deficiency is "slowed reaction" to an environment changes, i. e. the belated germination.

In our opinion, an appearance of hemitectospores was connected to evolutionary tendency to increase their environmental information exchange. The perforations, filled with hydrophilic fibrillar-crystalline matter

and protected from a direct influence by the perine, allow to come the external signals soon on the heat-shock proteines of cytoplasm.

An analogous phenomenon is known in evolution of gymnosperms microspores. According to Krassilov (2004), the appearance of perforated tectum is a special *prophetic* feature, i. e. preadaptation to sudden change of spore surface which will be very effective to spread and to root in the substrate.

This change is accompanied with degradation of perine structure carried out either 1) by dehydration and collapse of perisporium matrix, when perine (as thin or mostly invisible exosporium) covers a perforated tectum, or 2) when a perisporium is partly reduced, and IKI-reaction shows a remnant of fibrillar-crystalline matrix.

So, we think that the hemitectospores represent an unstable transitional condition between the archetypic thick-walled spores and the thinner-walled ornamented ones. An origin of smooth thin-walled spores is not considered here; we only note that they may be produced due to "sprinter" strategy of the sporulation and appeared in both "smooth thick-walled spored" and "hemitectosporous" taxa. In this case, smooth amyloid spores represent a rudimentary phenomena of exosporium reduction (compare with SEM of fractured spore of *Ganoderma valesiacum* with vanished perine, whose exposed exine strongly resembles the surface of the *Heterobasidion* spore, — see Pegler, Young, 1973, pl. 21, f. 4, 5 — or analogous picture demonstrated in Adaskaveg, Gilbertson, 1986, f. 14, 15).
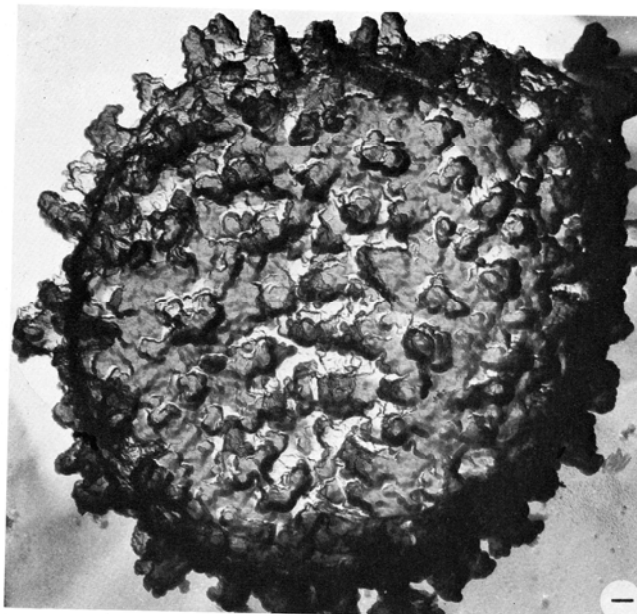

Fig. 16. SEM of basidiospore of *Crepidotus wakefieldii* by Pegler and Young (1972).

As said above, the spore spines of *Strobilomyces strobilaceus* are characterized by exceptionally peculiar shape. The same outline is characteristic for *Crepidotus wakefieldii* Pilát, as seen in SEM by Pegler and Young (1973; see Fig. 16). This spore pattern indicates that the cap-like tubercles of *Strobilomyces strobilaceus* and *Crepidotus wakefieldii* are remnants of continuous perisporium of a hemitectosporous ancestor. So, Singer was rather right when he designated the spores of *Crepidotaceae* as ganodermoid; here we may amend only — "ancestrally ganodermoid". (By the way, the data under consideration show that the gap between *Crepidotaceae* and *Strobilomycetaceae*, at least concerning to a spore morphology, rather disappears, no less than obvious gravitation of both families to the *Gomphales*).

Really, we deal with numerous independent phylogenetic lines in which different stages of a cycle "thick-walled spores — hemitectospores — ornamented spores" are fixed. Within one genus, the species may have a spore integument of different types (e. g., *Crepidotus*). In this connection, such hemitectosporous genus as *Haploporus* and its crassitunicate smooth-spored counterpart *Perenniporia* compel our attention. In our opinion, *Haploporus suaveolens* shows "the first steps" of integument perforation and degradation, while the genera *Wrightoporia* and *Heterobasidion* demonstrate the "latter" ones.

A natural place of these genera in taxonomy of higher basidiomycetes remains questionable. Aforegoing description of the spores of *Haploporus suaveolens* could produce an impression that they are homologous to the spores of *Ganoderma*, and, on the other hand, to those of *Heterobasidion*. If some other features common to the *Ganodermataceae*, *Perenniporiaceae* (incl. *Heterobasidion*), *Lachnocladiaceae* and *Wrightoporiaceae* (Melzer-positive skeletal hyphae having a tendency to dichotomous branching, and apically widened clavate basidia) are emphasized, their regrouping into the *Lachnocladiales* (or the "large" *Russulales*) could be rather logical. However, known molecular data distract this group, supported a position of *Heterobasidion* within the *Russulales* (Hibbett et al., 1997; Larsson, Larsson, 2003), whereas *Ganoderma* and *Perenniporia* appear belonging to the "polyporoid clade" (Moncalvo, 2000). From morphological viewpoint, this replacement looks very strange, though Corner (1987) mentioned the similarity of *Ganoderma* and *Polyporus*. Undoubtedly, this problem may be decided when a large set of new data will be analyzed.

Chapter 2

The genus Perenniporia in boreal Russia

Eight resupinate *Perenniporia* species known from boreal zone of Russia and adjacent countries are dealt with in this chapter. The concept and borders of the genus *Perenniporia* Murrill are discussed below.

The type species *Perenniporia medulla-panis* (Jacq.: Fr.) Donk has relatively wide distribution in hemiboreal ('oak') zone growing mostly on wood of *Quercus robur*. It is easily distinguishable by its narrow irregularly arranged indextrinoid skeletal hyphae and relatively small truncate spores. Its boreal counterpart is *P. kilemariensis* Spirin et Shirokov, *spec. nov.*, which has brighter basidiocarps and wider strictly parallel subhymenial skeletals strongly dissolving in KOH; a presence of chlamydospores is highly characteristic, too. It occurs on living *Tilia cordata* in old-growth boreal forests.

Another strictly boreal species, *Perenniporia subacida* (Peck) Donk, is recognized by dextrinoid parallel skeletal hyphae with wide lumen; its spores are not truncate and strongly dextrinoid. This species is widespread in old-growth taiga forests on both deciduous wood and conifers; when growing on *Picea abies*, it shows a peculiar connections with other polypores, in particular, *Heterobasidion parviporum* Niemelä et Korhonen. *Perenniporia valliculorum* Spirin et Zmitr., *spec. nov.*, is closely related to *P. subacida* but differs by semitranslucent thin basidiocarps, smaller spores, and narrower skeletals swelling inwards in KOH. This new species is found in old ravine forests, and observed on wood of *Betula pubescens* and *Abies sibirica*.

Till the moment, *Perenniporia narymica* (Pilát) Pouzar was known from the type locality in Siberia; three new localities in Russia are added below. This species is new to Belarus. It prefers to old mixed forests, producing intensive fructifications on thick fallen trunks of *Populus tremula*. In microscope it is identified by its parallel amyloid skeletals strongly dissolving in KOH, and non-truncate indextrinoid spores. *Perenniporia tenuis* (Schwein.) Ryvarden has similar ecology; it is bright-coloured (yellow to vitelline) polypore with faintly dextrinoid spores and skeletals. Its distri-

bution is revised because most of earlier records (as *Fomitopsis unita* (Pers.) Bondartsev var. *pulchella* Schwein.) were based on misidentification.

Two species found in Russian Far East are also described. First of them is referred as *Perenniporia tenuis* var. '*tenuis*', and differs from true *P. tenuis* (i.e. incl. var. *pulchella*) by its irregularly arranged indextrinoid skeletals and larger strongly dextrinoid spores. The second species is designated as *Perenniporia japonica* (Yasuda) Hattori et Ryvarden, and characterized by strongly dextrinoid broadly-ellipsoid spores and skeletals dissolving in KOH. This latter is new to Russia.

Pileate species having mostly subtropical or tropical distribution (*P. fraxinea* (Bull.: Fr.) Ryvarden, *P. ochroleuca* (Berk.) Ryvarden, and *P. ohiensis* (Berk.) Ryvarden) are not treated.

Two closely related species commonly regarded outside of this genus, *Haploporus suaveolens* (L.: Fr.) Donk and *Trametes ljubarskyi* Pilát, are also treated; their morphology, anatomy and ecology are described.

The species descriptions were made by W. Spirin except *Perenniporia valliculorum* Spirin et Zmitr. (described by these authors) and *Haploporus suaveolens* (by I. Zmitrovich and V. Malysheva).

PERENNIPORIA Murrill,
Mycologia **34:** 595, 1942.

Basidiocarps perennial, resupinate, effused-reflexed or pileate, cheesy-like, coriaceous to corky, variably coloured (whitish, grayish to bright yellow or ochraceous-brown). Pileal surface velutinate or covered by agglutinate cuticle or crust, light-coloured to almost black. Pores round to angular, mostly with thick dissepiment edges; pore surface of resupinate species often nodulose on sloping substrates. Context well-developed in pileate species, sometimes hardly visible to degenerating in resupinate ones, soft- to hard-corky. Tubes often stratified, cheesy-like to woody-hard, very rarely agglutinated.

Hyphal system dimitic or more often trimitic. Skeletal hyphae hyaline or coloured, thick-walled, variably arranged, dextrinoid, very rarely amyloid or yellowish in Melzer's reagent, cyanophilous in most species. Generative hyphae hyaline, mostly thin-walled, clamped. Cystidia often absent; conical or bottle-shaped cystidioles present in hymenium. Dendrohyphidia present at dissepiment edges of few species. Basidia broadly-clavate, four-spored, fibulate at the base. Spores as a rule thick-walled and truncate, narrowly- to broadly-ellispoid, with or without germ pore, in most species dextrinoid (not amyloid), strongly cyanophilous; spore wall smooth. Chla-

mydospores present in subiculum and subhymenium of some species, and also in culture (Stalpers, 1978; Lehmkuhl Gerber et al., 1999).

Causes a white rot of deciduous wood and conifers.

Typus: *Polyporus medulla-panis* Jacq.: Fr., 1821 (Lectotypus — see Donk, 1967 and Decock, Stalpers, 2005).

The genus was established by Murrill (1942); later Cooke (1953) and Donk (1967) selected *Polyporus unitus* Pers. as a type species which they considered as synonym of *Polyporus medulla-panis* Jacq.: Fr. Recently Decock et Stalpers (2005) showed that *P. unitus* and *P. medulla-panis* are not conspecific; so the generic name *Perenniporia* would be rejected as a *nomen dubium*. However, they selected an epitype and re-described a type species to avoid the instability in polypore taxonomy and to conserve a generic epithet.

Donk (1967) used the name *Perenniporia* Murrill firstly in European mycology; he discussed this generic name and proposed new combinations for two resupinate European species, *P. medulla-panis* and *P. subacida* (Peck), early regarded within the genera *Fomitopsis* P. Karst. and *Chaetoporus* P. Karst. (Bondartsev, 1953) respectively. Later Ryvarden (1972, 1978) added some pileate species of *Truncospora* Pilát (*T. ochroleuca* (Berk.) Pilát and *T. ohiensis* (Berk.) Pilát) and *Fomitopsis* (*F. cytisina* (Berk.) Bondartsev et Singer = *Polyporus fraxineus* Bull.: Fr.) characterized by truncate spores and variably dextrinoid spores. Nowadays the genus includes about 80 species (Dai et al., 2002), and their number becomes larger from day to day. However, the limits of a genus and its phylogenetic relationships remain unclear till the moment.

2.1. Perenniporia and related genera. Bondartsev et Singer (1941) erected the genus *Haploporus* Bondartsev et Singer for *Polyporus odorus* Sommerf., 1826. Their generic name was invalid because of the lack of Latin diagnosis; later Singer (1944) published correct description of the genus. In his remarkable book, Bondartsev (1953) changed the concept of a genus because he was of opinion that the name *Polyporus odorus* Sommerf. is doubtful, and regarded *Trametes ljubarskyi* Pilát as a neotype. Eriksson (1958) was the first who demonstrated the certainty of a name *Polyporus odorus* Sommerf. (as *Trametes odora* (Sommerf.) Fr.) and an independent status of this species. He noted thick-walled spores as its main microscopic feature. Niemelä (1971) made a scanning electron microphotograph displayed the character of spore surface in *H. odorus*: it appeared warted. This character was established as a primary difference between genera *Perenniporia* and *Haploporus* (Ryvarden, 1991); the lat-

ter was considered as monotypic. Donk (1971) argued the validity of a name *Polyporus suaveolens* L.: Fr. 1821, and proposed a new combination *Haploporus suaveolens* (L.: Fr.) Donk. Domański (in Domański et al., 1973) compared *Haploporus odorus* and *Trametes ljubarskyi*, and found them to be very similar in their morphology and anatomy, except the character of a spore wall.

Ryvarden (1998) established a new genus *Abundisporus* Ryvarden (type *Polyporus fuscopurpureus* Pers.) to separate the species with small coloured indextrinoid spores earlier regarded under the names *Perenniporia* and *Loweporus* Wright; later seven species were added to this genus (Parmasto, Hallenberg, 2000; Decock, Laurence, 2001; Dai et al., 2002). Dai et al. (2002) also gave a new reasons for division among *Perenniporia*, *Abundisporus* and *Haploporus*. In their opinion, the main features in this group are the characters of the spores: their colour (spores coloured in *Abundisporus* and hyaline in *Perenniporia* and *Haploporus*) and wall structure (warted in *Haploporus*). They considered the generic names *Haploporus* and *Pachykytospora* Kotl. et Pouzar as synonyms, and combined four species of the latter into the first.

Recently Decock and Ryvarden (2003) questioned a homogeneity of *Perenniporia* and segregated a new genus *Perenniporiella* Decock et Ryvarden of which the species are characterized by the spores without an apical germ pore, and have pileate, decurrent or pendant basidiocarps. *Perenniporia subacida* (Peck) Donk, *P. contraria* (Berk. et M. A. Curtis) Ryvarden and *P. subannosa* (Bres.) Decock et al. also have the spores without a germ pore, therefore their taxonomic position became unclear (Decock et al., 2001; Decock, Ryvarden 2003).

2.2. Perenniporiaceae and Perenniporiales. Jülich (1982) transferred the genus *Perenniporia* into a new family *Perenniporiaceae* Jülich; together with other small family, *Pachykytosporaceae* Jülich, it was regarded within the new order *Perenniporiales* Jülich. The sister groups of this order, in opinion of the author, are the *Fomitopsidales* (the families *Haploporaceae* and 'Heterobasidiaceae' = *Heterobasidionaceae*) and *Ganodermatales*. All these taxa include white-rot producing, di- or trimitic polypores with thick-walled, in some species truncate or ornamented spores. The order *Perenniporiales* was accepted by Knudsen (1995); he merged genera *Perenniporia*, *Haploporus*, *Heterobasidion* Bref. and *Pachykytospora* into the family *Perenniporiaceae* and placed it near the *Ganodermatales*. In this scope, the family and the order were regarded in "Nordic Macromycetes. Vol. 3" (Hansen, Knudsen, 1997).

Zmitrovich (2001) included these four genera into the family *Fomitopsidaceae* Jülich (together with *Abundisporus*, *Antrodia* P. Karst., *Daedalea* Fr., *Diacanthodes* Singer, *Gloeophyllum* P. Karst., *Pyrofomes* Kotl. et Pouzar, and

Wrightoporia Kotl. et Pouzar) of the order *Polyporales* (Herter) Gäum. All these genera are characterized by more or less expressed trimitic structure (in many species with coloured, dextrinoid or amyloid, often cyanophilous vegetative hyphae), and show a tendency to thickening of the spore walls. Arefiev (2003) tried to interpret the system given by Zmitrovich, comparing the ecological preferences of the species. He concluded that the *Perenniporiaceae* has an ancestral form close to the *Dichomitus* species, and regarded *Heterobasidion* as a member of this family.

The last changes in taxonomy of higher basidiomycetes were caused by the study of fungal rDNA genes (Hibbett, Thorn, 2001; Moncalvo et al., 2003). According to these studies, the genus *Perenniporia* is a member of large polyporoid clade (Moncalvo, 2000), together with *Ganoderma*, *Dichomitus* D. A. Reid and the most of trametoid fungi; so, there are proposed to regard the name *Ganodermataceae* and some other Jülich's family names as *nomina superflua* (Krüger, 2002). At the same time, genera *Heterobasidion* and *Wrightoporia* come into the *Russulales* (close to *Bondarzewia* Singer); this taxonomic replacement of these twos was suggested firstly by Stalpers (1979, 1996), and confirmed recently by Larsson and Larsson (2003). Recent study of Binder et al. (2005) showed well-supported group, consisting of *Perenniporia medulla-panis* and some *Polyporus*, *Datronia*, *Fomes*, *Daedaleopsis* and *Ganoderma* species ('core polyporoid clade').

An opposite viewpoint on taxonomy of *Perenniporia* and related genera was presented in paper of Zmitrovich and Wasser (2004). In this article the authors purposed to find a consensus between morphological and molecular data. These authors regarded *Cantharellales* Gäum. as an ancestral group of the *Homobasidiomycetes* from which three sister groups are derived — *Hymenochaetales* Oberw. and *Lachnocladiales* Jülich (through *Clavariachaete* Corner), and *Gomphales* Jülich (through *Gomphus* (Pers.) Gray). The family *Perenniporiaceae* was included within the *Lachnocladiales* due to invariably branching dextrinoid or amyloid skeletals; the *Ganodermataceae* was placed within this order, too. These taxonomic innovations have some reasons; then we see two alternative ways to protect the basidia: either to develop a tubular hymenophore (*Perenniporiaceae* and *Ganodermataceae*), or to produce a cathahymenium (*Lachnocladiaceae* D. A. Reid and *Dichostereaceae* Jülich). I found some herbarium specimens identified as *Scytinostroma* spp.; really they are sterile mycelial films often developed by *Perenniporia subacida*.

In any case, the natural place of *Perenniporia* and related taxa must be determined after much closer molecular study including the species of *Amylosporus* Ryvarden, *Haploporus*, *Diacanthodes*, and *Wrightoporia*.

2.3. Species key

1a. Basidiocarps pileate or effuse-reflexed ……………………………………… 2.
1b. Basidiocarps resupinate ……………………………………………………… 7.

2a. Spores warted, faintly IKI+; skeletals faintly dextrinoid. Basidio-
carps with strong aniseed smell. Mostly on *Salix*
…………………………………………………………………………. *Haploporus suaveolens*.
2b. Spores smooth; without strong smell …………………………………… 3.

3a. Pore surface bright yellow; on *Maackia* in Russian Far East
………………………………………………………………. *Perenniporia maackiae*.
(not treated, see description in Dai, Niemelä, 1994)
3b. Pore surface cream to ochraceous; on other substrates ………….. 4.

4a. Spores up to 8 μm long …………………………………………………… 5.
4b. Spores longer than 8 μm …………………………………………………. 6.

5a. Spores ellipsoid, mostly IKI-. Skeletal hyphae indextrinoid …….
…………………………………………………………………*Trametes ljubarskyi*.
5b. Spores drop-shaped; spores and hyphae strongly dextrinoid ……….
……………………………………………………………………. *Perenniporia fraxinea*.
(not treated, see description in Müller, Jahn, 1967)

6a. Upper surface cream to ochraceous. Spores up to 12 μm …………….
……………………………………………………………………………. *P. ochroleuca*.
(not treated, see Parmasto, 1979)
6b. Upper surface almost black. Spores longer than 12 μm ………………
………………………………………………………………………… *P. ohiensis*.
(not treated, see Gilbertson, Ryvarden, 1987)

7a. Skeletal hyphae strongly swelling and dissolving in KOH
…………………………………………………………………………………… 8.
7b. Skeletal hyphae unchanging or only swelling inwards in KOH
…………………………………………………………………………………… 10.

8a. Skeletal hyphae amyloid. Spores 4.5—5.8 × 2.8—3.9 μm, IKI-.
…………………………………………………………………… *P. narymica*.
8b. Skeletal hyphae inamyloid …………………………………………………… 9.

9a. Basidiocarps exceptionally tough in both fresh and dry condition. Skeletal hyphae yellowish in IKI. Spores 4.8—5.4 × 3.5—4.2 µm, IKI-. Chlamydospores present .... *P. kilemariensis.*

9b. Basidiocarps coriaceous. Skeletal hyphae strongly dextrinoid. Spores 4.1—5.5 × 3.0—4.3 µm, dextrinoid. Chlamydospores absent .... *Perenniporia japonica.*

10a. Skeletal hyphae indextrinoid. Trama irregular .... 11.

10b. Skeletal hyphae dextrinoid. Trama parallel .... 12.

11a. Skeletal hyphae with amyloid lumina. Spores 4.1—5.2 × 3.1—3.9 µm, variably dextrinoid .... *P. medulla-panis.*

11b. Skeletal hyphae with capillary lumina, yellow in IKI. Spores 5.5—7.8 × 4.3—6.1 µm, strongly dextrinoid .... *P. tenuis* var. '*tenuis*'.

12a. Skeletals faintly dextrinoid (pale reddish in IKI), spores truncate or not, 5.6—7.2 × 3.4—4.9 µm; hymenial surface bright yellow. Exclusively on angiosperms .... *P. tenuis* var. *pulchella.*

12b. Skeletals strongly dextrinoid, spores not truncate, up to 6 µm long. Hymenial surface cream to yellowish. On both deciduous trees and conifers .... 13.

13a. Dissepiment edges opaque; pore surface cream to ivory. Skeletals inflated up to 7 µm wide, unchanging in KOH. Spores 4.1—5.9 × 3.1—4.7 µm .... *P. subacida.*

13b. Dissepiment edges thin, semitranslucent; pore surface pale citric yellow to pale tan. Skeletals not inflated, up to 3.5 µm wide, swelling inwards in KOH. Spores 3.7—5.1 × 3.1—4.1 µm .... *P. valliculorum.*

2.4. Specimens examined

Perenniporia amylodextrinoidea. — **Canada.** Quebec, Gatineau Co., Cantley, *Prunus serotina*, 1973 *Ginns 9713* (DAOM 213748, dupl. in H).

P. japonica. — **Russia.** Primorye Reg., Kedrovaja Pad', *Salix*, 9.IX.1958, leg. *Vassiljeva*, det. *Bondartsev* (as '*Tyromyces narymicus* Bond. comb. nov.', LE 225668). — **China.** Jilin Prov., Antu Co., Changbaishan Nat. Res., *Tilia*, 15.VIII.1997 *Dai 2499* (H). — Beijing Prov., Xiangshan, *Platycladus*, 27.IX.1993 *Dai 1376* (H).

P. kilemariensis. Holotype and isotype (see below).

Perenniporia medulla-panis. — **Russia.** Leningrad Reg., Nizhnesvirsky Nat. Res., *Alnus glutinosa*, 16.IX.1996 *Zmitrovich* (LE 202130). — Nizhny Novgorod Reg., Arzamas Dist., Pustynsky Nat. Res., *Quercus robur*, 8.VII.1999 *Spirin* (LE 208964). — ibid., Lukoyanov Dist., Kurley, *Q. robur*, 27.VII.1999 *Spirin* (LE 210930, H). — ibid., Razino, *Tilia cordata* (?) and *Pinus sylvestris*, 22.VII.1997 and 5.VIII.1998 *Spirin* (LE 213681, 213609). — Nizhny Novgorod City, Botanical Garden, *Q. robur*, 3.VIII.2001 *Spirin* (LE 212233). — Samara Reg., Zhigulevsky Nat. Res., *Ulmus laevis*, 20.VIII.2000 *V. Malysheva 171* (LE). — Stavropol' Reg., Beshtau, *Carpinus betulus*, 24.VIII.1933 *Bondartsev* (LE 28513). — **Bulgaria.** Lublin, Nowo-Alexandra, *Quercus* sp., III.1910 *Bresadola* (LE 208378). — **Hungary.** Prenčow, *Quercus sp.*, 15.IV.1897 *Kmet* (LE 208329). — **Ukraine.** Crimea, *Quercus*, 10.IX.1937 *Bondartsev* (LE 28497, 28510).

Perenniporia narymica. — **Belarus.** Gomel' Reg., Turov Dist., *Carpinus betulus* (?), 31.VII.1958 *Komarova* (LE 208357). — **Russia.** Nizhny Novgorod Reg., Lukoyanov Dist., Razino, *Populus tremula*, 22.VII.1999 *Spirin* (LE 212360). — ibid., Panzelka, *P. tremula* and *Pinus sylvestris*, 3.VIII.2004 *Spirin 2058, 2067* (H). — ibid., Sharanga Dist., reserve "Kilemarsky", *P. tremula*, 28.IX.1999 *Spirin* (LE 214733, dupl. in H), 16.—19.VIII.2004 *Spirin 2106, 2110, 2217* (H). — **U.S.A.** New-York, Jamesville, White lake, *Acer sp.* (?), 27.IX.1951 *Lowe 5208* (LE 210097).

Perenniporia rosmarini. — **France.** Isère, Hyères sur Amby, *Malus*, 9.XII.1973 *David 3154* (LY, dupl. in H). — **Czech Republic.** Křivolátská Vrchovina, *Quercus*, 21.VII.1973 *Niemelä, Kotlaba & Pouzar* (H).

Perenniporia subacida. — **Russia.** Krasnojarsk Reg., Taseevo Dist., *Larix sibirica*, 1964 *Karatygin* (LE 25827). — Leningrad Reg., reserve "Nizhnesvirsky", *Populus tremula*, 18.IX.1996 *Zmitrovich* (LE 202124). — ibid., Veps Forest Res., *Picea abies*, 28.IX.2001 *Zmi-*

trovich (LE 211832). — ibid., Tosno Dist., *Betula pubescens*, 17.X.1961 *Bondartseva* (LE 28506). — Nizhny Novgorod Reg., Arzamas Dist., reserve "Pustynsky", *P. abies*, 1.VII.2000 *Spirin* (LE 213327). — ibid., Vetluga Dist., Klenovik, *Abies sibirica*, 9—12.VIII.1999 *Spirin* (LE 209787, 212625, 213330). — ibid., Kovernino Dist., Neveyka, *P. abies*, 26.VIII.2000 *Spirin* (LE 212627). — ibid., Sharanga Dist., Kilemarsky Nat. Res., *P. tremula*, 18—20.VIII.2004 *Spirin 2201, 2262* (H). — ibid., Tonshaevo Dist., Burepolom, *A. sibirica*, 28.V.2000 *Spirin* (LE 213344), Pizhma, *Pinus sylvestris*, 29.V.2000 *Spirin* (LE 213363), Okhtarskoye, *P. abies*, 30.V.2000 *Spirin* (LE 213329).

P e r e n n i p o r i a   t e n u i s . — **Russia.** Leningrad Reg., Tikhvin Dist., Veps Forest Res., *Betula*, 24.V.2000 *Manninen 664* (H). — Nizhny Novgorod Reg., Lukoyanov Dist., Razino, *Populus tremula*, together with *Megalocystidium luridum*, 17.VII.1998 *Spirin* (LE 208436, 213187). — **Canada.** Ontario, Middlesex Co., Bothwell, *Prunus*, 16.VIII.1934 *Cain 6423* (LE 25844). — **Finland.** Tammelä, Heinäman, *Alnus*, 27.IX.1879 *Karsten 2851* (type of *Physisporus vitellinus*, H), *Karsten 2852* (H).

P e r e n n i p o r i a   t e n u i s   var. 'tenuis'. — **Russia.** Primorye Reg., Posvetsky, Monguchai, *Betula*, 26.VII.1935 *Ljubarsky* (LE 28504). — **China.** Beijing Prov., Xiangshan, *Prunus*, 26.IX.1993 *Dai 1392* (H).

P e r e n n i p o r i a   v a l l i c u l o r u m . — Holotype and paratype (see below).

H a p l o p o r u s   s u a v e o l e n s . — **Russia.** Chuvashia, Shumerlya, *Acer* sp., 1930 *Shaposhnikova* (LE 28152). Karelia, Paanajarvi, Mutkalammi, *Salix caprea*, 21.08.1999 *Lositskaja* (LE). — Leningrad Reg., Veps Plateau, Dolgozero, *S. caprea*, VIII.2002 *Zmitrovich* (LE). — Primorye Reg., Shkotovo, *Syringa amurensis*, VI.1933 *Ljubarsky* (LE 28153). — **Sweden.** Lappmark, Muddus Nat. Park, Tuoljejokk, *S. caprea*, 2.VIII.1953 *Olsson & Eriksson* (as *Trametes odora* in Fungi Exsiccati Suecici *2633*).

T r a m a t e s   l j u b a r s k y i . — **Russia.** Samara Reg., Seredysh-Shalyga Island, *Populus nigra*, 25.VIII.2003 *V. Malysheva* (LE). — Tomsk Reg., without substrate indication, 1907 *Ivanitsky* (LE 19468). **Kazakhstan.** Alma-Ata Reg., *Salix*, 10.III.1943 *Kravtzev* (LE 19475).

2.5. Species descriptions

Perenniporia japonica (Yasuda) Hattori et Ryvarden, Mycotaxon **50:** 36, 1994. — *Trametes japonica* Yasuda, 1918. — Fig. 17.

Basidiocarps annual or short-living perennial, 2—4 mm thick, coriaceous but easily cut by razor blade. Margin sharply delimited from substrate, sterile, narrow (up to 1 mm wide), cream to brownish, sometimes rhizomorphic. Pore surface even, cream to grayish; pores angular, 4—6 per mm; pore mouths even. Section: context distinct, densely floccose, thin (up to 0.5 mm thick), cream; tubes not stratified, 2—3 mm thick, coriaceous.
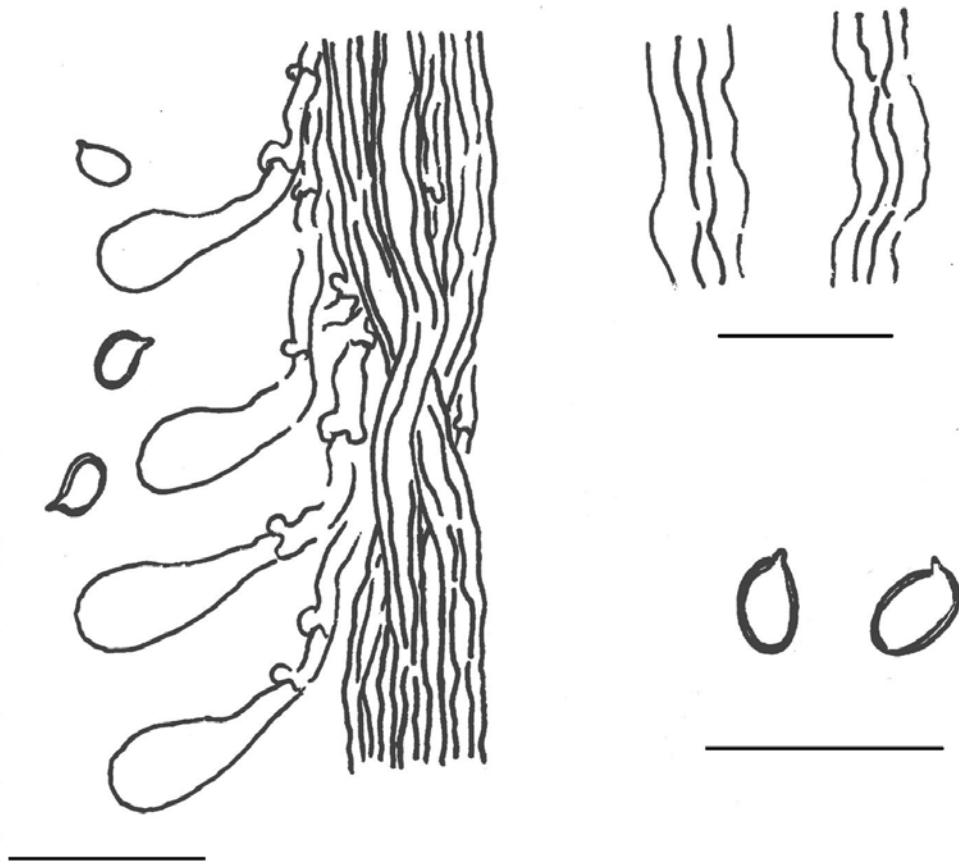
Fig. 17. *Perenniporia japonica.* (LE 225668): *a* — hymenium; *b* — subhymenial hyphae in KOH; *c* — spores. Scale bar = 10 µm.

Hyphal system dimitic. Trama subparallel. Skeletals thick-walled, with distinct wide lumina, hyaline, 2.5—4.3 µm wide, in tube trama inflated and then up to 6.8 µm wide, strongly dextrinoid and cyanophilous, swelling and intensively dissolving in KOH. Generative hyphae 2—2.5 µm

wide, hyaline, thin-walled, clamped. Cystidioles not seen. Basidia relatively small, clavate, four-spored, 10—15 × 3—5.5 μm, fibulate at the base. Spores broadly-ellipsoid to subglobose, with thickened walls, not or only slightly truncate, (3.9—)4.2—5.2(—5.5) × (3.0—)3.1—4.3(—4.5) μm, strongly dextrinoid and cyanophilous.

On *Salix* sp.; collected once in Russian Far East. New to Russia.

N o t e s . — The specimen was identified by Bondartsev as '*Tyromyces narymicus* c. n.'; however, strong dextrinoid reaction of both hyphae and spores rules out his identification. Skeletal hyphae of *P. subacida* (Peck) Donk are unchanging in KOH, therefore the identity with this latter is excluded. The brown-coloured skeletals of *P. tephropora* (Mont.) Ryvarden preclude from affinities with this one (Ryvarden, Johansen, 1980; Niemelä, 2002). Probably, we deal with yet unknown species; but the material is too scanty to definite solution.

Perenniporia kilemariensis Spirin et Shirokov, spec. nov.
Fig. 18; t a b . 4*a*.

Basidiomata perennia, incrassata, orbiculata, late prostrata, coriacea, exsiccatione durescens, odor gratus. Margo prostratus, pubescens, crassescens, pallidus ad ochraceus, hymenophoro obducens. Hymenophorum tubulosum, obscure uni—tetrastratosum (in summa 3—8 mm crass.), superficio nodulosum, aurantiacum ad brunneo-rufescens, quandoque albidopruinosus. Porae minutae, 6—8 per mm, circulatae, aliquando laceratae vel sinuosae. Subiculum 1—3 mm crass., pallido-croceum ad ochraceum, coriaceo-fibrillosum, incrustans.

Systema hypharum dimiticum. Hyphae generatoriae 1.5—3 μm diam., fibulatae, hyalinae. Hyphae sceleticae (3.5—)3.8—5.2(—6.0) μm diam., crassitunicatae, flavidae, in alcalis inflatae, inamyloideae, indextrinoideae, leniter cyanophilae, in trama parallelle collocatae. Leptocystidia 16—26 × 4—6 μm, rara, phialiformes ad conica. Basidia 15—25 × 4.5—6 μm, clavata, tetrasporifera, basi fibulata. Basidiosporae (4.7—)4.8—5.4(—5.5) × (3.1—)3.5—4.1(—4.2) μm, ellipsoideae, leviter truncatae, leniter crassitunicatae, uniguttulatae, apiculatae, indextrinoideae sed valde cyanophilae. Chlamydosporae tramaticae et subiculare, 6—17 × 4.5—7.5 μm, crassitunicatae, irregulariter ellipsoideae, guttulatae, inamyloideae, indextrinoideae et acyanophilae.

H o l o t y p u s : **Russia.** Nizhny Novgorod Reg., Sharanga Dist., Kilemarsky Nat. Res., *Tilia cordata*, 21.VIII.2004 *Shirokov & Spirin 2266* (H, I s o t y p u s — LE 214743).
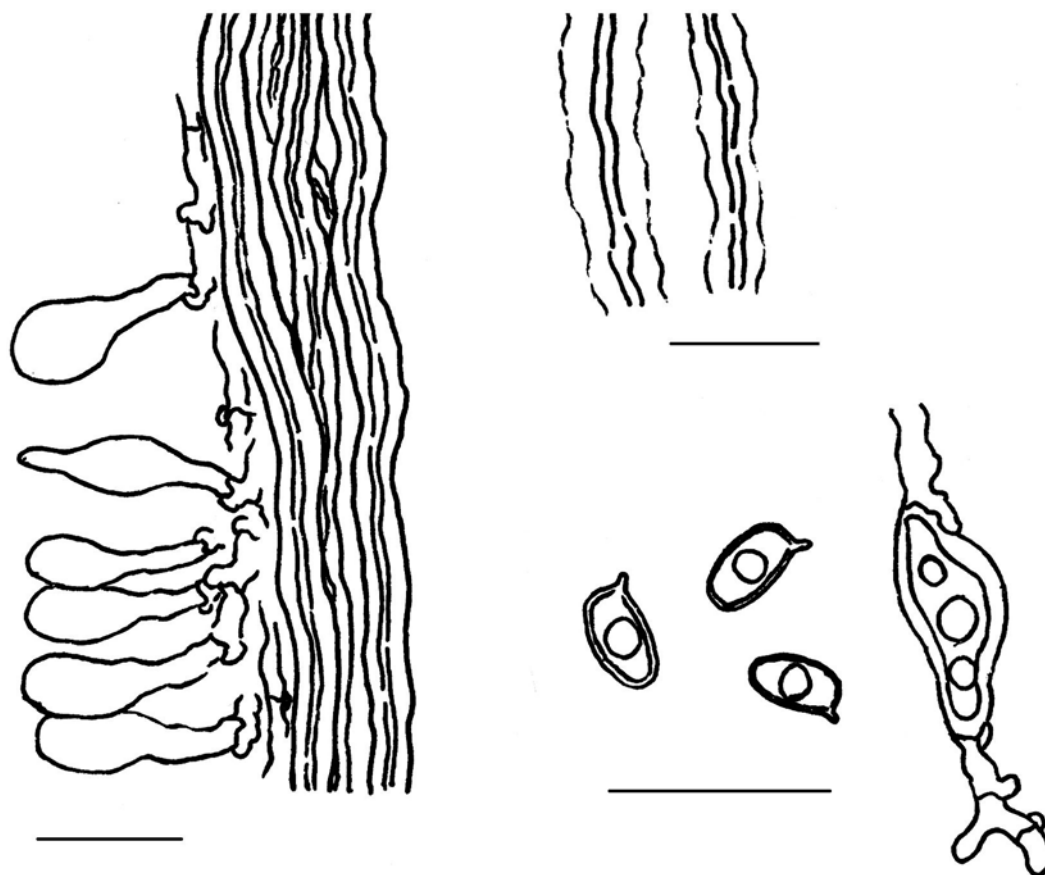
Fig. 18. *Perenniporia kilemariensis* (holotype): *a* — hymenium; *b* — subhymenial skeletals in KOH; *c* — spores; *d* — chlamydospore. Scale bar = 10 μm.

Basidiocarps perennial, resupinate, thick, largely effused along the living tree (up to 20 cm in longest dimension), densely coriaceous and hardly cut by knife in fresh condition, very tough when dry. Margin firstly sharp, opaque, whitish and pubescent, germinating the shallow pores, later thick, bright ochraceous to tan, in old basidiocarps degenerating. Pore surface uneven, nodulose, firstly bright orange with amber stains, later bright ochraceous to tan or reddish-brown, sometimes covering by whitish pruina; pores small, 6—8 per mm, round to slightly lacerate, thick-walled, sinuous and open in oblique positions; pore mouths even. Section: context distinct, 1—3 mm thick, pale saffron or ochraceous, tough-fibrillose, in older basidiocarps gradually merging with substrate; tubes indistinctly stratified, 1—4-layered (persistent layers totally covered by growing one), 3—8 mm thick, yellowish to ochraceous, partly agglutinated and brownish (tan). Odour faint, pleasant; taste mild.

Hyphal system dimitic. Skeletal hyphae dominating in all parts of basidiocarp, robustly thick-walled, with distinct lumina, yellowish in IKI, dis-

tinctly swelling and dissolving in KOH, weakly cyanophilous, (3.5—)3.8—5.2(—6.0) µm wide, tightly interwoven in subiculum, strictly parallel and very densely packed in tube trama. Generative hyphae very rare, clamped, hyaline, 1.5—3 µm wide. Cystidioles rare, 16—26 × 4—6 µm, bottle-shaped or conical. Basidia clavate, four-spored, 15—25 × 4.5—6 µm, fibulate at the base. Basidiospores ellipsoid, indistinctly to clearly truncate, (4.7—)4.8—5.4(—5.5) × (3.1—)3.5—4.1(—4.2) µm, with distinct, slightly thickened walls and central oil-drop, sharply apiculate, indextrinoid, strongly cyanophilous. Chlamydospores occurring in both trama and context, generated also by secondary mycelium overgrowing the older tubes, apical or intercalary, thick-walled, roughly ellipsoid or barrel-shaped, 6—17 × 4.5—7.5 µm, guttulate, IKI and CB-.

Etymology: 'kilemariensis' (Latin, adj.) — derived from the Russian name of the type locality ('Kilemary').

Distribution. — Known from the type locality.

Identification. — Undoubtedly, this new species is closely related to *Perenniporia medulla-panis*. They share nodulose small-pored basidiocarps, inamyloid skelelal hyphae staining yellow in IKI, and relatively small thick-walled truncate spores. However, *P. medulla-panis* is less bright, its subhymenial hyphae are irregularly arranged and unchanging in KOH; conidial state is unknown in this species. *Perenniporia subacida* differs in having Melzer-positive skeletals unchanging in KOH, and has dextrinoid spores. Another one, *P. narymica*, is easily identified by amyloid skeletals, non-truncate spores and larger pores; its basidiocarps are easily cut when fresh and less dense in dry condition. Tropical species *P. malvena* (Lloyd) Ryvarden has spores of the same size as the *P. kilemariensis*; however, this species is distinctly pileate, brownish, and its skeletal hyphae and spores are dextrinoid (Ryvarden, 1989). North-American species *P. amylodextrinoidea* Gilb. et Ryvarden has similar but less dense and bright basidiocarps; it sharply differs from our new species by its distinctly truncate and strongly dextrinoid basidiospores 4.0—4.8 × 3.0—3.9 µm. *P. compacta* (Overh.) Gilb. et Ryvarden has similar conidial state, but differs by larger spores and shallow pores (Gilbertson et Ryvarden, 1987).

Ecology. — This species was found on living linden trunk (*Tilia cordata*). The type locality represents old moist undisturbed forest along the small river; mean age of tree stand is 180 years. Intensively occupying the living trees, *P. kilemariensis* is, probably, a pathogenic species.

Perenniporia medulla-panis (Jacq.: Fr.) Donk, Persoonia **5**: 76, 1967. — *Polyporus medulla-panis* Jacq.: Fr., 1821. — Fig. 19; tab. 4*b*.

Basidiocarps perennial, resupinate to nodulose, largely effused (up to 30 cm long), corky but flexible and easily cut in fresh condition, tough when dry. Margin distinct, dense, whitish to cream or even dirty-ochraceous, up to 2 mm wide. Pore surface cream to ivory in intensively growing fructifications, then dirty ochraceous to brownish, even or on sloping substrates nodulose; pores firstly round, later angular to lacerate, 4—6 per mm, dissepiment edges thick, opaque, entire to slightly serrate. Section: context up to 1 mm thick, cream, densely coriaceous, in older fruitbodies often degenerating; tubes distinctly stratified, coriaceous to corky, 5—20 mm thick. No distinct odour, taste mild.
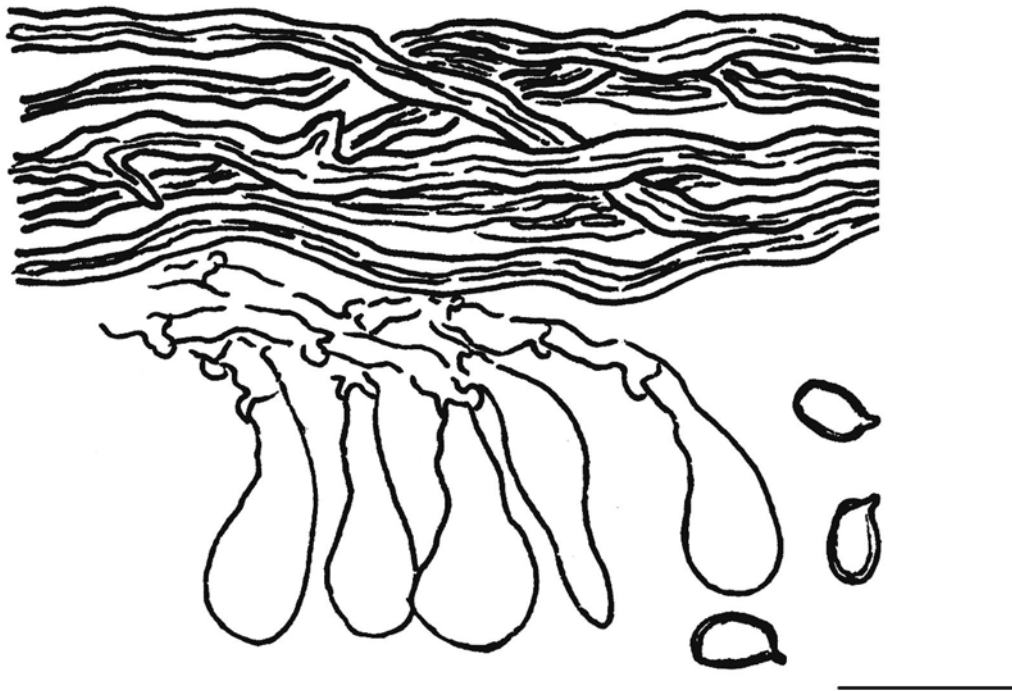
Fig. 19. *Perenniporia medulla-panis* (LE 210930): hymenium and spores. Scale bar = 10 μm.

Hyphal system trimitic. Skeletal hyphae densely interwoven in both subiculum and trama, 1.5—3.2 μm wide, thick-walled, with capillary lumina, inamyloid (or lumen bluish), indextrinoid, unchanging in KOH, strongly cyanophilous. Binding hyphae richly dichotomously branched, 1—1.8 μm wide; the set of reactions is the same as in skeletals. Generative hyphae present mostly in subhymenium, 1—2 μm, thin-walled, clamped. Cystidioles conical to bottle-shaped, 12—24 × 3.8—6.6 μm, often abun-

dant. Basidia broadly clavate, four-spored, 15—25 × 7—9 μm, fibulate at the base. Basidiospores broadly-ellipsoid, truncate, distinctly thick-walled, (4.0—)4.1—5.2(—5.6) × (3.0—)3.1—3.9(—4.2) μm, mostly aguttulate, indistinctly to clearly dextrinoid, strongly cyanophilous.

Distribution. — According to Ryvarden and Gilbertson (1994), the species has a worldwide distribution. However, some tropical specimens referred earlier to *P. medulla-panis* could represent the other species (Decock et Ryvarden, 1999). The distribution in Europe is almost limited by northern border of the oak zone.

Identification. — This species may be identified already in the field. The best diagnostic characters are corky stratose basidiocarps with thick opaque pore walls, and peculiar host (grows mostly on *Quercus robur*). However, being young or growing on untypical substrates, *P. medulla-panis* could be confused with other resupinate species. Then the narrow irregularly arranged tramatic skeletals and relatively small truncate spores aid to determine it. Decock and Stalpers (2005) listed the characters differing *P. medulla-panis* from other resupinate *Perenniporia* species known in Europe.

Ecology. — As said above, the distribution of *P. medulla-panis* in Europe and Russia is limited by its main host tree, *Quercus robur*. The species in question favours old-growing dense oak forests with numerous fallen trunks and stumps, and occurs even in suburban habitats and parks (Spirin, 2002). By both northern and southern limits of its distribution in European Russia, the species could be found on other deciduous trees, i. e. alder (Zmitrovich, 1999) and elm (Malysheva, Malysheva, 2004). Only one record exists from coniferous wood (*Pinus sylvestris* — LE 213609).

Perenniporia narymica (Pilát) Pouzar, Česká Mykol. **38:** 204, 1984. — *Trametes narymica* Pilát, 1936; *Poria elongata* Overh., 1942; *Perenniporia amylohypha* Ryvarden et Gilb., 1984. — Fig. 20; tab. 5a.

Basidiocarps short-living perennial, persisting at least three years, resupinate, widely effused (up to 20 × 10 cm), 2.5—10 mm thick, firmly attached, cheesy-corky when fresh, fibrillose-corky after drying. Margin firstly distinct but narrow (up to 1 mm), thickened (bolster-like), later fibrillose, whitish or pale-cream, or fusing with degenerating tubes (especially in upper part of basidiocarps) and forming the dirty-brown agglutinated film, sometimes separable in dry condition. Pore surface cream or yellowish to pale-buff, in older parts dirty-brownish and slightly agglutinated, on vertical substrates often nodulose; pores firstly regular, more or less round, with thin entire dissepiments, 6—7 per mm, later elongating and becoming irregular, angular to lacerate, 4—6 per mm. Section: context white to cream-coloured, corky, 1—2 mm thick, in old basidiocarps

often crumbling or degenerating to granular mass; tubes one-layered or indistinctly stratified, cheesy-like when fresh, corky and shrinking when dry, 2—8 mm thick, sometimes irregularly cracking and opening the lighter context. No distinct odour; taste slightly acidic or bitter.

Hyphal system dimitic. Subicular skeletals thick-walled, subsolid, 4—6 μm, dissolving strongly in KOH, weakly amyloid (grayish-bluish in Melzer's reagent), acyanophilous. Tramal hyphae almost parallel; skeletal hyphae 3—4 μm wide, with distinct lumina and occasional branches, and sometimes with varying diameter, squashing and dissolving in KOH, slightly to distinctly amyloid, acyanophilous, generative hyphae 2—3.5 μm wide, clamped, mostly thin-walled. Cystidioles abundant, conical, 20—32 × 3.8—4.6 μm. Basidia clavate, narrowing to the base, clamped, four-spored, 22—29 × 4.2—5.5 μm. Basidiospores oblong-ellipsoid, not truncate, with distinct walls, (4.2—)4.5—5.8(—6.2) × (2.6—)2.8—3.9(—4.1) μm, sometimes guttulate, sharply apiculate, IKI-, distinctly cyanophilous.

Distribution. — Circumpolar species (Ryvarden, Gilbertson, 1994), known from North America (Gilbertson, Ryvarden, 1987), Europe (David, Tortič, 1986), Siberia (type locality) and East Asia (Dai et al., 2002) from numerous deciduous, rarely coniferous trees. Till the moment *P. narymica* was known in Russia only from the type locality (Bondartseva, 1998), but real distribution of the species is much wider. The earlier record of *Fomitopsis unita* var. *pulchella* (current name — *Perenniporia tenuis* (Schwein.) Ryvarden) from Belarus (Komarova, 1964) belongs to this species; so, here it is published as new to this country.

Identification. — Amyloid reaction of skeletal hyphae and index-trinoid, not truncate spores are the exceptional characters, which making a position of this species within genus *Perenniporia* Murrill slightly isolated (Dai et al., 2002); so it seems, *P. narymica* may be easily distinguished from other resupinate *Perenniporia* species known in European Russia. *P. tenuis* is brighter polypore (chrome-yellow), its spores are distinctly longer and dextrinoid, and hyphae are unchanging in KOH. *P. kilemariensis* is exceptionally tough; it is easily recognized by its dense hyphal structure and presence of chlamydospores. *P. medulla-panis* has similar spores, but they are truncate, distinctly thick-walled, cyanophilous and dextrinoid. Moreover, this species differs in having distinctly stratified tubes and trimitic hyphal system (with true binding hyphae); tramal skeletals of *P. medulla-panis* are clearly narrower (1.5—3.2 μm) and partly amyloid. More complicated case is *P. subacida*. Young basidiocarps of both *P. narymica* and *P. subacida* are similar in its shape, colour, consistency and number of pores per mm. Clear differences could be caught only in microscope, and then distinctly dextrinoid spores and skeletals of *P. subacida* help in its identification.
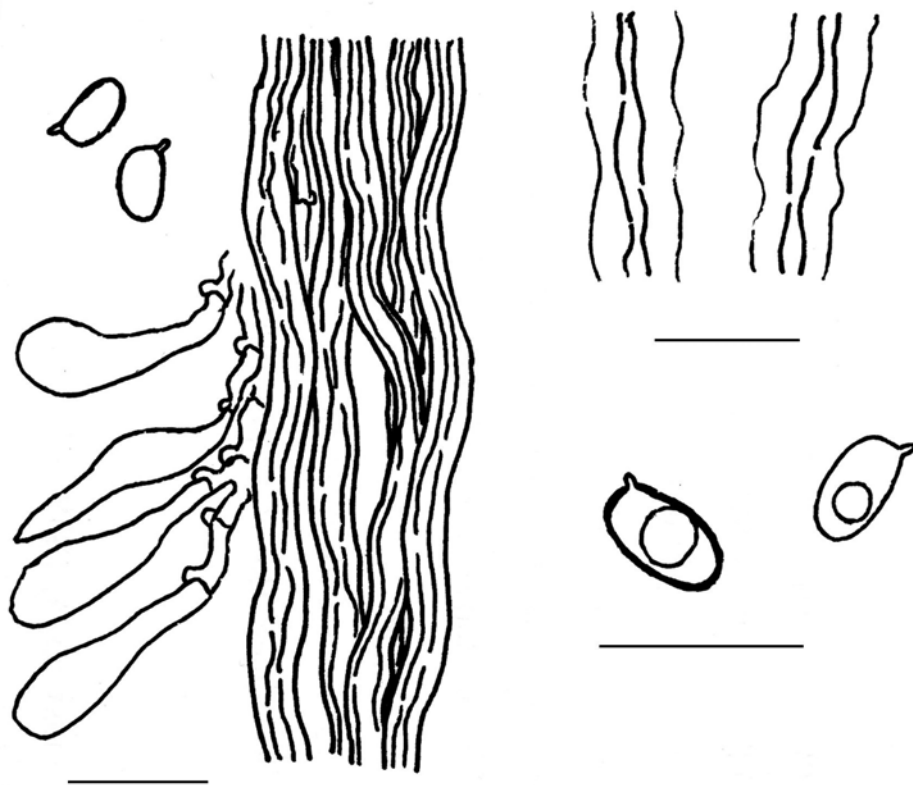
Fig. 20. *Perenniporia narymica* (Spirin 2058): *a* — hymenium; *b* — subhymenial skeletals in KOH; *c* — spores. Scale bar = 10 μm.

Besides these species, *P. narymica* is hardly distinguishable from *Antrodia pulvinascens* (Pilát) Niemelä, having similar basidiocarps and growing preferably on *Populus tremula*. The thickness of spore walls is often indistinct in *Perenniporia narymica*, and amyloid skeletals of *Antrodia pulvinascens* can lead to misidentification. Theoretically, there are no problems to differ *Perenniporia narymica* from *Antrodia pulvinascens* — the first one is white-rot fungus, while the latter causes a brown rot. However, in some cases the type of rot is very difficult to detect; then longer and narrower spores of *A. pulvinascens* and hyphae unchanging in KOH are the best characters to identify it.

Taxonomy. — As said above, *P. narymica* is untypical member of the genus. Decock and Stalpers (2005) assumed that its natural taxonomic position may be within *Antrodiella* or *Diplomitoporus*. In my opinion, *P. narymica* sharply differs from the species of both these genera. Core *Antrodiella* species have quite different hyphal structure and spores (Miettinen et al., 2006). The genus *Diplomitoporus* is artificial and *P.*

narymica cannot be adressed either to *Diplomitoporus* s. str., or to *Cinereomyces* Jülich (in sense of Spirin, 2005b).

Ecology. — Most of our records of *Perenniporia narymica* were made in herb-rich aspen forests. This forest type is widely distributed in European Russia, replacing old clear-cut areas. The tree stand consists of *Populus tremula*, partly of *Tilia cordata* and *Betula pubescens*; fallen spruce trunks are scattered here and there. The grass cover consists mostly of hemiboreal (nemoral) species, as *Asarum europaeum*, *Carex pilosa*, *Aegopodium podagraria*, *Actaea erythrocarpa*, and some ferns. Mean age of these forests is 80—120 years. They show a large species richness when are undisturbed or undergo the minimal human influence. Both hemiboreal and boreal fungal species occur there; an example is the neighbourhood of northern *Skeletocutis brevispora* Niemelä and southern *Dentipellis fragilis* (Pers.: Fr.) Donk. At the same time, fungal flora of these localities is enriched by continental species, for instance, *Antrodiella foliaceodentata* (Nikol.) Gilb. et Ryvarden, *Steccherinum murashkinskyi* (Burt) Maas Geest.; *Perenniporia narymica* also belongs to them. It produces extensive fructifications on large decorticated aspen trunks; no obligate successors are known for this species. Rarely *P. narymica* occurs in old pine and oak forests.

Preferring to hemiboreal forest types (Ryvarden, Gilbertson, 1994; Ryvarden et al., 2003), *P. narymica* represents a good example of 'nemoral irradiating species' (Zmitrovich et al., 2003): it means the fungus which is mostly distributed in oak zone but occasionally may be found within the intrazonal communities of boreal forests.

Perenniporia subacida (Peck) Donk, Persoonia **5:** 76, 1967. — *Polyporus subacidus* Peck, 1885. — Fig. 21.

Basidiocarps perennial, resupinate, often widely effused (up to 50 cm long), 2—20 mm thick, firmly attached to the substrate, cheesy-corky when fresh, tough but light-weight when dry. Margin of young fruitbodies indistinct or floccose, more or less even, whitish to cream, up to 1 mm wide, in mature state often well developed, sterile, dirty-ochraceous to yellowish- or reddish-brown. Pore surface firstly cream to ivory, later yellowish to pale tan, sometimes with grayish hue, more or less even, on sloping substrates nodulose, sometimes with pale brownish stains when bruised (reaction slow and well seen only in actively growing basidiocarps); more intensively coloured (reddish or dirty-ochraceous) patches of persistent pores scattered here and there; pores firstly more or less regular, round, 6—7 per mm, with thickened entire dissepiments, later becoming lacerate to partly sinuous with serrate dissepiments, 4—6 per mm. Section: context fibrous-corky, cream to pale buff, 0.5—2 mm thick, homogeneous;

tubes stratified, consisting of 2—12 layers, pale cream to ivory, soft-corky when dry, up to 20 mm thick (up to 3 mm thick in each layer). No distinct odour, taste slightly acidic or mild.
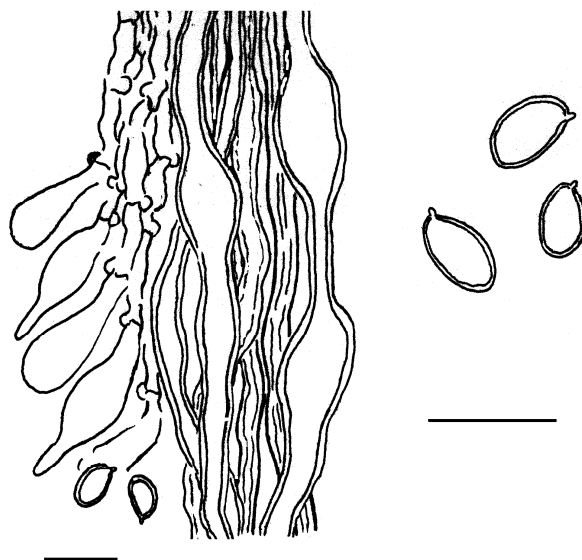
Fig. 21. *Perenniporia subacida* (LE 212627): *a* — hymenium; *b* — spores. Scale bar = 10 μm.

Hyphal system dimitic. Skeletal hyphae thick-walled, with distinct wide lumina, tightly interwoven in context, 4.5—7 μm wide, sometimes swollen up to 10 μm, subparallel in tube trama and (1.6—)1.8—4.6(—5.2) μm wide there, mostly unbranching, sometimes with regular inflations 5—7 μm wide, strongly dextrinoid (red-brown) in Melzer's reagent and cyanophilous, unchanging in KOH. Generative hyphae present mostly in tubes, with small clamps, 1.5—2.5 μm wide, thin-walled. Cystidioles conical to bottle-shaped, 12—25 × 3.8—5.6 μm. Basidia clavate, four-spored, 16—28 × 4—6.5 μm, clamped at the base. Basidiospores broadly-ellipsoid, with distinct thickened walls and large central oil-drop, (4.0—)4.1—5.9(—6.2) × (3.0—)3.1—4.7(—4.8) μm, sometimes guttulate, with varying reaction in IKI (faintly to strongly dextrinoid), strongly cyanophilous. Crystalline encrustation often present in subhymenium, mostly irregular in its shape.

Distribution. — Circumboreal species, known in Eastern Europe, Fennoscandia (Erkkilä, Niemelä, 1986; Ryvarden, Gilbertson, 1994), North-West Russia (Niemelä et al., 2001; Zmitrovich, 2003), East Asia (Núñez,

Ryvarden, 2001; Dai et al., 2002), and North America (Gilberson, Ryvarden, 1987).

I d e n t i f i c a t i o n. — In most cases the species is easily identified already in the field due to its cream or yellowish cheesy-corky fruitbodies with distinctly stratified tubes and thick-walled pores, and its preference to coniferous hosts. Microscopic study is needed to avoid the misidentification with other *Perenniporia* and some *Antrodia* species. Then distinctly dextrinoid wide skeletal hyphae with clear large lumina and strongly dextrinoid and cyanophilous spores aid to recognize *P. subacida*. See below notes to *P. valliculorum*.

E c o l o g y. — This is the only widespread *Perenniporia* species having clear boreal distribution. Most favorable habitats are moist old-growth taiga forests with numerous fallen trunks of both coniferous and deciduous trees in various stages of wood-decomposition. The main substrate of *P. subacida* is, undoubtedly, *Picea abies*. Occurring on decomposed spruce trunks, the species in question shows the peculiar connections with other wood-inhabiting fungi. As mentioned by Spirin and Shirokov (2002), *Perenniporia subacida* is a successor of *Heterobasidion parviporum* Niemelä et Korhonen, often growing together with this species. This connection was observed in old-growth southern taiga forests of European Russia; no analogous observations exist from other parts of the Northern Hemisphere. Another common successor of *Perenniporia subacida* is brown-rot polypore *Antrodia crassa* (P. Karst.) Ryvarden. The records from deciduous trees are solitary; any association with other wood-inhabiting fungi was not seen. Once *Perenniporia subacida* was collected from naked roots of dying *Populus tremula* (specimen *Spirin 2201*).

Perenniporia tenuis (Schwein.) Ryvarden, Norw. J. Bot. **30:** 9, 1972 (incl. var. **pulchella** Schwein.). — *Polyporus tenuis* Schwein., 1832; *P. pulchellus* Schwein., 1832. — Fig. 22; t a b. 5*b*.

Basidiocarps annual to short-living perennial, effused (up to 7 cm wide), 2—8 mm thick, firmly attached to substrate, cheesy-corky when fresh, corky in dry condition, sometimes slowly staining reddish-violet in KOH. Margin often distinct, yellowish, pubescent under the lens, up to 1 mm wide, persistent dirty-ochraceous to reddish-brown or almost black. Pore surface even, chrome-yellow to bright vitelline or ochraceous, sometimes cracking, in persistent specimens dirty brownish to almost blackish; pores angular, on sloping positions lacerate, with thick entire dissepiments, 3—5 per mm, sometimes intermixed with larger ones. Section: context corky, whitish, 1—2 mm thick, fusing with underlying decomposed wood; tubes pale yellowish, 1—6 mm thick, corky, indistinctly stratified (2—4-layered). No distinct odour, taste mild.

Hyphal system dimitic. Skeletal hyphae thick-walled, with disitinct wide lumina, tightly interwoven in subiculum, more or less parallel and loosely arranged in tube trama, (1.6—)1.8—2.8(—3.5) µm wide, faintly dextrinoid, strongly cyanophilous, unchanging in KOH. Generative hyphae thin-walled, clamped, present mostly in tubes, 1.2—2.6 µm wide. Cystidioles conical, 13—24 × 7—8 µm, numerous or rare. Basidia broadly clavate, four-spored, 20—32 × 5—9 µm, clamped at the base. Basidiospores ellipsoid, indistinctly to clearly truncate, thick-walled, (5.4—)5.6—7.2(—7.3) × (3.3—)3.4—4.9(—5.0) µm, faintly dextrinoid (rose-reddish), cyanophilous.

Distribution. — Rare boreal species; known in North America (Gilbertson, Ryvarden, 1987), Europe (Ryvarden, Gilbertson, 1994). The specimens from East Asia (Dai et al., 2002) belong to *P. tenuis* var. '*tenuis*' (see below).
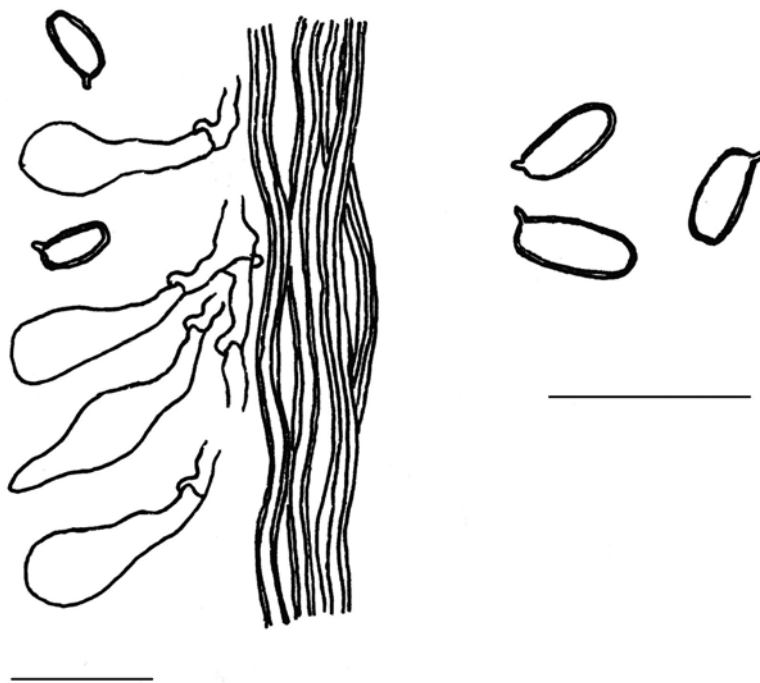
Fig. 22. *Perenniporia tenuis* (LE 213187): *a* — hymenium; *b* — spores. Scale bar = 10 µm.

The distribution in Europe remains uncertain because the material comprises two possible species (Niemelä et al., 1992 — see below, under *P. tenuis* var. '*tenuis*'). The North-European var. '*pulchella*' seems to be conspecific with the North-American *P. tenuis*, and known from Norway, Sweden (Ryvarden, Gilbertson, 1994; Ryvarden et al., 2003) and Finland (Niemelä et al., 1992; Martikainen et al., 2000). The first record from Russia (Bondartseva, 1964) is based on misinterpretation; this specimen be-

longs to *P. subacida*. The second record from Ural (Stepanova-Kartavenko, 1967) is also doubtful because no authentic material exists in LE. The Ukrainian records of *Fomitopsis unita* var. *pulchella* (Bondartsev, 1953), referred to *P. tenuis* by Akulov et al. (2003), represent typical *P. medulla-panis*; Belarussian specimen (Komarova, 1964) is *P. narymica* (see above). So, only two undoubted records were made in Russia: there are from Leningrad and Nizhny Novgorod Reg. (Niemelä et al., 2001; Spirin, 2005a).

Identification. — A little number of polypores has such bright-coloured and beautiful basidiocarps as *P. tenuis*. It could be misidentified with yellowish basidiocarps of *P. subacida*, when it grows on deciduous trees. In this case faintly dextrinoid narrower skeletals and clearly longer spores of *P. tenuis* make this species distinguishable.

Ecology. — In boreal zone the favorite substrate of *P. tenuis* is, undoubtedly, aspen (*Populus tremula*). Most of Finnish records as well as Russian one are from this substrate; also the finds on *Alnus* and *Betula* are known (Niemelä et al., 1992; Martikainen et al., 2000; Niemelä et al., 2001). The species prefers to old undisturbed luxuriant forests, and its presence is a strong argument to conservation of the area.

Perenniporia tenuis (Schwein.) Ryvarden var. **'tenuis'** sensu Niemelä et al., Karstenia **32**: 88—90, 1992 pr. p. — Fig. 23.

Basidiocarps annual to short-living perennial, appearing as small patches 2—3 mm wide, later fusing together and then largely effused (up to 7 cm in longest dimension), soft-corky in fresh condition, fragile when dry, sometimes with brownish stains when bruised, unchanging in KOH. Margin sharply delimited and partly separable from substrate, whitish to cream or even pale ochraceous, sterile, ca. 0.5 mm wide. Pore surface more or less even, cream to pale ochraceous, sometimes with brownish stains, rarely cracking; pore angular to lacerate, 3—5 per mm, with relatively thin entire dissepiments. Section: context whitish to cream, thin (up to 0.5 mm thick), densely floccose; tubes cream to pale ochraceous, 1—2 mm thick, not stratified, fragile. No distinct odour or taste.

Hyphal system dimitic to indistinctly trimitic. Skeletal hyphae thick-walled, with capillary lumina and irregular side branches, sometimes inflated, 2—3.5(—4) µm wide, in tube trama irregularly and loosely arranged, yellowish in KOH, yellow in IKI, cyanophilous. Generative hyphae thin-walled, hyaline, 1.5—2 µm wide, clamped. Cystidioles conical, 15—20 × 5—7 µm, rare. Basidia broadly clavate, 16—28 × 7—9 µm, fibulate at the base. Spores broadly-ellipsoid, distinctly truncate, sharply apiculate, thick-walled, (5.3—)5.5—7.8(—8.1) × (4.2—)4.3—6.1(—6.3) µm, strongly dextrinoid (bright reddish-brown in IKI) and cyanophilous.

Fig. 23. *Perenniporia tenuis* var. '*tenuis*' (LE 28504): *a* — hymenium; *b* — spores. Scale bar = 10 μm.

Notes. — The distribution and ecology of this taxon remain uncertain because of the vagueness of its taxonomic status. Without any doubts, the fungus called in Niemelä et al. (1992) '*Perenniporia tenuis* var. '*tenuis*' sensu European authors' represents good species described recently as *P. meridionalis* Decock et Stalpers (2005; see also Bernicchia 2005). Its best diagnostic characters are large strongly dextrinoid spores and irregularly arranged skeletals with capillary lumina staining yellow in Melzer's reagent. It seems, *P. meridionalis* is southern species widely distributed in oak zone of Europe.

Present record is the first from Russian Far East (see Specimens examined). Dai et al. (2002) recently noted *P. tenuis* var. '*tenuis*' from China. However, we can not address these specimens to *P. meridionalis* or even *P. rosmarini* David et Malençon (1978) because these both are the Mediterranean species characterized by graysh hymenophore with rosaceous tints, and the other host preferences. So, here we designated them as *P. tenuis* var. '*tenuis*'.

Perenniporia valliculorum Spirin et Zmitr., spec. nov.
Fig. 24; tab. 6.

Basidiomata annua vel quandoque perennia, orbiculata, late prostrata, tenuia, inito adhaerens, latemarginata, deinde separabilia, elastice-carnosa ad chartacea, inodora. Margo flavido-cremeus, pellicularis, irregulariter rhizomophosus, prostratus, deinde involutus. Hymenophorum tubulosum, unistratosum, 1—3 mm crass., superficio citrino ad pallido-cinnamomeo, guttulato et cavernuloso. Porae 5—7 per mm, circulatae ad lacerato-sinuosae, leniter subgelatinosae. Subiculum tenue (0.5 mm crass.), flavido cremeum, deinde ochraceum.

Systema hypharum dimiticum. Hyphae generatoriae 1—1.8 μm diam., fibulatae, hyalinae, tenuitunicatae. Hyphae sceleticae 2.5—4 μm diam. in subiculum et 1.5—3.5 μm diam. in trama, valde crassitunicatae, regulariter adventitio septatae, valde dextrinoideae cyanophiliesque, in trama parallele collocatae, in alcali constantae. Leptocystidia 16—25 × 4—7 μm, conica. Basidia 14—25 × 5—8 μm, laticlavata, tetrasporifera, basi fibulata. Sporae (3.5—)3.7—5.1(—5.2) × (3.0—)3.1—4.1 μm, late ellipsoideae, non truncatae, crassitunicatae, dextrinoideae, valde cyanophilae.

Holotypus: **Russia.** Nizhny Novgorod Reg., Varnavino Dist., Lap-shanga, *Betula pubescens*, 24.VIII.1999 *Spirin* (H; Isotypus — LE 208958).

Paratypi: **Russia.** Nizhny Novgorod Reg., Tonkino Dist., reserve "Tonkinsky", *Abies sibirica*, 21.VIII.2000 *Spirin* (H, LE 222974).

Basidiocarps annual or short-living perennial, resupinate, thin, firstly firmly attached, later easily separable from substrate, appearing as small patches 2—4 mm wide, widely effused (up to 15 cm) when mature, hygrophanous and elastic-fleshy in fresh and cardboard-like in dry condition. Margin well-developed, sterile, up to 2 mm wide, cream to yellowish, densely pellicular, even or initially rhizomorphic, partly agglutinated, sometimes separating and inrolling when dry. Pore surface firstly pale citric yellow, later pale tan and partly agglutinated, guttulate when fresh, then covered by small round depressions, silvery shining in herbarium specimens; pores firstly round, becoming lacerate to slightly sinuous, 5—7 per mm; dissepiments thin, semitranslucent, even to slightly serrate. Section: subiculum thin (up to 0.5 mm thick), yellowish to pale ochraceous, sometimes agglutinated and then reddish-brown on its upper side, papery in fresh and fragile in dry condition; tubes one-layered, 1—3 mm thick, concoloured with pore surface. No distinct odour, taste mild.
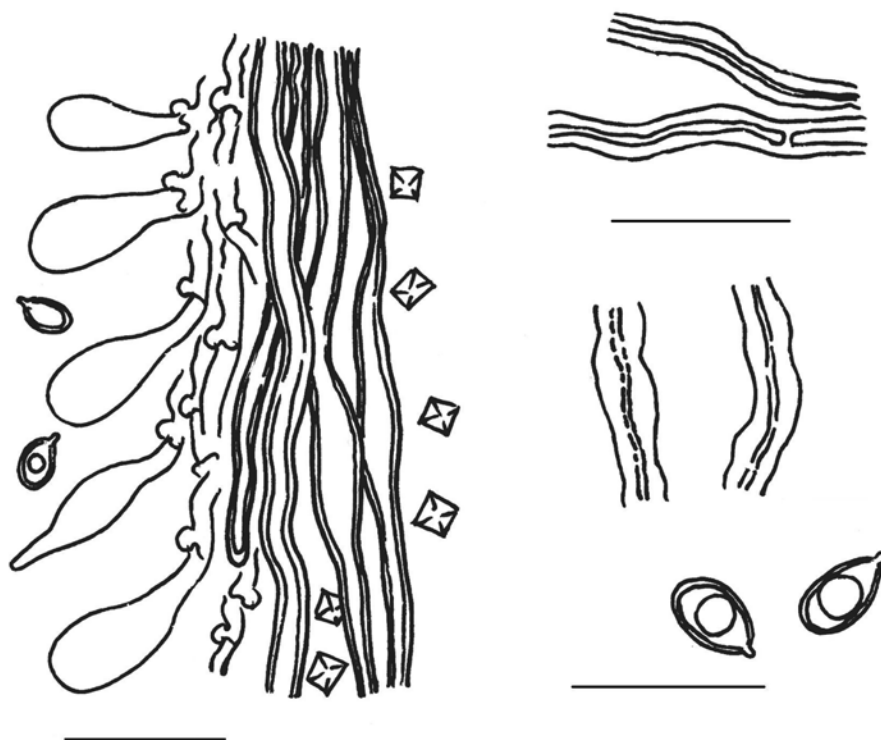
Fig. 24. *Perenniporia valliculorum* (holotype): *a* — hymenium; *b* — subicular hyphae; *c* — subhymenial skeletals in KOH; *d* — spores. Scale bar = 10 μm.

Hyphal system dimitic. Subicular skeletal hyphae 2.5—4 μm wide, with narrow lumina to subsolid, densely packed, rarely secondary septate, strongly dextrinoid and cyanophilous. Subhymenial skeletals strictly parallel, straight, non-branching, 1.5—3.5 μm wide, sometimes slightly inflated, covering by numerous cubical crystals 3—7 μm wide, strongly dextrinoid and cyanophilous, with distinct wide lumina in IKI and CB; in KOH firstly swelling inwards why the lumen becoming capillary, then slowly gelatinizing and thickening (not dissolving!). Generative hyphae thin-walled, 1—1.8 μm wide, clamped. Cystidioles conical, 16—25 × 4—7 μm, varying in number. Basidia broadly-clavate, 14—25 × 5—8 μm, four-spored, fibulate at the base. Spores broadly-ellipsoid, non-truncate, (3.5—)3.7—5.1(—5.2) × (3.0—)3.1—4.1 μm, with distinct thickened walls and large central oil-drop, moderately dextrinoid (reddish in IKI), strongly cyanophilous.

Etymology: 'valliculorum' (Lat., adj.) — derived from the Latin noun 'vallicula' (ravine, brook valley), referring to the habitats of this species.

Distribution. — This species is known from two localities in Nizhny Novgorod Region (European Russia); they both are by the southern

boundaries of boreal zone. Probably, it is overlooked or confused with other *Perenniporia* species.

I d e n t i f i c a t i o n. — Being fresh, this new species is strongly reminiscent of some *Antrodiella* species (especially *A. citrinella* Niemelä et Ryvarden and *A. romellii* (Donk) Niemelä). They share relatively small pores with semitranslucent dissepiments, and yellowish or tan pore surface; their similarity increases in herbarium specimens due to silvery shining pores. Older specimens resemble some other *Perenniporia* species, in particular, *P. narymica* and *P. subacida*, but differs by more fragile basidiocarps. Pores of *P. valliculorum* are smaller than in both these species; however, this feature is slight critical.

In microscope *P. valliculorum* could be confused with *P. subacida*, especially when KOH is used to make a preparation. As said above, the hyphae of *P. valliculorum* firstly swell inwards and show capillary lumina; then they become jelly-like and thicker. When measured in this moment, skeletals seem to be inflated and wider than they really are. So, the specimen could be misidentified as *P. subacida*. To know true width of hyphae, the mounts in IKI and CB are needed; carefully examined in these media, *P. subacida* sharply differs from *P. valliculorum* by its wider skeletals and invariably large lumen which is well seen also in KOH. Smaller spores and constant presence of beautiful cubical crystals aid to identify this new species.

E c o l o g y. — The species was collected twice in old-growth spruce forests located in brook valleys (so-called *Piceeta fontinale*). These habitats are very moist and characterized by presence of psychrophilic mosses and herbs. *Perenniporia valliculorum* favours large moss-covered trunks of both coniferous (*Abies sibirica*) and deciduous (*Betula pubescens*) trees, where it develops intensive fructifications. Its neighbours on coniferous wood are rare *Phellinus nigrolimitatus* (Romell) Boutdot et Galzin and *Phellinidium sulphurascens* (Pilát) Y.-C. Dai.

2.6. Additional species descriptions

Haploporus suaveolens (L.: Fr.) Donk, Proc. Koninkl. Nederl. Akad. Wetenschappen (C) **47:** 20, 1971. — *Boletus suaveolens* L., Sp. Plant.: 1177, 1753. — *Agaricopulpa suaveolens* (L.) Paul., 1793. — *Polyporus suaveolens* L.: Fr., 1821 (misappl.); *Polyporus odorus* Sommerf., 1826: Fr., 1828. — *Trametes odora* (Sommerf.: Fr.) Fr., 1838. — *Fomitopsis odora* (Sommerf.: Fr.) P. Karst., 1881 (nom. invalid.). — *Haploporus odorus* (Sommerf.: Fr.) Singer, 1944; *Ungulina fraxinea* var. *albida* Bourdot, 1932; *Fomitopsis odoratissima* Bondartsev, 1950.

Basidiocarps perennial, sessile, widely and firmly attached to substrate, applanate-ungulate to bracket-shaped, sometimes fusing together and then more irregular in shape, 5—15 cm wide, 3—7 cm wide, and 3—6 cm thick at the base, relatively light-weight, corky, much harder when dry. Pileal surface uneven, sometimes indistinctly lacunose or ribbed, firstly felty, whitish or cream with yellowish or brownish stains, later becoming more or less smooth and covered by thin and often cracked brownish, grayish to almost black crust. Margin obtuse, more or less even, often sterile, cream to pale ochraceous. Pore surface whitish, cream to pale ochraceous, even, often more or less oblique near to the substrate; pores roundish to elongated, some of them later slightly angular, 3—4(—5) per mm; dissepiments relatively thick, entire, firstly opaque, then slightly ceraceous and fragile. Section: context corky, soft, zonate and fibrillose, whitish, yellowish or cream, darkening when touched by KOH; tubes one-layered or indistinctly stratified, concoloured with pore surface. Odour very strong, pleasant, aniseed or almond (Bondartsev, 1953; Zmitrovich et al., 2005); taste bitter.

Hyphal system trimitic. Skeletal hyphae robustly thick-walled, (2—)2.5—3.5(—5.2) µm, non-branching, in tube trama weakly dextrinoid and cyanophilous, without these reactions in medullar tissue. Binding hyphae with moderately thickened walls, 1.7—2.5 µm wide, richly branching, IKI and CB-. Generative hyphae thin-walled, hyaline, (1.5—)1.7—2.2(—3.5) µm, clamped, strongly interwoven in tube trama, agglutinated in subhymenium. Cystidia none. Basidia clavate, (13.5—)15—20(—22) × 5—5.8(—6.3) µm, four-spored, fibulate at the base. Spores ovoid to short-cylindrical, (5.2—)5.5—6(—7.2) × (3.5—)4—5(—5.3) µm, with well developed apiculus and finely uneven surface, thick-walled, often guttulate; spore wall weakly dextrinoid, 0.6—1.2 µm thick, heterogeneous due to granular inclusions of strongly cyanophilous material.

D i s t r i b u t i o n. — The species is widely distributed in boreal zone of Northern Hemisphere and known from North America, Nordic countries, boreal Russia and East Asia (Bondartsev, 1953; Eriksson, 1958; Bondart-

seva, 1961; Niemelä, 1971; Gilbertson, Ryvarden, 1986; Ryvarden, Gilbertson, 1993; Blanchette, 1997; Dai et al., 2002; Zmitrovich, 2003) but everywhere rare. Most of known records are from the boreal zone of Europe.

Identification. — Characteristic features of *H. suaveolens* are moderately projecting, light-weight rounded caps with an obtuse margin and slightly oblique base, and strong aniseed-almond smell of fresh specimens, persisting up to 40 years in herbarium. Pileal form is varying from bracket- or console-shaped to irregular, stalactite-like. *Trametes suaveolens* (Fr.) Fr. is another fungus often growing on *Salix* spp. and having strong aniseed smell; this latter has larger pores (1—3 per mm) with opaque thick dissepiments, and more or less tomentose upper surface. In general, there is not difficult to identify *H. suaveolens* in nature and herbarium.

Nomenclature. — The name *Haploporus suaveolens* (L.: Fr.) Donk is seemingly more correct than *H. odorus* (Sommerf.) Bondartsev et Singer but avoided by most polyporologists due to its Friesian (1821) misinterpretation and application to another species known nowadays as *Trametes suaveolens* (Fr.) Fr. However, Linnaean (1737) description is undoubtedly intended for the first species (Donk, 1971), and Fries' "Systema mycologicum" is start-pointed mycological work owing to automatically sanctioned *name* but not a *species concept*. Another argument to use a name *Polyporus suaveolens* L.: Fr. is the ambiguous status of *Polyporus odorus* Sommerf.: Fr. (1828) which was also misapplied by Fries to his *Trametes suaveolens* (Fr.) Fr. (Fries 1874: 584, see his remark to *Trametes inodora* Fr.). No authentic material for both species exists in his herbarium. Therefore Bondartsev (1950) proposed a new epithet *Fomitopsis odoratissima* Bondartsev for *Polyporus suaveolens* L.: Fr. Later Niemelä (1971) selected a neotype for *Polyporus odorus* Sommerf. to use this name (as *Haploporus odorus* (Sommerf.) Bondartsev et Singer). Both operations remain a nomenclatural discussion to be open because Linnaeus' name formally has a priority. So, Donk's (1971) solution looks more logical, especially after neotypification of *Trametes suaveolens* (Fr. non L.) Fr. (Ryvarden, 1991).

Ecology. — The fungus grows mainly on drying *Salix caprea* in old taiga forests but may occur also on *Syringa*, *Padus*, *Cerasus*, *Ulmus*, and *Tilia* (these data were available from herbarium labels; they seem to be correct). It produces slowly developing white rot reminiscent superficially of that of *Fomes fomentarius*. The main habitats of *Haploporus suaveolens* are moist herb-rich biotopes where the old trees of *Salix caprea* are abundant.

Fig. 25. *Trametes ljubarskyi* (LE 19475): *a* — hymenium; *b* — spores. Scale bar = 10 µm.

Trametes ljubarskyi Pilát, Bull. Soc. Mycol. France **52**: 309, 1936. — Fig. 25.

Basidiocarps annual or short-living perennial, sessile, pileate, 5—15 cm long, 3—8 cm wide and 0.8—3 cm thick, densely coriaceous to corky, solitary or in small groups. Upper surface firstly velutinate, pale ochraceous with grayish tints, later becoming glabrous and partly agglutinated, tan to reddish brown in old or persistent basidiocarps. Margin sharp or terminally blunt, firstly grayish, then clay to ochraceous, up to 1 mm wide, sterile. Pore surface even, mostly ochraceous; pores firstly round, later more or less elongated, 3—4 per mm, with thin opaque entire dissepiments. Section: context pale ochraceous to clay, 0.3—0.8 cm thick, tough; tubes pale ochraceous, 1—2 cm thick, densely coriaceous. No distinct odour, taste mild.

Hyphal system trimitic. Pileal surface consisting of brownish skeletal hyphae 4—6 µm wide, glued together by amorphous matter easily dissolving in KOH. Skeletal hyphae hyaline to pale ochraceous in KOH, 3—5 µm wide, irregularly arranged in all parts of basidiocarp, with large lumina, sometimes inflated and then up to 8 µm wide, unchanging in IKI, cyanophilous. Binding hyphae present in both context and tubes, 1.5—3 µm wide, almost solid, strongly branched. Generative hyphae rare, present mostly in tubes, 1.5—2.5 µm wide, thin-walled, hyaline, clamped. Cystidioles conical, 15—25 × 5—6 µm, relatively rare. Basidia broadly cla-

vate, 15—28 × 6—10 μm, fibulate at the base. Spores broadly ellipsoid, flattened on ventral side, sometimes indistinctly truncate, (4.2—)4.5—6.8(—7.0) × (3.5—)3.6—4.5(—4.7) μm, hyaline, with distinct walls, faintly dextrinoid or not, cyanophilous.

Distribution. — This species has clearly continental distribution, being widespread in Russian Far East and Siberia (Bondartsev, 1953) and occuring in solitary localities in European part of Russia and Europe (Picri, Rivoire, 1993; Ryvarden, Gilbertson, 1994).

Identification. — This species has a great resemblance with pileate *Perenniporia* species, especially with *Perenniporia fraxinea* and *P. robiniophila*, which easily differ by strong dextrinoid reaction of both hyphae and spores. The *Trametes* species have strictly trimitic structure with solid hyphae, narrower and clearly clavate basidia; their spores are mostly cylindric and acyanophilous. *Polyporus pseudobetulinus* (Murashk. ex Pilát) Thorn, Kotiranta et Niemelä is characterized by more fleshy basidiocarps with stipe-like base, finally obtuse margin and well-developed pellicle on upper surface; in microscope, it is dimitic (with skeleto-binding hyphae), clampless, and has more prolonged cylindrical spores. In its hosts, *P. pseudobetulinus* is restricted to *Populus* spp. (Thorn et al., 1990).

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Table 4

Table 5

a. *Perenniporia kilemariensis* Spirin et Shirokov

a. *Perenniporia narymica* (Pilát) Pouzar

b. *Perenniporia medulla-panis* (Jacq.: Fr.) Donk

b. *Perenniporia tenuis* (Schwein.) Ryvarden

Table 6

Table 3

SEM-profiles of basidiospores in *Ganodermataceae*
(SEM by S. P. Wasser and A.F. Krakhmalny)

Perenniporia valliculorum Spirin et Zmitr.

a. *Ganoderma resinaceum* Boud. in Pat.

b. *Ganoderma applanatum* (Pers.) Pat.

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