OBECNÁ MYKOLOGIE

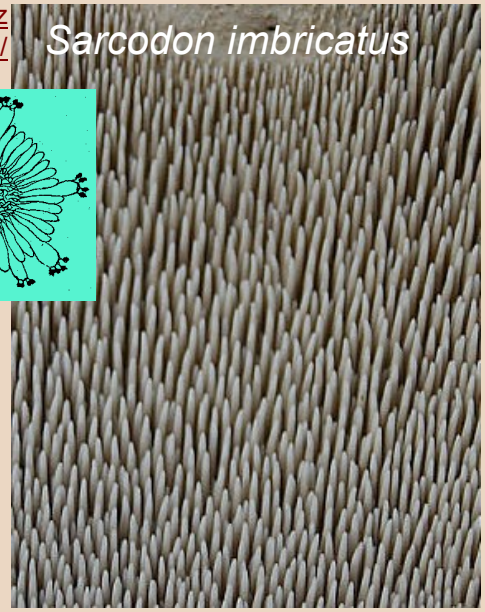
(místy se zvláštním zřetelem k makromycetům)

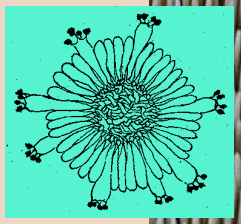
Vymezení pojmů „houby“ a „mykologie“ • Historický výskyt a teorie o původu hub • Stavba houbové buňky (cytoplazma, organely, jádro a bun. cyklus, bun. stěna) • Výživa a obsahové látky hub • Vegetativní stélka hub (nemyceliální houby, hyfy, hyfové útvary, pletivné útvary, stélka lišejníků, růst houbové stélky) • Rozmnožování hub (vegetativní, nepohlavní, pohlavní) • Genetika hub • Plodnice hub (sporokarpy, askokarpy, bazidiokarpy, anatomie plodnic, hymenofor, hymeniální elementy) • Spory hub (typy a stavba, šíření a klíčení)

evropský sociální fond v ČR
EVROPSKÁ UNIE
MINISTERSTVO ŠKOLSTVÍ, MLÁDEŽE A TĚLOVÝCHOVY
OP Vzdělávání pro konkurenceschopnost
INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

Hymenofor (= struktura, již pokrývá hymenium) vytváří u různých hub různé tvary pro zvětšení výtrusorodého povrchu:

Foto Martin Rozmoš, http://botany.cz/cs/sarcodon-imbricatus/

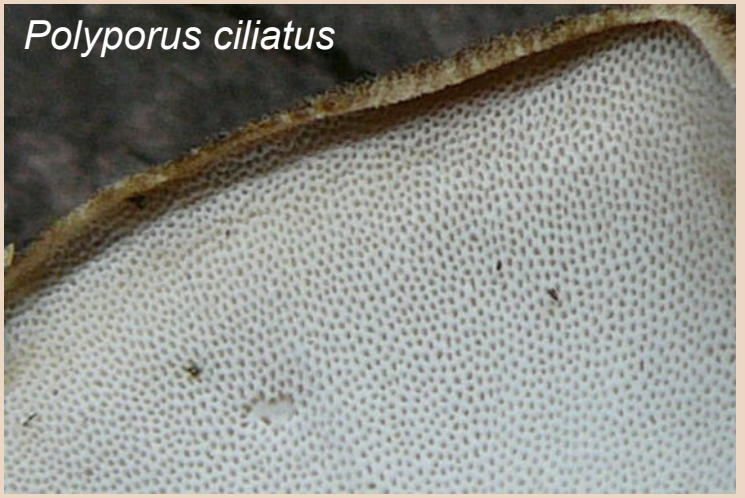




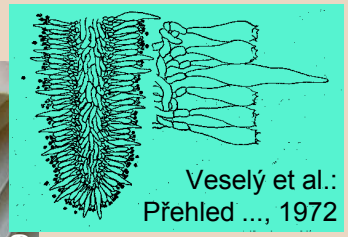
- hladký bez specifických tvarových struktur (výskyt u různých skupin i různých tvarů plodnic);
- ostnitý u rozlitých (corticioidní houby) i stipitátních plodnic (lošáky);
- zprohýbaný, lamelovitý – původně hladký povrch vytváří lamelovitou strukturu, více či méně anastomózující (u rozlitých, chorošotvarých i cantharelloidních plodnic);
- zvláštním typem jsou pseudolamely u *Schizophyllum*, podélně rozčísnuté a hygroskopické (za vlhka jsou rovné, za sucha se jejich půlky odchlípnou a stočí);

Foto O. Roučka, http://www.nahuby.sk/obrazok_detail.php?obrazok_id=53535; L. Tábi, http://www.nahuby.sk/obrazok_detail.php?obrazok_id=55827; B. Kuzmová, http://www.nahuby.sk/obrazok_detail.php?obrazok_id=55827

• pórovitý, rourkatý (póry = ústí rourek) – tvoří se v kompaktní hmotě (většina *Polyporales*) nebo se zřetelnými stěnami (větš. *Boletales*);
• lupenitý je nejen nejčastější (většina *Agaricales*), ale i má nejvýhodnější poměr povrch /objem (zvětšuje výtrusorodý povrch až 20x);
• gastroidní představuje hymenium uzavřené v břichatkovitých plodnicích, pokrývající stěny dutin, komůrek nebo lamel v glebě (vizuálně podobné theciu zprohýbanému uvnitř tuberothecií lanýžů).


Polyporus ciliatus


Xerocomus badius


Veselý et al.:
Přehled ..., 1972

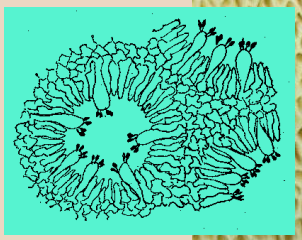



Foto Jens H. Petersen, http://192.38.46.48:8183/result.shtml?genSpec=Genus&ID=329

Gomphidius glutinosus

Foto *Polyporus ciliatus*:
Věra Svobodová, http://botany.cz/cs/polyporus-ciliatus/

Foto *Xerocomus badius*:
http://pms.wikipedia.org/wiki/Figura:Rourky.jpg

Weraroa novae-zelandiae
http://mushroomobserver.org/obs/7382?q=AUZr

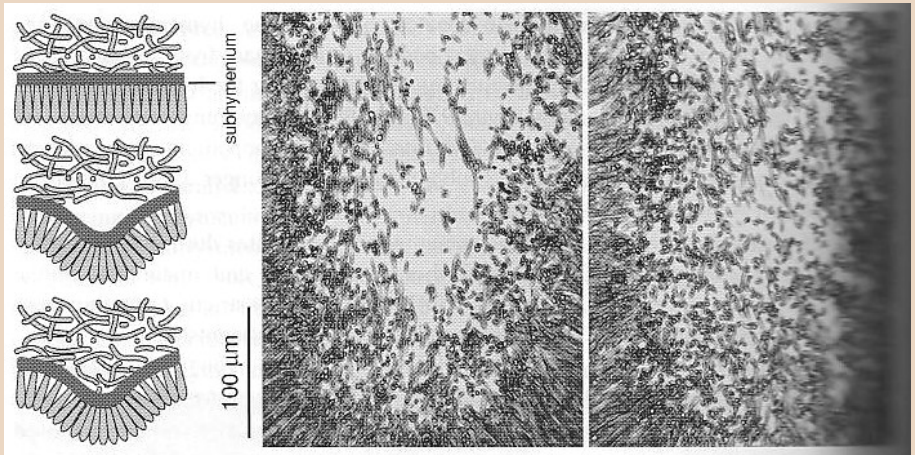


Figure 9.35: *Cantharellus* type initiation of the hymenophore, diagram of the early folding ... subhymenium and hymenium; and photographs of the hymenophore of *Cantharellus cibarius* ... left photograph a young fold showing disrupted trama and cavities, in the right photograph ... cavities in an older fold have been repaired by ingrown hyphae from the pileus context. – ... Clémençon 1997.

Clémençon: Cytology and Plectology ..., 2004.

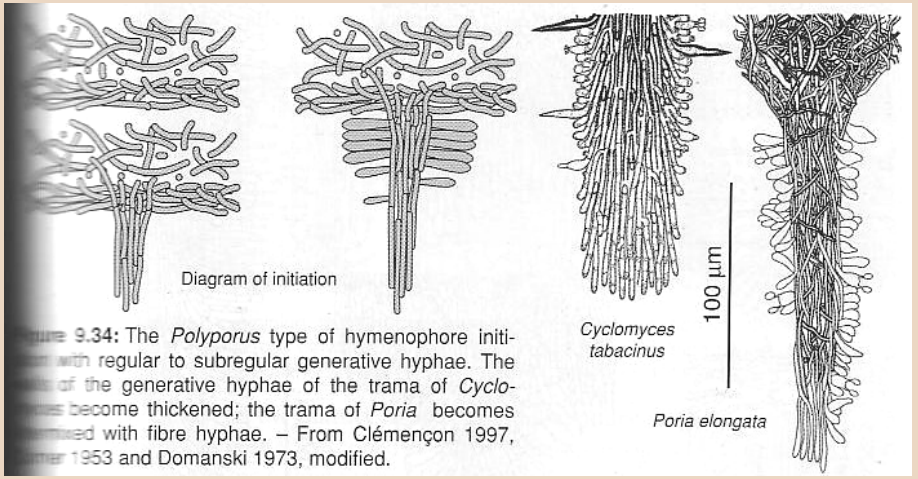


Figure 9.34: The *Polyporus* type of hymenophore initi... with regular to subregular generative hyphae. The ... of the generative hyphae of the trama of *Cyclo*... become thickened; the trama of *Poria* becomes ... with fibre hyphae. – From Clémençon 1997, ... 1953 and Domanski 1973, modified.

Různé způsoby zakládání hymenoforu: narůstání přehrádek mezi póry, na jejichž stěnách se tvoří bazidie (choroše, nahoře); zvlnění hymenia tlakem narůstajících bazidií (liška, vlevo nahoře); růst lupenu jako samostatné struktury se stavbou tramy odlišnou od tramy klobouku (typ. pro *Agaricales*, vlevo dole); vznik mezer mezi lupeny lyzí původně kompaktního pletiva hymenoforu (muchomůrka, dole).

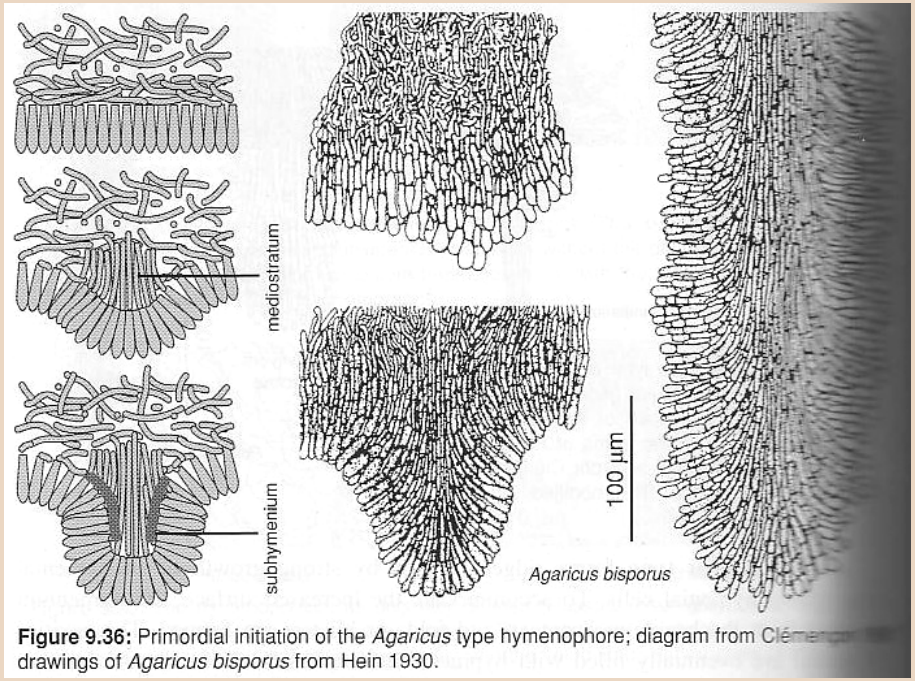


Figure 9.36: Primordial initiation of the *Agaricus* type hymenophore; diagram from Clém... drawings of *Agaricus bisporus* from Hein 1930.

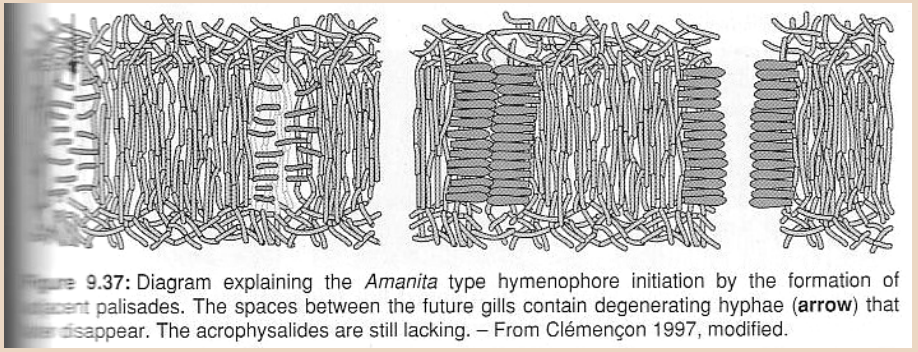
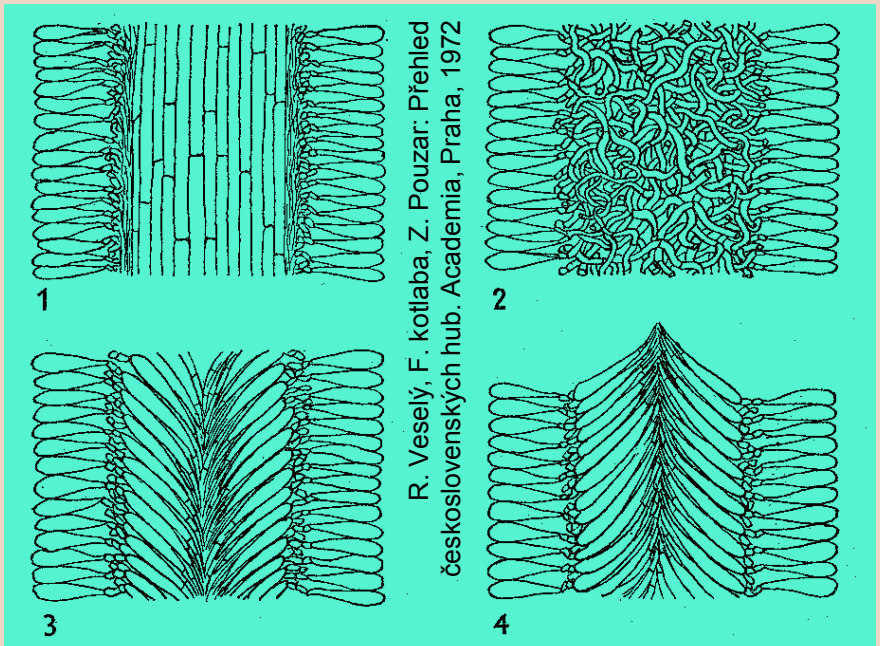


Figure 9.37: Diagram explaining the *Amanita* type hymenophore initiation by the formation of ... palisades. The spaces between the future gills contain degenerating hyphae (**arrow**) that ... disappear. The acrophysalides are still lacking. – From Clémençon 1997, modified.

Pletivo hymenoforu lze směrem k povrchu rozlišit na jednotlivé vrstvy: trama-subhymenium-hymenium.

Trama lupenů: obvykle jsou rozlišovány 4 základní typy podle uspořádání buněk: regulární, irregulární, bilaterální, inverzní (obr. dole), případně je možno rozlišovat více dílčích typů (schéma vpravo).



Typy tramy rourek a lupenů: 1. Trama pravidelná (regulární). 2. Trama nepravidelná (irregulární). 3. Trama rozčísnutá (bilaterální). 4. Trama převrácená (inverzní).

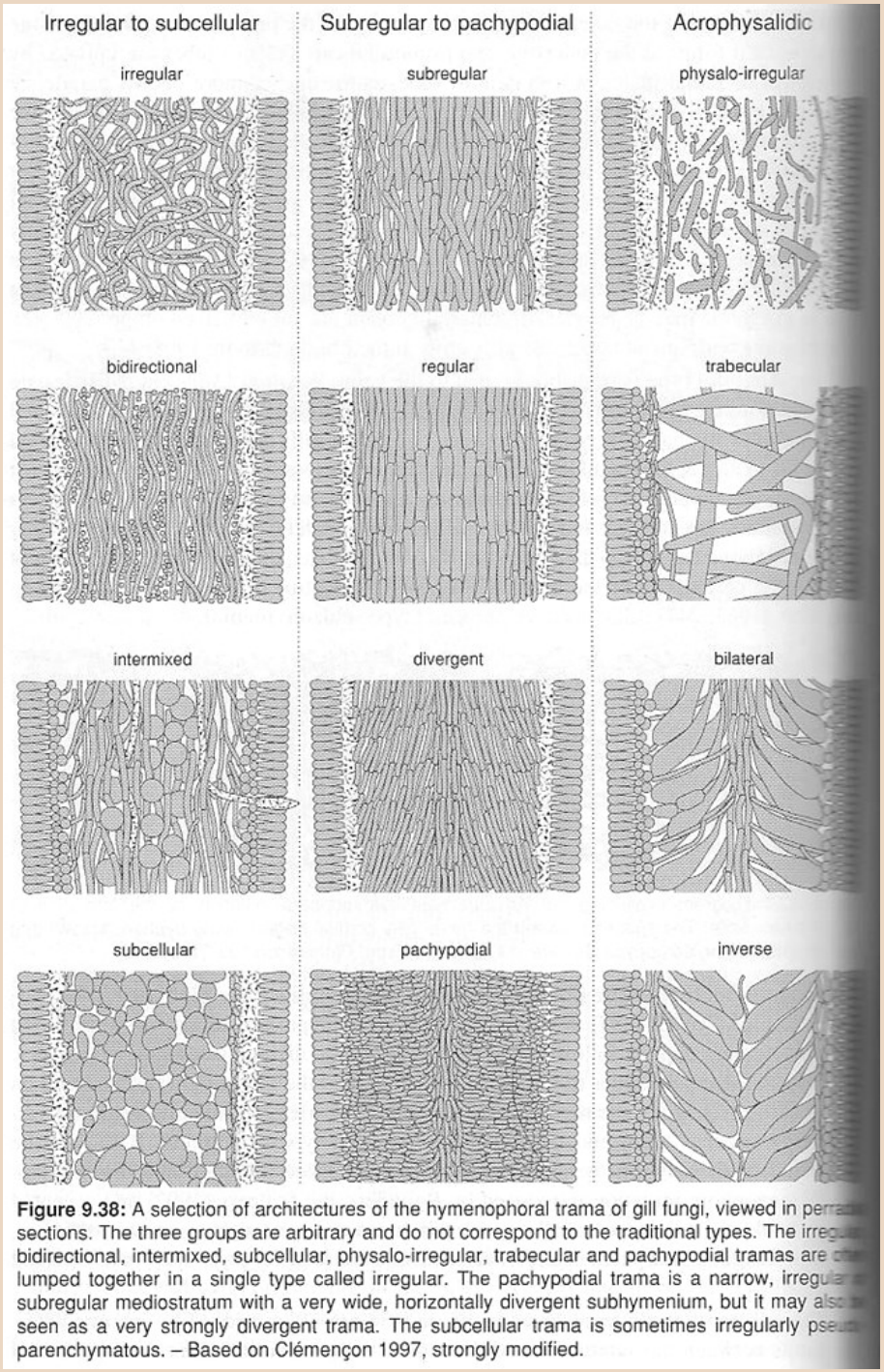


Figure 9.38: A selection of architectures of the hymenophoral trama of gill fungi, viewed in perra sections. The three groups are arbitrary and do not correspond to the traditional types. The irregu bidirectional, intermixed, subcellular, physalo-irregular, trabecular and pachypodial tramas are c lumped together in a single type called irregular. The pachypodial trama is a narrow, irregula subregular mediostratum with a very wide, horizontally divergent subhymenium, but it may also seen as a very strongly divergent trama. The subcellular trama is sometimes irregularly pseu parenchymatous. – Based on Clémençon 1997, strongly modified.

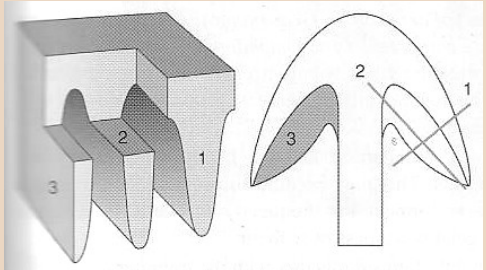
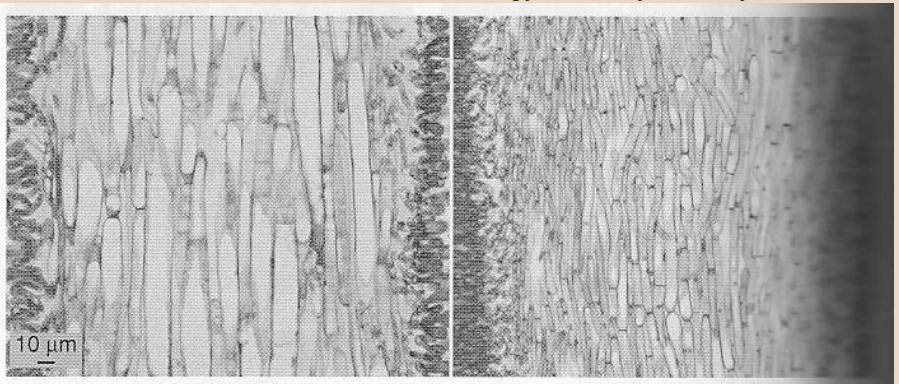


Figure 9.39: Terminology of the cutting planes for gills. 1: perradial. 2: paracial. 3: parahymenial. The angle between 1 and 2 is not necessarily orthogonal.

Clémençon: Cytology and Plectology of the Hymenomycetes, 2004.

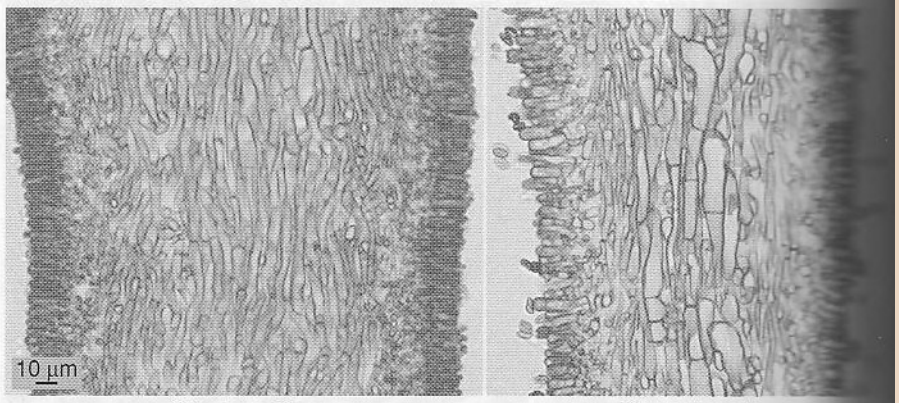
• trama **regulární** (= parallel; *Lepiota, Tricholoma* aj., řada lupenatých) – hyfy v mediostratu (střední oblast lupenu) jdou souběžně od báze k ostří lupenu; trama s ne zcela rovně jdoucími hyfami bývá odlišována jako subregulární;

– odvozené typy: divergentní trama – hyfy se stáčejí šikmo k povrchu lupenu; pachypodiální trama – hyfy se stáčejí kolmo k povrchu lupenu;



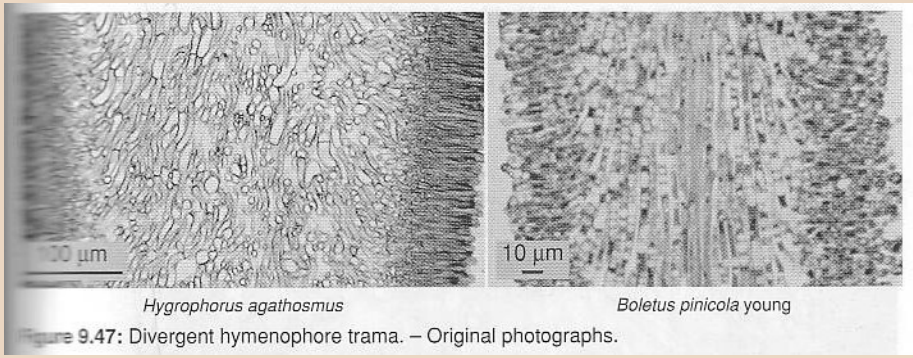
Entoloma juncinum *Tricholoma columbetta*

Figure 9.45: Regular gill trama with strongly inflated physalohyphae (*Entoloma*) and subregular trama with moderately inflated physalohyphae. Perradial sections. – Original photographs.



Clitocybe candicans *Gymnopilus sapineus*

Figure 9.46: Subregular gill trama with moderately inflated and greatly inflated physalohyphae, perradial sections. In *Gymnopilus sapineus* a central mediostratum made from strongly inflated physalohyphae and a lateral stratum made from thin generative just beneath the subhymenium can be distinguished. – Original photographs.



Hygrophorus agathosmus *Boletus pinicola* young

Figure 9.47: Divergent hymenophore trama. – Original photographs.

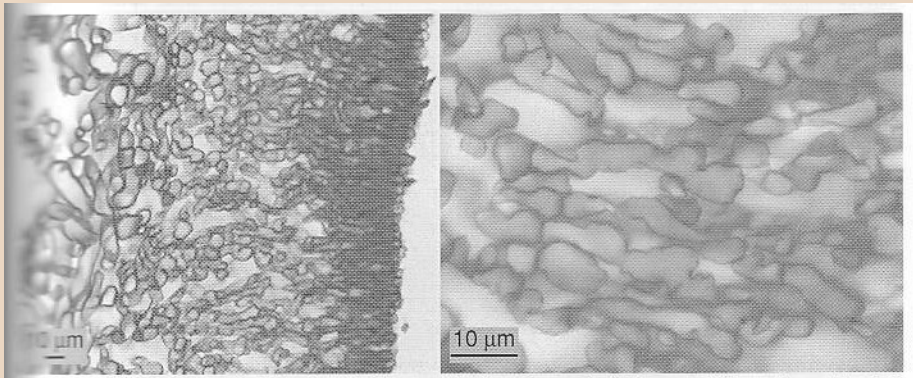


Figure 9.48: Pachypodial gill trama of *Chrysomphalina chrysophylla* in perradial sections. The left photograph shows the irregular mediostratum, the subhymenium and the hymenium, the right photograph shows the subhymenium only. – Original photographs.

• trama **irregulární** (= interwoven; *Pleurotus, Hygrophorus*) – hyfy tvoří v mediostratu nepravidelný propletenec;

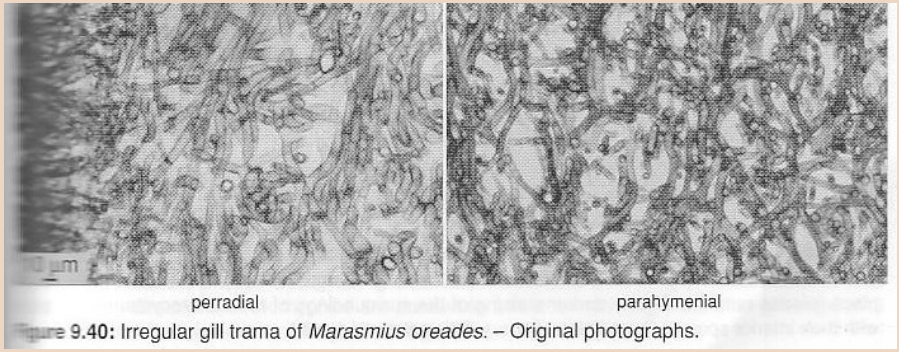


Figure 9.40: Irregular gill trama of *Marasmius oreades*. – Original photographs.

– odvozené typy: bidirekcionální trama – hyfy tvoří "síť" ve dvou kolmých směrech podél lupenu a shora dolů; "promíchaná" (intermixed) trama – více typů hyf, jsou vmíchány hyfy skeletové anebo trombo-plerní anebo ztlustlé buňky; subcelulární trama – stavba pseudoparenchymatická, krátké zakulacené buňky, prostory mezi nimi vyplňuje sliz nebo vzduch;

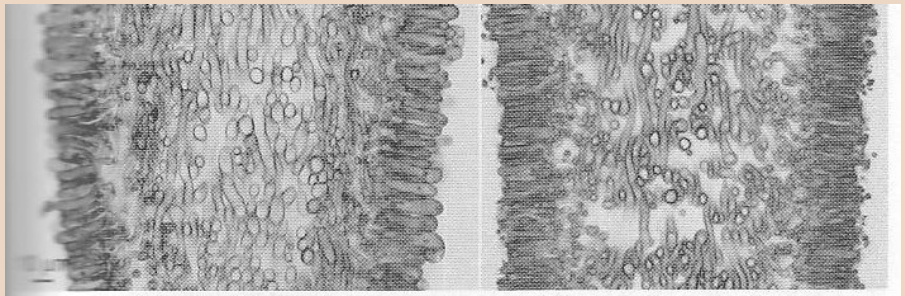

Lyophyllum decastes, near gill edge — *Clitocybe candicans*, near gill base

Figure 9.43: Bidirectional trama near the gill edge and in the gill base of otherwise subregular [illegible]. Perradial sections. – Original photographs.

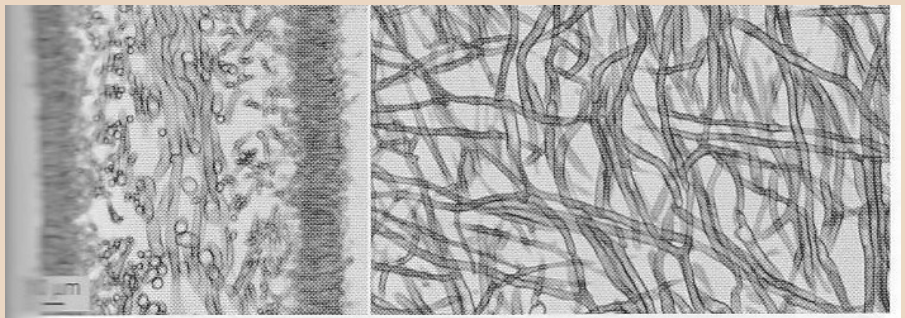
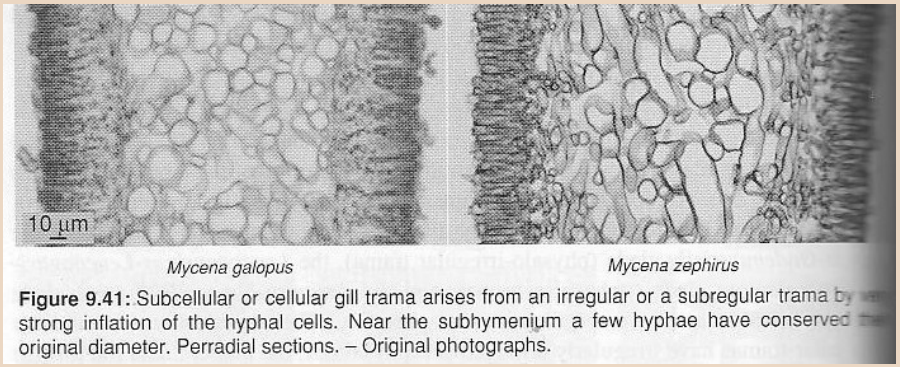
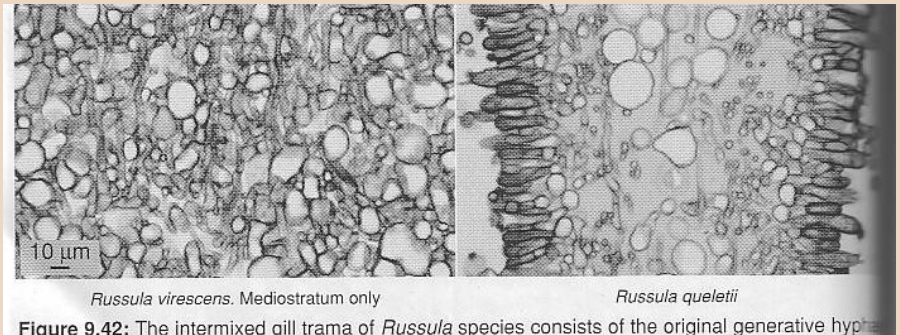


Figure 9.44: Bidirectional gill trama of *Panellus mitis* in paracial and parahymenial sections. The [illegible] average directions of the hyphae are parallel to and at a right angle with the gill edge, in a [illegible] parallel to the hymenium. – Original photographs.



Mycena galopus — *Mycena zephirus*

Figure 9.41: Subcellular or cellular gill trama arises from an irregular or a subregular trama by [illegible] strong inflation of the hyphal cells. Near the subhymenium a few hyphae have conserved [illegible] original diameter. Perradial sections. – Original photographs.



Russula virescens. Mediostratum only — *Russula queletii*

Figure 9.42: The intermixed gill trama of *Russula* species consists of the original generative hyph[illegible] and spherocysts. The gill trama of *Russula queletii* is gelatinous to keep the cells and hyphae [illegible] place (please note the slightly darker staining of the surroundings of the spherocysts, as compar[illegible] with their interior space). Perradial sections. – Original photographs.

– odvozené typy s rozvolněnými hyfami: fysalo-irregulární trama – inflátní fysalohyfy jsou všesměrně rozptýlené v gelatinózní hmotě; trabekulární trama – mohutné inflátní hyfy roztahují vnitřní tramu lupenu a vytlačují zbylé hyfy k okraji;

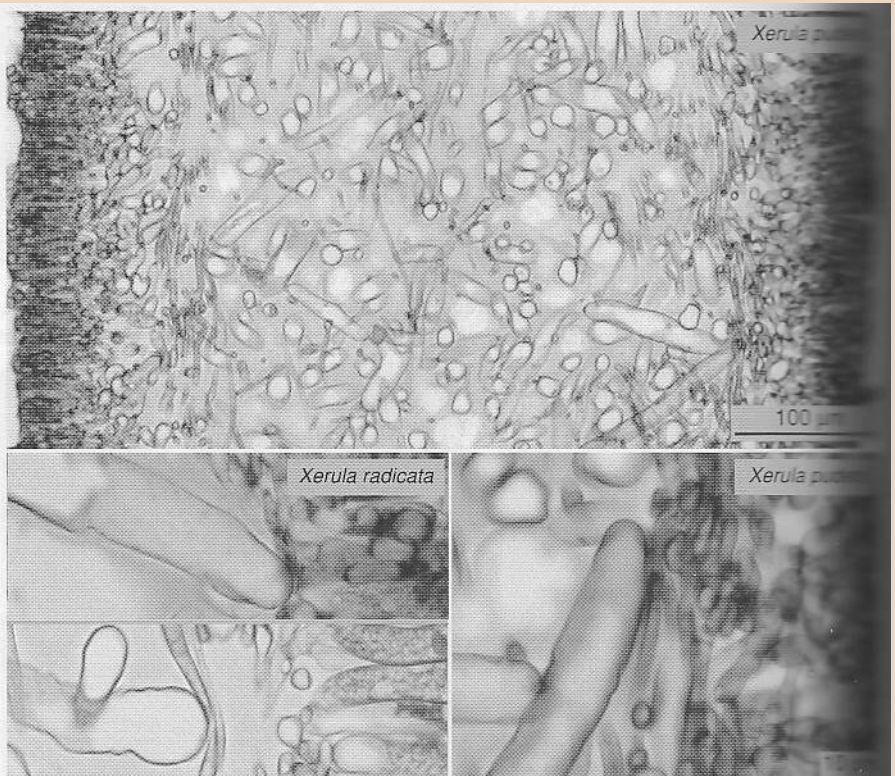
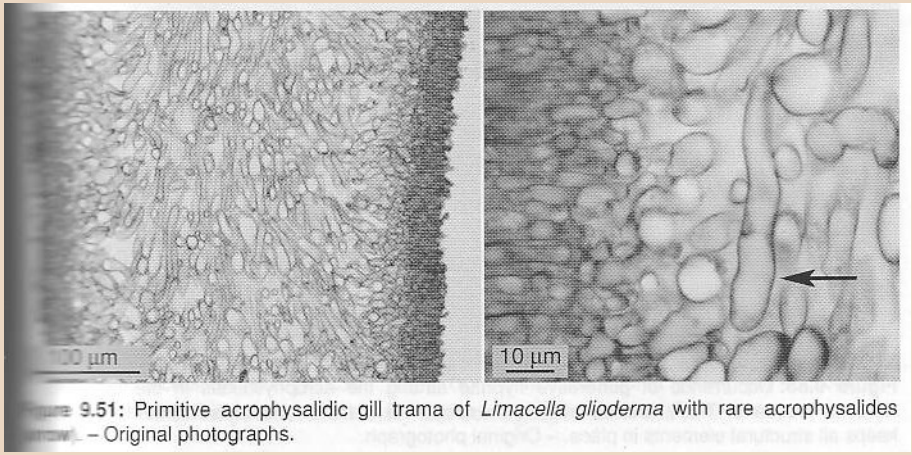
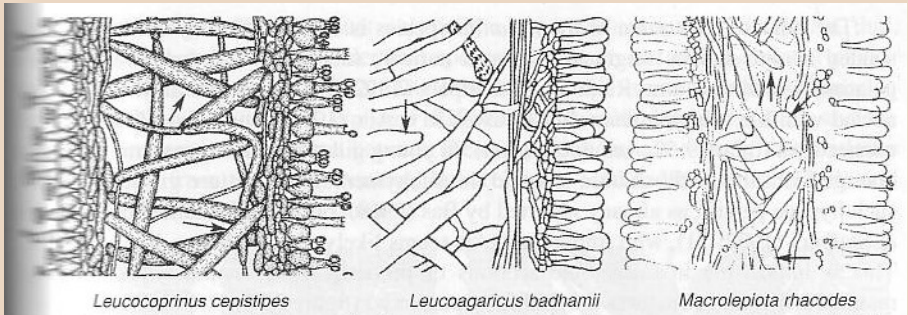


Figure 9.49: The acrophysalidic physalo-irregular gill trama of *Xerula pudens (Oude… badia)* and *Xerula radicata* is gelatinous, shows some remaining generative hyphae bet… strongly inflated hyphae and acrophysalides. The details show acrophysalides pushing aga… hymenopodium. – Original photographs.



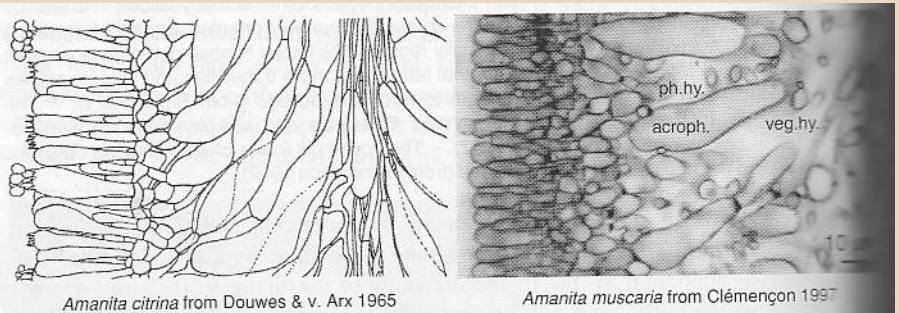
…ure 9.51: Primitive acrophysalidic gill trama of *Limacella glioderma* with rare acrophysalides …row. – Original photographs.



…ure 9.50: Trabecular gill tramas in the Leucocoprineae. Some acrophysalides marked by …rows. – In *Leucocoprinus cepistipes* the more or less transversely oriented, strongly turgescent …arise from the mediostratum that was originally regular. The lateral hyphae of the mediostratum …pushed aside and form the hymenopodium that later forms more trabeculas and acrophysalides …ards the inside and a cellular subhymenium towards the outside (from Buller 1924). – The …ure gill trama of *Leucoagaricus badhamii* shows trabeculae and acrophysalides, a hymeno…um and a subhymenium (from Locquin 1942). – The young gill trama of *Macrolepiota rhacodes* …s developing trabeculae and acrophysalides (from Heinemann 1989).

Heinz Clémençon: Cytology and Plectology of the Hymenomycetes. Bibliotheca Mycologica, vol. 199. J. Cramer, Berlin-Stuttgart, 2004.

• trama **bilaterální** (běžně označovaná pojmem divergent; *Amanita*)
– inflátní hyfy (fysalidy) vybíhající šikmo dolů odstředivě z tenkého mediostrata;



Amanita citrina from Douwes & v. Arx 1965 — *Amanita muscaria* from Clémençon 1997

Figure 9.52: The bilateral gill trama of the *Amanita* species consists of a narrow, subregular [illegible] stratum from which the turgescent acrophysalides diverge. The subhymenium is cellular. – *A. citrina*. Note that not all physalohyphae are free ending acrophysalides, but some continue [illegible] generative hyphae into the subhymenium. – In the young trama of *Amanita muscaria* [illegible] diverging generative hyphae (veg.hy.), some physalohyphae (ph.hy.) and acrophysalides (acroph.) can be seen clearly.

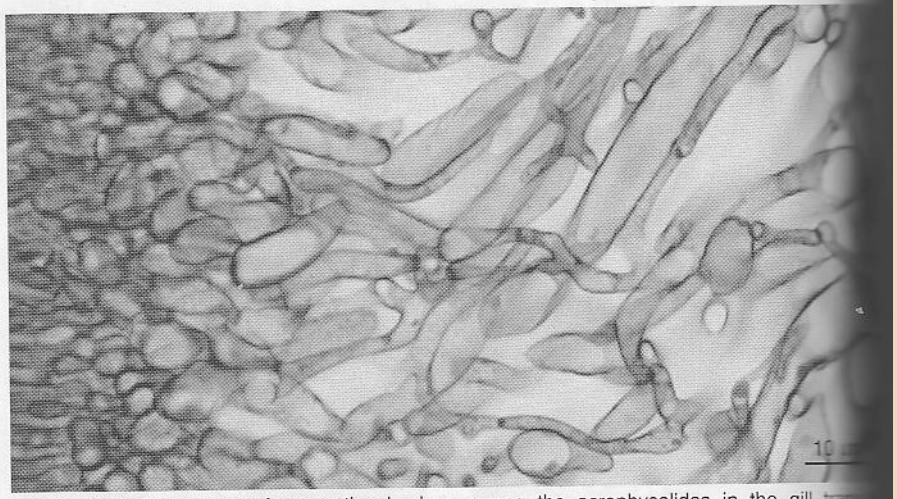


Figure 9.53: Occurrence of generative hyphae among the acrophysalides in the gill trama of *Amanita muscaria*. Thick, stained microtome section of material embedded in methacrylate keeps all structural elements in place. – Original photograph.

• trama **inverzní** (= convergent; *Pluteaceae*) – inflátní hyfy vyrůstají z tenkého hymenopodia šikmo dolů do středu lupenu.

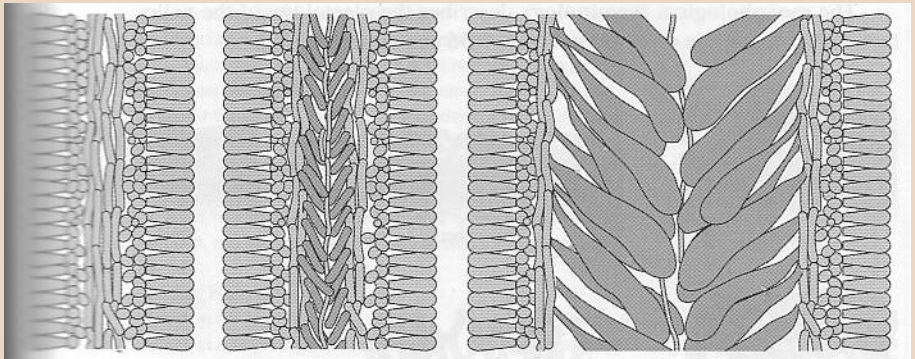
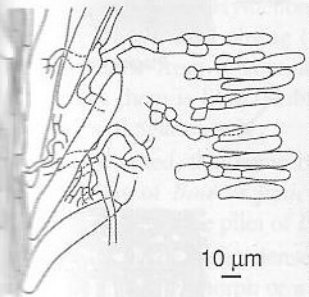
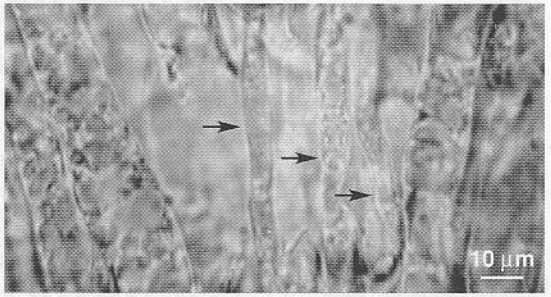


Figure 9.54: Diagram explaining the formation of the inverse gill trama and the hymenopodium from a primordial, subregular trama by formation of new cells and their turgescent expansion to become acrophysalides. The subhymenium is cellular. – From Clémençon 1997, modified.



Pluteus petasatus, from Bas 1969



Pluteus luctuosus, from Clémençon 1997

Figure 9.55: Origin of the acrophysalides and presence of generative hyphae (**arrows**) in the mid zone of the gill of *Pluteus*-species.

Heinz Clémençon: Cytology and Plectology of the Hymenomycetes. Bibliotheca Mycologica, vol. 199. J. Cramer, Berlin-Stuttgart, 2004.

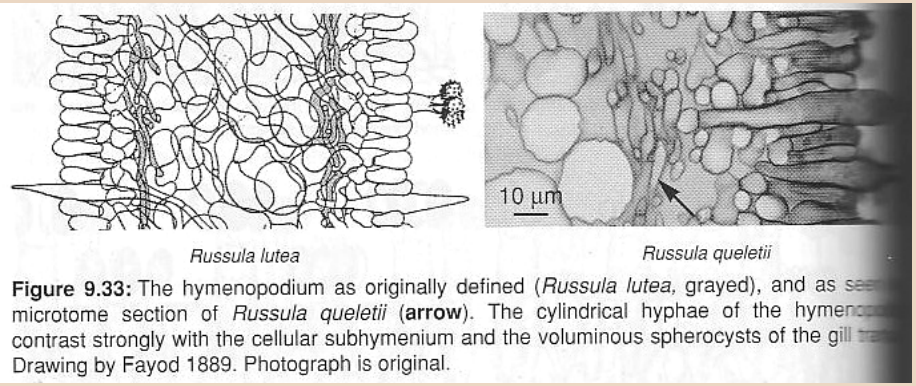


Figure 9.33: The hymenopodium as originally defined (*Russula lutea*, grayed), and as see microtome section of *Russula queletii* (**arrow**). The cylindrical hyphae of the hymenop contrast strongly with the cellular subhymenium and the voluminous spherocysts of the gill tra Drawing by Fayod 1889. Photograph is original.

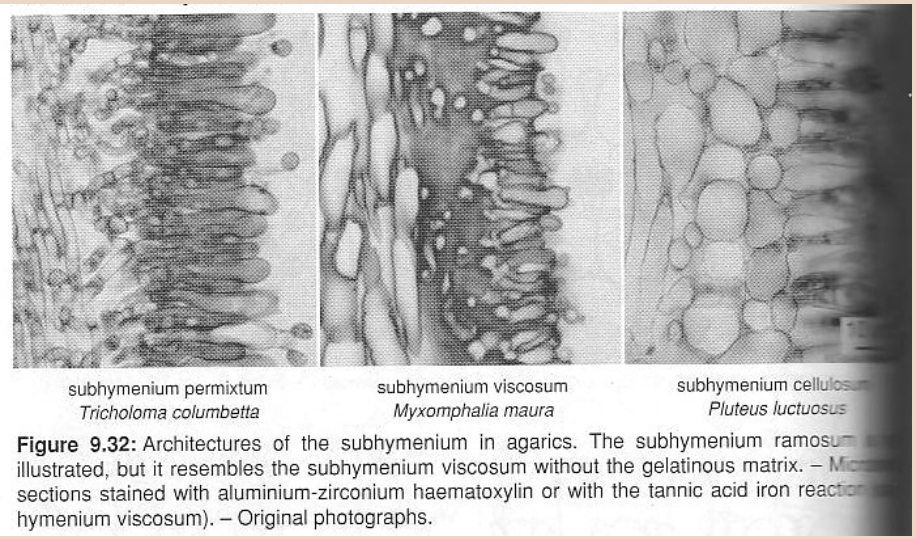


Figure 9.32: Architectures of the subhymenium in agarics. The subhymenium ramosum illustrated, but it resembles the subhymenium viscosum without the gelatinous matrix. – Mic sections stained with aluminium-zirconium haematoxylin or with the tannic acid iron reaction hymenium viscosum). – Original photographs.

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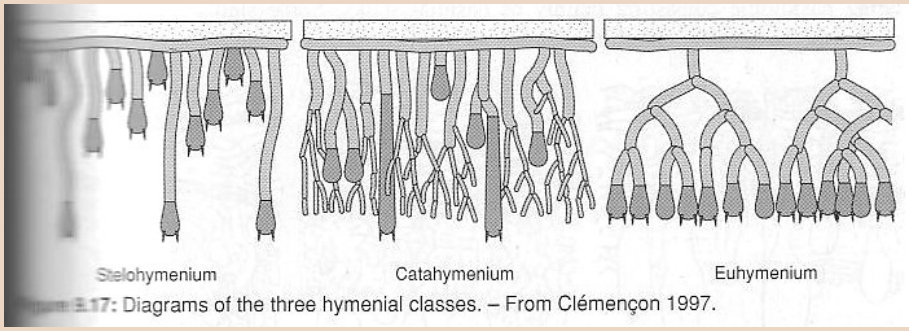
Hymenopodium je úzká oblast tenkých generativních hyf mezi tramou a subhymeniem – zřejmě zbytek primordiální tramy lupenů, jejíž buňky (na rozdíl od buněk tramy) neztlustly; často není odlišováno od subhymenia.

Subhymenium je vrstvička buněk pod hymeniem, v níž vznikají hymeniální elementy – mohou je tvořit nepravidelně propletené hyfy (s. permixtum), buňky jdoucí rovnoběžně s povrchem, z nichž se kolmo odvětvují elementy hymenia (s. ramosum, příp. s. viscosum, jsou-li stěny buněk gelatinózní) nebo ztlustlé až kulovité buňky tvořící pseudoparenchymatickou strukturu (s. cellulosum).

Výtrusorodá vrstva na povrchu je rouško neboli **hymenium** – jsou rozlišovány tři typy hymenia podle uspořádání bazidií a příp. dalších hymeniálních elementů:

- stelohymenium – jednotlivé bazidie na koncích hyf prorůstajících kolmo k povrchu, bez dalších struktur;
- katahymenium – bazidie "utopené" ve vrstvě hyfidií (viz dále), mezi nimiž prorůstají ven;



9.17: Diagrams of the three hymenial classes. – From Clémençon 1997.

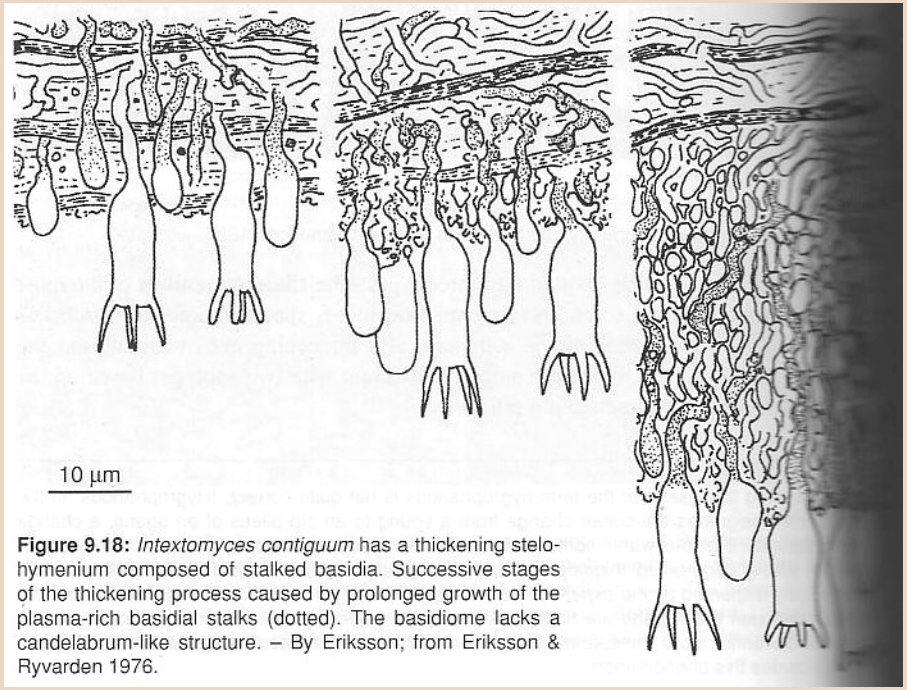
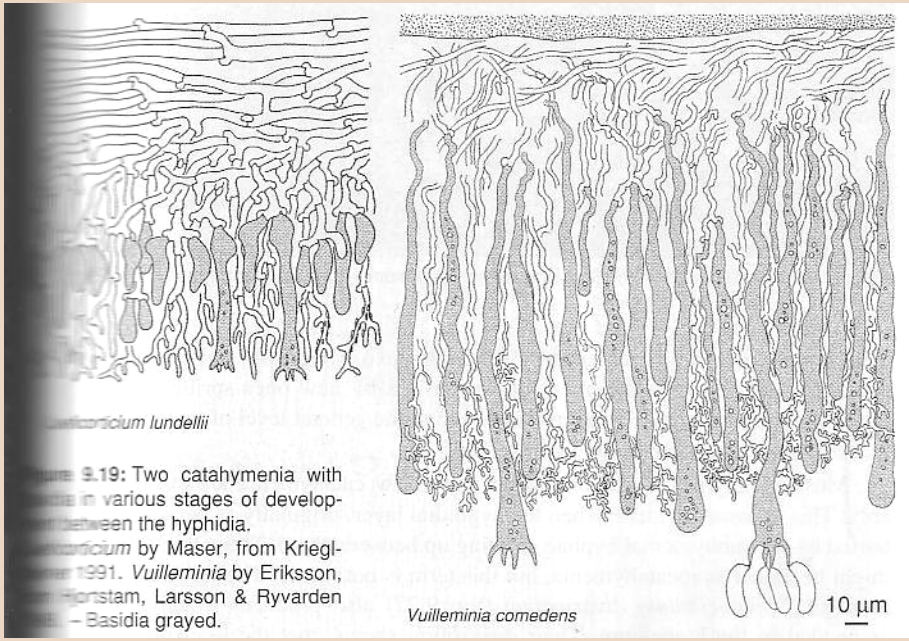


Figure 9.18: *Intextomyces contiguum* has a thickening stelohymenium composed of stalked basidia. Successive stages of the thickening process caused by prolonged growth of the plasma-rich basidial stalks (dotted). The basidiome lacks a candelabrum-like structure. – By Eriksson; from Eriksson & Ryvarden 1976.



Vuilleminia comedens

9.19: Two catahymenia with ... in various stages of develop... between the hyphidia. ...*cium* by Maser, from Kriegl... 1991. *Vuilleminia* by Eriksson, ... Hjortstam, Larsson & Ryvarden ... – Basidia grayed.

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• euhymenium – bazidie se tvoří na větvených hyfách vyrůstajících ze subhymenia,
– tilaiohymenium – na "větvích" hyf svazky bazidií netvořící souvislou vrstvu;
– leptohymenium – svazky bazidií na "větvích" hyf tvoří souvislou vrstvu, nově tvořené bazidie vrůstají mezi stávající;
– auxohymenium – vrstvu "vyprázdněných" bazidií přerůstají nově tvořené (případ "tloustnutí hymenia" hub, jejichž hymenium bývá vystaveno zničujícímu působení deště).

Clémençon: Cytology and Plectology of the Hymenomycetes, 2004.

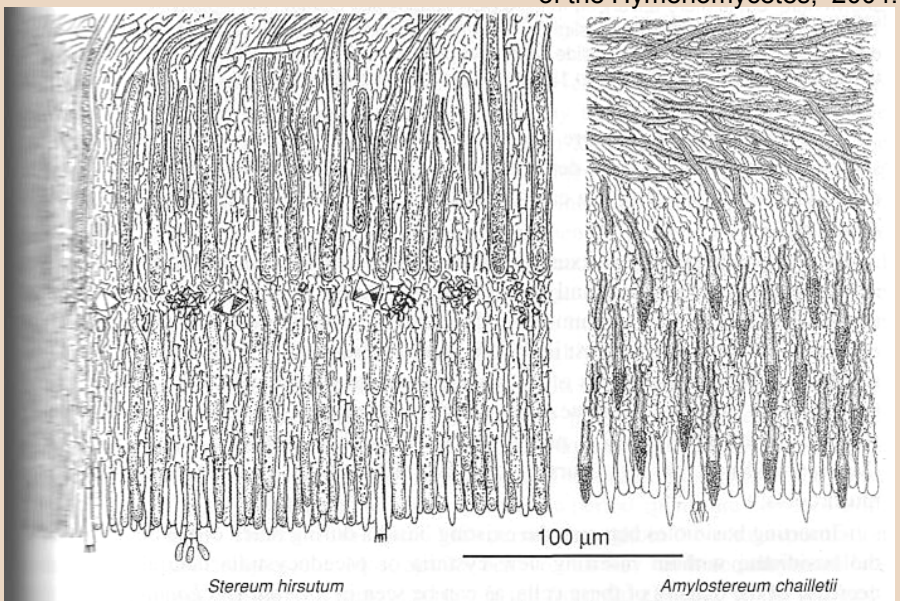


Figure 9.23: Auxohymenia with and without formation of layers. Old cystidia become embedded in strongly thickening subhymenium. – From Erisksson & al. 1984, Eriksson & Ryvarden 1973.

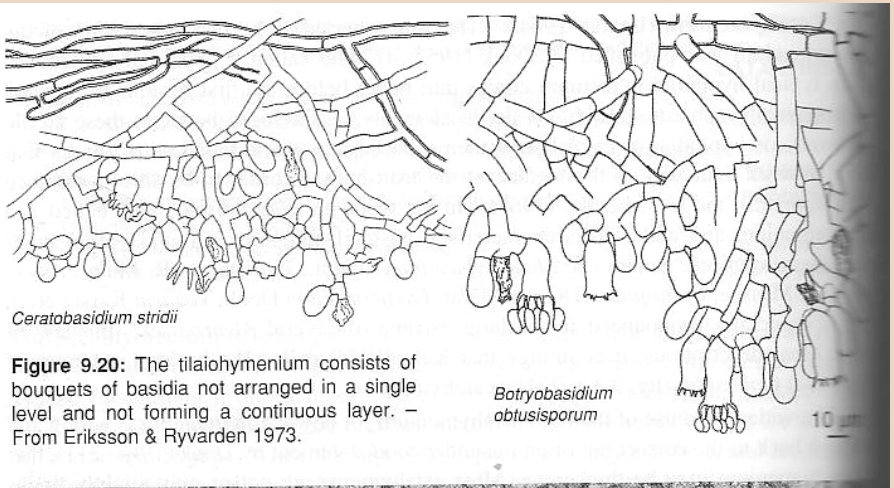


Figure 9.20: The tilaiohymenium consists of bouquets of basidia not arranged in a single level and not forming a continuous layer. – From Eriksson & Ryvarden 1973.

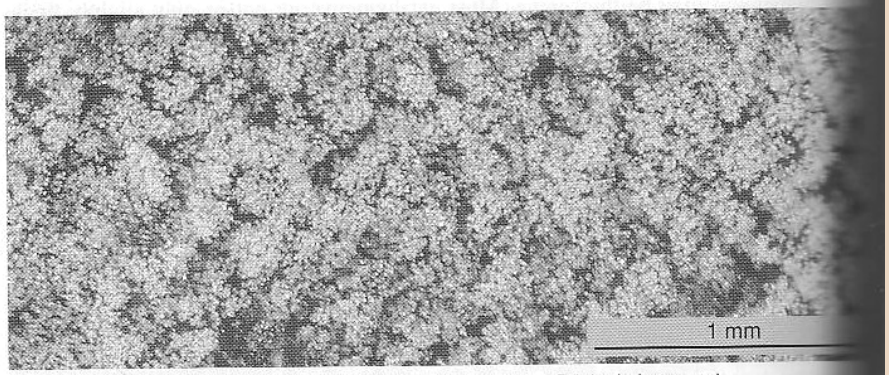


Figure 9.21: Tilaiohymenium of *Botryobasidium botryosum*. – Original photograph.

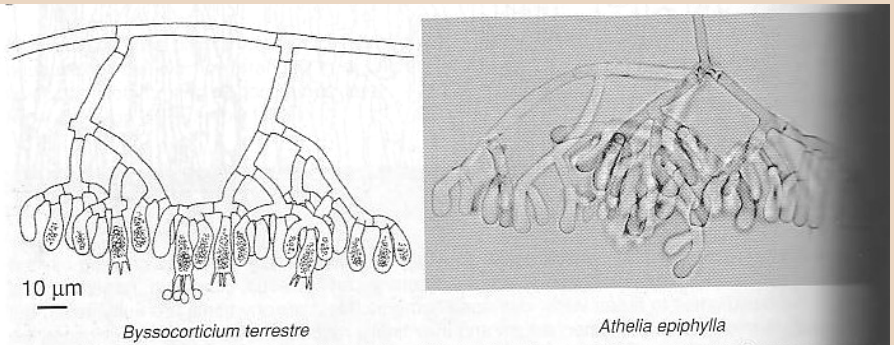


Figure 9.24: The basic structure of the leptohymenium is the candelabrum supporting many basidia arranged in a single, continuous layer and the placement of the young basidia between rather above the older ones. In primitive corticiaceous fungi this layer may still be somewhat irregular, shown here, but in more advanced fungi, e.g. in agarics and boletes, the leptohymenium is regular. The candelabrum of *Athelia* is slightly deformed, a consequence of the squashing of a three-dimensional structure between slide and cover glass. – Scale bar valid for both illustrations. Drawing from Eriksson & Ryvarden 1973, simplified. Photograph is original.

Dle postupu dozrávání bazidií lze rozlišit typ inekvihymeniferní (bazidie dozrávají postupně v úzké zóně postupující od ostří k bázi lupenu; některé hnojníky) a ekvihymeniferní (současné dozrávání bazidií na celé ploše hymenia, běžné). V izotropickém hymeniu dozrávají všechny bazidie zhruba zaráz, zatímco v anizotropickém se tvoří nepravidelná mozaika z oblastí "zralých" a "nezralých" bazidií (tyto typy jsou vždy ekvihymenif.).

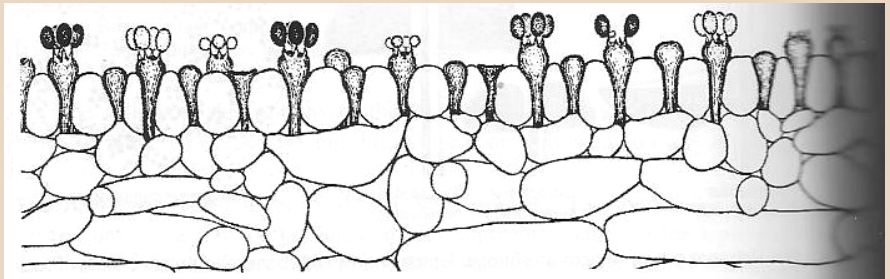


Figure 9.28: Isotropic hymenium of the *Bolbitius* type with monomorphic basidia between hymenial physalides. *Bolbitius vitellinus*. **Top:** Semi-diagrammatic section of the hymenium and hymenium. Basidia in all stages of development, including collapsed ones, are represented between the physalides.

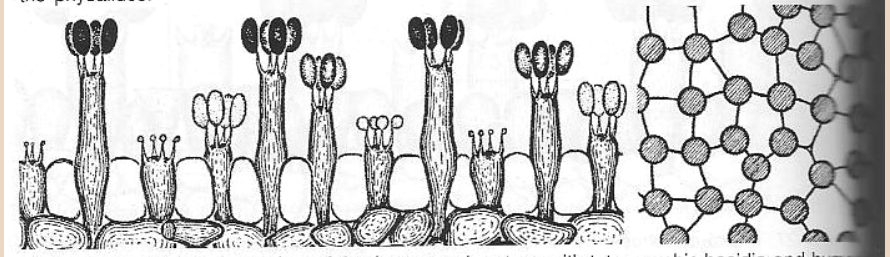


Figure 9.29: Isotropic hymenium of the *Leucocoprinus* type with tetramorphic basidia and hymenial physalides. Semi-diagrammatic section and surface view (basidia gray, physalides white). *Coprinus disseminatus*. – From Buller 1924, modified.

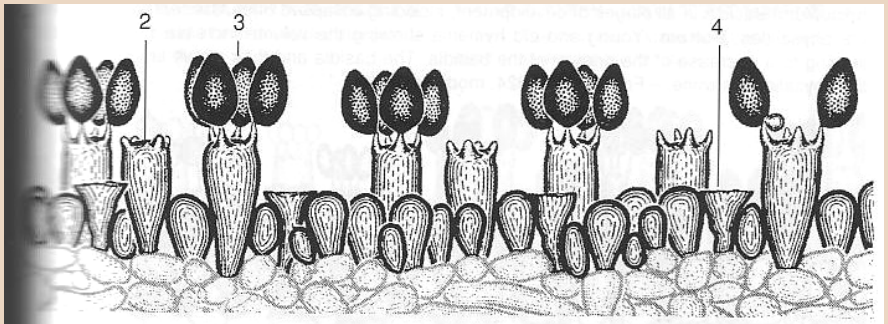


Figure 9.27: Macro-anisotropic hymenium of *Panaeolus campanulatus*, cross section through a maturation area with four successive generation of basidia. 1 = basidioles; 2 = maturing basidia; 3 = mature basidia; 4 = collapsed basidia. The basidia of each generation are all in the same phase of development. – From Buller 1922.

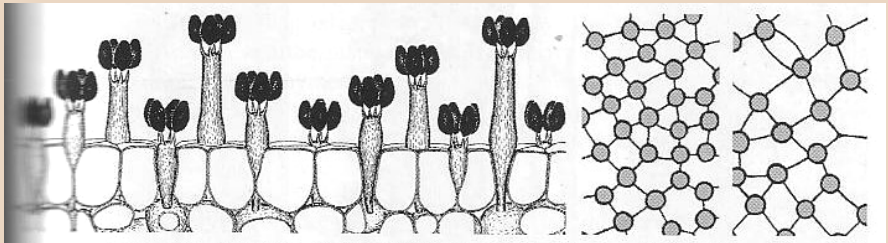
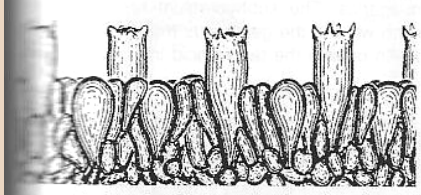
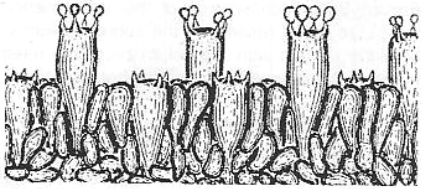


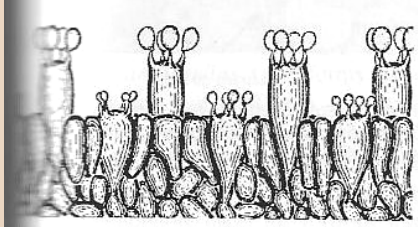
Figure 9.30: Isotropic hymenium of the *Coprinus* type with tetramorphic basidia and hymenial physalides. Semi-diagrammatic section and surface views of a young (left, physalides small) and a mature hymenium (right, physalides expanded). *Coprinus micaceus*. – From Buller 1924, modified.



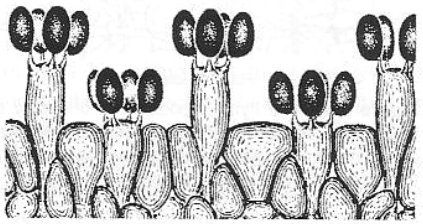
m.: The long basidia have developed sterigmata, short ones have not.



1 a.m.: The long basidia are developing spores, the short ones develop sterigmata.



a.m.; The long basidia have larger spores than short ones.



Midnight: Both generations have fully mature spores ready for discharge.

Figure 9.31: The long and the short basidia of *Coprinus sterquilinus* belong to two different generations that mature with only a slight delay in the second generation. – From Buller 1924.