

Keys and Descriptions of Russulas found in southern Vancouver Island coastal forests

Diagnostic characters

The figures below show three of the more important diagnostic characters of *Russula*. The spore colour is referred to in the following descriptions with a Romagnesi coded colour. Descriptions found in other literature may refer to Crawshaw or to their own colour codes. The ones that are most likely to be encountered are shown in their approximate chromatic and tonal position relative to the swatches of Romagnesi's 1967 colour chart.

The spore ornamentation chart drawn by Ben Woo for the Pacific Northwest Key Council is ordered by the amount and type of reticulation from A to E, and the height of the warts from 1 –small, to 3 –large. A Woo type consists of letter and number coordinates that can be easily referred to and used as a shorthand descriptor. Bon (1988) uses virtually identical categories.

The chart of epicutal structures shows common pileocystidia shapes. Type 1 is almost exclusively found in the *Pectinatae* such as *Russula pectinata*. Types 2, 3 and 4 are more common in the lower clades (1-6), types 5 and 6 are more common in clades 7-10 and the incrusted pileocystidia together with the incrusted primordial hyphae are found in clades 7 and 8. In any sliver of epicutis more than one shape may be found, but one or occasionally two will predominate, and these are associated with taxonomic position.

The macroscopic and microscopic reactions to a number of chemicals are noted in the descriptions. However, some are more useful than others. In addition, microscopic examination is facilitated by a further set of reagents. A summary of these follows.

Macroscopic use:

FeSO₄ (Ferrous sulphate); very useful –rub a crystal on the fresh stipe tissue, reaction ranges from salmon pink to blue-green, differentiates some taxonomic groups, e.g. the *Xerampelinae*.

KOH (potassium hydroxide) – a 3-5% aqueous solution; used on fresh stipe tissue may accelerate natural bruising reactions, turns flesh pink to red in *Russula cavipes*, on cap cutis it usually bleaches out the blue pigment.

NH₄OH (ammonia) – a 3% aqueous solution; useful in the *Sardoninae*, turns stipe tissue of *Russula sardonia* and *R. cavipes* pink to red.

Phenol – 2% in water; toxic and of limited use - place a drop on fresh stipe tissue, it turns brownish purple in almost every species except *Russula olivacea* and *R. alutacea*, in which it becomes blackcurrent-juice purple.

Gum guaiac – 1:5 w/v dissolved in 70% ethanol; of limited use - a drop on fresh stipe tissue turns quickly blue-green in most groups, weaker, slower and more grey in *Russula fragiles* and some close relatives.

Guaiacol – preprepared tincture; not often tested so taxonomic usefulness not fully assessed, - a drop on stipe tissue usually turns pink.

SV (sulphovanillin) – one drop of 50% sulphuric acid to a forceps-pinch of vanillin crystals, gently warmed to dissolve the crystals, hazardous but useful, - applied to slivers of fresh or dried cutis and gill tissue, reactions range from bright red, deep pink, purple to blue-black or sometimes merely a loss of colour to a pale grey or brown.

Microscopic use:

Extra wet water – to about 25ml water add 3 drops glycerol and 1-2 drops Kodak photoflow or similar wetting agent, for initial examination and measurement of cutis, gelatinous material and pigment are left intact, at least for several minutes.

KOH or NH₄OH - as above, for general viewing of tissues, removes the gelatinous substance from cutis tissues and usually also the pigment and most incrustations.

Congo red – 1:100 w:v in 3% ammonia, use KOH or ammonia to rinse stain off tissue and as mounting fluid - stains cell walls and septa, most useful for viewing cutis hyphae and thin gill sections or squash mounts, gives more contrast for photography.

SV - as for macroscopic use, stains contents of vascular hyphae and cystidia, the colour and intensity of the reaction is specific for several taxonomic groups.

Acid fuchsin – about 1g dissolved in 20ml 5% acetic acid, applied to sliver of cutis and allowed to soak 5-15 minutes. If it dries on the tissues the staining is improved, rinsed off in 2% hydrochloric acid for 1 minute then mounted in water. This is useful in species with encrusted hyphae, but the incrustations are also visible in SV and in water mounts with methylene blue or cotton blue (soak tissues in 2% hydrochloric acid first, then rinse well in water, to leave only acid resistant incrustations.)

Melzer's reagent: 0.5g iodine, 1.5g potassium iodide, 20ml water and 20ml chloral hydrate – essential for seeing spore ornamentation.

At minimum, FeSO_4 , SV, Melzer's reagent, water and 3% ammonia would suffice for a macroscopic and microscopic examination of most *Russula* species, adequate for making an identification with reasonable confidence. The microscopic staining of gill and cuticular cystidia in SV can be observed with a dissecting scope with a x25 objective, or even a very good hand lens with a magnification of at least x15, under which tiny dark dots on the gills or threads within the gelatinous matrix of the epicutis can be observed. The acid fuchsin reaction can be similarly observed.















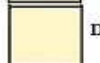



















| | | | Romagnesi 1967 | Kibby & Fatto 1990 | Buczacki 1992 | Crawshaw 1930 |
|------------------------------------------------|---------------------------------------------------|--|---------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| I Leucosporées (white or whitish spores) | a white spores (<i>R. cyanoxantha</i>) | |  | |  A |  A |
| | b whitish spores (<i>R. emetica</i>) | |  |  A |  B | |
| II Pallidosporées (cream spores) | a spores pale cream (<i>R. lepida</i>) | |  | | |  B |
| | c spores medium cream (<i>R. grisea</i>) | |  |  B |  C |  C |
| | d spores dark cream (<i>R. amoenicolor</i>) | |  |  C |  D | |
| III Ochrosporées (ochre spores) | a spores pale ochre (<i>R. exalbicans</i>) | |  |  D |  E | |
| | c spores deep ochre (<i>R. xerampelina</i>) | |  |  E |  F |  D |
| IV Xanthosporées (yellow spores) | a spores pale yellow (<i>R. faginea</i>) | |  |  F | |  E |
| | c spores medium yellow (<i>R. integra</i>) | |  |  G |  G |  F |
| | e spores strong yellow (<i>R. decipiens</i>) | |  |  H |  H |  G  H |

Figure 1 Spore print colour and code comparison between four authors. On a colour monitor the red-green-blue measurements for the Romagnesi swatches are as follows: Ia 255,255,255; Ib 254,255,241; IIa 253,252,217; IIc 253,248,198; IId 253,239,182; IIIa 252,233,178; IIIc 250,225,159; IVa 251,225,159; IVc 251,216,137; IVe 242,186,103. (On this scale 0,0,0 is black).

Russula Spore Ornamentation Types
















| | | | | | |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <p>1 warts small .1 - .4μm</p> <p>2 warts medium .4 - .9μm</p> <p>3 warts large .7 - 2.0μm</p> |  |  |  |  |  |
| |  |  |  |  |  |
| |  |  |  |  |  |
| | A warts isolated | B warts connected 2 to 3 | C warts with lines forming partial mesh | D warts with lines forming complete mesh | E warts in rows forming chains/ridges |

Figure 2 *Russula* spore ornamentation chart of Woo, drawn for the Pacific Northwest Key Council *Russula* Keys (Woo, 1989), with size and reticulation categories A to D being close to that of Bon, (1988), but with the addition of types E, in which the warts are catenate.

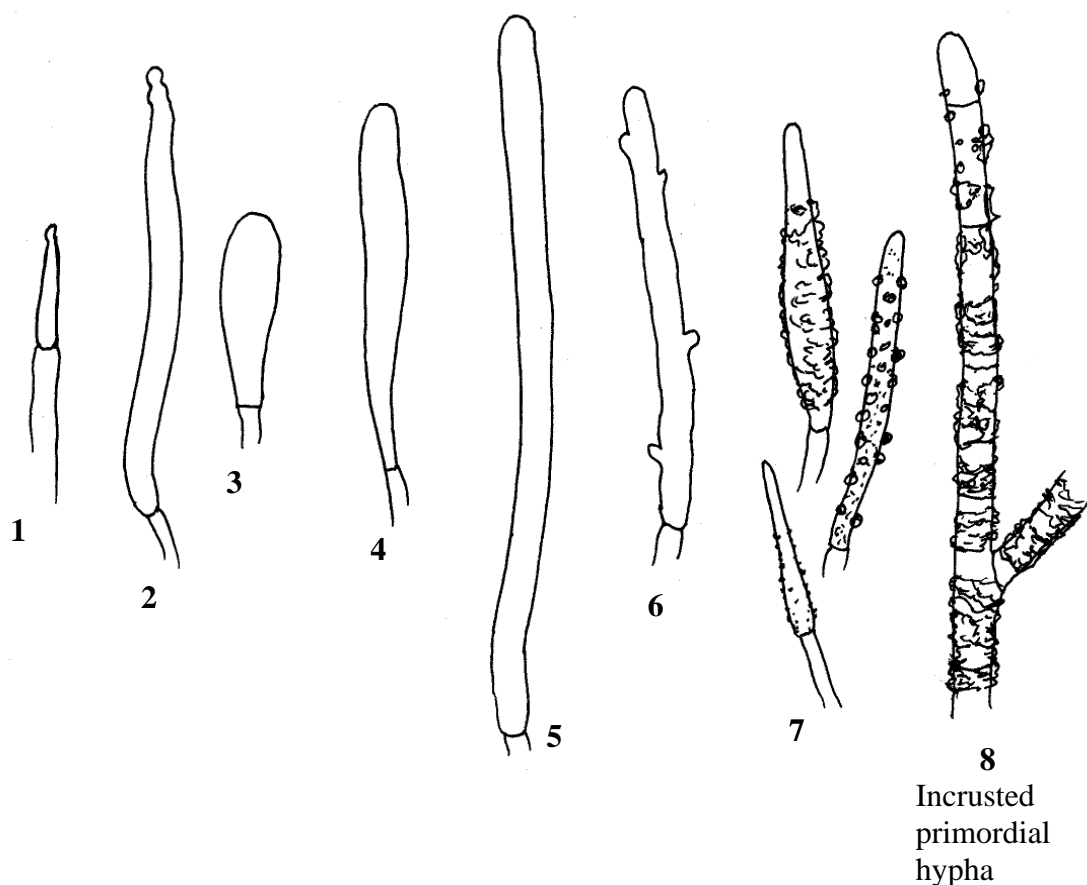


Figure 3 Specialized structures of the epicutis, 1-7 are pileocystidia: 1, aciculate or pointed; 2, \pm cylindrical with capitate or strangulate terminus; 3, shortly clavate or broad with obtuse end; 4, narrowly clavate with obtuse tip; 5, long, cylindrical with obtuse tip; 6, diverticulate; 7, various shapes -incrusted. Septation has here been considered separately but type 2 is occasionally up to 2 septate, rarely 3; types 4, 5 and 6 are usually septate, types 4 and 6 often with 0-2 septa, and type 5 with 2-5 or more. Types 2 and 3 have 0-2 septa in a few cases but these are more commonly aseptate. Incrusted primordial hyphae are normally regularly septate, branched and do not stain in sulphovanillin.

Keys to Russulas of Vancouver Island and the Pacific Northwest

Species in bold type are described in the following pages, others have been reported from the Pacific Northwest in various literature and in foray lists, and are included in this key for more complete coverage. Species keyed out but not described below may be looked up in Matchmaker (Gibson and Gibson 2003), or in Woo (1989) or the original publication. The keys are based on a traditional dichotomous key, except where more than two distinct characters can separate species or groups of species. Cap colour, spore colour, taste and some cases reaction to FeSO_4 are the initial differential characters, since those are the first to be observed. Finer divisions are made with bruising reactions, habitat and microscopic characters. Sometimes more information is given than is strictly necessary to segregate groups so that the key is useable by people with a wide range of experience and access to microscopes and laboratory facilities.

Polychotomous keys to major groups:

1. Gills with frequent subgills that are more or less regularly distributed in 2-3 tiers, cap white to cream, margins smooth, cutis not peelable or viscid, may bruise brownish in age but not bruising red, grey or black. **Key 2: *Lactaroides***

2. Gills as above, cap white, cream or shades of brown, margins smooth, cutis peelable only at the margins, dry or viscid, flesh bruising grey to black, sometimes with a pink to red interphase, spores with inamyloid suprahilar patch..... **Key 1: *Compactae***

3. Cap some shade of light to dark brown, lacking red, green, purple or clear yellow pigments, always with a deeply grooved (tuberculate) margin, even when young, surface viscid and sticky when moist, flesh usually browning, stipe with 4 or more lenticular cavities, odours usually strong, taste peppery to acrid with a soapy aftertaste, spores with an inamyloid suprahilar patch. Chromatograph of hot water extract of cutis having only browns and dull yellows, and lacking bands of blue, magenta or bright yellow. **Key 3: *Ingratula***

4. Cap colour various but not bright red or yellow, often pruinose, stipe usually solid, not developing a series of 3 or more cavities (but may be hollowed out by insect larvae), flesh usually firm and less brittle than other Russulas, usually mild or only slightly peppery, gills mostly all the same length or sometimes forked, acute to adnate at the cap margin (not obtuse), subgills infrequent and irregularly distributed, spores with an inamyloid suprahilar patch, often also with low ornamentation, basidia 6-12µm wide, cutis pigment poorly extracted by hot water and distinct magenta bands not separated by paper chromatography..... **Key 4: *Heterophyllidia***
5. Cap colour may include white, pink, red, yellow, green, purple, violet and black or a mixture of these, cutis often peelable, gills as in 4 above, but may also be obtuse to rounded at the cap margin, stipe often spontaneously developing three irregular cavities, occasionally more (but solid in Clade 8), taste mild to acrid, spores with an amyloid suprahilar patch, basidia 7-17µm wide, cutis pigment easily extracted by hot water and separated by paper chromatography into blue-grey, magenta and yellow bands **Key 5**

Key 1: *Compactae* -Clade 1b

- 1.1 a) Flesh turning distinctly pink to red before greying or blackening. 1.2
 b) Flesh graying or blackening directly..... 1.5
- 1.2 a) Gills thick and distant, only 4-5 per cm at mid-radius..... 1.3
 b) Gills thinner, more closely spaced 1.4
- 1.3 a) Spores with ornamentation up to 0.3 microns, European.... *R. nigricans* Fries
 (see notes under *R. dissimulans*).
 b) Spores with ornamentation up to 0.7 microns, North American
*Russula dissimulans* Shaffer
- 1.4 a) Taste peppery, flesh turning pink before graying. *Russula densifolia* (Secr.)
 Gillet (see notes under *R. adusta*).
 b) Taste mild, flesh at most greyish or brownish pink before greying.....1.5
- 1.5 a) Cap cutis pure white when undamaged, flesh blackening strongly within a minute
 of bruising, no pink interphase *Russula albonigra* (Kromb) Fries
 b) Cap cream to dingy yellow-brown when undamaged, bruising reaction slower
 and weaker, blackening only in age or after several hours..... 1.6
- 1.6 a) Cap smooth, viscid when wet, stipe smooth, hyphae of cap epicutis with yellow-
 brown pigment globules in 5% KOH or water mounts *Russula adusta* Fries
 b) Cap dry, felty, stipe with tiny floccules, hyphae of cap epicutis with dark brown
 pigment globules in 5% KOH or water mounts
*Russula anthracina* var. *insipida* Romagnesi

Key 2: *Lactaroides* –Clade 2b

- 2.1 a) Taste mild to only slightly peppery 2.2
 b) Taste strongly peppery to acrid..... 2.3
- 2.2 a) Gills thick and distant, spore ornamentation generally under 1µm high, not confirmed for North America.....*Russula delica* Fries
 b) Gills thin and narrow, close to crowded, common in the Pacific Northwest.....
***Russula brevipes* var. *brevipes* Peck**
- 2.3 a) Cap diameter medium to large, usually 10cm or more, spores 8-11.3 x 7.8-9.4µm, gills with blue-green tints near the stipe.....***Russula brevipes* var. *acrior* Shaffer**
 b) Cap smaller, lacking blue-green tints on gills, spores 6.2-8.5 x 4.5-6µm..... .
***Russula cascadenis* Shaffer**

Key 3 *Ingratae* -Clade 3

- 3.1 a) Cap cream, margin smooth when young, cutis up to 1mm thick, rubbery and easy to peel almost completely, odour mild or of coconut. ***Russula crassotunicata* Singer**
 b) Cutis not peelable, cap margins striate to tuberculate when young 3.2
- 3.2 a) Strong sweet odour of marzipan, maraschino cherries (benzaldehyde) or almond essence, sometimes with a foetid component, pileocystidia cylindrical 3.3
 b) Odour not as above 3.5
- 3.3 a) Spore ornamentation of ridges forming a partial to complete reticulum 3.4
 b) Spore ornamentation of mostly isolated warts, odour with a more pronounced foetid component..... *Russula foetens* Fries
- 3.4 a) Spore ornamentation under 1.8µm high, habitat with Sitka spruce
 ***Russula fragrantissima* Romagn.**
 b) Spore ornamentation up to 2.6µm high.....*Russula laurocerasi* Melzer
 (see notes under *R. fragrantissima*)
- 3.5 a) Spore print white, Romagnesi 1a-1b, cap generally below 7cm diameter, stipe with more than 10 lenticular cavities, pileocystidia cylindrical and voluminous, SV +, odour subtle, ± fruity,..... 3.6
 b) Spore print cream to pale yellow, odour strong, not fruity, stipe usually with fewer cavities, pileocystidia small, inconspicuous and lanceolate with contents showing only a few weakly staining granules in SV..... 3.7
- 3.6 a) Under conifers ***Russula pallescens* Karsten**
 b) Under broadleaved trees.....***Russula farinipes* Romell.**

- 3.7 a) Cap cutis with minute granular appearance, at least over central area, the granules usually red-brown, microscopically they are composed of clumps of upright smooth-walled articulated hyphae and pileocystidia, habitat with Douglas fir ***Russula granulata* Peck.**
- b) Cap cutis smooth, fibrillose or becoming areolate but these patches not granular in appearance 3.8
- 3.8 a) On beach dunes at the edge of Sitka spruce, pine and western hemlock forest, odour with spermatic, Jerusalem artichokes or fishy-almond components, usually dark greyish yellow-brown 3.9
- b) In the coastal Douglas-fir zone 3.10
- 3.9 a) Spores with a partial reticulum ***Russula cf. pectinata* Fries**
- b) Spores with mostly isolated warts *Russula amoenolens* Romagn.
(see notes under *R. cerolens* and *R. cf. pectinata*).
- 3.10 a) Cap 5.3-9cm diameter, pale to mid grey-brown, odour like bleach but also with a fresh ozone or cottonwood component, spores mid to deep cream, Romagnesi IIc-d, ellipsoidal, mean L:W around 1.33, articulated hyphae common in epicutis
..... ***Russula cerolens* Shaffer**
- b) Cap under 5cm diameter, pale dull yellow-brown, articulated hyphae rare in epicutis, spores pale cream, Romagnesi Ib-IIa, spores broadly ellipsoidal, mean L:W around 0.26 ***Russula pectinatoides* Peck**
- c) Not quite matching key choices from 3.7 on *Russula sororia* group
(see notes under *R. cerolens*

Key 4 *Heterophyllidia*

- 4.1 a) Spore print white, Romagnesi 1a to 1b 4.2
 b) Spore print cream to yellow, Romagnesi IIa and darker..... 4.6
- 4.2 a) Cap dark brown centrally with brown, olive or green margins and with subtle radial wrinkles 4.3
 b) Brighter, paler or with more pink..... 4.4
- 4.3 a) Under Douglas firs, stipe with rosy flush, cap margins green, gills tinged yellow-green, no pileocystidia.....***Russula smithii* Singer**
 b) Under Sitka spruce or western hemlock, stipe usually with a pale pink-grey to green-grey pruina, gills cream and bruising brown, pileocystidia present but may be sparse ***Russula brunneola* Burlingham**
- 4.4 a) Flesh salmon pink to greyish pink in FeSO₄, epicutis hyphae with short, often inflated cells..... 4.5
 b) Flesh slowly grey to greenish in FeSO₄, gills pliable, cap with a mixture of green, purple and violet, epicutis hyphae narrow and filamentous
 ***Russula cyanoxantha* Fries**
- 4.5 a) Cap green, at the margins the cutis breaking up into angular patches, cap cutis mostly cellular with sphaerocytes in the epicutis and no pileocystidia, spores very pale cream, Romagnesi Ib-IIa, with deciduous trees.....
***Russula virescens* (Shaeffer) Fries**
 b) Cap light green to brownish green, spores under 7µm long, epicutis with short cylindrical pileocystidia and occasional thick-walled hair-like cells over the centre .
 ***Russula heterophylla* Fries**
 c) Cap light pinkish brown, light purple with buff to dull yellow or cream, epicutis as in previous but spores over 7µm long***Russula vesca* Fries**

- 4.6 a) Cap various dull colours overlain with a pale greyish pruina, drying matte.... 4.10
 b) Cap colours as above or paler, not pruinose and drying subglossy 4.9
 c) Cap blue-green, grass-green to yellow-green, not pruinose..... 4.8
 d) Cap reddish to purple, stipe pink to purple 4.7
- 4.7 a) Cap velvety to suede-like, usually under 7cm diameter, mostly dark reddish to purple with a pale grey bloom, sometimes with paler or browner areas, margins strongly striate, pleurocystidia voluminous, 10-20µm wide and contents not refractive, vascular hyphae absent (Bills and Miller 1984), spores reticulate.....
*Russula mariae* Peck
 b) Cap velvety to suede-like, larger (~11cm) brownish-yellow centrally with purple to violet margin, margin smooth, pleurocystidia under 8µm wide, mostly embedded and contents refractive, vascular hyphae and pileocystidia present, spores not reticulate*Russula cf. sublevissima* (Romagn.) Kuhn. Romagn.
 c) Cap large, up to 22cm diameter, dark purple, spores reticulate
*Russula maxima* Burl.
 (This species is placed in the *Heterophyllae* subsection *Griseinae* by Thiers (1997), but Singer (1942) placed it in the *Integrinae* (roughly equivalent to *Integrae* in Sarnari 1998)
- 4.8 a) Cutis breaking up into angular patches near the cap margins, spores very pale cream, Romagnesi Ib-IIa, with deciduous trees*Russula virescens* (Shaeffer) Fries
 b) Cutis not breaking up, can be peeled to at least half-radius, sometimes completely, spores light cream, Romagnesi IIa-c *R. aeruginea* Lindbl. ex Fr.
- 4.9 a) Dingy white, tinged with pink or yellow, spores yellow, Crawshaw E, or about Romagnesi IIIc-IVa, stipe unchanging, taste with bitter component
*Russula basifurcata* Peck
 b) Cap yellow-brown, pink-brown to light chocolate brown, spores cream, Romagnesi IIa-c, taste mild.....*Russula mustelina* Fries
 c) Cap light to mid grey with tinges of blue, green and pink, spores deep cream,

Romagnesi IIId to IIIa, stipe bruising yellowish to brown, taste mild to slightly peppery, with shore pine and Sitka spruce ***Russula medullata* Romagn.**
 d) As for previous but spores paler and habitat with beech.
 *Russula grisea* (Secr.) Fr. (see notes under *R. medullata*)

- 4.10 a) Cap grey-green to greenish brown, very pruinose, convex to pulvinate at maturity, epicutis sometimes with pseudoparenchymatous layer, with a variety of tree hosts but especially oak *Russula modesta* Peck
 b) Cap pinkish brown to grey-brown to blue-grey with pale grey pruina, becoming funnel-shaped with margins uplifted before fully mature, epicutis with some inflated cells but not forming a pseudoparenchymatous layer
 ***Russula parazurea* Shaeffer**
 c) Cap ochre in centre, margins purple, cutis margins suede-like
 ***Russula cf. sublevispora* (Romagn.) Kuhn. Romagn.**

Key 5 Other *Russula* subgenera

Russulas with various colours including bright red and yellow, with an amyloid suprahilar patch on the spores, and with easily hot-water extractable pigments that are separable by paper chromatography into blue, magenta and yellow bands, (at least in coloured species). Cap is assumed to be viscid when wet unless described otherwise.

- 5.1 a) Cap white, cream or yellow, lacking other colours 5.2
- b) Cap with colours other than above 5.8
- 5.2 a) Taste mild to slightly peppery or bitter, spores some shade of yellow 5.3
- b) Taste acrid, spores white 5.6
- 5.3 a) Cap yellow, flesh greying to blackening, habitat often in swampy areas, epicutis with incrustated hyphae *Russula claroflava* Grove
- b) Cap cream to yellow, flesh unchanging 5.4
- 5.4 Cap cream with dull yellow centre, spore print pale yellow, Romagnesi IIIa, epicutis with incrustated primordial hyphae *Russula albida* Peck
- b) Cap bright clear yellow, generally below 8cm diameter, pileocystidia none or doubtful, not staining in SV 5.5
- c) Cap pale yellow, up to 10cm diameter, epicutis with frequent pileocystidia staining grey in SV and taste sometimes slightly peppery and/or bitter
 *Russula flaviceps* Peck
- 5.5 a) Spore print dark yellow, Romagnesi IVe, epicutis with incrustated primordial hyphae, pileocystidia none or doubtful, odour of apricot, with oaks
 *Russula lutea* (Huds.: Fr.) Gray
- b) Cap as previous or more buff coloured, no special odour, spores paler, Romagnesi IVa, epicutis as previous, with hardwoods *Russula gilva* Zvara

- c) As above but with conifers, spores Romagnesi IVd *R. chamaeleontina* Fries

Cap white, taste acrid, spores white

- 5.6 a) Cutis up to 1mm thick, rubbery and easy to peel almost completely, taste acrid, stipe grey-green in FeSO₄ *Russula crassotunicata* Singer
- b) Cutis thinner, less than 500µm thick even in the cap centre, peeling no more than 2/3 the radius, stipe pinkish in FeSO₄..... 5.7
- 5.7 a) Cap cream with pale yellow centre, fragile, developing slightly greyish yellow tinges as the flesh beneath the cutis turns dingy with a waterlogged appearance, fragile, spores strongly reticulate, pileocystidia clavate with 0-1-septa, habitat with conifers on or near rotten wood.....*Russula raoultii* Quel.
- b) Cap pale cream with dull yellow centre, firm, pileocystidia cylindrical to clavate with up to 4 septa, spores finely reticulate, in oak-Douglas fir forest.....
..... *Russula crenulata* Burl.
- c) Deep cream, sometimes as dark as yellow-brown on the disc, spores not reticulate, with conifers in the Pacific Northwest (Arora 1986)
..... *Russula cremoricolor* Earle
- 5.8 a) Flesh of stipe blue-green with FeSO₄, flesh bruising yellow then brown, odour often of shellfish, taste mild when mature 5.9
- b) Flesh of stipe brownish with FeSO₄, (possibly green) and bright blackcurrant-juice purple with 2% phenol, flesh not bruising as above but stipe may bruise brown without a yellow phase, taste mild, hard-fleshed, cap surface dry, like kid leather, epicutis lacking pileocystidia and incrustated hyphae 5.12
- c) Flesh of stipe not blue-green with FeSO₄, but may be salmon pink, pinkish grey brownish or greyish, odour and taste variable..... 5.13

Cap various colours, flesh blue-green with FeSO₄

- 5.9 a) Cap primary red to deep purple, lacking greenish or grey hues..... 5.10
- b) Cap brown to dark brown with olive, greyish or ochraceous tints 5.11

- c) Cap paler, light tones of olive to brownish pink or brown, with a brownish bloom, spores Romagnesi IIc-d or IIIc, 8.2-12µm x 7-10µm, epicutis with numerous long, free, hair-like hyphal ends, habitat western hemlock-Sitka spruce stands
 ***Russula isabelliniceps* Grund**
- 5.10 a) Cap deep purple sometimes with ochraceous patches, spores Romagnesi IIIb-c, 6.2-10 x 5-8µm, mostly in Douglas fir forest. ***Russula xerampelina* (Schaeff.) Fries**
 b) Cap primary red to bright magenta on the margins, almost black or brownish centrally, paler in age, spores Romagnesi IIIa, 8-12µm x 6.5-9µm
 ***Russula semirubra* Singer**
- 5.11 a) Olive, brown and purple with a dense pruina in lighter and greyer hues than the base colours, as if the cap were mouldy, epicutis with numerous erect hair-like hyphae around 2µm wide and up to 120µm long ***Russula cf. pruinosa* Vel.**
 b) Cap very dark brown centrally, finely velvety, olive towards the margins, which may also have a subtle vinaceous tint, margins smooth
 ***Russula elaeodes* (Bres.:Romagn.) Bon**
 c) Cap as b) but bald and margins striate-tuberculate *Russula viridofusca* Grund (see notes under *R. elaeodes*.)
- 5.12 a) Cap a mixture of olive green and purple, becoming dull brown tinted in patches with these colours, no shellfish odour, spore print deep yellow, Romagnesi IVc, spores with mostly isolated warts up to 2µm high ***Russula olivacea* (Schaeff.) Fries**
 b) Cap with more red to purple than above, otherwise similar, spores with warts generally under 0.5µm high, connected with a partial to complete reticulum
 ***Russula alutacea* Fries**
- 5.13 a) Cap bright red to blood red, sometimes fading, in some cases with orange, yellow or cream areas, lacking purple, violet, grey or green 5.14
 b) Cap lacking bright to blood red 5.19

Flesh not blue-green in FeSO₄:

Cap red, with or without orange and yellow

- 5.14 a) Taste mild or slightly bitter, spores white to pale cream Romagnesi Ia-IIa..... 5.15
 b) Taste mild or slightly bitter, spores yellow to deep yellow, Romagnesi IIIb-IVd
 5.16
 c) Taste distinctly peppery to acrid, spores white, Romagnesi Ia-Ib, stipe white . 5.17
 d) Taste distinctly peppery to acrid, spores yellow, Romagnesi IIa or darker, stipe
 pink..... 5.18
- 5.15 a) Cap deep velvety red, (but may be pink with yellow margin, Kibby and Fatto
 1990) not or barely viscid when wet, cutis not peelable, spores pale cream,
 Romagnesi Ib-IIa, epicutis with incrustated pileocystidia
 ***Russula lepidiformis* Murrill**
 b) Cap pink to deep red to brownish red, spores pure white, Romagnesi Ia, cutis
 peeling 1.2 to completely, small species only 3cm diameter or less, incrustated
 primordial hyphae and inflated cells in epicutis, with oaks
Russula praetenuis Murrill
- 5.16 a) Buttons orange to red, more yellow when young and in age, flesh greying to
 blackening, spores light yellow, Romagnesi IIIb-c, epicutis with pileocystidia, with
 conifers ***Russula decolorans* Fries**
 b) Cap yellow mottled with orange and red, spores deep yellow, Romagnesi IVd,
 epicutis lacking pileocystidia but with incrustated primordial hyphae, in deciduous or
 coniferous forest ***Russula chamaeleontina* Fries**
- 5.17 a) Usually on decaying wood, stipe white, unchanging, cap red ± yellow patches,
 fading dramatically to almost white, spore ornamentation of warts 0.8-1.4µm high,
 reticulate, epicutis with abundant pileocystidia ***Russula silvicola* Shaffer**
 b) In soil or rotten wood, cap red mottled with yellow or yellow centrally with an
 orange-pink to copper red margin, spores with mostly isolated warts under 1µm

high, pileocystidia infrequent, inconspicuous *Russula bicolor* Burl
 c) In sphagnum, cap red, occasionally with orange patches, spores reticulate, warts
 up to 1.7µm high, epicutis with frequent multiseptate pileocystidia.....
Russula emetica Fr. ex S.F. Gray

- 5.18 a) Under pines, cap red ± cream areas near the margin, barely viscid, drying matte,
 margin smooth, stipe bruising yellow, flesh firm, spores 6.6-8.9 x 5.2-7.5µm
 ***Russula sanguinea* (Bull.) Fries**
 (=*R.* *rosacea* (Pers.ex Secr.) S.F.Gray)
 b) Similar to a) but under *Abies* and *Tsuga*, more fragile and spores larger, 8.5-11.5
 x 7-10.8µm *Russula americana* Singer
 c) Similar to b) but with viscid cap drying glossy, striate margin, stipe not bruising
 yellow, habitat in wet seeps under *Tsuga* and spores 7-9.5 x 6-7.5µm.....
 ***Russula americana* var. *modicasporea* nom. prov.**

- 5.19 a) Cap pale pink, purplish pink or light terracotta with a cream to yellow centre, or
 mottled with these colours, taste peppery to acrid 5.20
 b) As for a) but taste mild..... 5.22
 c) Cap predominantly of various green, olive, grey, yellow-brown, grey- brown or
 green-brown hues, mostly lacking pink, red or purple, reaction with FeSO₄ often
 weak or greyish 5.23
 d) Cap predominantly of vinaceous, red-brown, purple, violet or purple-brown hues,
 sometimes with green, black or yellow-brown areas, usually in the centre, in some
 cases fading dramatically to pale, dingy versions of these colours..... 5.32

Cap pinkish with cream to yellow centre

- 5.20 a) Spores white, stipe white but bruising bright yellow ... ***Russula* cf. *luteotacta* Rea**
 b) Spores white, stipe white, not bruising 5.17
 c) Spores yellow 5.21

- 5.21 a) Stipe sometimes with a pink flush, bruising yellow-brown at the base, spores ochraceous yellow, Romagnesi IVb, Woo A2, or in local collections, B2-C2, mushroom with subtle odour of honey or gingerbread, in Douglas fir forest

***Russula veteriosa* Fries**

- b) Stipe white \pm yellow stains at the base, cap deep brownish pink on the margin with brown centre when young, fading to a pinkish margin with dull yellow centre, spores reticulate, estimated Romagnesi IIIc *Russula inconstans* Burl.

- 5.22 a) Small species mostly under 6cm cap diameter, spores deep yellow, Romagnesi IVd, epicutis lacking pileocystidia but with incrustated primordial hyphae

..... *Russula chamaeleontina* Fries

- b) Cap diameter up to 10cm, spores deep yellowish cream, Romagnesi IIIa, epicutis with incrustated pileocystidia ***Russula velenovskyi* Melzer & Zvára**

Cap brown, olive, green, yellow-brown or grey, lacking purple or bright colours

- 5.23 a) Taste mild 5.24

- b) Taste peppery to acrid 5.28

- 5.24 a) Flesh firm and robust, cap margin remaining smooth into late maturity 5.25

- b) Flesh softer and more fragile, cap margin becoming striate at maturity 5.27

- 5.25 a) Flesh where damaged turning reddish then grey to black, cap colours very variable, PDAB (paradimethylaminobenzaldehyde) - vivid magenta on stipe (Woo, 1989), epicutis lacking pileocystidia but with incrustated primordial hyphae

..... ***Russula occidentalis* Singer**

- b) Flesh not bruising as above 5.26

- 5.26 a) Cap not or barely viscid, breaking concentrically into small areoli especially near the margin, not peelable in mature basidiomata, flesh bright blackcurrent-juice purple in 2% phenol, epicutis lacking pileocystidia and incrustations, spore print deep yellow, Romagnesi IVc, spores with mostly isolated warts up to 2 μ m high

- *Russula olivacea* (Schaeff.) Fries
- b) Flesh reaction with 2% phenol normal, (brownish-purple), cap viscid when wet, peelable 1/2-2/3, spore print variable -Romagnesi IIIc-IVc, epicutis with pileocystidia that barely react with SV, and primordial hyphae with contents pink in acid fuchsin but incrustations sporadic *Russula integra* Fries
- 5.27 a) Cap bright golden brown, more red-brown centrally with an olivaceous margin, becoming a rich brownish-yellow, spores orange-yellow, Romagnesi IVd, up to 14 x 11.5µm with isolated warts up to 2.2µm high *Russula aureofulva* nom prov
- b) Cap light grass green, spores light orange-yellow, Romagnesi IIIc, up to 10 x 8.3µm with warts up to 2µm high..... *Russula aeruginoides* nom. prov.
- c) Small species under 3cm wide, cap colour variable but often brown centrally with a grey margin, spore print Crawshay E, sometimes listed as peppery, under birches, possibly synonymous with *R. versicolor* *Russula blackfordae* Peck
- 5.28 a) Cap dark gray brown or olive brown, flesh bruising reddish then greying, spores cream, Romagnesi IIa-c, subcutis cellular..... *Russula consobrina* Fries
- b) Spore print darker, flesh not bruising as above..... 5.29
- 5.29 a) Cap brown and yellow or olive-grey 5.30
- b) Cap a clearer, brighter green to olive-green..... 5.31
- 5.30 a) Cap dark brown with yellow margin, spores crawshay D-E, habitat deciduous woods-possibly Eastern N.A. only *Russula disparilis* Burl.
- b) Cap light to deep olive-grey, spores yellow ochre, Romagnesi IVd, spores with warts up to 0.4µm high, reticulate *Russula murina* Burl
- 5.31 a) Cap yellow-green, green or olive green, slight purple tints at the margin are possible but not recorded from North American material, stipe white, bruising pale yellow to yellow-brown, spores deep ochraceous yellow, about Romagnesi IVd, sometimes slightly paler, spore warts 0.7-1.5µm high, isolated

.....*Russula urens* Romell apud Schaeff.

- b) Cap as above but stipe with pink flush and staining bright yellow at the base
spores paler -light orange, Romagnesi IIIc, spore warts mostly under $0.7\mu\text{m}$, \pm
isolated*Russula queletii* cf. *var. flavovirens* (Bomm.-Rouss.)

Cap purple with or without other colours

- 5.32 a) Taste peppery to acrid, spores white, Romagnesi Ia-b..... 5.33
b) Taste peppery to acrid, spores cream to yellow, Romagnesi IIa-IVe 5.35
c) Taste mild, spores white, Romagnesi Ia-b 5.45
d) Taste mild, spores cream to yellow, Romagnesi IIa-IVe 5.46
- 5.33 a) Cap a more or less uniform pale pink-grey to pale purple-grey, margin smooth,
only slightly striate in age, spores white to pale buff, Romagnesi Ia-IIa, growing on
very decayed wood..... *Russula stuntzii* Grund
b) Cap with two or more colours..... 5.34
- 5.34 a) Cap purple to violet with a darker, black or greenish centre, buttons often green
only, fading in age to a pale purple at the margin and pale greyish to light brown
centrally, margin soon striate, soft fragile at maturity, odour of stewed apples or
coconut, usually on or near woody debris, with conifers, spores reticulate,
subglobose *Russula fragilis* (Pers. : Fr.) Fries
b) As a) but more robust, sometimes with more brown centrally or with dull yellow
patches, on ground in deciduous or coniferous forest, stipe browning strongly at
base, spores narrowly ellipsoidal.....*Russula krombholzii* Shaffer
(=R. atropurpurea (Krombh.)Britzelm.)
c) As for a) but a more intense deep purple, under willows, and spores smaller: 7.0 -
 8.5×5.2 - $6.5\mu\text{m}$ with warts under $0.8\mu\text{m}$ *Russula laccata* Huijsman

Cap purple and other colours, taste acrid, spores cream to yellow

- 5.35 a) Stipe inner flesh turning pink to red in NH_4OH or KOH (test fresh not dried
material)..... 5.36

- b) Stipe white, not reddening in alkaline solutions, often yellowing especially at the base 5.37
- c) Stipe not reddening in alkaline solutions, usually with a partial to complete pink, reddish, purple or violet flush, at least in some basidiomata of any collection, some species yellowing at the stipe base 5.41
- 5.36 a) Stipe pink to violet, gills yellow when young, firm, on sandy soil with pines, spores light yellow, Romagnesi IIIa, reticulate *Russula sardonias* Fries (= *R. drimeas* Cooke)
- b) Stipe white or with just a flush of pink, gills cream when young, spores pale cream, Romagnesi IIa or slightly paler, with Douglas fir and grand fir *Russula cavipes* Britzelmayr
- 5.37 a) Cap a more or less uniform pale greyish purple, spores white to pale buff, Romagnesi 1b-IIa but pinker, stipe not yellowing, on decayed wood that has cubical brown-rot *Russula stuntzii* Grund
- b) Purplish hues usually mixed with other colours and stipe at least yellowing in age or when damaged 5.38
- 5.38 a) Small fragile species, cap generally under 5cm diameter, aspect like *R. fragilis* (key entry 5.31b) habitat birch or other deciduous woods 5.39
- b) Medium to large species generally over 5cm up to 13cm cap diameter, habitat with Douglas fir 5.40
- 5.39 a) Under birch, slightly peppery to acrid, spores yellow, Romagnesi IIId-IIIf, stipe and flesh bruising yellow, spores up to 9µm long, partially reticulate, odour faintly fruity *Russula versicolor* Schaef.
- b) Cap violet with a green centre, stipe yellowing to browning, spore print cream, Romagnesi IIa-b, spores 9-11µm long, warts pointed, isolated, odour of pelargonium and menthol, in moist deciduous woods *Russula violacea* Quélet
- c) Cap, stipe and spore print as b) above, weakly yellowing to browning, spores up

to 8.5µm long, with complete reticulum, habitat moist coniferous or mixed woods ...
 *Russula olivaceoviolascens* Gillet

- 5.40 a) Cap vinaceous to violet, darker in the centre, up to 10.3cm diameter, margin striate-tuberculate spore print light yellow, Romagnesi IIIb approximately, spores up to 9µm long, ornamentation Woo C2 and E2, mostly with Douglas fir but occasionally with pine *Russula placita* Burl.
 b) Cap redder than above, vinaceous to light purple with a brown to yellowish centre, up to 13 cm diameter, margin pruinose when young, striate in age, stipe staining yellow at the base, spores very similar to above but slightly darker en mass -an estimated Romagnesi IIIc *Russula inconstans* Burl.
- 5.41 a) Habitat in Douglas fir-western hemlock forest 5.42
 b) Habitat with coastal Sitka spruce 5.44
 c) Habitat with pines on calcareous or basaltic soils, fleshy species similar to *R. queletii* (key entry 5.44a) but more robust with a relatively short pink to violet stipe, gills cream rather than yellow when young, odour of apples spores light yellow, Romagnesi IId-IIIa, and more reticulate, nodulose or diverticulate pileocystidia.....*Russula torulosa* Bres.
- 5.42 a) Cap a slightly brownish to greyish purple, stipe flushed pink, bruising yellow-brown at base, odour of geraniums or stewed fruit, spores cream, Romagnesi IIa or slightly lighter (but darker than 1b), Woo types C1-2 to D1-2, pileocystidia sometimes diverticulate *Russula pelargonica* Niole
 b) Odour not distinct, spores darker 5.43
- 5.43 a) Macroscopically like *R. fragilis* (key entry 5.31b), sometimes larger, but stipe white ± pink flush and spores light yellow, Romagnesi IIc-IIIa, ornamentation of isolated warts up to 1µm high with little or no reticulum, locally on ground under Douglas fir, but also with birch *Russula gracilis* Burl.

b) Cap larger, up to 13cm diameter, deep brownish red, pinkish brown, darker centrally, margin smooth, stipe flushed reddish near the base, spores deep yellow, Romagnesi IIId-IVa, spores up to 11µm long (Thiers 1997), warts isolated or joined in heavy ridges, partially reticulate *Russula mordax* Burl.

- 5.44 a) Cap 3-11 cm diameter, a mixture of green and purple to violet, sometimes fading to pale greyish pink, firm when young, soon becoming soft and fragile, stipe with a partial to complete pink to violet pruina and staining bright yellow at the base, roughly equal in length to cap diameter. Within the stipe cortex at the very base is a thin layer of bright yellow tissue (more distinct in young basidiomata). Odour of stewed apples, gills cream when young, spore print varies from cream to light yellow Romagnesi IIc-IIIc, spores with mostly isolated warts, pileocystidia occasionally diverticulate *Russula queletii* Fries
- b) As above but with more vinaceous and less green hues, stipe only partially coloured, sometimes white, the base yellow-brown rather than bright yellow, spores light cream, Romagnesi IIa-c, microscopic characters similar to those of *R. queletii*, habitat under Sitka spruce and western hemlock but within the rain forest rather than along the coastal fringe *Russula cf. fuscorubroides* Bon

Cap purple and other colours, taste mild, spores white

- 5.45 a) Like *R. fragilis* key entry 5.31b, in all macroscopic and microscopic characters but taste completely mild *Russula fragilis* var. *mitis* nom. prov.
- b) Cap pinkish to vinaceous, sometimes more blue-grey or yellow-green, pruinose, peeling 1/4, stipe with pink flush, habitat deciduous woods, mild or occasionally slightly peppery, epicutis lacking pileocystidia but with incrustated primordial hyphae *Russula lilacea* Quélet
- c) Cap brownish to greyish violet, centre darker, more brown or black, pruinose, peeling 3/4, (like *R. murrillii*, key entry 5.57a, but with white spores) epicutis lacking pileocystidia but with incrustated primordial hyphae, habitat conifers especially spruce *Russula azurea* Bresad.

- 5.46 a) Spores cream to light yellow, Romagnesi IIa-IIId 5.47
 b) Spores deep yellow IIIa and darker..... 5.52

Cap purple and other colours, taste mild, spores cream to light yellow

- 5.47 a) Robust species, cap colours mixed, dark to pale tones of green, purple and yellow-brown, flesh bruising grey to deep grey-brown to black usually with a reddish interphase ***Russula occidentalis* Singer**
 b) Not bruising as above but may bruise brown or yellow 5.48
- 5.48 a) Small to medium fragile species generally under 5cm (-6.5cm) across, with striate margins, pileocystidia usually 2-5 septate and constricted at the septa, SV+, sometimes weakly so, incrustations in epicutis none or rare 5.49
 b) Medium to large robust species generally over 5cm across, margins smooth.. 5.51
- 5.49 a) Pileocystidia septate, epicutal hyphae sometimes filled with a deep yellow material. Habitat under Sitka spruce, alder and birch. ***Russula puellaris* Fries**
 b) Whole mushroom not strongly yellowing, but may yellow at stipe base 5.50
- 5.50 a) Habitat in wet coastal Sitka spruce-western hemlock forest, not always in sphagnum moss, cap dark to light purple tinged with brown or olive, becoming much browner as the flesh beneath yellows in age, spores up to 10.2µm, partially reticulate, warts 0.5-1.1µm high..... ***Russula sphagnophila* Kauffman**
 b) Habitat with oaks and apparently in one case, western hemlock, cap purple to violet tinged with brown, brownish in the centre, spores under 9µm long, wart height and reticulation variable, subcutis or hypodermis sometimes with sphaerocytes amongst the interwoven hyphae . ***Russula brunneoviolacea* Crawshaw**
- 5.51 a) Cap large, up to 22cm diameter, dark purple, almost black on disc, stipe flushed with pink, spores partially reticulate, warts 0.5-1.5µm high, pileocystidia few.....
 ***Russula maxima* Burl.**
 b) Cap up to 12µm, brownish vinaceous, sometimes with yellow brown spots or

centre, stipe usually white, rarely with a touch of pink, sometimes peppery in the gills or when young, spores reticulate, warts under 0.5µm high, pileocystidia abundant, deeper ones with incrustations..... ***Russula viscida* Kudřna**

Cap purple and other colours, taste mild, spores deep yellow

5.52 a) Remarkably firm fleshed species, not yellowing nor browning much, cap margins smooth except in age 5.53

b) Flesh texture normal to fragile, stipe sometimes yellowing or browning at the base 5.56

5.53 a) Cap surface the texture of kid leather, not or barely viscid when wet, spores deep orange-yellow, Romagnesi IVb-d, flesh of stipe turning bright blackcurrent-juice purple in 2% phenol, epicutis lacking pileocystidia and incrustated hyphae..... 5.54

b) Flesh not brittle except in age, with smooth, viscid cap surface, cap brown with vinaceous or green areas, gills close and almost paper-thin, stipe white, not bruising but may brown slightly at the base, cutis peelable to at least 1/2 the cap radius, epicutis with pileocystidia and sparsely incrustated hyphae 5.55

5.54 a) Cap of drab olive, brown and/or purple, cutis not peelable when mature, breaking into small concentric areoli near the margin, stipe pink, spores with isolated warts 0.5-1.4µm high, DNA of ITS-F to ITS4-B is around 1141bp, (around 240-300bp longer than other Russulas) ***Russula olivacea* (Schaeff.) Fries**

b) Cap with vinaceous to purple, sometimes brownish, marbled with or olive or dull yellow or these colours in the centre, cutis peelable to at least 1/2 the radius, stipe white ± a pink flush, spores reticulate, warts 0.2-0.5 microns high..***Russula alutacea* Fries**

5.55 a) Cap purplish brown with deep green centre, stipe white, unchanging, spores deep orangish-cream, Romagnesi IIIc, quite densely warted, Woo types 3A-3B, habitat Sitka spruce, huckleberry and salal ***Russula cf. integra* Fries (1st variety)**

b) Cap some shade of brown marbled with vinaceous and olive areas, stipe weakly

browning at the base, spores deep orange-yellow, Romagnesi IVc, Woo types (A2) - B2-C2 (-E2), habitat Douglas fir-western hemlock forest
 ***Russula cf. integra* Fries (2nd variety)**

- 5.56 a) Cap generally a mixture of mid to light olive green and brownish-yellow, with pinkish purple towards the margins when mature, colours quite variable when very young, even within one collection, stipe not yellowing or browning at the base, spores deep warm cream to pale orange, Romagnesi IIIa-c, Woo types A2-3, B2-3, warts 0.6-1.2µm stipe unchanging to slightly greying ***Russula abietina* Peck**
 b) Cap predominantly purple to violet, brown, olive and green colours, when present, are only over the disc 5.57

- 5.57 a) Cap an opaque, chalky purple to violet, sometimes with black, brown or olive tints in the centre, often a darker zone around the disc which looks rather like a smear of charcoal, cap viscid, drying matte, stipe white, base sometimes browning or yellowing and with an iodoform odour, epicutis with abundant heavily incrustated primordial hyphae, pileocystidia absent to rare, subcutis cellular..... 5.58
 b) Cap of similar colours to above or a more reddish or brownish purple, but with a more translucent appearance, epicutis lacking incrustations but with frequent multiseptate pileocystidia greying in SV 5.59

- 5.58 a) Habitat with Douglas fir, stipe base occasionally spores orange-yellow, Romagnesi IVa-c, with a partial, broken reticulum, stipe base usually not yellowing but occasionally has an iodoform odour..... ***Russula murrillii* Burl.**
 b) As above but stipe more often yellowing at the base, spores with a complete reticulum and habitat with spruce and pine ***Russula turci* Bresad.**

- 5.59 a) Small species, cap 2- 5.4cm diameter, mid to deep violet with a black to deep green centre, fading to greyed versions of these colours, margin striate, stipe discolouring light yellow-brown where bruised, taste slightly peppery in gills, spores light dull orange to ochre, Romagnesi IIIb-c, with mostly isolated warts.

- Habitat Sitka spruce-western hemlock forest
***Russula nauseosa* (Pers.) Fries**
- b) Size ranging larger, stipe unchanging to slightly greying, cap colours a more
 reddish or brownish purple, spores darker 5.60
- 5.60 a) Cap up to 8.5cm diameter, reddish purple with a very dark centre which
 sometimes fades to yellow-brown, colours usually radially streaked, margin smooth
 until old, spores deep ochre yellow, Romagnesi IVd to IVe, reticulate, habitat with
 Douglas fir***Russula cessans* Pearson**
- b) Cap usually up to 9cm diameter, sometimes to 15cm, vinaceous to purple,
 usually with a brown centre, spores pale ochre, Crawshay D-F, habitat with Sitka
 spruce***Russula zelleri* Burl.**

Synoptic keys

Each number codes for the species or variant as listed below this key, in approximate clade order, numbers in bold type are described in the following pages. Species may appear in more than one character category when it is variable for that character, for example, *R. brevipes* (coded 8) may be mild or slightly peppery.

| Predominant cap colours | Taste peppery | Taste mild |
|---------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| White to cream to pale yellowish | 2, 6, 7, 8, 9, 10, 22 , 41, 42, 43 | 1, 3, 4, 5 , 6, 7, 8 , 31, 75 |
| Bright yellow | | 67, 68, 69, 87, 88 |
| Bright red, \pm orange, yellow or cream areas | 47 , 48, 49, 64 , 65, 66 | 76 , 79 |
| Pink to light terracotta with yellowish areas | 51, 52 , 80, 81 | 27, 69, 74, 82 , 86 , 96 |
| Deep red to vinaceous | 38, 39, 46, 53, 55 , 56, 57 , 58, 59, 62 , 63, 80, 108 | 24, 38, 76 , 77, 84, 94, 95, 103 , 104, 105 , 108 |
| Purple, violet, blue, \pm green, black or brown areas | 32 , 39, 40, 44 , 51, 53, 56 , 57, 58, 61, 62, 63 , 100, 106 , 107, 108 | 23, 24, 32 , 33, 35, 45 , 70, 71 , 72, 73, 78 , 85, 86, 90, 91, 92 , 94, 97, 103 , 104, 105, 106 , 108 |
| Green | 23, 25 , 26, 28, 36 , 37, 78 , 83, 86 , | 44, 54 , 61, 93 |
| Browns and greys | 2, 3 , 6, 11, 12, 13 , 14, 15 , 16, 17, 18, 19, 20, 21, 32 , 38, 40 , 60, 89, 108 | 1, 3, 4, 5 , 6, 12, 16, 25, 29, 30 , 32, 33, 34, 35 , 37, 38, 77, 78 , 83, 84, 90, 91, 92, 96, 97, 98 , 99, 102, 105 , 108 |

| | | |
|-------|--------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|
| Other | 34 – pale, tints of pink, green and grey 40 – pale purplish grey 89 - yellow margin, dark brown disc | 102 – golden brown and olive green 108 - grey with yellow margin |
|-------|--------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|

Taste sometimes also with bitter component:

3, 10, 15, 17, 18, 22, 31, 40, 64, 65, 66, 75, 76, 87, 103.

| Cap margins | |
|----------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Striate to tuberculate at or before early maturity | 67, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 68, 80, 82, 90, 99, 100, 105, 106, 107, 108 |
| Smooth when young, margin usually somewhat striate in maturity | 36, 37, 41, 42, 44, 45, 46, 47, 48, 49, 51, 52, 53, 54, 55, 56, 60, 61, 62, 63, 65, 66, 69, 70, 72, 74, 77, 81, 87, 88, 89, 91, 93, 96, 101, 102, 103, 104 |
| Smooth, not or barely becoming striate in age | 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 38, 39, 40, 43, 50, 57, 58, 59, 64, 71, 73, 75, 76, 78, 79, 83, 84, 85, 86, 92, 94, 95, 97, 98 |
| Cap peelable - proportion of radius | |
| 0 - 1/4 | 2, 3, 4, 5, 7, 8, 9, 10, 11, 14, 16, 18, 19, 20, 21, 25, 26, 31, 35, 38, 42, 49, 55, 57, 58, 64, 65, 76, 93 |
| >1/4 - 3/4 | 1, 6, 13, 15, 17, 22, 23, 24, 27, 28, 29, 30, 32, 33, 36, 37, 39, 41, 40, 43, 47, 48, 50, 53, 54, 56, 59, 60, 61, 62, 63, 66, 69, 70, 71, 72, 75, 77, 78, 79, 80, 81, 82, 83, 84, 86, 88, 89, 90, 91, 92, 94, 96, 97, 98, 100, 101, 102, 104, 105, 106, 108 |
| 3/4- | 22, 36, 47, 67, 68, 73, 74, 107, 108 |

| | |
|------------|--|
| completely | |
|------------|--|

| Pattern type of chromatograph of extracted pigments | |
|-----------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Pattern 1 | 40, 44, 45, 46, 47, 53, 55, 56, 64, 66, 67, 76, 78, 81, 82, 83, 84, 93, 102, 103 *24, 39, 48, 49, 51, 57, 58, 63 , 65, 68, 69, 77, 79, 101 |
| Pattern 1 - <i>Xerampelinae</i> type with magenta bands not fluorescing in blue LED light. | 38, 71, 91, 94, 95, 96, 97, 98, 99, 106 *70, 72, 73 |
| Pattern 1, other variations | 36 -very little magenta, not fluorescing in LED 41 -very little magenta or yellow 92 -the upper magenta band not fluorescing in LED or UV *50 -reduced magenta and blue *88 -no magenta bands |
| Pattern 2 | 86 |
| Pattern 3 | 29, 30, 32, 34, 35 *23, 26, 27, 28, 31, 33, 37 |
| Pattern 4 | 22, 43, *42 |
| Pattern 5 | 1, 3, 4, 5, 11, 12, 13, 15, 18, 20, 21 *2, 6, 14, 16, 17, 19 |

* These sets of species have not been tested here but are assumed to have their particular pattern because of their clade position and, in some cases, they have been assessed by Gluchoff (1969, 1975)

| Gills and subgills | |
|-------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|
| Gills with frequent, more or less regularly distributed subgills sometimes forming 2-3 tiers (cap margin also inrolled) | 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 |
| Gills all the same length or with few, irregularly distributed subgills and/or forked gills | 11-108 inclusive |

| Stipe surface colour | |
|-----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Stipe white to cream | 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 26, 27, 28, 29, 31, 32, 34, 37, 36, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 60, 61, 62, 67, 68, 69, 70, 71, 73, 75, 76, 79, 80, 83, 84, 86, 87, 88, 89, 91, 92, 93, 98, 99, 100, 101, 103, 104, 105, 106, 107, 108 |
| Stipe usually or occasionally flushed with pink to violet | 24, 25, 30, 33, 35, 37, 51, 52, 53, 54, 55, 56, 57, 58, 59, 63, 64, 65, 66, 72, 74, 77, 78, 81, 82, 85, 90, 94, 95, 96, 97, 102, (23, 27, 39, 44, 45 , 69, 70, 84) |
| Stipe usually or occasionally flushed with grey-green | 30, 32, 35, 36 |

Species in parenthesis normally have a white stipe but coloured flushes have occasionally been reported.

| Bruising reactions of the flesh | |
|--------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Trama bruising pink or red, then grey to black | 2, 3, 5, 6, 86 (50 -red to grey, not blackening) |
| Trama bruising grey to black - no distinct reddish phase | 1, 4, 79, 88 (87 -slight or inconsistent reaction) |
| Trama bruising ochre yellow, \pm browning later | 10, 20, 21, 22, 35, 57, 61, 62, 64, 81, 90, 94, 95, 96, 97, 98, 99, 105, 107, 108 (24, 25 , 28, 29, 30 , 69, 91, 106 , -slightly yellow-brown only) |
| Trama bruising grey-brown to red-brown | 11, 12, 13, 14, 15, 16, 17, 18, 19, 26, 27 |
| Stipe base bruising bright yellow, (may turn brownish later) | 52, 53, 54, 57, 64 (55, 56, 58 , 60, 62, 63 , 65, 66 , 70, 80, 90, 91, 105, 106 , 107 -dull yellow only) |


| | |
|-------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Stipe base bruising brown | 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 42, 43, 55, 56, 58, 60, 75, 76, 77, 78, 86, 93, 94, 95, 96, 97, 98, 99, 101, 108 (67, 71, 81, 84 -browning only slightly) |
| Aging a buff-grey or yellowish grey as if waterlogged | 39, 40, 41, 44, 45, 46, 47, 48, 51, 52, 53, 54, 55, 56, 58, 59, 60, 62, 63, 65, 66, 102, 103, 104, 105, 106, 108 |

| Reactions to chemicals: | | |
|------------------------------------|-----------------------------------------------------------------------|-----------------------------------------------------|
| FeSO ₄ on stipe cortex: | Blue-green | 94, 95, 96, 97, 98, 99 |
| | Grey-green or grey | 1, 2, 3, 4, 5, 6, 12, 15, 22, 23, 37, 86, 90 |
| | Reaction none or very weak | 52, 63, 71, 84, 102 |
| | Salmon pink to brownish pink (normal) | All remaining species |
| NH ₄ OH and KOH | Red on stipe cortex and gills | 56, 57 |
| | No reaction or accelerating normal bruising reactions on stipe cortex | All remaining species |
| 2% phenol on stipe surface | Blackcurrent purple | 77, 78 |
| | Weak to pinkish | 5 |
| | Brownish purple (normal) | All remaining species |

| | | |
|----------------|-------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Sulphovanillin | Cutis staining bright pink to red (this reaction is not often recorded for species not described in this thesis) | 35, 75, 95 |
| | Gills staining as above | 24, 25, 30, 35, 36, 75, 92, 93, 95, 101 |
| | Other reactions | 36, 95 cap trama deep pink 52 red at stipe base 86 primordial hyphae pink 93 pileocystidia pink |
| | Pileocystidia not or barely staining, (or no pileocystidia) | 1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 13, 14, 15, 16, 19, 23, 24, 25, 26, 27, 28, 29, 30, 34, 35, 67, 68, 69, 70, 71, 72, 73, 74, 75, 77, 78, 82, 83, 84, 85, 86, 87, 88, 91, (92 see above), 93, 94, 95, 96, 97, 98, 101, 104 |
| | Normal reaction, vascular hyphae and cystidia stain grey, purple or black, cutis and gills stain purple, brown or grey: | 8, 9, 17, 18, 20, 21, 22, 30, 31, 32, 33, 36-66 inclusive, 76, 79, 81, 99, 100, 102, 103, 105, 106, 107, 108 |

| Spore colour – Romagnesi codes, figure ?? | |
|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| White Ia-Ib | 1, 2, 3, 4, 5, 6, 8, 9, 12, 13, 20, 21, 22, 23, 25, 26, 27, 28, 39, 42, 43, 46, 49, 52, 73, 74, 30, 41, 44, 45, 47, 48, 72, 76 |
| Cream IIa-IId | 7, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 24, 28, 29, 31, 32, 33, 34, 35, 36, 37, 38, 40, 50, 51, 53, 55, 56, 58, 61, 62, 63, 76, 79, 85, 86, 90, 91, 96, |

| | |
|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | 98, 99, 105 |
| Yellow IIIa-IIIc | 31, 34, 53, 54 , 57, 58, 59, 64 , 65, 66, 75 , 80, 82, 83 , 88, 79, 89, 90, 92 , 93, 94, 95, 96 , 100, 104, 106 , 107, 108 |
| Orange- yellow IVa-IVe | 59, 60, 67 , 68, 69, 70, 71 , 77, 78, 81, 84 , 87, 89, 97 , 101, 102, 103 , 104, 106 |

| Spore ornamentation using Woo's codes, (refer to fig. 23) | | | | | |
|-------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| 1 | 20, 21 , 23, 28, 30, 34, 35 , 42, 49 | 1, 2, 4 , 6, 11, 12, 16, 20, 21 , 27, 30, 31, 32 , 33, 34, 35, 36, 42 , 49, 60, 71, 82 , 89 | 1, 2, 3, 4, 5 , 6, 7, 11, 12 , 16, 29, 30 , 32, 33, 36 , 37, 38, 43 , 62, 63, 71 , 80, 82 | 1, 3, 4, 5 , 11, 38, 41 , 43, 46 , 58, 62, 63  | 7, 33, 36, 82 |
| 2 | 13, 14, 15 , 17, 20, 21, 22, 25 , 30, 34 , 49, 75 , 53, 54, 55 , 61, 67, 78, 84 , 99, 101, 92 , 104 | 8, 9, 11, 12 , 13, 14, 15, 17, 20, 21, 22, 25 , 26, 30, 34, 36 , 49, 53 , 54, 55 , 51, 52 , 58, 59, 64, 65, 66, 67 , 68, 69, 73, 71, 74, 75, 78, 81 , 82, 84 , 88, 89, 90, 91 , 96, 97 , 99, 92 , 104, 107, 108 | 5, 7, 8, 9, 10, 11 , 12, 13 , 28, 33, 36 , 37, 43, 44, 45, 47 , 56, 57 , 58, 59, 62, 63, 64 , 65, 67 , 68, 71, 74, 76, 77, 81 , 82, 84 , 87, 88, 79, 90, 91, 94, 96 , 97, 100, 103 , 107 | 5, 8, 9 , 24, 28, 36, 39 , 41, 43, 44 , 45, 46, 47 , 48, 50, 57, 62, 63 , 70, 77, 85, 103 | 7, 8, 9, 18, 24 , 36, 41 , 70, 84 , 100, 105 |
| 3 | 25, 55 , 61, 72, 78, 83, 86 , 79, 89, 93, 95, 96 , 98, 99 , 101, 102, 92, 105 | 8, 9, 25, 40, 52, 55 , 66, 69, 78, 83, 86 , , 90, 93, 94, 95, 96, 98 , 99, 92, 105, 106 | 7, 8, 9, 40, 44, 45 , 47, 52, 56, 79, 90 , 94, 98, 105 | 8, 9 , 24, 44, 45, 47 , 48 | 7, 18, 19, 56 |
| | A | B | C | D | E |

| Spores: suprahilar patch | |
|-------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Most spores with an inamyloid to weakly amyloid area or a poorly defined area | 1, 2, 3, 4, 5, 6, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37 |
| Most spores with a well defined, distinctly amyloid area | 7, 38, 39, 40, 41, 42, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108 |
| Spores variable or difficult to assign to one of the above two categories | 7, 8, 9, 10, 24, 25 |

| Spore length to width ratio -(shape) | |
|---------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| Subglobose, 1.10-1.19 | 5, 8, 9, 16, 18, 36, 40, 44, 45, 52, 66, 67, 78, 81, 82, 83, 93, 103, 105 |
| Broadly ellipsoidal, 1.20- 1.29 | 1, 12, 15, 20, 21, 22, 25, 29, 30, 32, 35, 38, 41, 43, 46, 47, 53, 54, 55, 56, 63, 64, 71, 75, 76, 84, 90, 91, 94, 95, 96, 97, 98, 102, 92, 106 |
| Ellipsoidal, 1.30-1.39 | 3, 4, 10, 11, 13, 14, 34, 86 |

| Cutis, characters other than the normal ixotrichodermis | |
|----------------------------------------------------------------|-------------------------------------------------------------------------------|
| Epicutal hyphae with incrustations: | 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 79, 82, 83, 84, 85, 86, 87, 88 |
| With mere traces of incrustation: | 38, 47, 52, 92 |
| Not known if incrustations present: | 80 |
| Cutis predominantly of spherical and | 28 |

| | |
|---------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| inflated cells | |
| Epicutis with multiseptate hyphae looking like chains of short, sometimes inflated cells (excluding cystidia) | 11, 12, 13, 14, 15, 24, 25, 26, 29, 30, 31, 32, 33, 34, 35, 37, 78 22 also has thickened walls |
| Epicutis with (a few) thick walled long, tapered, hair cells | 26, 27 |
| Subcutis cellular | 70, 71 , 72, 74 91 ± cellular clusters in an otherwise interwoven subcutis |

| Pileocystidia types (types not mutually exclusive), (refer to fig. 24) | |
|-------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 -small, tapered | 11, 12, 13, 14, 15, 16, 22, 97 |
| 2 -long, cylindrical, tip strangulate-capitate, usually 0-2 septate | 1, 2, 3, 7, 17, 18, 19, 20, 21, 22, 23, 29, 30, 31, 32, 33, 34, 35, 36, 38, 39, 40, 41, 42, 43, 44, 45, 48, 49, 52, 53, 54, 55, 56, 57, 58, 60, 62, 63, 64, 65, 66, 81, 94, 98, 102, 104 95, 96, 97 , 37 -few or rare, not consistently present |
| 3 -clavate, tip obtuse, 0-1 septate | 18, 19, 26, 27, 36, 41, 44, 46, 47, 61, 62, 63, 83, 105 |
| 4 -cylindro-clavate, tip obtuse, usually 0-2 septate, occasionally 3 | 6, 26, 27, 29, 30, 33, 34, 35, 37, 38, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50, 51, 52, 55, 58, 59, 60, 61, 62, 66, 79, 81, 82, 83, 84, 87, 89, 90, 91, 92, 93, 98, 99, 100, 101, 102, 104, 105, 106, 107, 108 95 -few to rare 85 -assumed present |
| 5 -long, cylindrical, tip obtuse, mostly >2 septate | 38, 47, 48, 50, 51, 52, 53, 54, 55, 59, 60, 61, 64, 65, 82, 84, 87, 92, 94, 102, 103, 105, 107, |

| | |
|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | 108 67 -poorly differentiated, uncertain |
| 6 -diverticulate, generally 0-3 septate | 2, 3, 46, 55, 56, 58, 63, 64, 65, 66, 101, 103 |
| 7 incrustated pileocystidia | 76, 82 75 -pileocystidia poorly differentiated 83, 84 -weakly and variably incrustated |
| 8 incrustated primordial hyphae | 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 86, 88, 106 83, 84, 92 -structures appearing like primordial hyphae but lacking obvious incrustating material |
| Pseudocystidia also present in epicutis | 17, 18, 19, 20, 21, 29, 31, 36, 37, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 69, 76, 89, 91, 92, 93, 98, 101, 103, 106 8, 9, 10, 11, 15, 12, 13, 14, 16, 67 -rare to occasional |
| Pileocystidia and pseudocystidia lacking or doubtful. | 78, 4, 5, 8, 9, 10, 24, 25, 28, 68, 69, 70, 71, 72, 73, 74, 77, 86, 88 |
| No data available for these characters | 80 |

Habitat and tree associations. Most species are found in habitats with a mixture of trees, so the host tree may be any or all of those in the habitat, therefore these habitat categories are not mutually exclusive.

| | |
|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| Under Douglas firs | 1, 3, 4, 8, 9, 10, 11, 12, 15, 24, 29, 31, 32, 35, 36, 38, 41, 44, 51, 56, 59, 60, 63, 71, 75, 78, 80, 81, 82, 84, 91, 92, 94, 95, 97, 100, 103 |
|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|

| | |
|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| Under western hemlocks | 41, 44, 45, 47, 65, 66, 71, 75, 78, 86, 91, 92, 93, 94, 95, 99, 102, 13, 18, 52, 55, 96, 98, 106 |
| Under Sitka spruce | 18, 22, 30, 47, 53, 54, 70, 83, 90, 96, 98, 101, 104, 105, 106, 13, 55, 8, 9, 1 50 -unspecified spruce species |
| Under alders | 1, 10, 52, 84 |
| Under oaks | 7, 16, 24, 28, 50, 74, 87, 76, 43, 67 |
| Under true firs (Abies) | 41, 55, 56, 65 |
| Under pines | 13, 34, 48, 57, 58, 60, 64, 38, 82, 10, 14, 70, 87, 100, |
| Under birches | 28, 49, 88, 107, 108 |
| Under madrone | 38, 82 |
| Under willows | 46 |
| In boggy places or wet seeps ± sphagnum | 48, 62, 66, 88, 90 |
| Usually on rotten wood | 40, 41, 44, 45, 47, 93 |
| Coniferous forest* | 3, 4, 6, 17, 21, 32, 42, 62, 69, 73, 79, 95 |
| Deciduous forest* | 6, 14, 16, 17, 20, 24, 26, 27, 28, 32, 61, 68, 72, 74, 89 |
| Mixed forest* | 2, 19, 23, 33, 37, 39, 49, 77, 85 |

* These categories include species for which the available data is non-specific and species with a wide range of host or habitat. The species listed here are in addition to those given in more specific habitats above.

Table 1 Species code numbers used in the synoptic key

| | | | |
|------------|---------|-------|----------------------------|
| Key number | species | Clade | Polychotomous key entry |
|------------|---------|-------|----------------------------|

| | | | |
|-----------|--------------------------------------------------|----|----------|
| 1 | <i>R. adusta</i> | 1b | 1.6 |
| 2 | <i>R. densifolia</i> | 1b | 1.4 |
| 3 | <i>R. anthracina</i> var. <i>insipida</i> | 1b | 1.6 |
| 4 | <i>R. albonigra</i> | 1b | 1.5 |
| 5 | <i>R. dissimulans</i> | 1b | 1.3 |
| 6 | <i>R. nigricans</i> | 1b | 1.3 |
| 7 | <i>R. delica</i> | 2b | 2.2 |
| 8 | <i>R. brevipes</i> | 2b | 2.2 |
| 9 | <i>R. brevipes</i> var. <i>acrior</i> | 2b | 2.3 |
| 10 | <i>R. cascadiensis</i> | 2b | 2.3 |
| 11 | <i>R. cerolens</i> | 3b | 3.10 |
| 12 | <i>R. pectinatoides</i> | 3b | 3.10 |
| 13 | <i>R. cf. pectinata</i> | 3b | 3.9 |
| 14 | <i>R. amoenolens</i> | 3b | 3.9 |
| 15 | <i>R. granulata</i> | 3b | 3.7 |
| 16 | <i>R. sororia</i> group | 3b | 3.10 |
| 17 | <i>R. foetens</i> | 3c | 3.3 |
| 18 | <i>R. fragrantissima</i> | 3c | 3.4 |
| 19 | <i>R. laurocerasi</i> | 3c | 3.4 |
| 20 | <i>R. farinipes</i> | 3b | 3.6 |
| 21 | <i>R. pallescens</i> | 3b | 3.6 |
| 22 | <i>R. crassotunicata</i>* | 3d | 3.1, 5.6 |
| 23 | <i>R. cyanoxantha</i> | 3a | 4.4 |
| 24 | <i>R. mariae</i> | 4a | 4.7 |
| 25 | <i>R. smithii</i> | 4a | 4.3 |
| 26 | <i>R. heterophylla</i> | 4c | 4.5 |
| 27 | <i>R. vesca</i> | 4c | 4.5 |

| | | | |
|-----------|------------------------------------------------|----|------------|
| 28 | <i>R. virescens</i> | 4b | 4.5, 4.8 |
| 29 | <i>R. mustelina</i> | 4b | 4.9 |
| 30 | <i>R. brunneola</i> | 4b | 4.3 |
| 31 | <i>R. basifurcata</i> | 4d | 4.9 |
| 32 | <i>R. parazurea</i> | 4d | 4.10 |
| 33 | <i>R. grisea</i> | 4d | 4.9 |
| 34 | <i>R. medullata</i> | 4d | 4.9 |
| 35 | <i>R. cf. subvelispora</i> | 4d | 4.10 |
| 36 | <i>R. aeruginea</i> | 4d | 4.8 |
| 37 | <i>R. modesta*</i> | 4d | 4.10 |
| 38 | <i>R. viscida</i> | 5a | 5.51 |
| 39 | <i>R. krombholzii</i> | 5a | 5.34 |
| 40 | <i>R. stuntzii</i> | 5a | 5.33, 5.37 |
| 41 | <i>R. raoultii</i> | 5b | 5.7 |
| 42 | <i>R. cremoricolor</i> | 5b | 5.7 |
| 43 | <i>R. crenulata</i> | 5b | 5.7 |
| 44 | <i>R. fragilis</i> | 5b | 5.34 |
| 45 | <i>R. fragilis var. mitis</i> | 5b | 5.45 |
| 46 | <i>R. laccata</i> | 5b | 5.34 |
| 47 | <i>R. silvicola</i> | 5b | 5.17 |
| 48 | <i>R. emetica</i> | 5b | 5.17 |
| 49 | <i>R. bicolor</i> | 5b | 5.17 |
| 50 | <i>R. consobrina</i> | 5c | 5.28 |
| 51 | <i>R. gracilis*</i> | 5d | 5.43 |
| 52 | <i>R. cf. luteotacta</i> | 5d | 5.20 |
| 53 | <i>R. queletii</i> | 5e | 5.44 |
| 54 | <i>R. queletii cf. var. flavovirens</i> | 5e | 5.31 |

| | | | |
|--------------|---------------------------------------------|----|------------------|
| 55 | <i>R. fuscorubroides</i> | 5e | 5.44 |
| 56 | <i>R. cavipes</i> | 5e | 5.36 |
| 57 | <i>R. sardonias</i> | 5e | 5.36 |
| 58 | <i>R. torulosa</i> | 5e | 5.41 |
| 59 | <i>R. mordax</i> * | 5e | 5.43 |
| 60 | <i>R. murina</i> * | 5e | 5.30 |
| 61 | <i>R. violacea</i> | 6 | 5.39 |
| 62 | <i>R. olivaceoviolascens</i> * | 6 | 5.39 |
| 63 | <i>R. pelargonia</i> | 6 | 5.42 |
| 64 | <i>R. sanguinea</i> | 6 | 5.18 |
| 65 | <i>R. americana</i> | 6 | 5.18 |
| 66 | <i>R. americana var modicasporea</i> | 6 | 5.18 |
| 67 | <i>R. lutea</i> | 7a | 5.5 |
| 68 | <i>R. gilva</i> | 7a | 5.5 |
| 69 | <i>R. chamaeleontina</i> | 7a | 5.5, 5.16, 5.22 |
| 70 | <i>R. turci</i> | 7a | 5.58 |
| 71 | <i>R. murrillii</i> | 7a | 5.58 |
| 72 | <i>R. lilacea</i> | 7b | 5.45 |
| 73 | <i>R. azurea</i> | 7b | 5.45 |
| 74 | <i>R. praetenuis</i> * | 7b | 5.15 |
| 75 | <i>R. albida</i> | 7b | 5.4 |
| 76 | <i>R. lepidiformis</i> | 7b | 5.15 |
| 77 | <i>R. alutacea</i> | 8a | 5.12 |
| 78 | <i>R. olivacea</i> | 8a | 5.12, 5.22, 5.54 |
| 80 79 | <i>R. decolorans</i> | 8b | 5.16 |
| 81 80 | <i>R. inconstans</i> * | 8c | 5.21, 5.40 |
| 82 81 | <i>R. veteriosa</i> | 8c | 5.21 |

| | | | |
|--------------|----------------------------------|------|------------|
| 83 82 | <i>R. velenovskyi</i> | 8d | 5.22 |
| 84 83 | <i>R. integra 1</i> | 8d | 5.26, 5.55 |
| 85 84 | <i>R. integra 2</i> | 8d | 5.26, 5.55 |
| 86 85 | <i>R. maxima*</i> | 8d | 4.7, 5.51 |
| 87 86 | <i>R. occidentalis</i> | 8d | 5.25, 5.47 |
| 88 87 | <i>R. flaviceps*</i> | 8d | 5.4 |
| 88 88 | <i>R. claroflava</i> | 8d | 5.3 |
| 89 | <i>R. disparilis*</i> | 9a | 5.30 |
| 90 | <i>R. sphagnophila</i> | 9a | 5.50 |
| 91 | <i>R. brunneoviolacea</i> | 9a | 5.50 |
| 92 | <i>R. abietina</i> | 9a | 5.56 |
| 93 | <i>R. aeruginoides</i> | 9a | 5.27 |
| 94 | <i>R. xerampelina</i> | 9b | 5.10 |
| 95 | <i>R. semirubra</i> | 9b | 5.10 |
| 96 | <i>R. isabelliniceps</i> | 9b | 5.9 |
| 97 | <i>R. cf. pruinosa</i> | 9b | 5.11 |
| 98 | <i>R. elaeodes</i> | 9b | 5.11 |
| 99 | <i>R. viridofusca</i> | 9b | 5.11 |
| 100 | <i>R. placita *</i> | 10a | 5.40 |
| 101 | <i>R. urens</i> | 10a | 5.31 |
| 102 | <i>R. aureofulva</i> | 10a | 5.27 |
| 103 | <i>R. cessans</i> | 10a | 5.60 |
| 104 | <i>R. zelleri*</i> | 10a? | 5.60 |
| 105 | <i>R. puellaris</i> | 10b | 5.49 |
| 106 | <i>R. nauseosa</i> | 10b | 5.59 |
| 107 | <i>R. versicolor</i> | 10b | 5.39 |
| 108 | <i>R. blackfordae</i> | 10b | 5.27 |

* Approximate clade position is a best estimate based on available descriptions, since herbarium or fresh specimens were not examined.

Other species clade positions that were not verified by DNA analyses in this thesis or in referenced literature are based on morphological similarities to species whose clade position has been verified.

Descriptions of Vancouver Island Russulas

Clade 1b

Subgenus *Compactae* (Fries) Bon

(Epicrisis: 349, 1838). Doc. Mycol. 65: 53, 1986

Section *Compactae* Fries

Epicrisis 1838: 349, 1838

(Equivalent to *Nigricantinae* in Romagnesi 1967)

Russula adusta Fries

Epicrisis Myc. 350. 1838

Description of Vancouver Island collections:

Cap 5.5-8.2cm diameter, larger ones, to around 10cm, were seen but not collected.

Convex when young but often also with a small central depression, becoming more or less plane or more often developing a broad, shallow central depression, the margins usually remaining somewhat downcurved and inrolled even in age, margins not striate, cutis peeling less than 1/4 in some to up to 1/3 of the radius. Colour a pale slightly greyish cream, developing dull yellow to yellowish brown to dark greyish brown streaks and mottles, the margin usually not discolouring as much. Centrally, the colour may be lighter or darker than the rest of the cap. Eventually the whole cutis becomes grey-brown, generally not blackening until in a state of decay. Surface viscid when wet, drying matte. Flesh white, firm, where cut changing to grey or greyish pink, slowly darkening to grey-brown and sometimes blackish, the reaction is slow compared to others in this subgenus.

Gills warm pale cream, bruising or aging pale dingy brown, sometimes with a pinkish-grey-brown phase, eventually nearly black, close, with more or less regular subgills

interspersed, no forking seen, arched, adnate to adnexed and sometimes ascending at the stipe, acute at the cap margin, about 1/3 to 1/2 the depth of the cap trama at half-radius.

Stipe 2.7-4.8cm x 1.8-2.3cm, (up to 4cm in larger basidiomata that were seen but not collected), about equal in length to that of the cap diameter, cylindrical to clavate, sometimes also broadening at the apex and base, white, pubescent near the apex, bruising slowly pinkish brown or directly brown to almost black. The stipe rind is around 3 mm thick and encloses a firm bread-textured solid trama that may be hollowed out by insect larvae in age, and which bruises like the cap trama, not much darker than the stipe cap cutis in dried specimens.

Texture firm, not particularly brittle at first but becoming so in age.

Taste mild, like bread, sometimes with a faint fleeting pepperiness in the gills of immature basidiomata.

Odour not distinctive, slightly of bread.

Spore colour white, Romagnesi Ia.

Spores 6.5-9.5 (-10) x 5-7.5µm, L:W 1.03 -1.56, mean 1.26 (n=30), globose, subglobose, broadly ellipsoidal to ellipsoidal. **Ornamentation** of blunt to pointed, often triangular warts 0.1-0.2µm high generally, but occasionally up to 0.4µm, rarely isolated, mostly connected by fine to heavy lines forming a broken to complete reticulum, **Woo types** C1-D1. **Suprahilar patch** inamyloid, a smooth elliptical area about 3µm long, sometimes with tiny warts and lines. **Hiliferous appendix** 1.2-1.9µm long, 1.2-1.8µm wide near the base. **Basidia** mostly 4-spored, some 2-spored, more rarely 1 and 3-spored, 30-52 x 8-10µm, clavate when immature, narrowly clavate to almost cylindrical but slightly bulbous in the upper 1/3 when mature. Sterigmata 5-7µm long, around 1.2µm wide near the base. **Pleurocystidia** frequent to abundant, 32-84 x 5-7.5µm, originating in the outer subhymenium, protruding hardly at all, at most to about 13µm, cylindrical to fusoid, sometimes irregularly constricted, tips rounded, acute, capitate, contents refractive, yellowish in KOH, grey to black in SV. **Cheilocystidia** similar to

pleurocystidia in shape but barely reacting with SV. Subhymenium 20-30µm thick, pseudoparenchymatous. **Gill trama** of sphaerocytes, vascular hyphae rare.

Cutis 90-280µm thick, quite elastic, in some sections appearing to have a lower pale layer but on microscopic examination this is actually an unblackened layer of the cap trama overlying the darkened trama. **Subcutis** interwoven, embedded in a weak gelatinous matrix that is inconspicuous in 5% KOH, of septate, branched hyphae 2.5-4µm wide, partially filled with an amorphous to slightly refractive yellow-brown pigment.

Epicutis not distinct from the subcutis, interwoven with erect free hyphal ends, 2-5µm wide but with frequent short inflated sections up to 10µm wide, and often with the terminal or subterminal cell inflated into an ampullate shape. Near the cap margin, some of the hyphal ends appear cystidioid in shape, and a few contain yellowish (in SV) refractive contents while others have amorphous, pale grey contents. Since the hyphal ends are also varied in form, some with a long tapering end cell, many others with a short, slightly inflated end cell, and some containing pigment, it is difficult to differentiate between cystidia and hyphal ends. In SV the light yellow-brown vacuolar pigment in the epicuticular hyphae darkens to a grey-brown. Pileocystidia rare, mainly at cap margin, 14-117 x 3-8µm cylindrical, mostly non-septate, capitate, occasionally with bi-lobed tips like a double capitum, with yellowish refractive contents not reacting in SV or with a few black granulations. **Hypodermis** of small slightly flattened sphaerocytes appearing greyish in KOH and water mounts.

Trama of discrete clusters of sphaerocytes bound by a hyphal mesh, often with brown pigment, and occasional vascular hyphae.

Chemical reactions: FeSO₄ - greenish-grey; KOH - no reaction on cap or stipe; NH₄OH - no reaction; Phenol - deep red-brown; SV - dark grey-brown on the gills, light pink-brown on the cuticle, hymenial cystidia grey to black, vascular hyphae and pileocystidia not or barely reacting.

Habitat and tree associations: On the forest floor in moist, deep duff under regeneration Douglas fir forest with western hemlock and red alder, with or without veteran trees or wild cherry, with undergrowth including sword fern, huckleberry and salal.

Collections: CR010902-02, along the High Ridge trail near an old growth Douglas fir and western red cedar amongst salal, Francis King Park N48.4837°, W123.4505°. CR010909-04, in a swale containing red alder, cherry and Douglas fir, by the trail to Kemp Lake N48.3784° W123.7904°.

Notes. The identification of these collections as *Russula adusta* rather than *R. densifolia* was made on the basis of a mild taste, the lack of a distinct red phase in the bruising reaction, which was at most a pinkish-brown, their similarities to a European collection of *R. adusta* and the difference between these collections and that of a *Russula densifolia* from Oregon. Although the spores are very close in size and description between the two species, the Vancouver Island collections had spores with a slightly lower ornamentation than that of the Oregon *R. densifolia*, in keeping with the observations of Shaffer (1962), Sarnari, (1998) and Romagnesi (1967). The spores however still have slightly coarser and higher ornamentation than in those authors' descriptions, and are more like the drawings and descriptions of spores of *R. adusta* by Thiers (1997) of California material. The European collection of *R. adusta* had a weak but definite odour of wine corks and a very slow bruising reaction, the flesh only becoming dingy grey a day after cutting. Pacific Northwest collections of *R. adusta* do not seem to have this wine cork odour, but they taste and sometimes smell a bit like bread, another fermentation product of yeast. There are some anomalies with the Vancouver Island collections - *R. adusta* should have a brownish pink reaction with FeSO₄ rather than the greenish grey that is typical for *R. densifolia* (*sensu* Shaffer 1962, but not Singer, 1957). Both Shaffer (1962) and Thiers (1997) comment on the occurrence of collections that appear to intergrade between *R. densifolia* and *R. adusta*, in taste, spores and bruising reactions, so the differentiation between these species can be difficult.

Unfortunately, even with fresh material no amplifiable rDNA could be extracted from these collections.

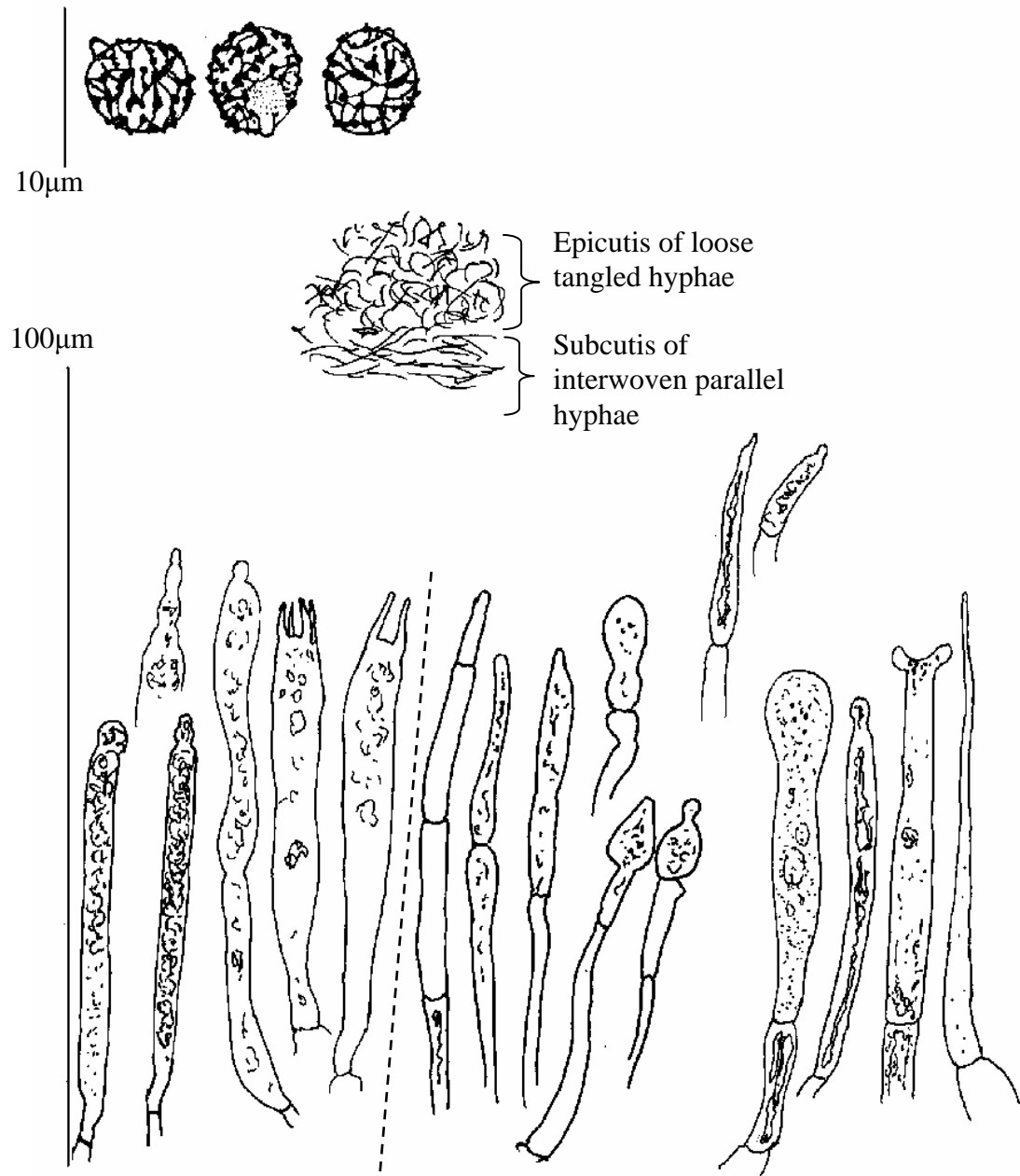


Figure 4 Microscopic characters of *Russula adusta*: Top, spores with 10 µm scale bar; middle, diagram of section through cutis; bottom left, hymenial cystidia and basidia; bottom right, hyphal ends and pileocystidia from the epicutis, the six drawings on the far right are from the cap margin; lower scale bar is 100 µm.

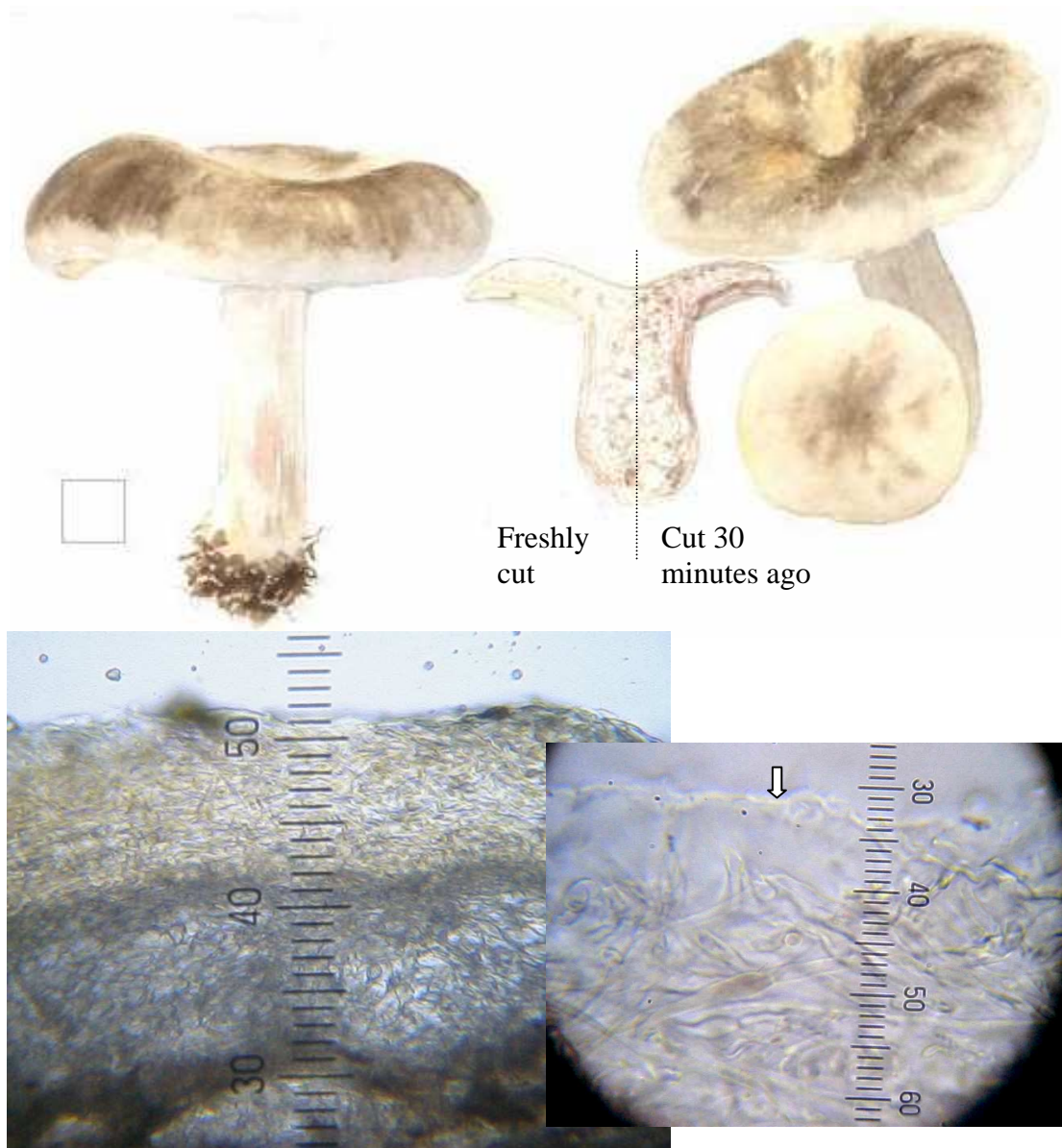


Figure 5 Macroscopic and cutis characters of *R. adusta*: Top, illustration showing profile and cap surface of young and mature basidiomata, and a longitudinal section showing the bruising reaction of the flesh when freshly cut (left side of section) and after 30 minutes (right side); the square is 1 cm² and shows spore colour. Below left, section through cap cutis showing the light yellow-brown pigment in the cuticular hyphae, the hypodermis is the grey layer between N40 and 42 on the scale, in which 10 divisions are 100 µm. Bottom right, section through the epicutis showing the viscid layer above the free hyphal ends (arrowed), 10 divisions on the scale are 25 µm.

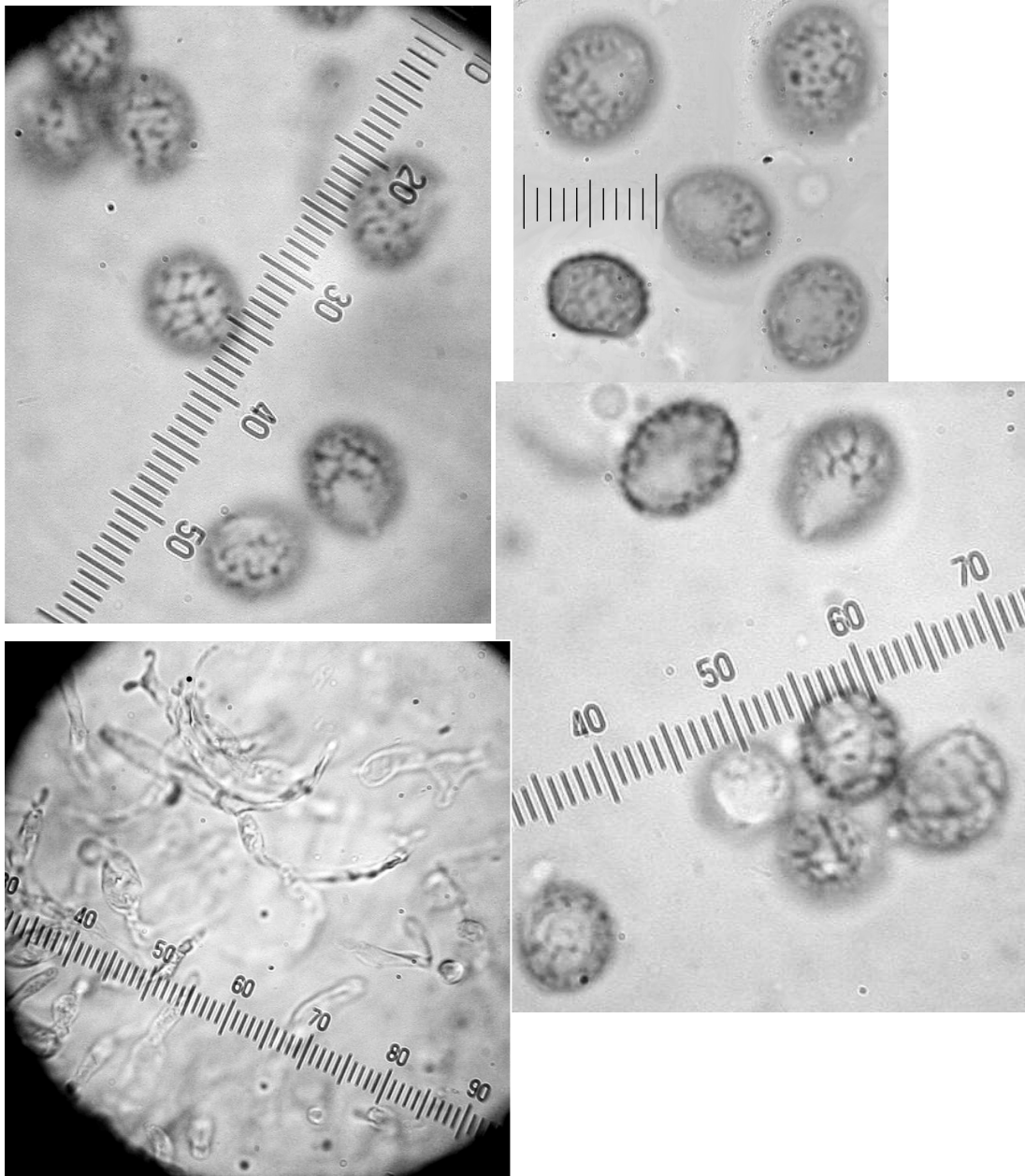


Figure 6 Spores and epicutis of *R. adusta*: Top left, spores from a Vancouver Island collection; top right, for comparison, spores from a Bulgarian collection of *R. adusta*; bottom right, spores from an Oregon collection of *R. densifolia*, scale is in 1 μ m divisions on the latter three photographs. Bottom left, surface view of the epicutis of the cap margin showing hyphal ends and pileocystidia of varying shapes, 10 scale divisions are 25 μ m.

***Russula anthracina* var. *insipida* Romagnesi**

Russula anthracina Romagn. (basionym) (nom. inval., art. 37.1 ICBN)

Bull. mens. Soc. linn. Lyon 31 (6): 173. 1962.

Description of Vancouver Island collections:

Cap 3.9-8.5cm diameter, plane with a central depression, becoming shallowly infundibuliform, dirty cream with dull brown to pinkish grey-brown mottling, becoming darker with handling and in age until dark grey to olive brown on the margin and almost black in the centre. General appearance almost identical to that of *Russula adusta* (see fig. ?? under that species description). Surface dry, somewhat felty to tangled-fibrillose especially over the disc, margins smooth, inrolled, cutis barely separable at the margin only, flesh creamy white, turning grey then black with very little to no reddish phase. In the dried basidiomata, the trama is black but the cutis on the cap and stipe are dark brown.

Gills pale cream with a slightly orange cast when seen edge-on, bruising and aging through grey to almost black, the white spores giving an ashy appearance. The gills are arched, 1/2 to 2/3 the depth of the cap trama at half radius, acute at the cap margin, only slightly decurrent, sometimes adnexed and ascending at the stipe, close to crowded, frequent lamellulae and some forking and anastomosing near the stipe in the immature basidioma, none in the older ones. Under a hand lens, the gill margins are minutely fringed due to protruding cheilocystidia.

Stipe 1.5-3.5 x 1.5-2.8cm, short and stubby, practically equal in both dimensions, length less than half the cap diameter, tapering slightly downwards. Surface white, minutely floccose, longitudinally rugulose, bruising grey-brown with the floccules darker, trama solid, becoming crumbly in age, cream at first, soon discolouring greyish and finally soot-black.

Texture hard but brittle.

Taste mild, in the older basidiomata slightly bitter.

Odour not distinctive.

Spore colour white, Romagnesi 1a.

Spores 7.6-9.6 x 5.8-7.5µm, L:W 1.17-1.45 with a mean of 1.31 (n-30), ellipsoidal to broadly ellipsoidal, some toward pyriform (the narrower end near the hiliiferous appendix) occasionally slightly allantoid. **Ornamentation** of low, small, rounded to pointed warts 0.1-0.2µm high, occasionally up to 0.4µm, often in rows partially around the spore, mostly connected by fine lines, rarely heavy lines, sometimes with small isolated warts especially near the suprahilar patch, otherwise forming an almost complete reticulum, **Woo types** C1-D1. **Suprahilar patch** an elliptical inamyloid and unornamented patch about 3µm long. **Hiliiferous appendix** 1.3-1.5µm long, 1.2-1.4µm wide at the base. **Basidia** 47-65 x 6.5-7 µm, most 4-spored but 2-spored ones frequent, narrowly clavate and almost cylindrical, the spent basidia filled with a brownish pigment. Sterigmata 4-8µm long and 1-1.3µm wide near the base. **Pleurocystidia** and cheilocystidia 48-120 x 6-10µm, rare broad ones to 13µm wide, with yellow-brown refractive contents, staining grey in SV but variably so, cheilocystidia barely reacting, some without refractive contents, originating at various levels within the subhymenium, protruding 10-40 µm. The basic shapes are more or less cylindrical to narrowly fusoid, often with constrictions, with diverse tips, many simply with a subacute to rounded end, others capitate or with a short to long appendage with a series of strangulations along their length. **Cheilocystidia** numerous. Subhymenium 25-35 µm, interwoven but with frequent short cells and so appearing intermediate between pseudoparenchymatous and interwoven. **Gill trama** of small irregular sphaerocytes and very occasional vascular hyphae.

Cutis 120-250µm thick, of two layers. **Subcutis** about 3/4 to 2/3 the total depth, of light brownish to hyaline, slightly gelatinized, more or less horizontal hyphae 1.5-4µm wide, a few of which have dark contents like the epicutal hyphae. **Epicutis** interwoven with few free hyphal ends, of more or less repent hyphae varying in width along their length

between about 2.5 and 7µm, with occasional segments down to 1µm and up to 10µm wide, containing large globules of amorphous dark brown pigment, sometimes this fills a hyphal cell completely, such that the epicutis resembles a tangle of transparent intestinal tracts. Some epicutal hyphae have colourless contents but are otherwise of similarly varying width. Hyphal ends undifferentiated to tapered in the centre of the cap, towards the margins a few hyphal ends may be inflated to short, broad clavate cells, around 10µm wide, few terminate in pileocystidia. Pileocystidia 53-145 x 5-10µm, uncommon, found mainly on the cap margin, more or less fusiform with a capitate tip or cylindrical with a lobed tip, contents yellowish and refractive, incompletely filling the cell, not reacting in SV or with a very few dark granules. **Hypodermis** of dark, somewhat flattened tramal sphaerocytes and interwoven tramal hyphae that are continuous with those of the subcutis.

Stipe cortex containing frequent vascular hyphae 7-11µm wide, some of which terminate at the surface in pseudocheilocystidia with obtuse to slightly capitate ends, not reacting with SV or at most a few dark granules. The minute floccules visible through a hand lens consist of tufts of tangled free hyphal ends most of which contain dark brown vacuolar pigment.

Trama of discrete clusters of sphaerocytes bound by a hyphal mesh, with occasional vascular hyphae up to 7.5µm wide and sometimes with an inflated terminus up to 10µm, not reacting with SV.

Chemical reactions: FeSO₄ - greyish; KOH and NH₄OH - accelerating the blackening on all tissues; phenol - dark purple-brown; SV - on gills a deep red-brown, on cap cutis and stipe cortex magenta then purple-brown, not reacting with the contents of pileocystidia or vascular hyphae, or at best a few small dark granulations, staining pleurocystidia greyish, but this is difficult to assess since the contents are often greyish to begin with.

Habitat and tree associations: Both collections were made in moist areas with deep duff and a mixture of conifers and deciduous trees. Its host trees are probably Douglas fir and/ western hemlock, but it may equally have alder and cottonwood as hosts.

Collections: CR001007-03 an immature specimen and so not included in the spore measurements above, from a moist low-lying area close to the Cowichan River, under western hemlock, Douglas fir and cottonwood, also with many big-leaf maples, N48.756267°, W123.8254°. CR021019-01 in a mixed age stand with old-growth trees, under western hemlock, Douglas fir and red alder, with big-leaf maples and western red cedars, Royal Roads University woodlands, N48.434833°, W123.478417°.

Notes: Romagnesi recognised *Russula anthracina* as differing from *Russula albonigra* (Krombh.) Fries in spore ornamentation, the darker vacuolar pigment, the taste and the presence of pileocystidia, and within this species three varieties were described. *Russula anthracina* as a species distinct from *R. albonigra* has been supported in subsequent texts such as Bon (1988, 2002) and Sarnari (1998). These collections were at first assumed to be *R. adusta* as they are similar macroscopically, but that species does not have the little floccules on the stipe, blackens less, is viscid, has a less fibrous-felty cap surface, lacks the distinctive dark brown globules in the epicutal hyphae and has more globose spores with stronger ornamentation. It also differed from the collection of *R. albonigra* below in the macroscopic appearance of the cutis, the pigment in the cuticular hyphae, the slower bruising reaction, the reaction of pleurocystidia with SV, the shape of the basidia and the flocculate stipe surface. *Russula dissimulans* or *Russula nigricans* have a much thinner cutis but a similar epicutis, but these species stain red before turning black, have more distant, thicker gills, and rounder, more strongly ornamented spores.

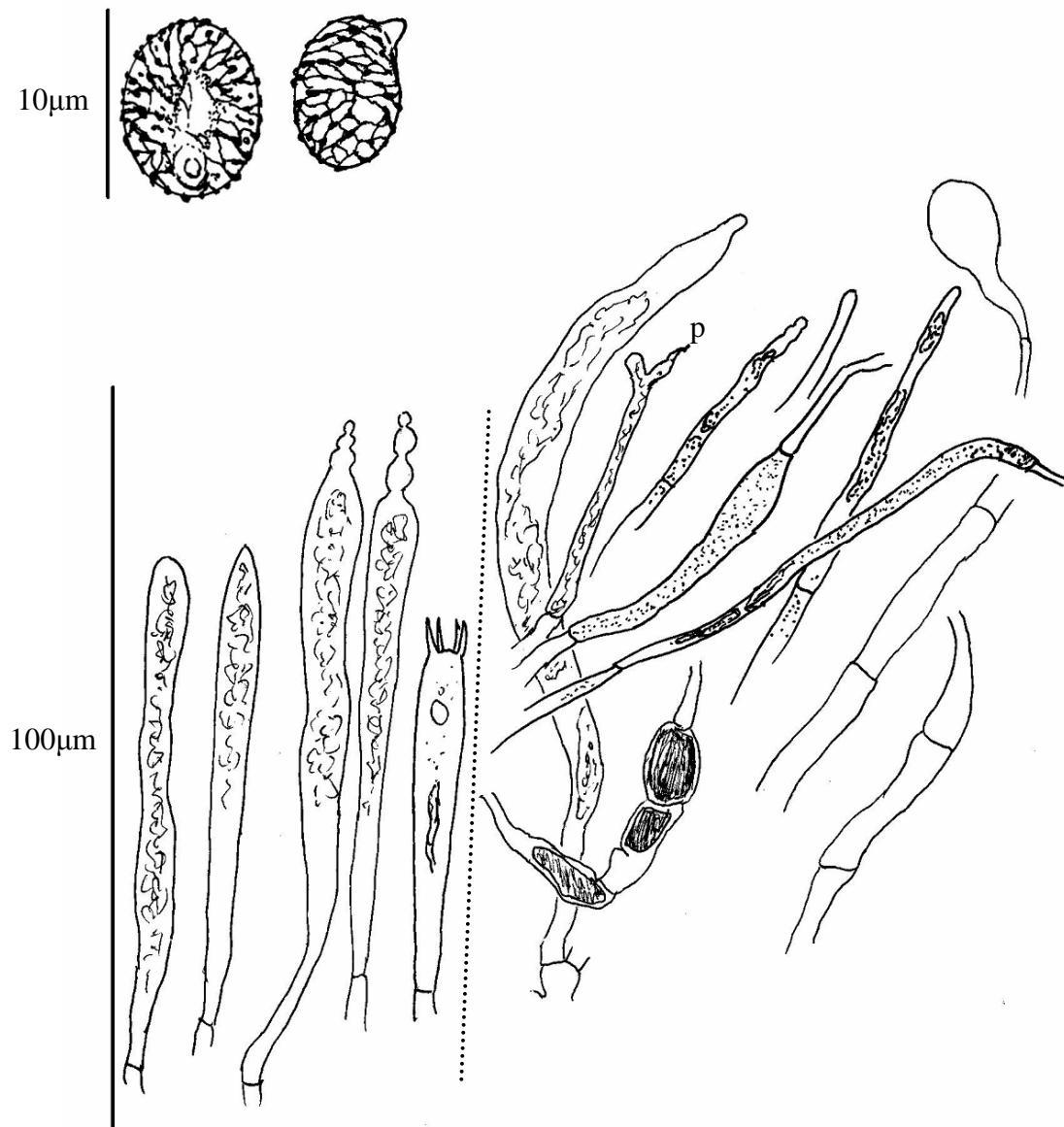


Figure 7 Microscopic characters of *Russula anthracina* var. *insipida*: Top. Spores with 10 µm scale bar; bottom left, hyphal cystidia and basidium; bottom right, hyphae and hyphal ends from the epicutis, the large capitate and small lobed pileocystidia are marked "p", note that some of the broader and ampullate shapes occur along the epicutal hyphae, rarely as the terminal cells. The lower scale bar is 100µm.

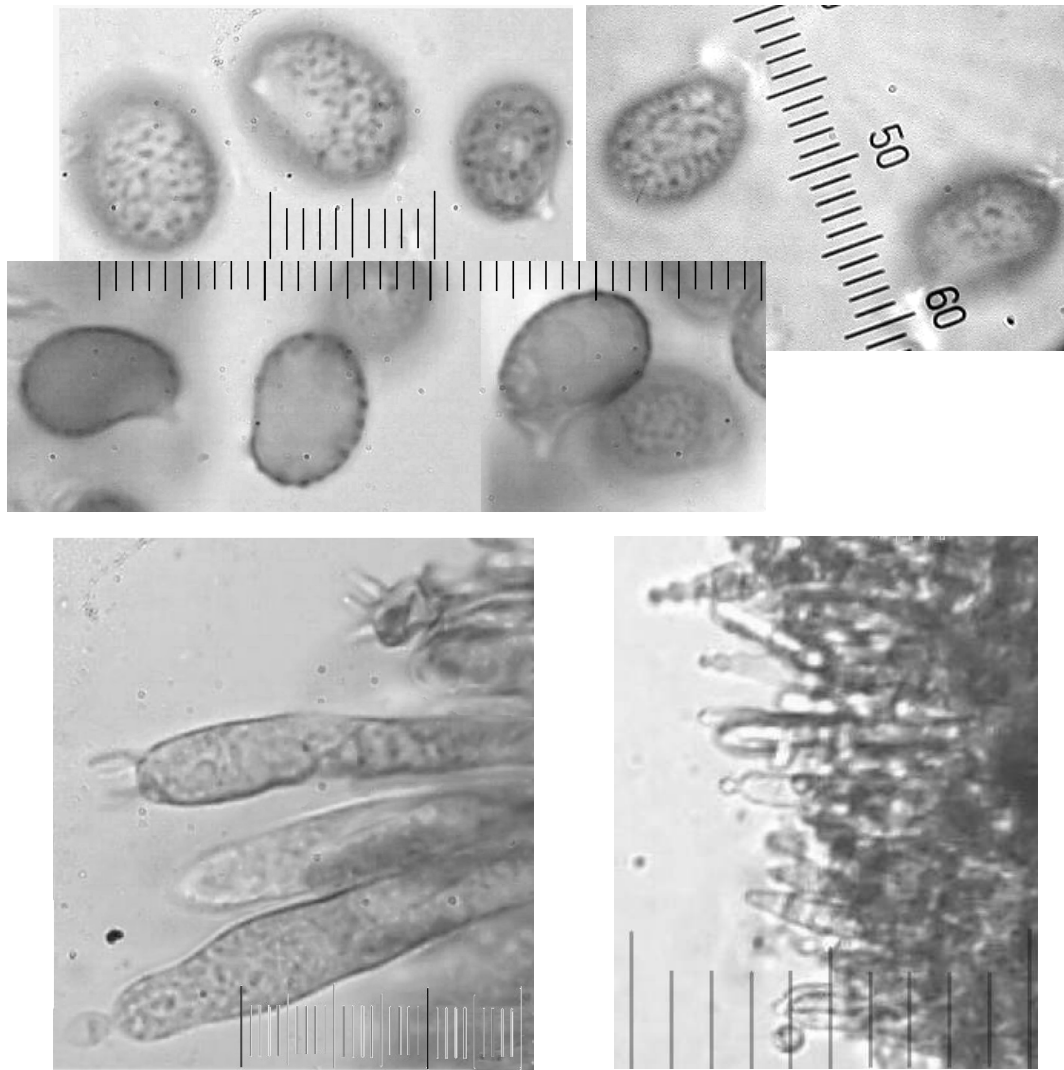


Figure 8 Characters of the hymenium of *R. anthracina* var. *insipida*: Top, spores showing the surface ornamentation and below, profiles showing the variation in shapes, the scales are all in 1 μ m divisions; bottom left, a spent basidium which shows an accumulation of brownish pigment inside, a maturing one, and two cystidia, the scale is in 1 μ m divisions; below right, versiform cheilocystidia on the gill edge, with a scale in 10 μ m divisions.

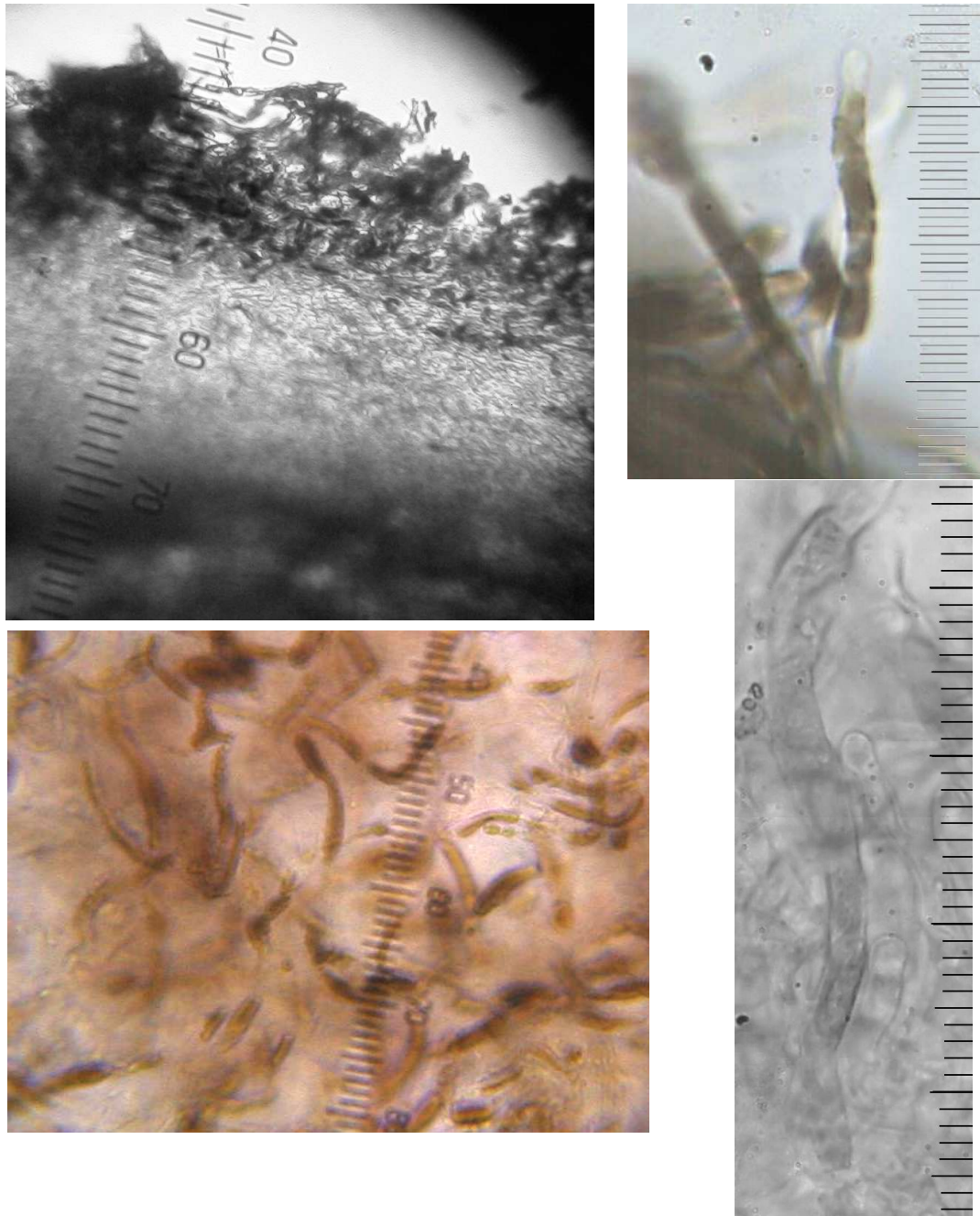


Figure 9 Cutis of *R. anthracina* var. *insipida*: Top left, section through the cutis showing the mostly hyaline subcutis and the epicutis of tangled hyphae containing dark pigment, 10 divisions on the scale are 100 μ m; below left surface view of epicutal hyphae showing discontinuous pigmented contents, 10 scale divisions are 25 μ m; top right, close up view of epicutal hyphal ends containing pigment globules, scale is in 1 μ m divisions; lower right, pileocystidia from near the cap margin, (tip unfortunately missing), scale is in 2.5 μ m divisions.

***Russula albonigra* (Kromb) Fries**

(*Agaricus alboniger* Krombholtz: Naturgetr. Abbild. Schwämme (Prague) 9: 27, 1845)

Mon. Hymen. Suec. 2: 324, 1863.

Description of Vancouver Island collections:

Cap 6.2cm diameter, shallowly infundibuliform in this early mature collection, margin smooth, inrolled, colour pure white, subglossy, moist to slightly viscid, not bruising as quickly as the underlying flesh and remaining white in places even when the trama beneath is quite black, but eventually becoming grey-brown and finally almost black. Cutis peeling 1/4 of the cap radius. Cap trama firm and white at first, becoming directly black where damaged within about one minute, in the dried collection under a 25x lens the flesh is seen to have black spots amid a dark brownish flesh.

Gills white, becoming grey-brown and finally blackening, close to crowded with frequent lamellulae, not in regular tiers, adnexed at stipe, at this stage not decurrent, subacute at cap margin, broadening only slightly towards the margin or at mid-radius, about 1/3 to half the trama depth approximately 2-3 mm at half-radius.

Stipe 5 x 2cm more less cylindrical or slightly clavate, surface white, trama solid, with one horizontal cavity starting to develop in this collection, bruising a little brownish then quickly black both on the cortex and the stipe trama.

Taste mild.

Odour not distinctive.

Spore colour slightly creamy white, Romagnesi Ib.

Spores 8.2-11 x 5.8-7.8µm, L:W1.27-1.64, mean 1.38 (n=30), narrowly to broadly ellipsoidal, ornamentation of small blunt to conical warts, 0.1-0.3µm high, isolated or connected by fine lines, forming a partial or sometimes almost complete reticulum, **Woo**

types B1, C1 or D1. Suprahilar patch a smooth inamyloid area. **Hiliferous appendix** relatively small, 1.2-1.4 x 1.1-1.2µm. **Basidia** 4-spored, 40-52 x 8-12µm, narrowly clavate or slightly bulbous in the upper 1/3, in general a little broader than in other species in the *Nigricantae*. Sterigmata 4-7µm long by 1.2-1.7µm wide near the base. **Pleurocystidia** frequent but sometimes hard to see, 45-100 x 5-11µm, originating in the subhymenium, many not protruding beyond the basidioles, others protrude 20–25µm more often towards the gill margin, cylindrical to slightly fusoid, tips obtuse, capitate, or with an appendix of a series of strangulations, contents refractive, light greyish in KOH, not reacting with SV, sometimes appearing partly empty. **Cheilocystidia** similar to pileocystidia except more of them protrude up to 25µm. Subhymenium 15-35µm, pseudoparenchymatous. **Gill trama** of sphaerocytes, vascular hyphae rare.

Cutis 50-160µm in the dried basidioma, up to 200µm at half-radius in fresh specimens, in some areas, mostly towards the margin, the cutis is thinner, not differentiated into distinct layers, of interwoven more or less parallel hyphae with a few free ends, 2-3µm wide, with occasional sections up to 15µm wide, containing discontinuous light brownish pigment. Towards the centre of the cap the cutis is in two layers; with a subcutis of parallel interwoven hyphae and frequent to occasional vascular hyphae 6-7µm wide with yellowish refractive contents not reacting in SV. **Epicutis** of mostly upright hyphae, the majority undifferentiated, and pileocystidia, in places with a thin layer of gluten visible on the upper layers. The subapical portions of many hyphae are narrow and helical, and hyphae at the surface frequently contain light to mid grey-brown globules of pigment. **Pileocystidia** that can be easily differentiated from the normal hyphal ends not seen, some of the hyphal ends terminate in ampullate or short-clavate cells that look similar to cystidia but the contents are rarely different from those of cuticular hyphae. Rarely a vascular hypha ascends through the cutis to terminate at the epicutis but does not form cystidioid shapes. **Hypodermis** compactly interwoven and including small flattened sphaerocytes, continuous with the tramal tissues below.

Trama of large clusters of sphaerocytes bound by a hyphal mesh. Some of the clusters are densely black, this appears to be in part due to hypha containing dark pigment, and in

part to an intercellular matrix of this dark pigment. Vascular hyphae with yellowish refractive contents rare.

Chemical reactions: FeSO₄ -greenish-grey; phenol -purple-brown; SV -when fresh no colour at all on cutis or gills, not reacting with any hyphal type nor changing the colour of the tissues on the dried tissue.

Habitat and tree associations: in old-growth coniferous forest with Douglas fir and western red cedar, probably also with western hemlock in the understory.

Collections: BK010904-01, from the Surveyers trail area, John Dean Park, Saanich Peninsula, approximately N48.613°, W123.445°.

RFLP:

| Collection | ITS1-F to ITS4-B | Hinf1 | Alu1 | Sau3A |
|-------------|------------------|-------|--------------|-------|
| BK010904-01 | 848 | 380 | unsuccessful | 632 |

Notes: Perhaps the most striking character of this species is the pure white cap in contrast to the rapid and dramatic blackening of the flesh, the two characters from which it takes its name. A similar species is *Russula atrata* Shaffer, which differs only in its thicker cutis, generally 200-450µm thick, with an interwoven subcutis and a trichodermis above. The Vancouver Island *R. albonigra* in fact has this type of cutis in the centre of the cap, and the thinner, simple cutis towards the margins. *Russula atrata* tends to be associated more with oaks and *R. albonigra* with conifers, although both may be found in mixed forest.

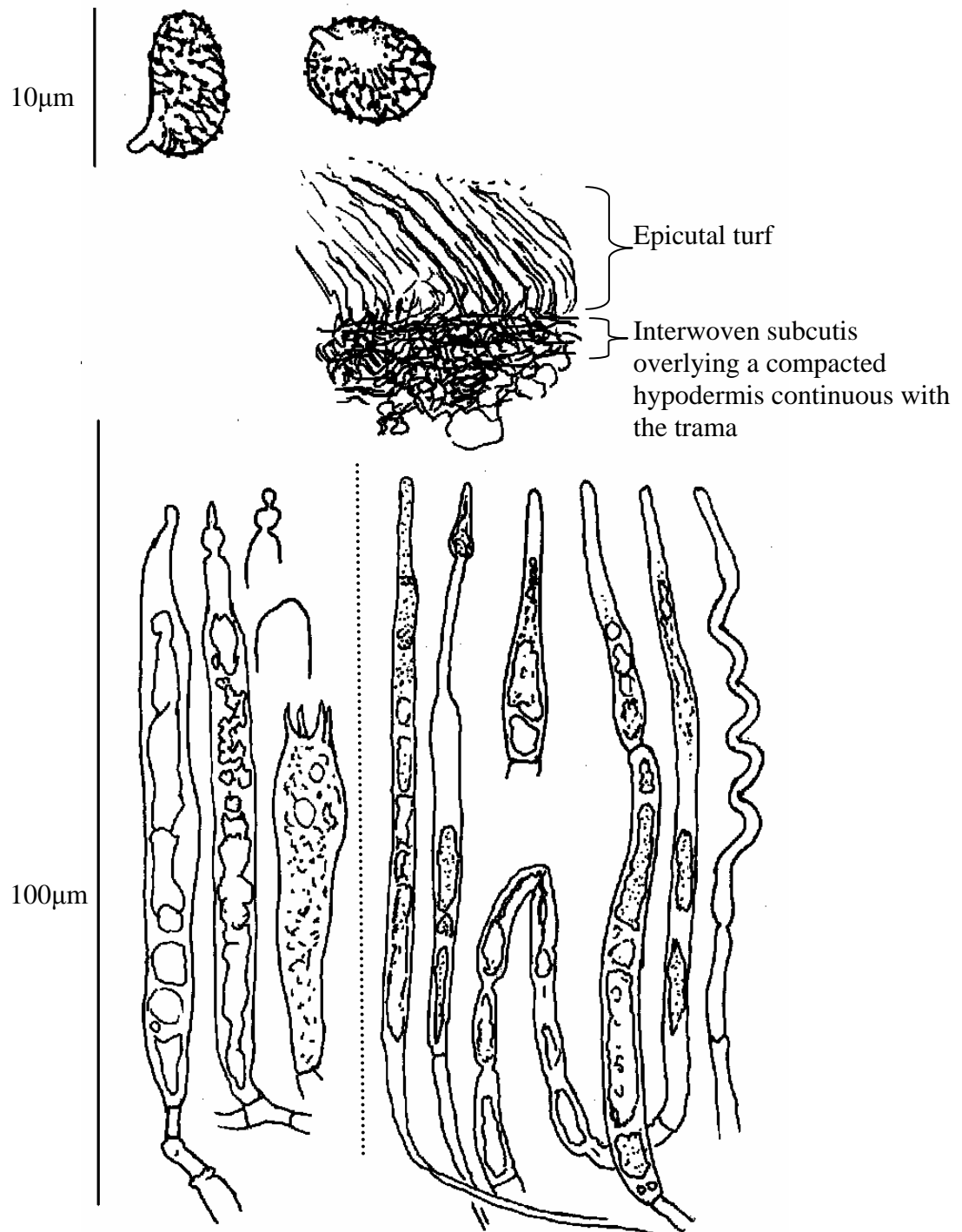


Figure 10 Microscopic characters of *Russula albonigra*: Top, spores with 10µm scale bar; middle, diagram of the cutis structure; bottom left, hymenial cystidia and basidium; bottom right, hyphal ends from the epicutis, the lower scale bar is 100µm.

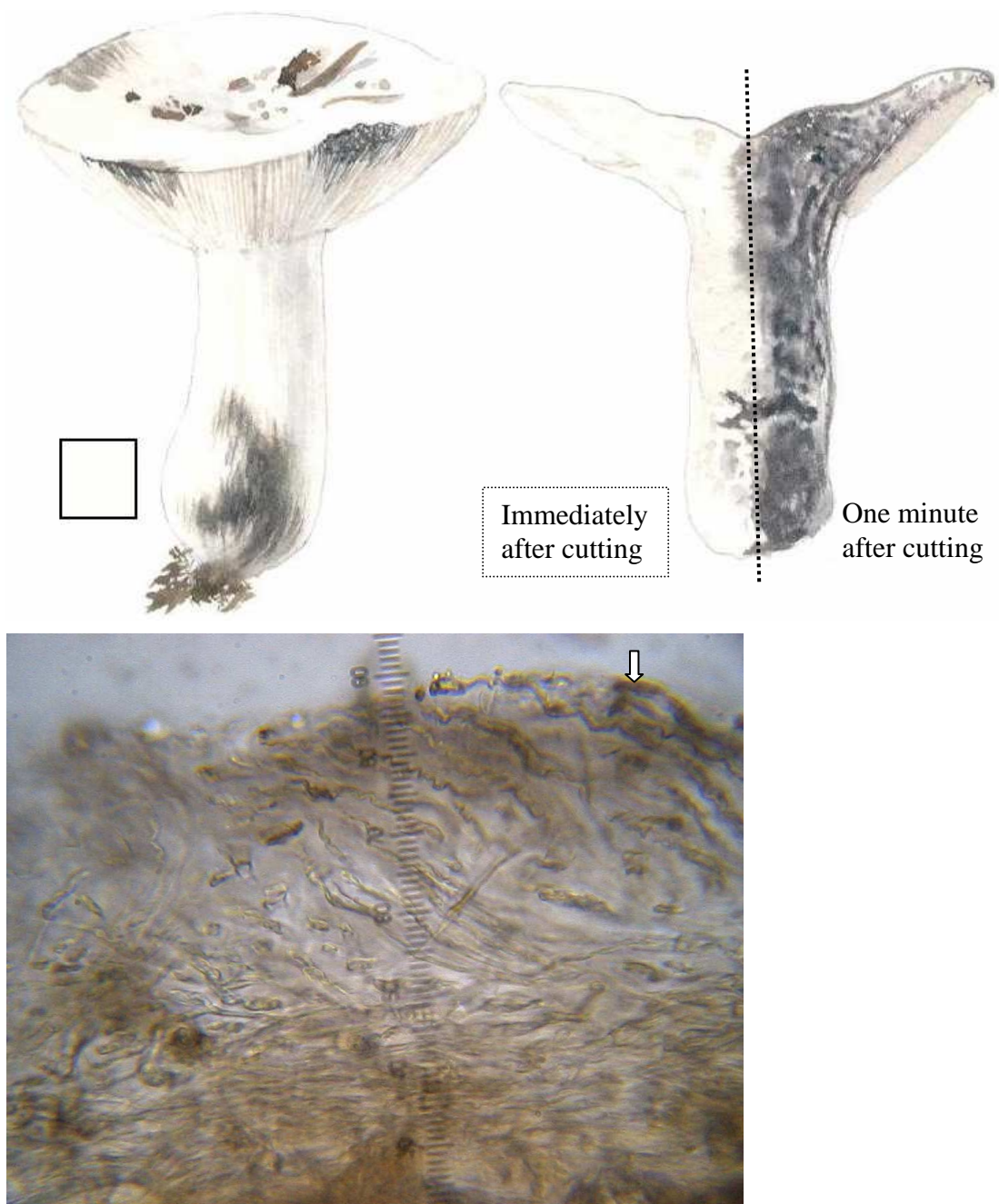


Figure 11 Macroscopic and cutis characters of *R. albonigra*: Top, illustration of profile and longitudinal section, the left half of the which shows the flesh immediately after cutting and the right half after one minute, the square is 1cm^2 and shows spore colour; bottom, section through the cutis near the cap centre showing the upright epicutal hyphae above a subcutis of interwoven parallel hyphae, at the surface a hypha with vacuolar pigment globules is arrowed, 10 scale divisions are $25\mu\text{m}$.

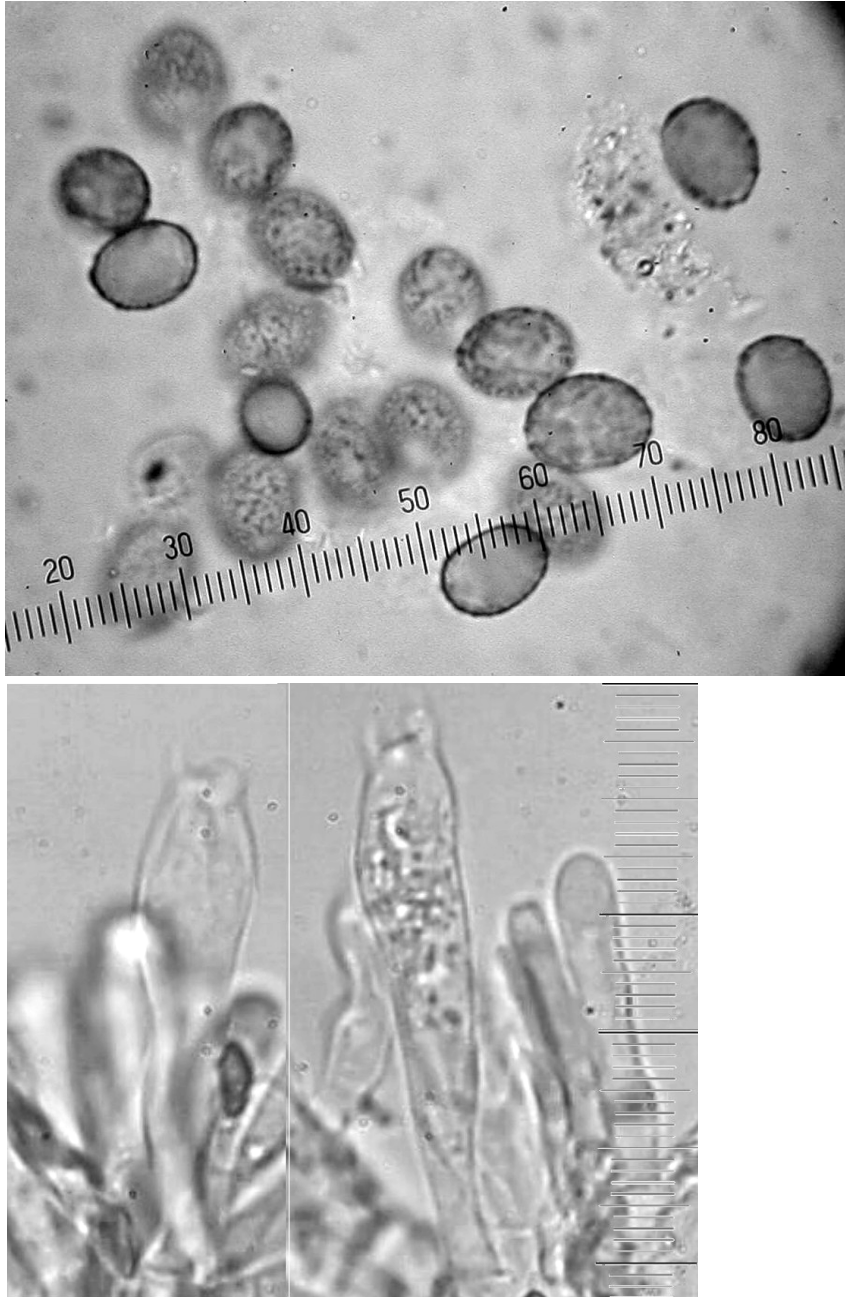


Figure 12 Characters of the hyphenium of *R. albonigra*: Top, spores with 1µm division scale; bottom, two basidia with basidioles, both are 4 -spored but two of the sterigmata are out of the focal plane in both pictures, the scale is in 1µm divisions.

***Russula dissimulans* Shaffer**

Brittonia, 14: 267-270, 1962

Description of Vancouver Island collections:

Cap 6-16cm diameter, convex to plane, with or without a central depression when young, becoming pulvinate or uneven, eventually shallowly infundibuliform, margin smooth, inrolled. Cap colour a dingy creamy white when young, soon becoming mottled with grey-brown, often retaining a few whitish spots, eventually completely dark brown and blackening in age, dry, not viscid even when wet, matte, minutely areolate, cutis peeling 0-1/4 the cap radius. Cap trama firm and creamy white when fresh and young, where damaged rapidly becoming a bright terracotta red, which dulls to a grey-brown and finally becomes almost black.

Gills pale cream, bruising red to reddish grey, then grey-brown to black, subdistant to distant and up to 1.5 mm thick, 2-3 tiers of lamellulae, adnexed and slightly ascending to adnate at stipe, only slightly decurrent in age, acute at cap margin, ventricose, 8-15 mm deep at half-radius, approximately equal to 1.5 times the depth of the trama at half-radius. The gill margins may be minutely fringed and sometimes darker due to the presence of cheilocystidia containing the reactive pigment. In wet weather the gill margins seep droplets of clear liquid, this may also be due to condensation.

Stipe 4-8.5 x 1.5-4cm, solid, clavate when young, becoming more or less cylindrical, surface white to pale cream, turning grey-brown, reacting like the cap trama when damaged, the trama bruising more strongly and rapidly than the cortex, becoming black.

Texture firm, brittle, the gills are exceptionally brittle.

Taste mild.

Odour not distinctive to faintly phenolic.

Spore colour white Romagnesi Ia.

Spores 7.3-9.1 x 6-8.1µm, occasionally spores measuring as little as 6.5 x 5.6 or up to 12.2 x 10 are found, normal spore L:W = 1.05-1.36, mean 1.18 (n=63), globose, subglobose or broadly ellipsoidal, ornamentation of blunt, rounded to pyramidal warts 0.3-0.8µm high, sometimes 2-3-catenate, forming short ridges, or connected by fine to heavy lines forming a partial to complete reticulum. The average size of warts varies among collections, some having warts mainly at the smaller end of the scale, others towards the larger end, but in any spore print there are several of each extreme, **Woo types** C1, C2, D1 and D2. **Suprahilar patch** inamyloid, smooth. **Hiliferous appendix** 1.5-1.8 µm long and between 1-1.4 µm wide near the base. **Basidia** 4-spored, or often 2-spored, 45-60 x 8-12µm, but most under 10µm wide, narrowly clavate, slightly bulbous in the upper 1/3. Sterigmata 5-8µm long and 1- 1.2µm wide near the base.

Pleurocystidia frequent to abundant but sometimes hard to see, 38-74 x 4-5µm, originating in the subhymenium, most are embedded in the hymenium, a few protrude up to about 12µm, cylindrical, tips obtuse to rounded, contents refractive, yellowish in KOH, weakly greying in SV, sometimes only partly filled with refractive material.

Cheilocystidia protruding 20-40µm, some with light brown amorphous pigment, others hyaline, most lacking refractive contents (appearing empty), 35-60 x 6-10µm, sometimes 1-2-septate, the terminal cell gradually tapering to a subacute or obtuse end.

Subhymenium 25-50µm thick, pseudoparenchymatous. **Gill trama** of sphaerocytes with occasional to frequent vascular hyphae containing dark brown pigment.

Cutis 30-100µm thick, of one to two layers, in some areas of the cap the subcutis is absent or extremely thin, and only the epicutis is present directly overlying the tramal tissues. **Subcutis** about 1/2 to 3/4 the total depth of the cutis when present, a layer of interwoven, non-gelatinised, hyaline hyphae 1-7.5µm wide. **Epicutis** of repent, interwoven hyphae 2.5-5µm wide, with few to no erect hyphal ends, sometimes with inflated terminal or subterminal cells up to 10µm wide, most with globules of brown pigment giving them the appearance of transparent intestines. **Hypodermis**, none.

Pileocystidia not seen.

Trama of sphaerocytes in fairly large clusters, for example, 4-5 deep by about 18 cells across, bound by a hyphal mesh, with few vascular hyphae visible.

Chemical reactions: FeSO₄ - greyish; KOH - no reaction on cap or stipe; NaOH₄ - no reaction on cap or stipe; phenol - pinkish; SV - brown on cutis but not reacting with any cuticular cells, weakly grey on hymenial cystidia.

Habitat and tree associations: on the forest floor, generally in mineral soil, in one case on a rocky knoll with shallow soil, often along trails, in mature regeneration forest; under western hemlock, or Douglas fir, or Sitka spruce, or red alder, or western red cedar; with understory sword fern.

Collections: CR000919-10, by the trail between cabins and dormitory on a rocky knoll, with western hemlock and western red cedar, Bamfield Marine Science Centre, N48.8315°, W125.1345°. CR010814-04, in a mixed age stand of western hemlock and Sitka spruce, Fairy Lakes trail, N48.585283°, W124.35925°. CR010909-02 amongst young regeneration, western hemlock and Douglas fir, with red alder and wild cherry, Kemp Lake area, N48.375283°, W123.78037°. 021020-SVIMS, a collection brought from either the Blueberry flats or Sooke Potholes area and deposited at the SVIMS mushroom show at Swan Lake, Victoria, the presence of western hemlock is indicated by needle litter adhering to the stipe bases. 021027-RN, collected in the Cowichan Lake area during a SVIMS foray, western hemlock and possibly Douglas fir presumed to be in the habitat.

| Collection | ITS1-F to ITS4-B | RFLP: | HinfI | AluI | Sau3A |
|-------------|------------------|----------|-------|------|----------|
| CR010814-04 | 871 | 400, 326 | | 705 | 565, 230 |
| 021027-RN | 857 | 349, 244 | | | 647 |

Notes Shaffer (1962) separated *Russula dissimulans*, a North American species, from its close European relative *Russula nigricans*, which name has often been given to collections of the former. He comments that Singer (1958) considered the North American representatives of the *R. nigricans* complex to be a subspecies as they differed from the European species. The difference rests on the slightly thinner and closer gills of *R. dissimulans* and the larger spores with warts up to 0.7µm rather than a maximum of 0.3µm for *R. nigricans*. A perusal of the many photographs of *R. nigricans* on European

websites on the Internet shows that the gill spacing varies and that *R. dissimulans* does not differ from some of these collections. Sarnari (1998) mentions a number of 4-5 lamellae per cm near the edge of an 18cm diameter basidioma, and 2-3 mid-radius. In the 16cm diameter Vancouver Island basidioma, there are 5-6 lamellae and lamellulae per cm at the border and 4, sometimes 5, at mid-radius. Shaffer gives the spore size for *R. nigricans* as 6.3-7.9 x 5.3-6.8µm and that of *R. dissimulans* as 7.7-10.8 x 6.5-9µm, whereas Sarnari (1998) gives 7.2-9.2 x 6-7.5µm for the former and the measurements given by Romagnesi (1967) fall in between. Clearly, if there is a difference between the European *R. nigricans* and the North American *R. dissimulans*, the characters of gill spacing and spore size are insufficient to separate the species.

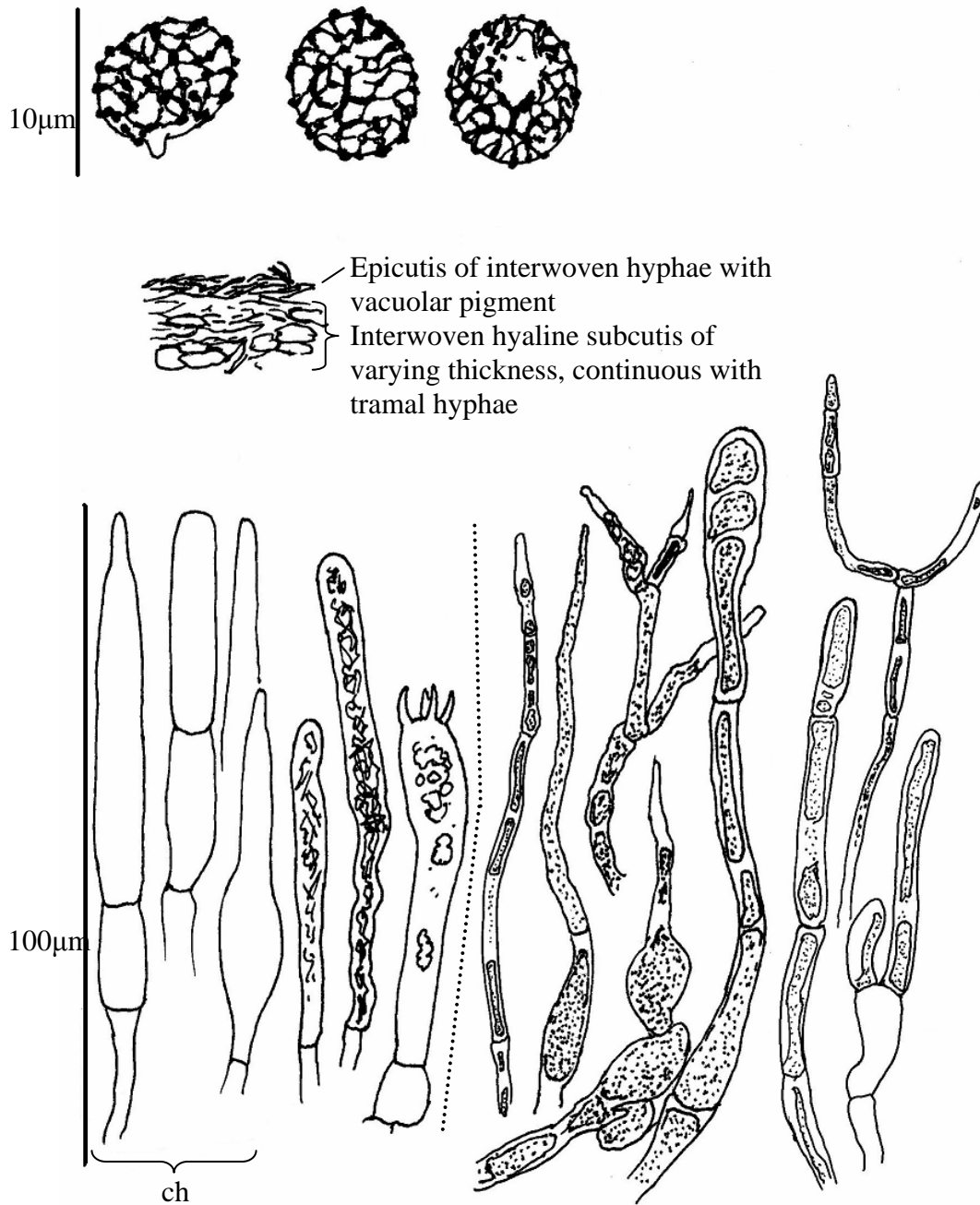


Figure 13 Microscopic characters of *Russula dissimulans*: Top, spores with 10µm scale bar; middle, diagram of the cutis structure; bottom left, cheilocystidia (ch), pleurocystidia and basidium; bottom right, hyphal ends from the epicutis, the lower scale bar is 100µm.



Figure 14 Macroscopic characters of *R. dissimulans*: Top, view of the top and underside showing the initial red bruising stage and the exuded or condensed droplets on the gills, photograph by Bryce Kendrick; bottom, young basidioma and mature 16cm diameter one, where the stipe has turned dull brown and the broken gills still show some reddish staining but are starting to turn grey-brown.

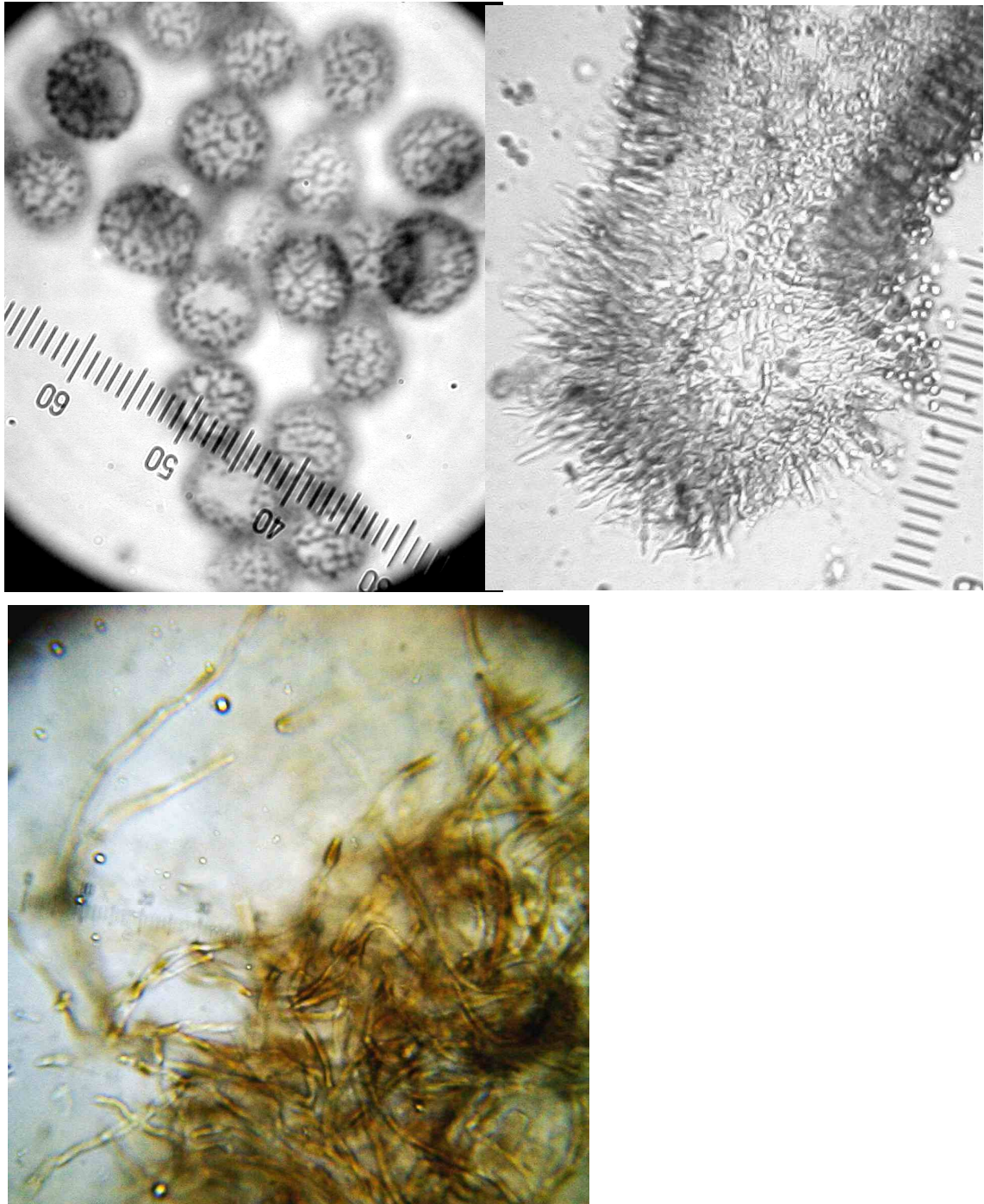


Figure 15 Hymenium and cutis of *R. dissimulans*: Top left, spores with 1µm division scale; top right, section through the gill at the margin showing dense numbers of cheilocystidia, 10 scale divisions are 100µm; bottom, hyphal ends of the epicutis showing brown pigment globules within, scale is in 1µm divisions.

Clade 2b

Subgenus *Compactae* (Fries) Bon

(Epicrisis: 349, 1838). Doc. Mycol. 65: 53, 1986

Section *Lactaroides* (Bataille) Konrad and Josserand

(Fl. Mon. Astér: 63, 1908). Bull. Soc. Mycol. Fr. 50: 263, 1934
(equivalent to *Plorantinae* in Romagnesi 1967).

Russula brevipes var. *brevipes* Peck

N.Y. St. Mus. Rpt. 43: 20, 1890

Russula brevipes var. *acrior* Shaffer

Mycologia 56: 223-225, 1964

Description of Vancouver Island collections in which the two varieties will be described together, noting any differences, since intermediates occur:

Cap 3.7-over 20cm diameter, most often in the range of 10-15cm but in productive years (such as fall, 2004), basidiomata as large as 30cm diameter occur. The shape is typically broadly infundibuliform even when immature, regularly lifting a disc of duff on its top (figure 2?), margins becoming increasingly uplifted in age until the cap assumes a broad V-shaped cross section. The cap margins are inrolled and remain so until post-maturity, not becoming striate, cuticle not peelable. The cutis is a chalky white, dry, matte, soft and felty at the margins when young, developing light brown stains where damaged or where the margins dry out in warm weather: beneath the cuticle, the flesh is creamy-white, in var. *acrior* it may have a slight blue-green tinge when young, unchanging when cut but eventually turning dirty cream to brownish in age and around insect larval tunnels.

Gills close to crowded, usually with two tiers of subgills that are often relatively regularly distributed, (although this varies among individuals); occasionally some forking occurs also, sometimes water-like droplets are exuded in moist weather. The

colour is a very pale cream, developing light brown spots and stains where damaged. In var. *acrior* the young gills often have a pale blue-green tint, gradually becoming cream but usually retaining a blue-green zone at the junction with the stipe into maturity, eventually this fades in age. The gills are arched, at least in the outer half of the cap radius, in some basidiomata, mostly when young, they may be sinuate or bellied towards the stipe as in figure X below, but as the cap expands they become arched throughout, adnate to decurrent at the stipe, narrow and acute at the cap margin, with a depth of about $1/4 - 1/2$ the of the cap trama at half radius, brittle.

Stipe 3-8 x 0.9-4cm, relatively short, the length usually less than the cap diameter, most often cylindrical, occasionally tapering downward, firm, stuffed with a firm trama; unchanging when cut, but eventually hollow and brownish inside the rind. Surface a chalky white when young, becoming dingier and brownish with age; not or only slightly longitudinally rugulose, staining brown around the base and where damaged. In var. *acrior* the stipe has a blue-green band at the apex which fades in age, becoming indistinguishable from that of var. *brevipes*.

Texture hard but brittle, becoming crumbly in age.

Taste mild or with a slight to distinct latent pepperiness in var. *brevipes*, slowly peppery to acrid in var. *acrior*.

Odour not distinctive or mushroomy, becoming unpleasant or fishy in age.

Spore colour white to pale cream, Romagnesi Ia or 1b, the latter being encountered less frequently locally than pure white, among the Vancouver Island collections all have white spores except one, a mild-tasting var. *brevipes* from Koksilah.

Spores 8-11.3 x 7.8-9.4 μ m, L:W 1.03-1.29, with a mean of 1.17 (n = 46), subglobose to broadly ellipsoidal, ornamentation somewhat variable, of low blunt to high pointed warts 0.7-2.0 μ m high, isolated or more commonly with light to heavy connectives forming a partial reticulum, occasionally the reticulum is complete, catenate warts are common, sometimes forming a low ridge. **Woo types** 3B, C and D and occasionally 2 B,C and D

or between 2D and 2E. **Suprahilar patch** a weakly amyloid area of irregular outline, the borders of which are slightly more amyloid and raised than the centre. **Hiliferous appendix** 1.7-2.5µm long, and 1.2-1.9µm wide at base. **Basidia** 4-spored, 57-80 x 9-14µm, narrowly clavate to clavate, sometimes with a relatively long, narrow base. Sterigmata 7-10µm long by 0.7µm wide at the base. **Pleurocystidia** 75-125 x 7.5-10µm, protruding up to 22µm beyond the basidioles, originating in the subhymenium or outer trama, cylindrical, fusoid or narrowly clavate, tips obtuse or capitate, contents yellowish, refractive in KOH, dark grey in SV. **Cheilocystidia** similar to pleurocystidia in shape and distribution but often shorter, to about 80µm. Subhymenium 15-35µm thick, of interwoven hyphae, gill trama of sphaerocytes with common SV₊ vascular hyphae.

Cutis 50-300µm thick, not gelatinous, consisting of loosely interwoven, sometimes tortuous, septate, branched hyphae 3-6µm wide, the upper 20-50µm may be more compactly interwoven and of repent light brown hyphae over some parts of the cap, in other parts hyaline semi-repent to ascendant hyphae form a deep loosely interwoven cottony layer which gives the cap its chalky or felted appearance. Single or bundles of 2 to about 6 slender hyaline hyphae frequently emanate above the interwoven layers. Occasional branched laticifers 4-6µm wide with yellowish slightly refractive contents not reacting in SV permeate the cutis, sometimes ending in a non-differentiated terminus at the surface. Some of the surface hyphae appear in water and 5% KOH mounts to have occasional small droplets adhering to their surface, although such hyphae do not have clamp connections: it is possible they are foreign in origin as other, more distinctly foreign hyphae as well as soil particles become entrapped in the epicutis. No other descriptions consulted mention such droplets. **Hypodermis** none, the cuticular hyphae are a continuation of the tramal hyphae. **Pileocystidia** not seen, although some hyphae have slightly refractive contents in their terminal cells.

Trama of discrete clusters of sphaerocytes bound by a hyphal mesh, laticifers rare in some basidiomata, common in others.

Chemical reactions: FeSO₄ - pinkish; KOH - no reaction to light yellowish brown on cap and stipe; NH₄OH - no reaction; guaiac - blue-green; phenol - brownish purple; SV

- purplish grey on the gills, blue-grey on the cuticle, cystidia and vascular hyphae grey to black.

Habitat and tree associations: With Douglas fir, western hemlock and possibly Sitka spruce as host trees, *R. brevipes* is found in old growth and mature regeneration forests, over about 40 years in general, being most numerous in forests about 70-120 years old where during its fruiting period it can be the most abundant epigeous mushroom present.

Collections: CR001202-br *R. brevipes* var. *brevipes*, Rocky Point in mature regeneration Douglas fir with large madrone and cedar N48.331617°, W123.5549°. CR021015-01a *R. brevipes* var. *brevipes*, Rainforest trail east side of the road, Long beach area, P.R.N.P. in old growth western hemlock and Sitka spruce with western red cedar, N49.049°, W125.699°. CR980827-01 *R. brevipes* var. *acrior*, in forest next to the junction of the road to Bamfield with branch 167 in mature regeneration western hemlock, Sitka spruce and Douglas fir N48.8875°, W124.9155°. CR981114-03 and CR001001-05 *R. brevipes* var. *acrior*, Koksilah ridge, on southeast facing slope in regeneration Douglas fir with madrone, salal and Oregon grape, N48.6559°, W123.7292°. CR001105-01 *R. brevipes* var. *acrior*, Discovery Island along trail from campground to lighthouse, under regeneration Douglas fir, N48.4257°, W123.2325°. CR010909-br/a *R. brevipes* var. *acrior*, Kemp Lake area, under regeneration Douglas fir with red alder and salal, N48.378°, W123.7873°. CR021102-br/a *R. brevipes* var. *acrior*, Royal Roads near the small swamp with old-growth and understory Douglas fir and western hemlock with western red cedar and Oregon grape, N48.434467°, W123. 478867°.

| | ITS1-F to | RFLP: | | |
|---------------|-----------|----------|------|-------|
| Collection | ITS4-B | HinfI | AluI | Sau3A |
| CR001105-br/a | 885 | 378, 265 | 565 | 226 |
| CR001001-05 | 885 | 378, 265 | 565 | 245 |
| CR010909-br/a | 816 | | | |

Notes. *Russula brevipes* is locally probably the most common species of *Russula* encountered. It is found throughout the coastal forests and in the coastal mountains along the mainland of the Pacific Northwest. It may be confused with white species of

Lactarius, locally *Lactarius controversus* has a very similar colour and stature, but the flesh exudes a white latex and the gills are a little pinker and more crowded. *Russula cascadiensis* appears almost identical but smaller, has an acrid taste and lacks any blue-green tints, and it has smaller, narrower spores. The spore size is the only really reliable means of distinguishing *R. cascadiensis* from *R. brevipes* var. *acrior* as the latter varies greatly in size; this factor appears to be very dependent on local conditions. In Europe, two species are considered close to the two varieties of North American *Russula brevipes*: *R. delica* Fr. (similar to var. *brevipes*) and *R. chloroides* (Krom.) Bres. (similar to var. *acrior*), and their rDNA sequences show them to be closely related but not identical. When Shaffer described *Russula brevipes* var. *acrior* he also wrote a comprehensive description with illustrations of *R. brevipes* var. *brevipes* in the same publication (pages 220-223), after examining collections from mainland North America including Washington and Oregon. These descriptions provide further useful information and details on this species.

On Vancouver Island, *Russula brevipes*, (presumably both varieties) is frequently parasitized by *Hypomyces lactifluorum*, turning it into what is commonly known as a lobster mushroom, collected locally for food.

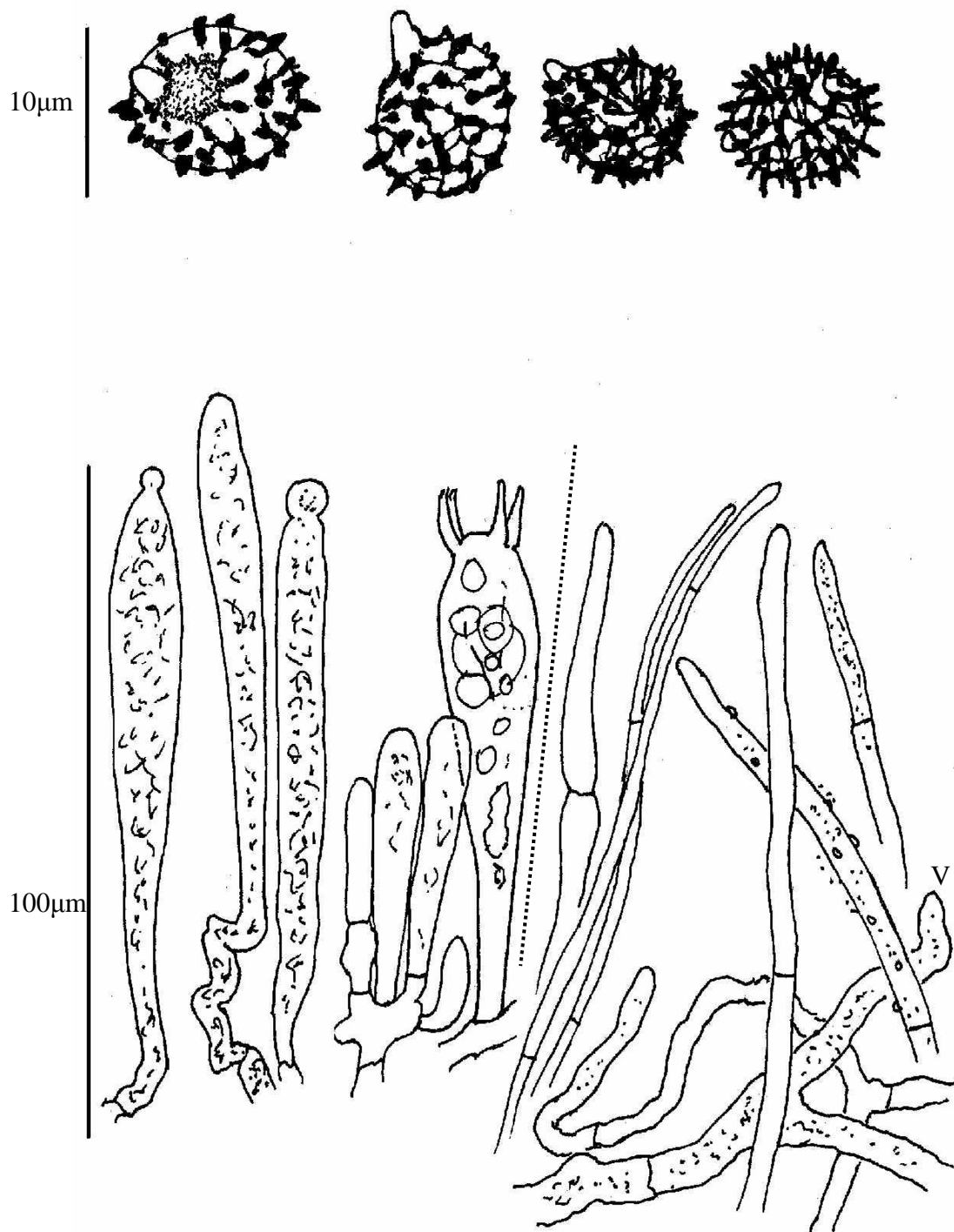


Figure 16 Microscopic characters of *Russula brevipes*: Top, spores, scale bar is 10µm; bottom left, pleurocystidia, basidioles on basal cell and basidia; bottom right, hyphae from the cutis including long narrow hyphae, one with droplets on the surface, and a vascular hyphae (V), lower scale bar is 100µm.



Figure 17 Macroscopic characters of *Russula brevipes*: Top, illustration of a small basidioma of var. *acrior* showing the blue-green tints typical in the young to early mature stage and the light brown bruising where dry or damaged, the square is 1 cm² and shows spore colour. Bottom, typical appearance in habitat with a wad of duff being lifted by the expanding caps and the incorporation into the cutis surface of soil and debris.

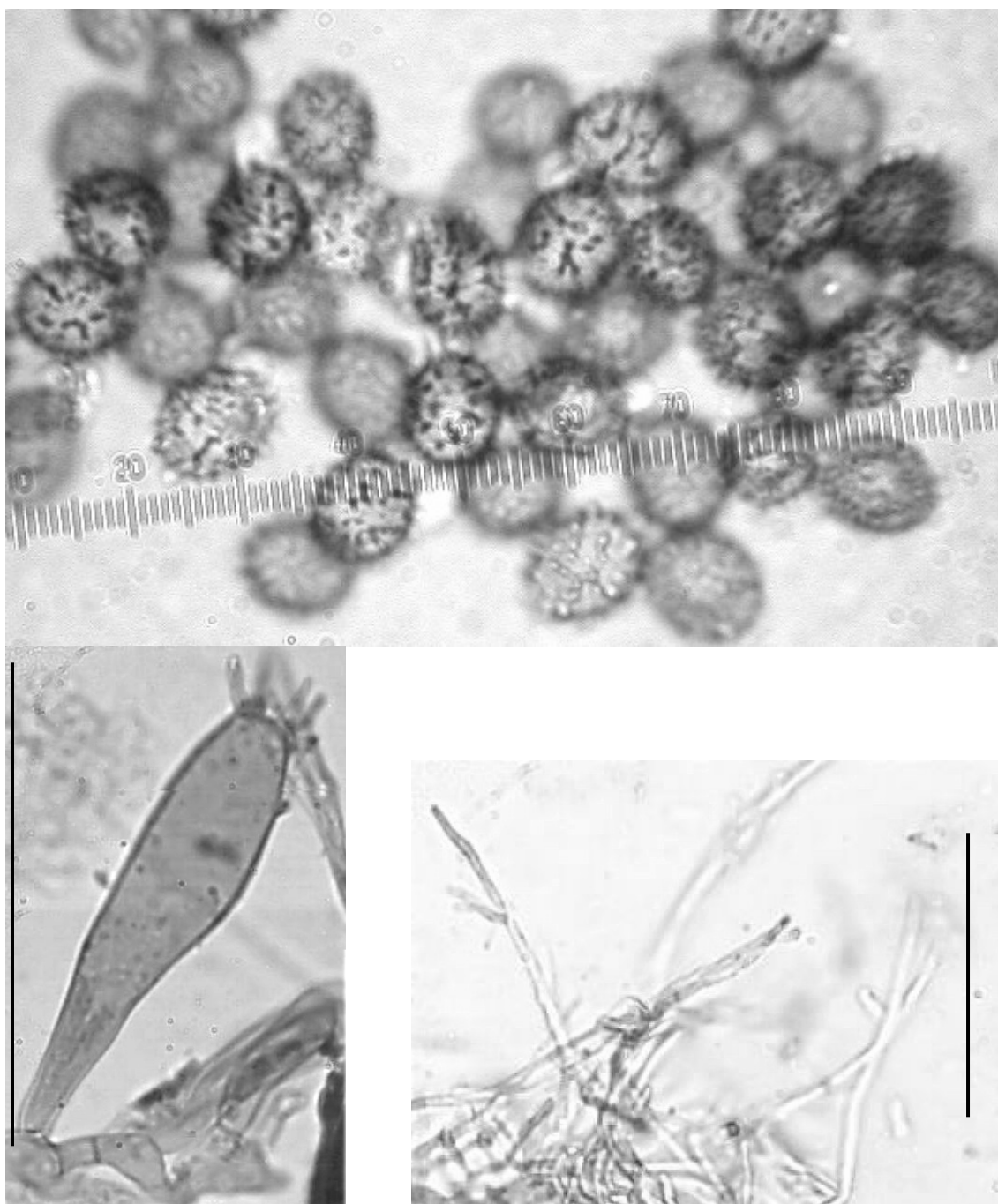


Figure 18 Microphotographs of *R. brevipes* var. *acrior*: Top, spores, one division on the scale is 1µm; bottom left, basidia stained with Congo red, scale bar is 50µm; bottom right, hyphal ends from the epicutis, scale bar is 100µm.

***Russula cascadiensis* Shaffer**

Mycologia 56: 212, 1964

Description of Vancouver Island collections:

Cap 4-4.7cm diameter, creamy white but developing light red-brown marks, dry, matte, minutely felty, centrally depressed, becoming broadly infundibuliform, margins smooth, inrolled and remaining so throughout maturity, peeling less than 1/4 the radius. Soil particles and debris are embedded in the cap cutis. Cap trama about 4-5 mm deep at half-radius, not bruising when cut but developing light brownish discolourations around insect larval channels, eventually the whole cap aging this colour.

Gills pale cream without any traces of blue-green, close to crowded with frequent subgills, thin, narrow, about 3mm deep at the deepest part, just beyond half-radius, adnate to slightly decurrent at the stipe, acute at the margin, arched, not particularly brittle, spotting brownish where damaged and in age.

Stipe 2.1-2.7cm x 1.1-1.6cm, short, about half the cap diameter in length, clavate, white, very firm, not bruising when cut but browning lightly around insect damage and round the base, solid.

Texture firm, but no more brittle than the average *Russula*.

Taste more or less bitter at first, then acrid.

Odour mild, mushroomy, not distinctive.

Spore colour pale buff, Romagnesi IIa-b.

Spores 6.2-8.5 x 4.5-6µm, L:W 1.19-1.46 with a mean of 1.37 (n=30), most are ellipsoidal, but oblong or tear-drop shaped spores are common, ornamentation of low rounded, sometimes heavy warts, mostly 0.2-0.4µm, occasional warts reach to about 0.8µm high, warts often in rows, with thin to heavy connectives forming a partial

reticulum, some isolated warts occur, Woo type C2. **Suprahilar patch** variable, on some spores an unornamented inamyloid area, on others a small lightly amyloid patch, on many an area of smaller but similar ornamentation to the rest of the spore, with tiny warts sometimes forming rows radiation from the hiliferous appendix. **Hiliferous appendix** 1.5-2 μ m long, 1.2 μ m wide near the base. **Basidia** 4-spored, 37-52 x 8-10 μ m, narrowly clavate, some almost cylindrical. Sterigmata 4-5 μ m long and 1.2-2 μ m wide at the base, some appearing relatively short and fat, others normally proportioned.

Pleurocystidia abundant but sparse near the gill margins, 50-75 x 6-10 μ m protruding less than 20 μ m, originating in the subhymenium or outer trama, fusoid or irregularly cylindrical, tips rounded, capitate, or with a short to long (sometimes half the length of the cystidia) narrowed extension. Contents refractive in KOH, brownish grey in SV, occasional ones with non-refractive contents. **Cheilocystidia** sparse, similar to pleurocystidia. **Subhymenium** 15-40 μ m thick, pseudoparenchymatous but often including interweaving hyphae, gill trama of sphaerocytes and vascular hyphae with yellowish contents staining weakly grey in SV.

Cutis 130-220 μ m thick at half-radius, of similar and locally variable thickness elsewhere. **Subcutis** tightly interwoven with no gelatinous matrix, of hyaline hyphae 1.5-4 μ m wide, but becoming brownish towards the trama and continuous with the hyphal network of the trama, and containing ascendant laticiferous hyphae 2.5-5 μ m wide that mostly terminate below the surface in an undifferentiated or capitate end. There appears a somewhat distinct irregular boundary where clusters of sphaerocytes abut the cutis. **Epicutis** not uniformly distinct from the subcutis, of compacted repent hyphae in parts, elsewhere of semi-erect unbranched non to rarely septate hyphal ends, usually in tufts and emerging up to 150 μ m beyond the surface, sometimes small clusters of hyphae adhere together along their length forming a loose rope-like structure.

Pileocystidia none seen, very rarely a laticifer forms a capitate pseudocystidium at the surface.

Trama of small discrete clusters of sphaerocytes bound by a dense hyphal mesh with frequent laticifers.

Chemical reactions: FeSO₄ - light brownish pink; KOH and NH₄OH - no reaction; phenol - pinkish brown; SV - grey-brown on the cuticle and gills, cystidia and vascular hyphae brownish grey, sometimes very weak.

Habitat and tree associations: In shrubby river valleys with red alder and western hemlock and/or Douglas fir.

Collections: CR981013-03, Cape Scott park near the beginning of the San Joseph bay trail, with western hemlock, Sitka spruce, red alder, huckleberry and salal, N 50.773°, W 128.403°. CR001007-cas, Koksilah River area, near the road at the Park boundary, with Douglas fir and red alder, N 48.6531°, W 123.7325°. CR001001-06 Cowichan River trail under Douglas fir, western hemlock and red alder with big-leaf maple and western red cedar, N 48.762°, W 123.7796°.

ITS1-F to

| Collection | ITS4-B | RFLP: HinfI | AluI | Sau3A |
|--------------|--------|-------------|---------------|---------------|
| CR001007-cas | 840 | 369, 346 | 500, 367, 230 | 272, 213, 172 |

Notes. *Russula cascadiensis* is named after the Cascade mountains of the Pacific Northwest, where the holotype originated, although it ranges as far as Michigan (Shaffer 1964). It looks like a miniature *Russula brevipes* and can really only be distinguished from peppery forms of that species by microscopic examination of the spores, (see notes under *R. brevipes*). The spore print of *R. cascadiensis* is darker than that of most *R. brevipes*, which locally at least, is most often white. The taste of local collections of *R. cascadiensis* includes an initial slight bitter component, and vascular hyphae are common in the cutis, characters not typical for this species according to Shaffer's description. Another similar species, *Russula vesicatoria* Burl. has a bitter then acrid taste and also common vascular hyphae in the cutis, and otherwise differs from *R. cascadiensis* only in its slightly larger basidiomata, up to 11cm diameter, stronger odour (like *Lactarius camphoratus*) and slightly larger spores (6.8-9.3 x 5.6-7.3µm). Burlingham collected *Russula vesicatoria* from Florida and New York State but to my knowledge it has not been reported from the Pacific Northwest. The cap diameters of these Vancouver Island collections are at the low end of the scale, Shaffer described them as between 4 and 9cm,

and it may be that larger ones have simply been overlooked and assumed to be *R. brevipes*.

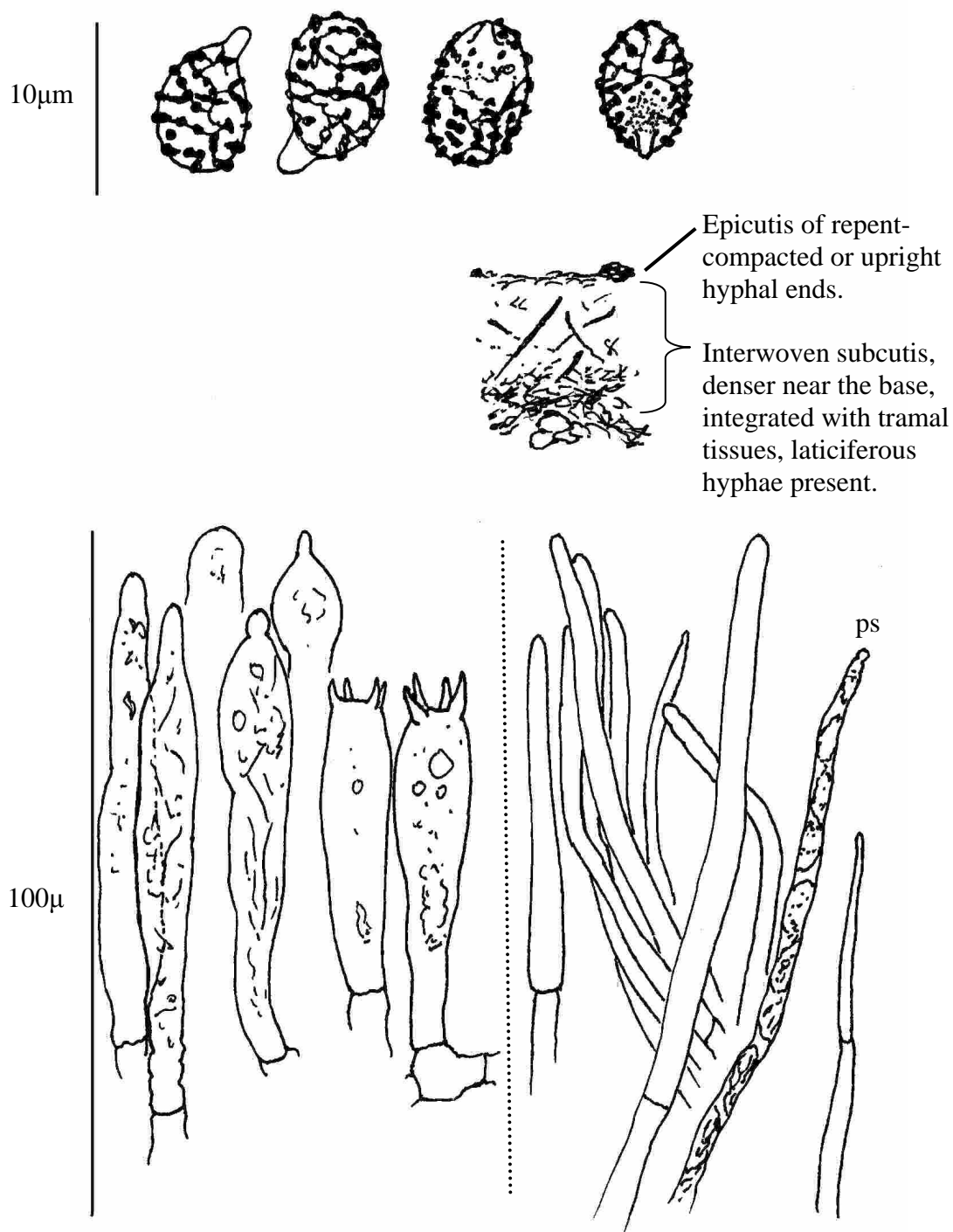


Figure 19 Microscopic characters of *R. cascadiensis*: Top, spores with 10µm scale bar; middle, diagram of section through cutis; bottom left, hymenial cystidia, the most common two shapes on the left, and basidia; bottom right, epicutal hyphal ends and a laticiferous hyphal end (pseudocystidia, labelled ps) that remains embedded within the cutis, lower scale bar is 100µm.



Figure 20 Illustration of *Russula cascadiensis* showing profile and longitudinal section, note the frequent subgills, the square is 1cm² and shows the spore colour.

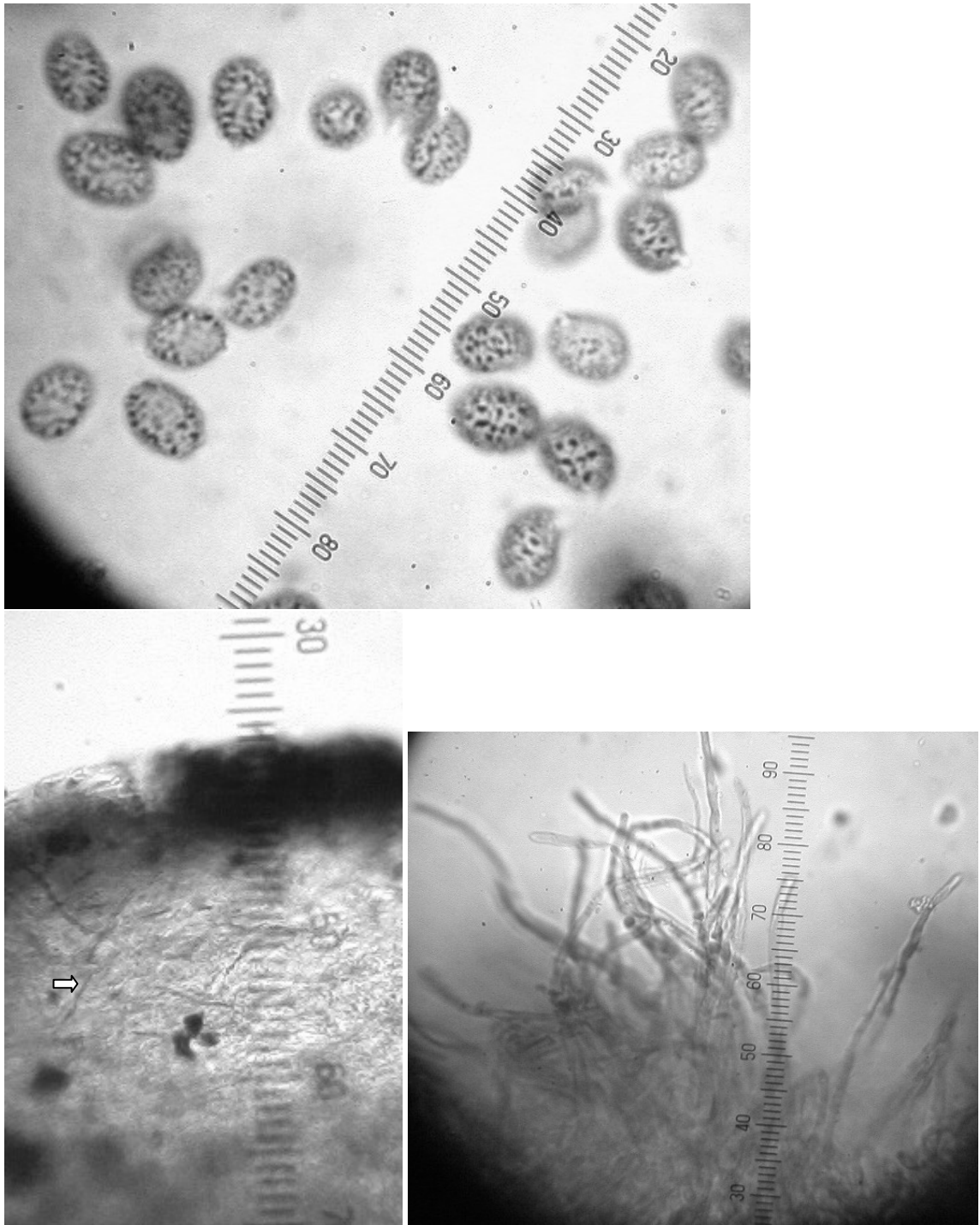


Figure 21 Photographs of microscopic characters of *R. cascadiensis*: Top, spores, one scale division is $1\mu\text{m}$; bottom left, section through the cutis showing a few ascendant vascular hyphae, one of which is arrowed, 10 scale divisions are $100\mu\text{m}$, and the trama/cutis interface is at the 63 mark in this section. Bottom right, a tuft of upright epicuticular hyphal ends, 10 scale divisions are $25\mu\text{m}$.

Clade 3

Subgenus *Ingratula* Romagnesi

Doc. Mycol, 69: 39, 1987

Section *Ingratae* (Quél.) Maire

Subgenus *Ingratula* consists of *Russula* species with brown, yellow-brown, grey-brown or red-brown cuticle pigmentation with no traces of red, purple or green. Typically the cuticle is thicker, sticky and often more gelatinous than in other groups of *Russula*, and the margins of the cap are deeply striate-tuberculate even when immature due to the thinness of the trama towards the cap margin. Section *Ingratae* contains numerous species with the strongest odours found in *Russula*, such as bleach (chlorine), spermatic, fish, almonds (benzaldehyde), maraschino cherries, rubber, Jerusalem artichokes and fruit, often with mixtures of these odours. The taste is often acrid with a soapy or oily element, but some species are mild. The stipe is generally creamy white with a tendency to bruise brown, and the trama has a series of four or more lenticular cavities from an early stage, a feature rare in other *Russula* groups, that generally have fewer, irregularly shaped cavities. In older basidiomata the stipe becomes completely hollow. The spores are cream, rarely white, never deep yellow. Microscopically, the spores have little to no amyloid ornamentation on the suprahilar patch, and often incompletely amyloid warts. The pileocystidia react only very weakly to sulphovanillin, yet the vascular hyphae in the subcutis and the hymenial cystidia generally react strongly.

Macroscopically this subgenus can be differentiated from similarly coloured *Russulas* in subgenera *Russula* and *Incrustatae* by a chromatograph of the cuticle extract (Chapter 2). In the *Ingratula* the chromatograph shows no reds or blues, just a greyish zone at the baseline and a yellow-brown zone behind the solvent line, which may split into three yellowish zones: a lighter yellow that is pale yellow in UV light, a darker yellow which is orangeish in UV light, and at the solvent line a UV-negative greyish-brown.

Clade 3b

Subsection *Foetentinae* (Melzer & Zvara) Singer

Series *Pectinata* Sarnari ad int. (*Pectinatae* Bon)

In addition to the main features of the *Ingratae*, the *Pectinata* have in common spores with normal *Russula* ornamentation of conical or hemispherical warts and no wing-like ridges. Spore shapes are a useful identifying character at the species level, with globose to subglobose spores less common than elongate-ellipsoidal spores. The *Pectinata* all have very small inconspicuous lanceolate pileocystidia, not reacting or barely greying in SV, little differentiated from cuticle hyphal end cells. In some texts, for example Thiers (1997), species in this group are considered to lack pileocystidia. The subcutis contains numerous vascular hyphae with granular contents greying strongly in SV. The odours in this group are usually strong with a spermatic or bleach component, sometimes fishy, rubbery or of Jerusalem artichokes.

The literature in this group is rife with synonyms and homonyms, and the microscopic differences between species are often very slight. Odour and colour play a large role in species differentiation, the former being subjective, the latter somewhat variable. In the species described below, it was difficult to determine an unambiguous identification and in future these collections may be re-identified as a different taxon, perhaps a local variant. As several collections had characters intermediate between species and other collections assumed to be of the same species could be variable, it is probable that closely related species in this group hybridize. This may have given rise to the confusion in the literature mentioned below in the notes accompanying species descriptions. With this in mind, the descriptions below should not be regarded as definitive for the species named.

***Russula cerolens* Shaffer**

Mycologia 64: 1036. 1972

Description of Vancouver Island collections:

Cap 5.3-9cm, pulvinate when young, remaining centrally depressed with the margins eventually unevenly flared, grey-brown to dull yellowish brown, darker in the centre, becoming pallid in age, no reddish brown areas. Margin striate-tuberculate even when young, up to 2cm or around 1/3 of the radius, peeling only at the margin, surface sticky, glutinous when wet, drying matte, occasionally with patches breaking into minute areoli. Trama creamy white, unchanging.

Gills cream, subdistant, adnexed, ventricose, acute at margin, around twice the depth of the cap trama at half radius, narrowing towards either end, occasional subgills, no forking or only very close to the stipe, not discolouring.

Stipe 4-11 x 1.4-2.8cm, clavate or fusoid, with 5-6 lenticular cavities, becoming hollow in age. Stipe rind around 5 mm thick, trama bready-textured, dirty white and faintly greying where cut, stipe surface white, smooth, turning pale grey-brown where handled, base of stipe bruising strongly red-brown in some specimens, patchy or paler in others, not turning red with KOH.

Texture firm, not very brittle to brittle, gills pliable.

Taste unpleasant, slowly peppery to acrid, especially in the gills, and with an oily, soapy component.

Odour strong, at first somewhat like bleach but with fresh, pleasant overtones, of ozone or cottonwoods in spring, eventually smelling strongly spermatic or of bleach, even after drying. Shaffer (1972) describes the odour as waxy, Thiers (1997) as oily, unpleasant.

Spore colour light cream-yellow, Romagnesi IIc to d.

Spores 6-8.5 (-10) x 4.8-6.8µm, narrowly or broadly ellipsoidal, sometimes pip-shaped, L:W 1.07-1.73, average 1.33 (n=76). **Ornamentation** of low rounded warts up to about 0.5µm, occasionally to 0.8µm, isolated, 2-3 catenate or with fine to thick connectives forming a partial to almost complete reticulum, sometimes with several longitudinally oriented rows of isolated or joined warts. **Woo types** B1-2, C1-2 and D1. **Suprahilar patch** inamyloid or barely amyloid, in Melzers' reagent appearing as a well defined very pale grey area with little or no ornamentation, on some spores there is a small darker patch within this area at the base of the hiliferous appendix, which is 1.5 to 2µm long. **Basidia** 40-50 x 6.5-9µm, columnar to narrowly clavate, sterigmata up to 8µm long and slender, often under 1µm wide. **Pleurocystidia** abundant and densely distributed, 57-100 (140) x 6-10µm, most are around 8µm wide, more or less cylindrical, narrowly clavate or fusoid, ends mostly capitate or with a series of constrictions ending in a terminal button, some merely acute, arising from the inner subhymenium or the trama, sometimes embedded in the hymenium, sometimes protruding up to 40µm, contents refractive in KOH, black or with black globules in SV. Shaffer (1972) comments on seeing some with inflated apices up to 17µm wide in some basidiomes. **Cheilocystidia** frequent, 50-70 x 5- 8µm, protruding 15-20µm, ends rounded or more frequently ampullate or capitate contents refractive or not, staining purple to black in SV. **Subhymenium** about 40-50µm thick, pseudoparenchymatous. **Gill trama** of sphaerocytes and frequent vascular hyphae.

Cutis around 280µm thick at half radius, ranging from 100µm at the margin to up to 750µm at the cap centre in mature basidiomata; an ixodermis with patches of trichoixodermis. **Subcutis** of radially oriented interwoven repent hyphae and numerous vascular hyphae which sometimes continue into the epidermis, contents yellowish in KOH, dark grey and granular in SV. **Epicutis** interwoven in surface view with occasional free hyphal ends, also with clusters of vertical multiseptate hyphal ends, around 3-5µm wide, appearing articulated or sometimes like a string of beads, the terminal cell tapering to a point, 25-40µm long, and often with refractive or granular contents. Cuticular hyphae 2-7.5µm wide, most at the narrow end of the range with occasional broader ones. **Pileocystidia** infrequent, clustered, mostly tapered and

sometimes with a tiny capitum, 25-50 x 3-5µm, differentiated only by the contents being more refractive and sometimes slightly greyer in SV than similarly shaped hyphal ends.

Pseudocystidia not differentiated, just the occasional terminus of a laticifer, mostly in the subcutis and rarely emerging into the epicutis. **Hypodermis** a brown layer of small flattened cells.

Trama of clusters of sphaerocytes bound by a hyphal mesh.

Chemical reactions: FeSO₄ - pinkish brown; KOH - no reaction on cuticle, yellow brown on stipe; NH₄OH - slightly brownish; guaiac - rapidly deep blue-green; guaiacol - red; phenol - chocolate brown; SV - cutis purple in sulphovanillin, gills magenta at first, rapidly turning dark grey.

Habitat and tree associations: trooping in shrubby woodland edges with Douglas fir and Garry oaks; shrub and ground cover may include ocean spray, broom, grass, salal and blackberry, September to December.

Collections: CR001007-01, alongside a trail under Douglas fir, western hemlock and red alder with big-leaf maple, western red cedar, sword fern and shrubs. Cowichan River trail, N48. 756267°, W123.8254°. CR021219-01 and CR040923-01 at N48.4364°, W123.4806° and CR040919-01 at N48.4361°, W123.4821°, all from Royal Roads University woodland near the roadside in grass under Douglas fir with garry oak, broom and trailing blackberry (*Rubus ursinus*). BK010904-02, Thomson Cabin trail in John Dean Park on the Saanich Peninsula, N48.613°, W123.443°. CR040927-01 at N48.453350°, W123.491067° from the lower part of the garden situated in a small ravine between Wentwich Road and Rainville, under Douglas fir, garry oak, ocean spray (*Holodiscus discolor*) and trailing blackberry. CR001121-01 at N48.4599°, W123.3129° at the side of a chip trail on the south side of the University of Victoria in mixed woodland of Douglas fir, madrone, garry oak, ocean spray, blackberry and alder. This last collection was smaller, darker in colour and with fewer inflated-articulated hyphae in the epicutis, and a less acrid taste.

| Collection | ITS1-F to | | | |
|-------------|-----------|-------------|---------------|---------------|
| | ITS4-B | RFLP: HinfI | AluI | Sau3A |
| CR001007-01 | 856 | 375 | 340, 260, 200 | 310, 235 |
| CR021219-01 | 857 | 376 | 340, 255, 195 | 320, 226, 190 |

Notes *Russula cerolens* is closely related to *R. amoenolens* Romagn. and is separated only by the reticulation of the spores (Shaffer 1972). Romagnesi (1967) considered the latter species synonymous with *R. sororia* described by Schaeffer, renaming it *R. amoenolens* after recognising it as a different species to *R. sororia* (Fries) Romell ss. Boud. Sarnari (1998) separates these two species on the basis of size, odour, habitat and reaction with guaiac; *R. amoenolens* is smaller, smells of unripe Camembert cheese as well as spermatic (Jerusalem artichokes in Bon 1987), has a strong, rapid reaction with guaiac and grows with oak and shoreline pines; *R. sororia* has a weak guaiac reaction and a similar odour to *R. cerolens* but grows with broadleaved trees, Moser (1978) gives *R. sororia* as having the odour of Jerusalem artichokes). *Russula cerolens* is not a European species so was not considered by either Romagnesi or Sarnari. However, it appears to be very similar to *R. sororia* but for the increased reticulation on the spores of the former and preference for conifers or mixed conifer-hardwood. *Russula sororia* differs from both *R. amoenolens* and *R. cerolens* in its subglobose rather than ellipsoidal spores, smaller warts which are only up to 0.4µm, and flesh, especially the stipe, which discolours strongly red-brown on handling and in age, and has only a weak reaction with guaiac. This species has not been recorded from the Pacific Northwest.

The Vancouver Island collections of *R. cerolens* were made at the edge of the Douglas fir forest, in an area with broom, oak, often with ocean-spray, and all with blackberry, which may indicate more than one mycorrhizal partner. Shaffer (1972) gives the habitat for *R. cerolens* as under spruce and pine, sometimes on dunes, and made his description based on material collected in Oregon and northern California by Alexander Smith, mostly from coastal regions but also from Blue River, which is in the foothills of the western Cascade mountains. The collections identified as *R. amoenolens* in North America came from Illinois, Massachusetts and Michigan, which suggests that this

mushroom is an eastern species while *R. cerolens* is western. Thiers (1997) gives both for California, finding *R. cerolens* under conifers and hardwood-conifer forests in coastal counties of northern California, and *R. amoenolens* under pines, especially in coastal regions. He comments that the separating factor of spore ornamentation is not consistent and questions the distinctness of the two species. Collection CR001121-01, appeared to have characters intermediate between *R. cerolens* and *R. pectinatoides*. A comparison of spore sizes (fig. 40) shows most similarity with *R. cerolens*, the ornamentation being the same.

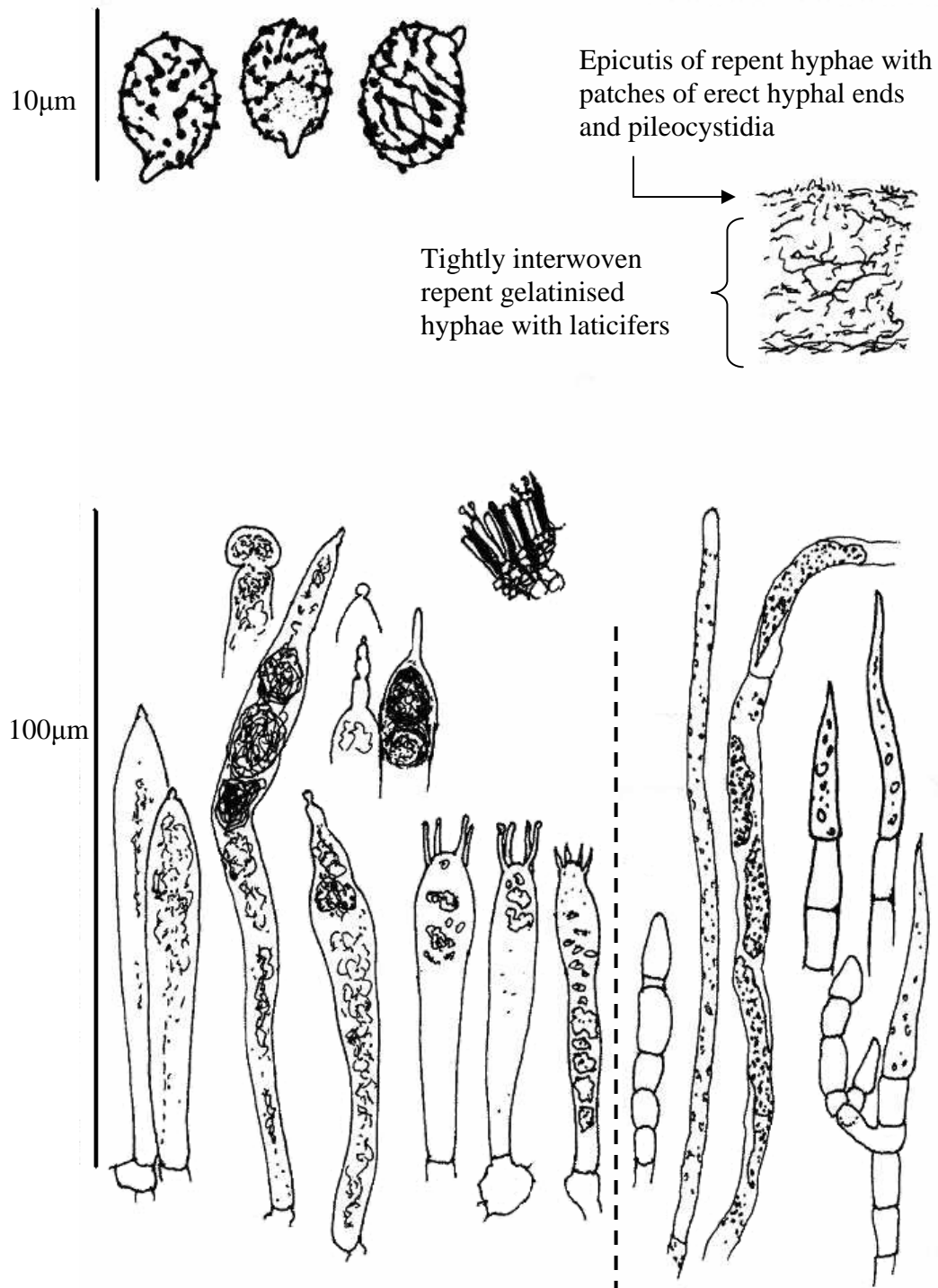


Figure 22 Microscopic characters of *R. cerolens*: Top left, spores with 10µm scale bar; top right, plan of cutis in section in 5% KOH; lower left, hymenial cystidia and basidia, the two on the left are cheilocystidia, those in the centre are pleurocystidia with different forms of apices, basidia on the right, and above these a plan of the hymenium; lower right, epicutal hyphal ends, a laticifer (centre) and pileocystidia, lower scale bar is 100µm;



Figure 23. Macroscopic characters of *R. cerolens*; Immature and mature basidiomata in situ and in profile.

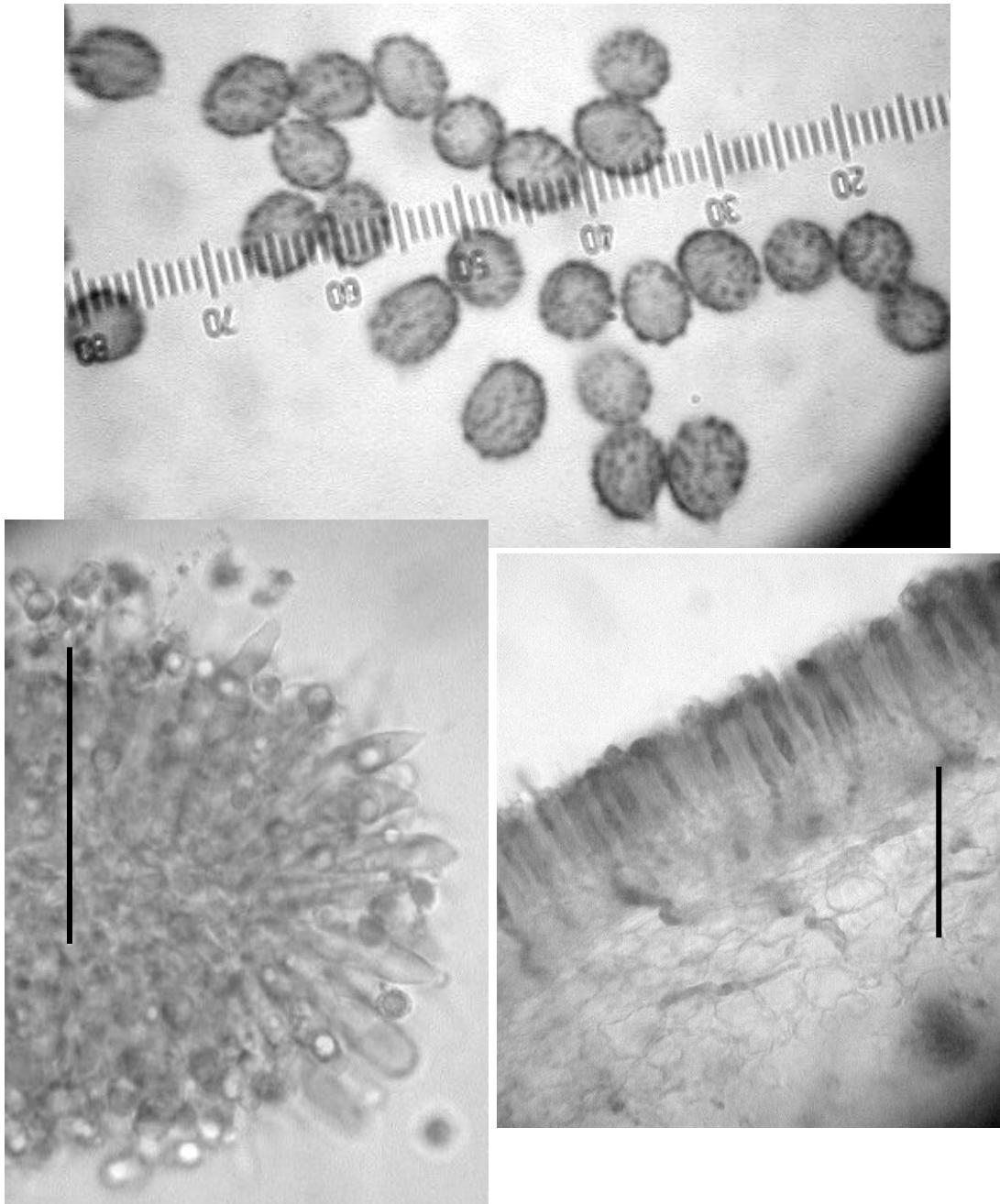


Figure 24. Hymenium of *R. cerolens*: Top. spores with 1 μ m division scale; bottom left, section through the gill edge showing several cheilocystidia, some with refractive contents and some without, scale bar is 100 μ m: bottom right, section through hymenium showing dark pleurocystidia with origins mostly in the lower subhymenium, and either embedded or with protruding tips, scale bar is 100 μ m.

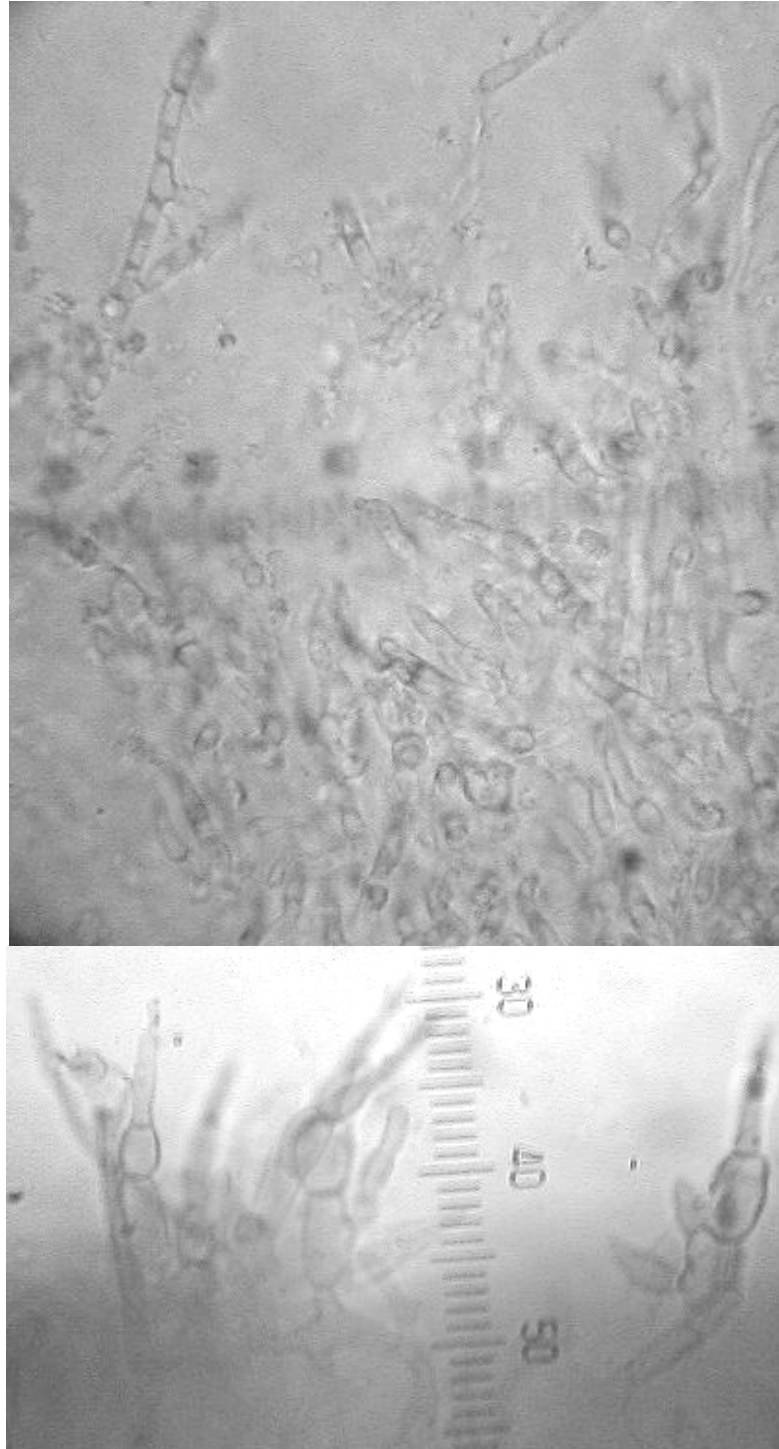


Figure 25. Epicutis of *R.cerolens*: Top, surface view of an epicutal trichodermal patch of showing the numerous hyphal ends of chains of short cells; bottom, hyphal ends and pileocystidia in the epicutis, 10 scale divisions are 25 μ m for both photographs.

***Russula pectinatoides* Peck**

N.Y. St. Mus. Bull. 1907 116 : 43, *pl. 105, f. 6-10.*

Description of Vancouver Island collections:

Cap 3.1-3.9cm, at first rounded with a central depression and incurved margin, expanding to plane or centrally depressed, margins long incurved, striate-tuberculate with the cutis stretched and splitting over the striations, which extend approximately 1/3 of the radius. Cutis a pallid yellow-brown, to yellow brown or dark grey-brown to dark greyish yellow-brown, becoming paler in age, usually darkest in the centre, may appear fibrillose, sticky to viscid, drying matte, sometimes with a whitish bloom when young, peeling 1/3-1/2 the radius, thick and elastic near margin, flesh immediately beneath grey-brown. Cap trama pale cream, about 0.5cm deep at half-radius when mature, unchanging when damaged.

Gills pale warm cream, close to crowded, lamellulae not seen, forking at stipe and out to half-radius, free to very narrow to notched at stipe, falciform, acute at cap margin, about 1/2 to 3/4 as deep as the cap trama at half radius

Stipe 2.9-3.5cm x 1.0-1.3 m, narrowly clavate, white, pruinose when young, sometimes rugulose to ridged, stuffed with a bready-textured trama that has 4 to 5 lenticular cavities, eventually becoming hollow, bruising lightly grey-brown round insect holes and at stipe base but otherwise unchanging. Stipe length approximately equal to cap diameter.

Texture firm, becoming brittle in age.

Taste mild at first and slightly sweet, finally peppery to acrid and leaving a soapy, oily aftertaste.

Odour fishy with rubbery or almond and rancid components.

Spore colour pale cream, Romagnesi Ib-IIa

Spores 5.8-8.2 x 5-6.2µm, tear-drop-shaped or ellipsoidal, occasionally subglobose, L:W 1.08-1.53, average 1.26, warts generally small, most up to 0.5µm high, occasionally to 0.7µm high, rounded or bluntly conical, isolated or more usually with fine or occasionally heavy connections between two to several warts, sometimes 2-3 warts catenate or in longitudinal chains, spores with a partial reticulum quite common. Spore ornamentation and shape quite varied within one basidioma **Woo types** B1-2, C1-2. **Suprahilar patch** inamyloid or barely amyloid, in Melzers' reagent appearing as a very pale grey area with little or no ornamentation, on some spores there is a small darker patch within this area at the base of the hiliferous appendix, which is 1-1.5µm long. **Basidia** 50-58 x 7.5-9µm, very narrowly clavate, almost cylindrical with a slight broadening near the top, 4-spored, sterigmata 3-5µm long. **Cheilocystidia** and pleurocystidia, abundant and densely distributed, 55-90 x 5-10µm, arising from the gill trama, embedded in the hymenium or protruding only about 15µm, contorted-cylindrical, apices rounded or with a tiny point or capitum, with yellow refractive contents, dark purple-grey to black in SV, cheilocystidia orange in SV. **Subhymenium** 20-30µm thick, pseudoparenchymatous. **Gill trama** of sphaerocytes and vascular hyphae.

Cutis 120-300 (-500)µm thick. **Subcutis** of radially aligned, tightly packed interwoven repent hyphae with numerous vascular hyphae containing yellow droplets, staining grey and granular in SV. **Epicutis** of repent to patchily upright hyphal ends, 2-4µm wide, mostly filamentous with either an undifferentiated hyphal terminus or of cystidioid tapering, ampulliform or fusiform-capitate end cells supported on one or two short, sometimes branched cells up to 5µm wide. Very few articulated hyphae. **Pileocystidia**, 11-45 x 4.5-5µm at the widest, hard to find and see, tapering as for hyphal end cells but with slightly granular contents, not staining in SV. **Pseudocystidia** rare, just an occasional undifferentiated terminus of a vascular hyphae, usually within the subcutis but occasionally reaching the surface. **Hypodermis** none.

Trama of discrete clusters of sphaerocytes enmeshed in hyphae.

Chemical reactions: FeSO₄ – grey-brown; KOH -no change on cap cutis, yellowish on stipe; NH₄OH - no reaction; guaiac - strongly blue-green; phenol - brownish purple; SV - colourless to brownish on cutis, purple-grey on gills.

Habitat and tree associations: Mature and regeneration Douglas fir, with or without western hemlock, along the edges of trails or in more open areas with shrubs.

Collections: CR001002-02, with regeneration Douglas fir in lawn by the ringroad at the University of Victoria, N48.4605°, W123.3111°. CR001024-02, with Douglas fir, western hemlock, big-leaf maple and western red cedar, by the trail through Mystic Vale, University of Victoria N48.4594°, W123.3093°.

Notes: In this thesis, collections identified as *R. pectinatoides* differed from collections identified as *R. cerolens* in their smaller stature, milder taste and stipe with only four to five cavities, whereas *R. cerolens* generally has five or six. Microscopically *R. cerolens* has many more of the chains of short inflated cells in its epicutis than does the local *R. pectinatoides*, which also has paler, rounder, spores with a shorter hiliferous appendix, but both species have spores with a partial reticulum. Collections of local *R. pectinatoides* have the spore ornamentation of *R. pectinatoides* (Peck), but the spores are paler and the extreme base of the stipe lacks the strong reddish bruising. Peck's description states the taste is mild; Romagnesi (1967) who describes *R. pectinatoides* sensu Singer, says it is fleetingly hot and sometimes bitter, Shaffer (1972) describes it as moderately acrid in the gills. The pale colour, small size and broadly ellipsoid to subglobose spores distinguish this species from other local *Pectinata*.

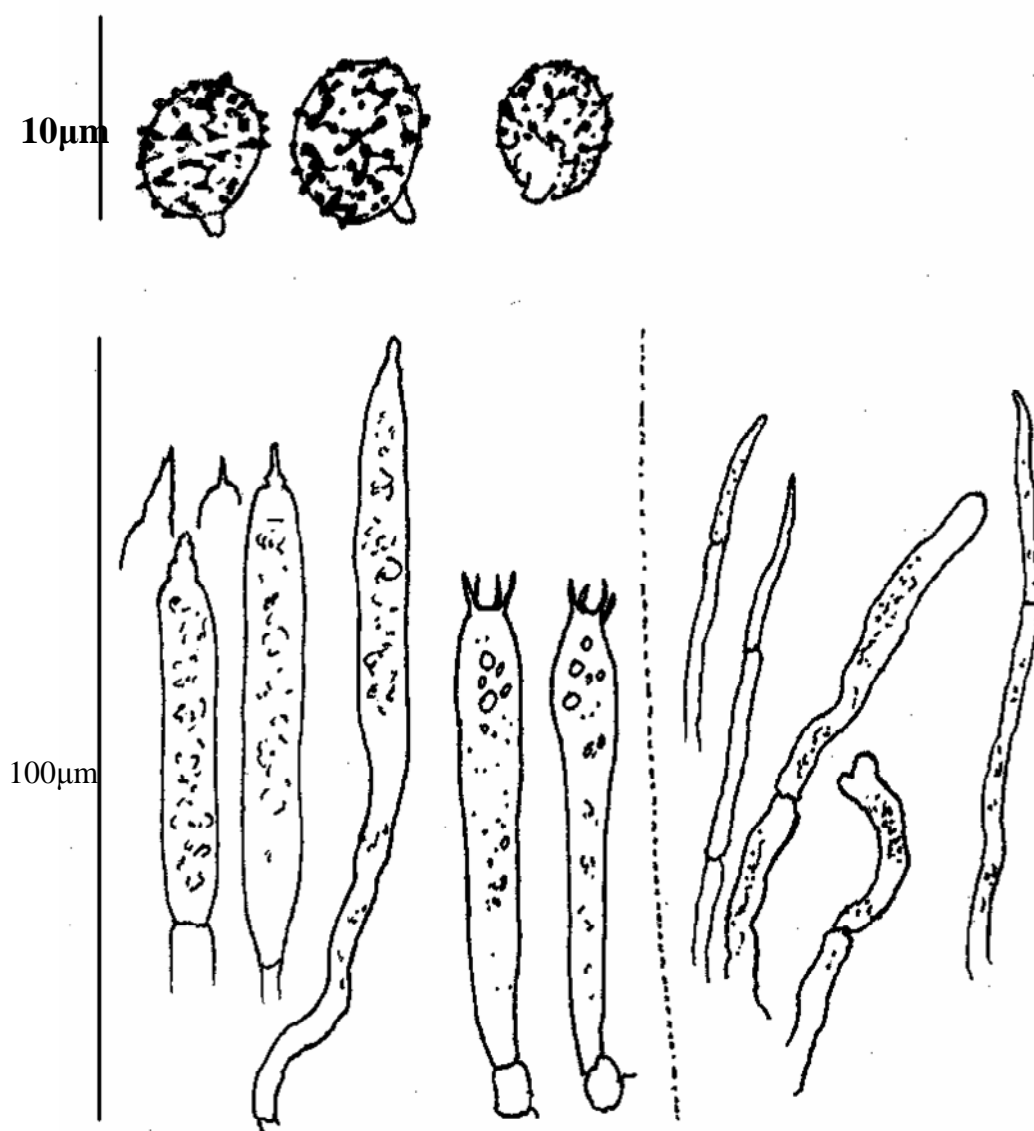


Figure 26. Microscopic characters of *R. pectinatoides*: Top, spores with 10µm scale bar; lower left, hymenial cystidia and basidia; lower right, pileocystidia, laticifers and hyphal ends in epicutis, lower scale bar is 100µm.

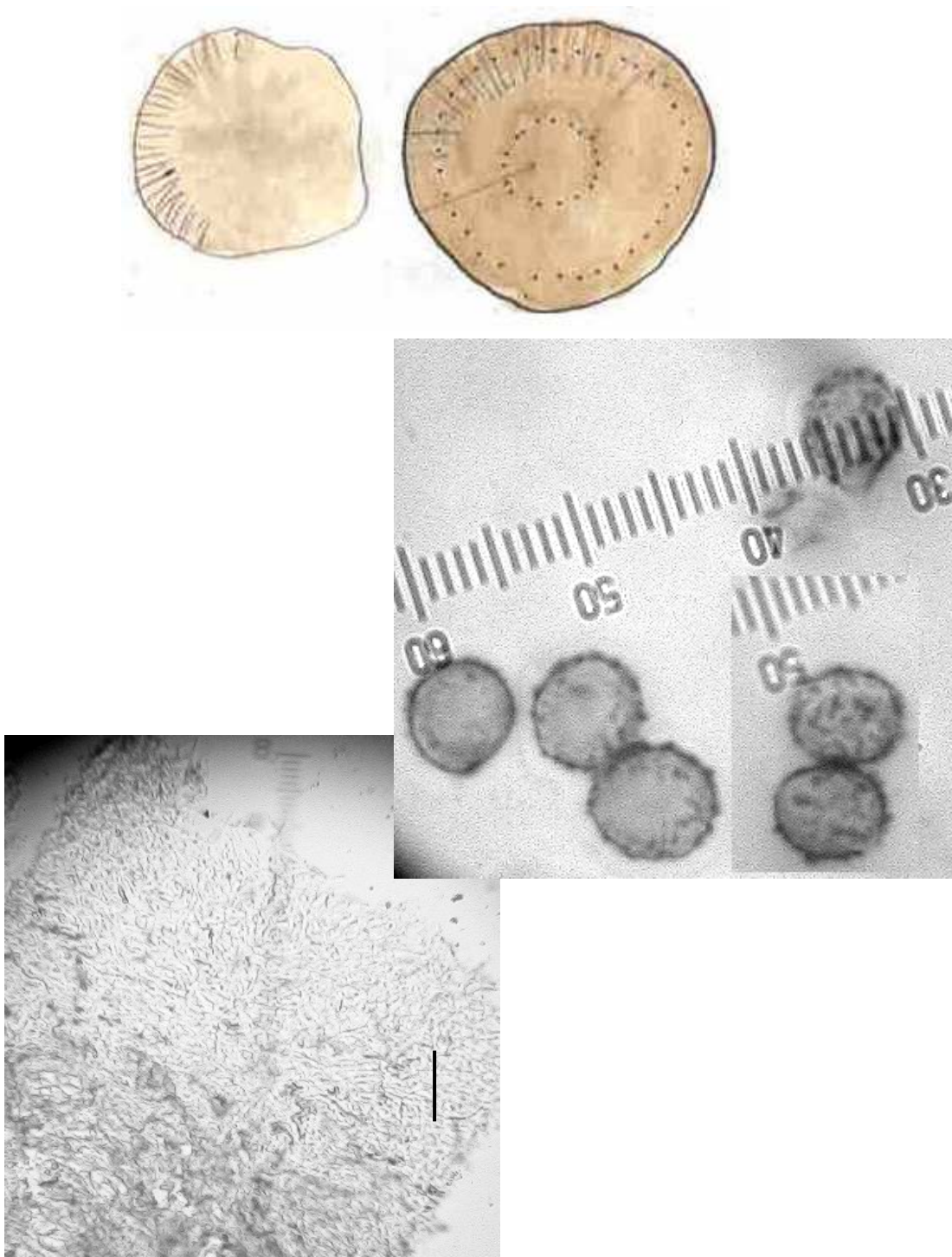


Figure 27. Macroscopic and microscopic characters of *Russula pectinatoides*: Top, field sketch of cap surface showing colours; middle right, spores with 1 μ m division scale; bottom left, section of cutis from *R. pectinatoides* showing a gradual merging of the interwoven subcutis with the tramal tissue, scale bar is 100 μ m.

***Russula cf. pectinata* Fries**

Epicrisis p.358. 1838

Description of Vancouver Island collections as *R. cf pectinata*

Cap 2.9-11.1cm, convex to pulvinate when young, becoming plane or more usually centrally depressed with the margins acute, sometimes lobed; grey-brown or dark yellow-brown when young, the mature caps paler, dull yellowish brown to dull brown, darker in the centre, developing reddish brown areas and spots particularly in the centre. Margin striate-tuberculate even when young, between 1/4-1/3 or occasionally to 1/2 of the radius, some peeling only 1/4, others up to 3/4 the radius. Surface sticky-viscid, drying matte in the centre, otherwise subshining with a silky appearance. When fresh slightly radially fibrillose, and occasionally with scurfy patches toward the centre, breaking into minute areoli. Cap trama creamy white, unchanging, tinged with cap colour directly beneath the cuticle.

Gills pale warm cream, sometimes with pinkish tints when viewed edge-on, subdistant to close, narrowly adnexed to almost free, falcate or arched, acute at margin, deepest at the mid-point, shallow at first becoming slightly deeper than the cap flesh at mid-radius, usually developing red-brown spots in age.

Stipe 2.4-6.9 x 0.7-2.4cm, more or less cylindrical or broadening at the base, stuffed, developing 4-5 lenticular cavities and becoming hollow in age. Stipe surface white, smooth to slightly rugulose, turning pale grey-brown where handled, base of stipe speckled with red-brown spots and stains, flesh unchanging where cut but browning around insect larval damage.

Texture firm, becoming more fragile in age, gills neither particularly brittle nor pliable, normal for *Russula*.

Taste initially bitter in three collections, then slowly peppery to acrid, especially in the gills, sometimes with a soapy aftertaste.

Odour spermatic to bleach with almond and fishy components, or in one case also hints of Jerusalem artichokes.

Spore colour pale cream Romagnesi Ib to IIa.

Spores 6.8-9 (-10) x 4.8-7 μ m, mean 7.6 x 5.6, narrowly or broadly ellipsoidal, L:W 1.14-1.7, mean 1.36 (n=66). Spore ornamentation of low rounded warts up to about 0.5 μ m, 2-3 catenate or with fine connectives forming a partial, broken reticulum, and often also with isolated warts, occasional spores with mostly isolated warts. **Woo types** A2, B2-C2. **Suprahilar patch** inamyloid or barely amyloid, non-ornamented or sometimes with a speckling of tiny warts, often bordered by normal warts.

Hiliferous appendix 1.5 to 2 μ m long. **Basidia** 35-50 x 5-10 μ m, columnar to narrowly clavate, sterigmata up to 6 μ m long and slender, often under 1 μ m wide.

Cheilocystidia infrequent to frequent, 50-90 x 9-10 μ m, non-staining or staining purple in SV, otherwise very similar to pleurocystidia. **Pleurocystidia** abundant and densely distributed, 33-100 x 7-13 μ m, cylindrical, fusoid to clavate but often contorted and pinched at intervals, embedded in the hymenium or only protruding about 15 μ m, arising from the inner subhymenium or the trama, contents refractive in KOH but occasionally not, yellowish near base or throughout, usually dark purple to grey in SV. **Subhymenium** about 25-30 μ m thick, pseudoparenchymatous. **Gill trama** of sphaerocytes and frequent vascular hyphae.

Cutis 200-440 μ m thick at half-radius, in some caps distinctly in two layers. **Subcutis** about 200 μ m thick, of tightly interwoven hyphae around 2 μ m wide, light pink in SV, and with numerous vascular hyphae containing yellow oily droplets which stain weakly and appear granular or bubbled in SV and which often extend into the epicutis. **Epicutis** around 240 μ m thick or about half the depth of the cutis, an uneven trichodermis with patches of more or less upright hyphal tips, stretching at the margins to a thin broken layer with more repent hyphae. Cuticular hyphae 2-8 μ m wide, most at the narrow end of the range with occasional broader ones mostly in the epicutis and often terminating in an articulate hyphal tip of chains of short, slightly inflated cells, sometimes with a tapered apical cell. **Pileocystidia** infrequent,

clustered, mostly tapered and sometimes with a tiny capitum, most 12-35 x 3-5µm at the base, more rarely long ones up to 110µm can be found, generally near the margins, and these may be cylindrical-capitate or tapered. Pileocystidia differentiated only by the contents being more refractive and sometimes slightly greyer and more granular in SV than similarly shaped hyphal ends. **Pseudocystidia** not differentiated, just the occasional terminus of a laticifer which sometimes emerge into the epicutis particularly near the cap margin.

Trama of clusters of sphaerocytes bound by a hyphal mesh.

Chemical reactions: FeSO₄ -greyish salmon to brownish pink; KOH -no reaction or slightly darkening the cuticle, yellow brown on stipe; NH₄OH -no reaction; guaiac - strongly blue-green; phenol -pinkish brown; SV -cutis purplish pink, gills dull magenta at first, rapidly turning deep purple.

Habitat and tree associations: In troops at the edge of forested areas in the dunes and the spruce fringe along the shore in the western hemlock very wet maritime subzone, with western hemlock, shore pine, Sitka spruce, near shrubby areas of salal, kinnikinnik and blackberry.

Collections: CR001114-28, PJ010919-20, CR011031-06 from the Wickanninish dunes area to the north end, at the side of the trail close to the parking lot at the edge of the forested area, all approximately N49.02167°, W125.67467°. PJ010919-10, CR 021016-14 and CR021016-04, from the spruce fringe area alongside the southern part of the Wickanninish boardwalk, N49.015733°, W125.67335°.

| RFLP: | | | | |
|------------|------------------|-------|---------------|----------|
| Collection | ITS1-F to ITS4-B | HinfI | AluI | Sau3A |
| 021016-14 | 865 | 365 | 340, 258, 190 | 320, 257 |

Notes: A.H. Smith made a collection he identified as *Russula pectinata* from Crescent City, a coastal town in Northern California, and which was subsequently

studied by Singer (1957). The collections from Wickanninish match the description of *R. pectinata* given by Romagnesi (1967) except that the local collection has larger spores, up to $9 \times 7 \mu\text{m}$ instead of up to $7.7 \times 5.7 \mu\text{m}$. The spore size does match that of the description of *R. pectinata* by Singer (1957) for mostly North American material. The colour of local collections is darker than that of Romagnesi's description, but he mentions the texture of the cuticle which sometimes breaks up into areolae, and the presence (in his illustrations) of longer, more cylindrical pileocystidia such as those very occasionally seen in Wickanninish collections. Romagnesi states that the taste is acrid, not bitter, *R. praetervisa* (= *R. pectinatoides* f. *amarescens* Romagn.(nom. inval.)) is very similar to the Wickanninish collections in taste as well as most morphological characters and is a Mediterranean species of coniferous-hardwood forests on sandy soils. Singer (1957) gives the habitat for *R. pectinata* as under conifers and *Fagales* in damp depressions while Romagnesi gives it as under broadleaved trees in grassy openings on clay soils. The Wickanninish soils are sandy but close enough to the ocean to be kept moist by the fog-belt and rain. *Russula cerolens* is very similar and these collections were at first thought to be a darker variant of that species, since it is common further south, but the RFLP patterns of *R. cf. pectinata* were most similar to those derived from *R. pectinata* sequence data published through GenBank. However, very few of the *Pectinata* had been sequenced at the time of writing and there may be other species with similar RFLP patterns. In consequence, and pending further information, the Wickanninish collections can only be regarded as a species close to *R. pectinata*.

Russula amoenolens is very similar, with an odour and appearance that matches the above collections, the spores however have warts that are mostly isolated and the habitat is with coastal pines and oak (i.e. dryer than at Wickanninish).

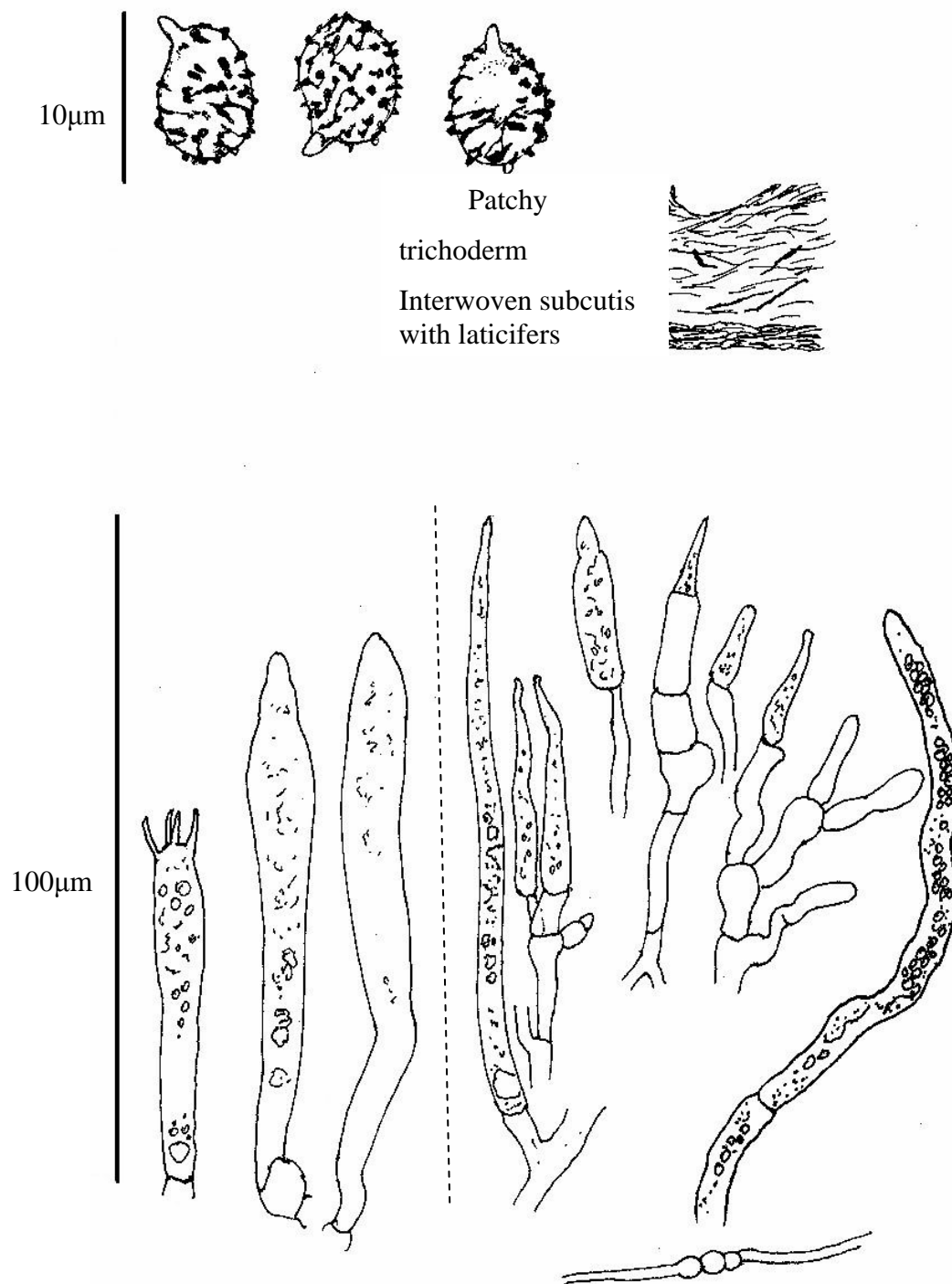


Figure 28. Microscopic characters of *Russula cf. pectinata*: Top, spores with 10µm scale bar; lower left, basidia and hymenial cystidia; lower right, pileocystidia, hyphal ends in epicutis and laticifer, bottom, occasionally occurring bulbous hyphae near septum, lower scale bar is 100µm.



Figure 29. Macroscopic characters of *R. cf. pectinata*: Top, illustration showing the cap and gill colour of immature, mature, longitudinal section and gills, coloured square is 1cm² and shows spore colour; middle, *R. cf. pectinata* in situ (photograph by A. Ceska); bottom, specimens showing typical lenticular stipe cavities, red-

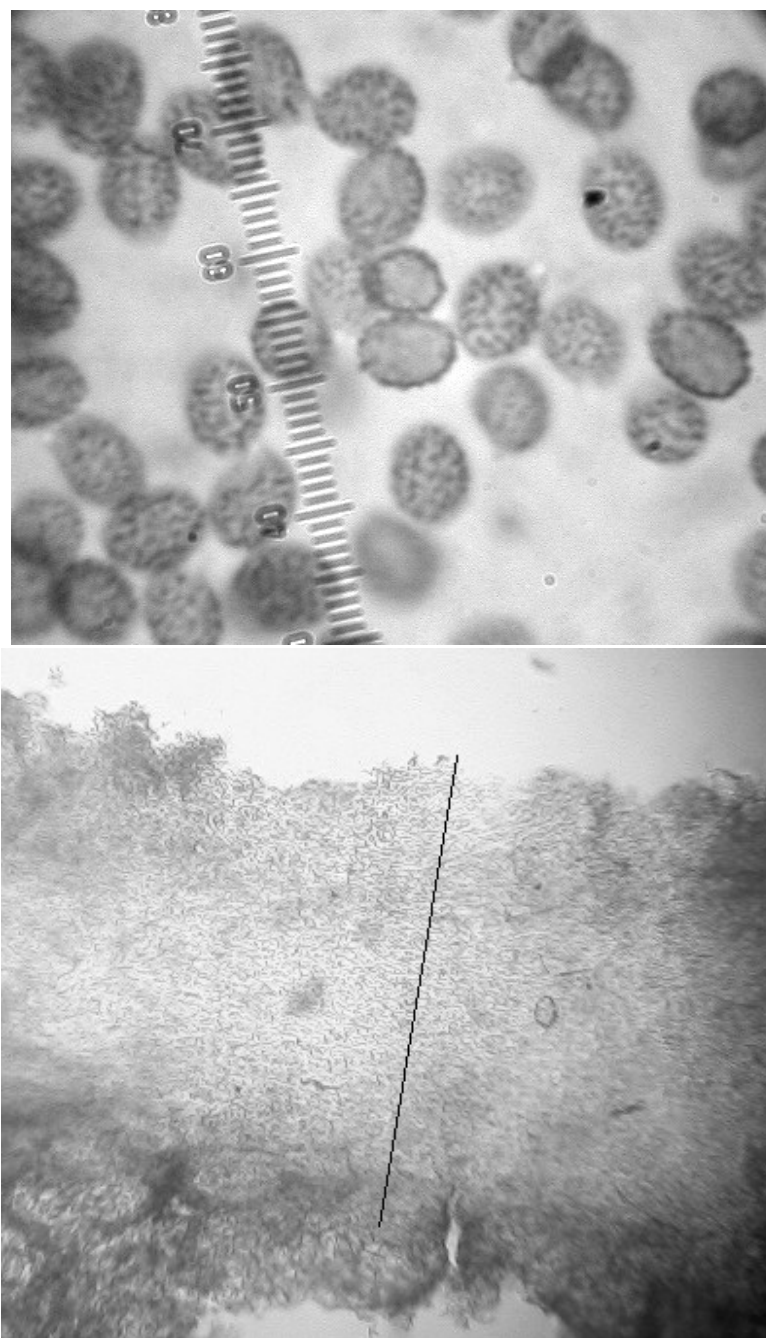


Figure 30 Microscopic characters of *R. cf. pectinata*: *Top*, spores with 1μm division scale; *bottom*, section through cutis showing uneven epidermal layer, tightly interwoven subcutis and more pigmented hypodermis at the junction with cap trama, scale bar is 500μm.

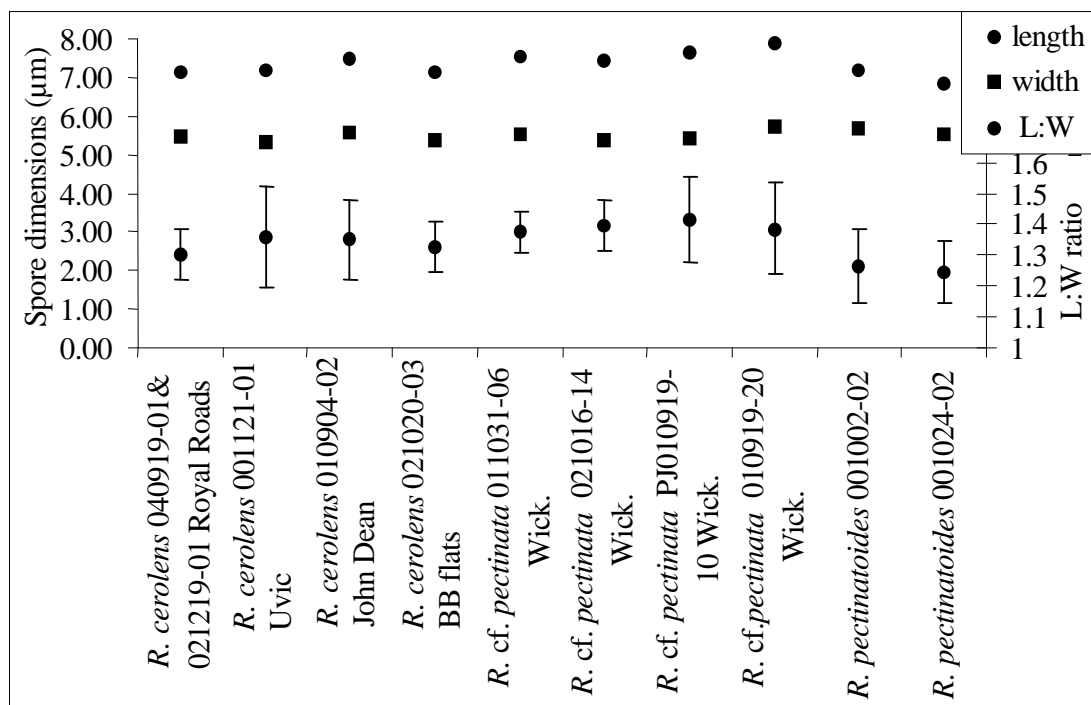


Figure 32 Comparison of spore dimensions and L:W ratio of *Russula cerolens*, *R. cf. pectinata* and *R. pectinatoides*. Error bars on ratio are one standard deviation and the difference between *R. cerolens* and *R. cf. pectinata* are not significant at $\alpha = 0.5$, but *R. pectinatoides* differs significantly from the other two ($p = 0.002$).

Table 2 Morphological characters of closely related species in the *Pectinata* obtained from the literature as mentioned.

| Russula species | <i>R. sororia</i> sensu Romagnesi 1967 | <i>R. amoenolens</i> sensu Romagnesi 1967 | <i>R. cerolens</i> sensu Shaffer 1972 | <i>R. pectinatoides</i> sensu Shaffer 1972 | <i>R. pectinata</i> sensu Singer 1957 |
|-----------------------------|--------------------------------------------------------|-----------------------------------------------------------|-------------------------------------------------------|------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| Cap diameter (cm) | 5-10 (12) robust, rare | 3.5-6, firm | 4-8, firm Shaffer, 5-10 Thiers | 2.5-8 fragile | 4-7, firm at first, soon fragile |
| Stipe length (cm) | 3.5-5 (7) | 3-4.5 | 3-5 | 2.5-5.1 | 2-4.3 |
| Stipe width (cm) | 1-2.5 | 0.9-1.5 | 1-2 | 0.5-2.0 | 0.6-1.4 |
| Bruising | rusty inside stipe | yellowing in stipe, grey-brown | rusty at base of stipe only | brownish at base of stipe | grey-brown at stipe base, not reddish brown |
| Odour | spermatic, like amoenolens but weaker, fruity | Jerusalem artichokes, Camembert, spermatic | bleach-ozone | spermatic-waxy with fruity, fishy or rubber component | smoked herring, spermatic, camembert or pleasant, of Jerusalem artichokes when young |
| Taste | slowly acrid | slowly strongly acrid, oily | slowly acrid & soapy | spermatic, waxy, mildish to faintly acrid, | acrid, sometimes slowly |
| Guaiac reaction | feeble | strong and rapid | strong and rapid | strong and rapid | not known |
| Spore colour | IIb-c | IIb | IIc-d | IIc-d | IIb |
| Spore size (microns) | subglobose 6-8.2 x 5.7-7.2 | ellipsoidal 7-8.5 (9) x 5-6.7 | ellipsoidal 6-8.7x 4.8-6.5 | varied, broadly elliptic-elongate 5.4-8.4 x 4.6-7.3 up to 10.9 x 7.7 in some basidiomata | subglobose 6-10 x 6-8.5, most 7.3-9 x 6-8 |

| Russula species | <i>R. sororia</i> sensu Romagnesi 1967 | <i>R. amoenolens</i> sensu Romagnesi 1967 | <i>R. cerolens</i> sensu Shaffer 1972 | <i>R. pectinatoides</i> sensu Shaffer 1972 | <i>R. pectinata</i> sensu Singer 1957 |
|----------------------------------------------|-----------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|
| L:W | | | 1.15-1.45 | | |
| Spore ornamentation (μm) | up to 0.4 Woo 1B-1C | up to 0.75 warts mostly isolated, partial reticulum rare, Woo 2B | up to 0.8 Woo 1B-C, 2b-2C-2D | up to 1.0 (1.4) Woo 2A-2B(3A), isolated (Singer 1958), forming an incomplete reticulum (Shaffer 1972) | 0.6-1.0 mostly isolated or in pairs |
| Basidia (μm) | 40-65 x 7.5- 10 | 38-55 x 6.5- 10 | 38-67 x 5- 11.3 | 34-51 x 6.2- 11.3 | 35-40 x 8-10 |
| Hymenial cystidia (μm) | 63-110 (225) x 7- 10, SV++ | 60-115 x 6.5- 9.5 μm , sometimes of two types, SV++ sometimes with yellow oily inclusions in base | 37-97 x 5.3- 10.2 μm , occasionally with inflated tips to 17 μm . SV++, embedded or projecting to 40 μm . | sometimes two types; 40-79 x 5.7- 10 μm greyish- yellow SV+, embedded, and 39-90 x 7.2-13.6 μm , constricted apices, almost SV-, hyaline, projecting to 36 μm | 40-78 x 7-10 versiform, often appendiculate SV+ |
| Pileocystidia | tapered | tapered, black in SV, yellow globules | tapered, SV- or weak SV+ | subfusiform or tapered, sometimes terminal button, sparse SV+ granules | |
| Epicutis hyphae | ramified, articulate, some thin, some wide | | hyphal ends articulate, sometimes like beads, | articulate, sometimes inflated or subfusiform, | filamentous, with oleiferous hyphae |

| Russula species | <i>R. sororia</i> sensu Romagnesi 1967 | <i>R. amoenolens</i> sensu Romagnesi 1967 | <i>R. cerolens</i> sensu Shaffer 1972 | <i>R. pectinatoides</i> sensu Shaffer 1972 | <i>R. pectinata</i> sensu Singer 1957 |
|------------------------|------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|-------------------------------------------------------------------|
| | | | inflated cells to 5.7 or 10µm common. | some with granular contents, ends \pm capitate | |
| Habitat | broadleaved, (conifers?) clay, chalk and sandy soils | littoral pines, deciduous oak woods in warm. dry areas, mediterranean zone. | Under pine and spruce, sometimes on dunes, weedy edges of Douglas fir, oak, blackberry, salal. | open areas in mixed woods, sometimes on rotten wood | Under conifers and <i>Fagales</i> in damp depressions |
| Peeling | | 1/4 to 3/4 | less than 1/4 | 1/3-2/3 | |
| Other | | | 5% NH ₃ OH no effect | 15% NH ₃ OH strong red- brown | |

***Russula granulata* Peck sensu Shaffer**

Peck. 1901, New York State Mus. Ann. Rept. 53: 843, *pl. C, f. 1-5*.

Shaffer 1972, Mycologia 64: 1019.

Description of Vancouver Island collections

Cap 4.7-8.6cm, dome-shaped when young with incurved margin, becoming centrally depressed at maturity but retaining the incurved margin, sometimes lobed, striate to slightly tuberculate, but finer and not as lumpy as others in the *Ingratae*, from 1/5 to 1/4 the radius. Colour dark yellow-brown to dull brown with reddish-brown speckles over the centre when young and with a whitish bloom, becoming a paler dull yellow brown at maturity with red-brown streaks and mottles from the centre outwards almost to the striations, feeling rough to the touch and visually with a minutely granular texture. The granules look loose but are in fact part of the cutis. Buttons not viscid, mature caps viscid when wet, drying matte, becoming areolate, peeling 1/4-3/4 the radius with the trama immediately beneath tinted pale brownish.

Trama pale greyish cream, not discolouring when cut.

Gills pale cream, bruising and spotting rust-brown, close to crowded, narrowly adnexed to almost free, adnate at the margin, arched, about 1.5 times the depth of the cap trama at mid-radius, occasional lamellulae and some forking throughout the radius.

Stipe 5.0-7.6 x 1.4-2.2cm, clavate, firm, stuffed but developing 4-5 lenticular to irregular cavities. Stipe surface dingy white, pruinose at the apex, smooth to slightly rugulose below, with red-brown stains at the base, unchanging where cut.

Texture firm and not particularly brittle.

Taste mild at first, slowly becoming increasingly peppery with a soapy component.

Odour strong, spermatic with coconut or maraschino and almond components but less sweet and more soapy. Shaffer mentions a cocoa component to the odour which was not apparent in these collections.

Spore colour pinkish cream Romagnesi IIc-d in tone but a little pinker.

Spores 5-8 μm x 4.2-6 μm , ellipsoidal to broadly ellipsoidal, L:W 1.1-1.6, warts 0.5-0.8 μm , bluntly conical, isolated or 2-3 joined by fine lines, sometimes warts in rows, roughly longitudinally oriented, **Woo types** 2A, 2B. **Suprahilar patch** inamyloid, or a very pale greyish area in Melzer's reagent, with a scattering of very tiny warts.

Hiliferous appendix 1.5-2 μm long, around 1.2 μm wide at base. **Basidia** 40-58 x 7.5-10 μm , clavate or narrowly clavate, 4-spored. Sterigmata 4-6 μm long and up to 2 μm wide at the base. **Cheilocystidia** and **Pleurocystidia** 50-110 x 7.5-10 μm , protruding 10-22 μm beyond basidioles, arising from within the subhymenium or occasionally the trama, narrowly clavate or fusoid, shape fairly smooth and even rather than contorted as in other *Pectinata*, tips mostly rounded, occasionally with a small button, contents refractive, yellow in 5% KOH or water, purple in SV.

Subhymenium about 20-35 μm thick, pseudoparenchymatous, gill trama of sphaerocytes of varying sizes but very few vascular hyphae.

Cutis 250-550 μm thick, consisting of an uneven light brownish epicutis 40-70 μm thick but missing in patches and a thick subcutis of interwoven pale yellow hyphae which become slightly darker towards the bottom and merge gradually into the trama so that there is no strongly defined division between the two tissues. **Subcutis** interwoven, becoming looser towards the top and embedded in a gelatinous matrix and with many yellow, refractive vascular hyphae 3-8 μm wide that rarely react with SV. Cuticular hyphae 1-4 μm wide, of uneven diameter with occasional short inflated sections giving some of them a knobbly appearance. **Epicutis** of loosely interwoven hyphae terminating in more or less upright, chains of short, moderately inflated cells giving them an articulated appearance, the apical cell may be rounded and undifferentiated or a cystidium. The septa between these articulated cells appear yellow and thickened at the edges. Hyphal ends tend to be clumped to form the

"granules" seen macroscopically, and are bound with a brownish gelatinous matrix through which some of the end cells protrude, while others are confined by it.

Pileocystidia frequent but clumped into the granules, of more or less capitate lanceolate to tapered cells, 10-75µm by 3-6 wide at their base, with light brown refractive contents not staining in SV.

Trama of clusters of sphaerocytes bound by a hyphal mesh with occasional SV+ vascular hyphae.

Chemical reactions: FeSO₄ - greyish on stipe surface, pinkish on trama; KOH - darkening the cuticle, slightly yellowish on stipe, on dried material the cutis becomes bright red-brown; guaiac - blue-green; phenol -purplish brown; SV - no effect on cutis, purple on gills. Shaffer notes that 30% KOH turns the flesh strongly red-brown, but this was not tested on local material.

Habitat and tree associations: In a stand of 50-70-year-old Douglas fir with understory holly, Canadian dogwood, snowberry, Pacific blackberry and grass, in early November.

Collections: CR001108-01 and CR001108-02, in a stand of mature Douglas fir, Royal Roads University, to the west of the main entrance, N48.439150°, W123.478183°; and N48.437767°, W123.479517° respectively.

| Collection | ITS1-F to | RFLP: | | |
|-------------|-----------|-------|---------------|----------|
| | ITS4-B | Hinf1 | Alu1 | Sau3A |
| CR001108-01 | 827 | 390 | 340, 260, 200 | 310, 235 |

Notes The Vancouver Island collections agree very well with the descriptions in Shaffer (1972), from which further information may be derived. *Russula granulata*, according to Shaffer (1972), Singer (1957) and Bills (1984), is rather cosmopolitan in its habitat, having been recorded from mountainous and lowland areas under a variety of hardwood and coniferous trees. The collections described here are the only ones made from Vancouver Island to-date and the first records for British Columbia. Another collection made from a similar habitat at Rocky Point in December of the

same year (2000), initially thought to be this species, was found to be closer to *R. pectinatoides*

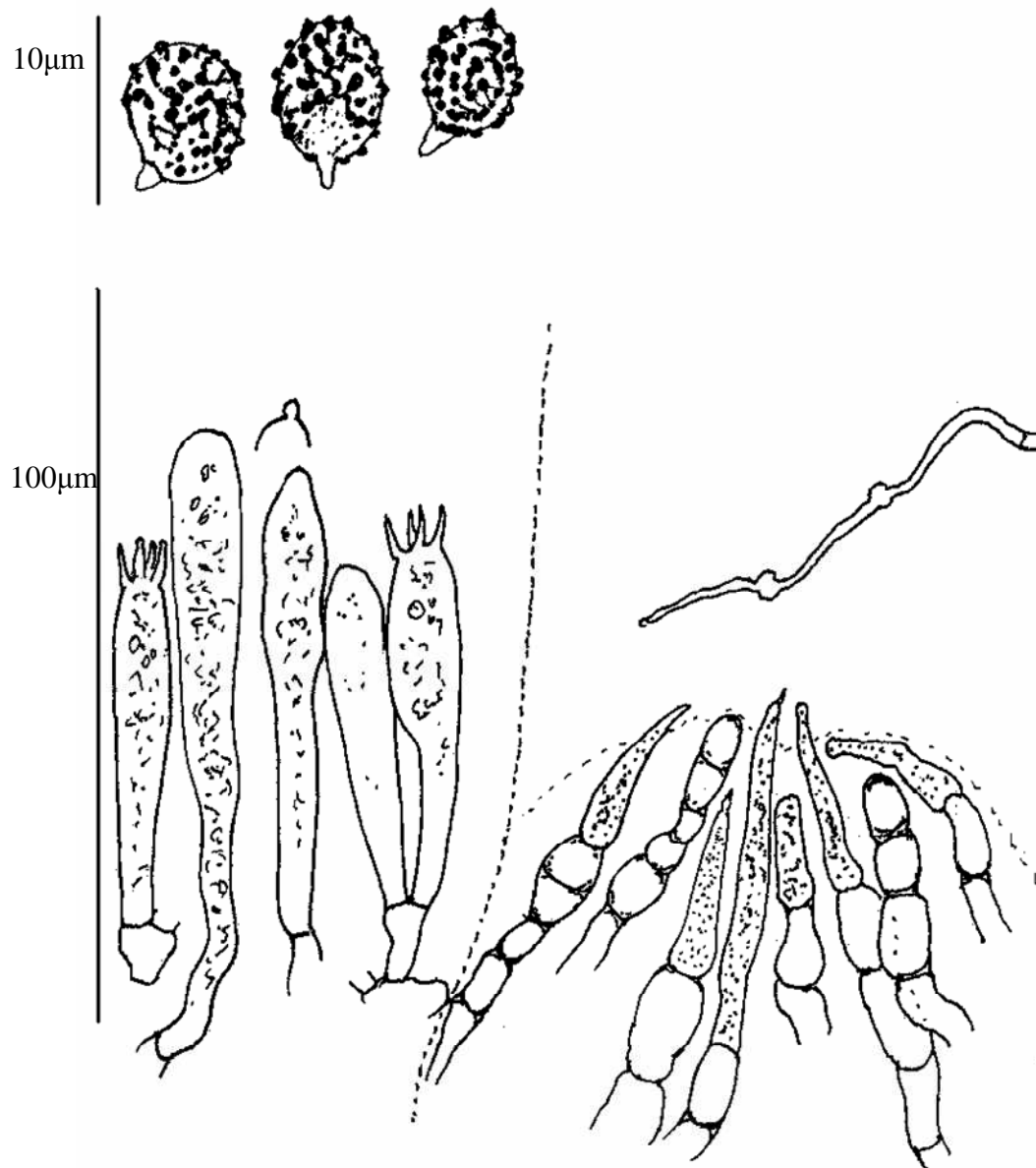


Figure 33. Microscopic characters of *R. granulata*: Top, spores with 10µm scale bar; lower left, basidia, hymenial cystidia and basidia with basidiole; lower right, pileocystidia and hyphal ends in epicutal granule, faint dotted line over them represents the gelatinous matrix. Above is a common form of cuticular hyphae with uneven diameter and bulbous sections, lower scale bar is 100µm.



Figure 34. Macroscopic characters of *Russula granulata*: Illustration of immature, mature and longitudinal section, coloured square is 1cm² and shows spore print colour.

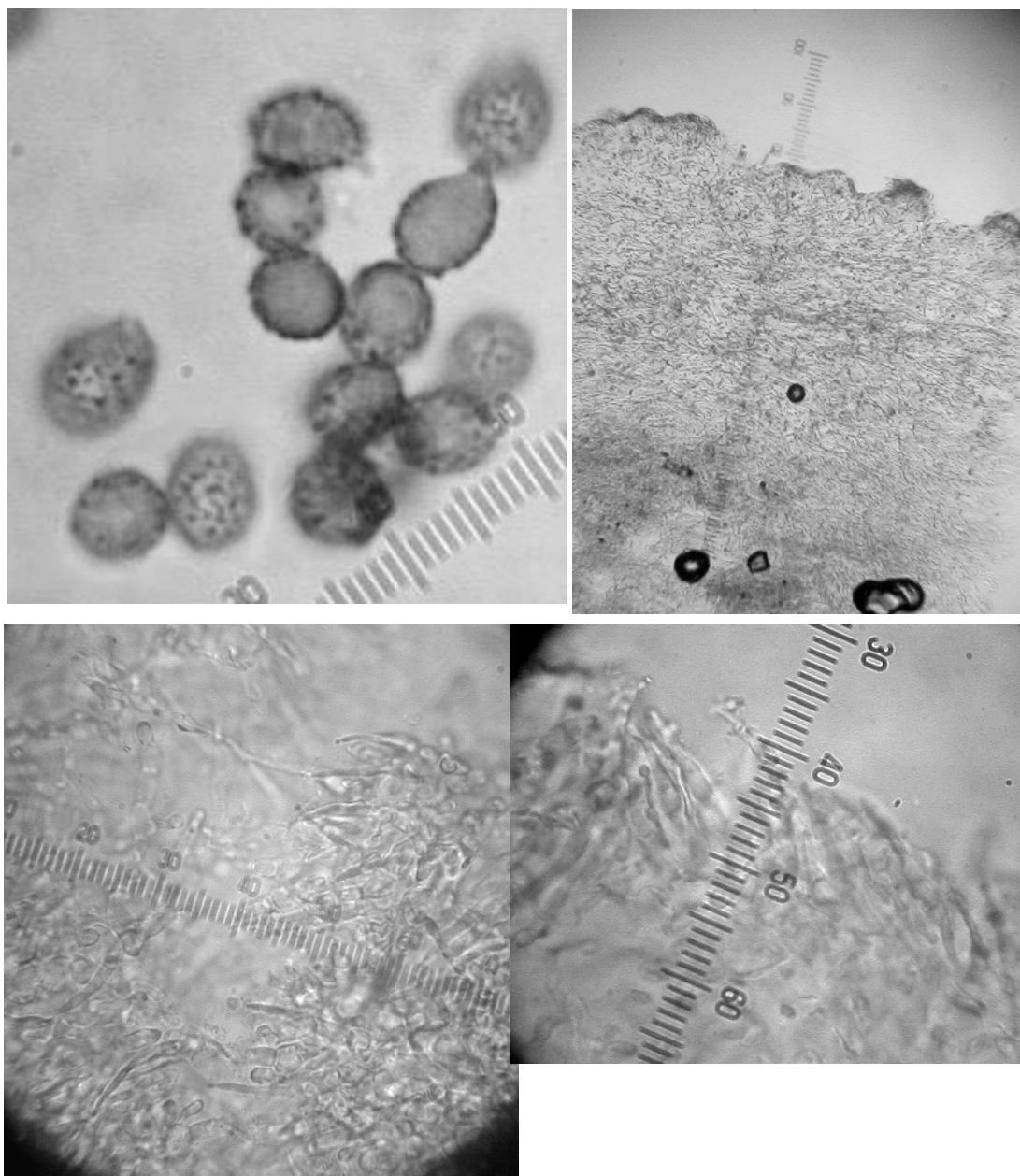


Figure 35. Characters of the hymenium and cutis of *R. granulata*: Top left, spores with 1 μ m division scale; top right, section through cutis showing the relatively deep subcutis and the uneven epicutis, the raised bumps give the granular appearance to the surface, 10 scale divisions are 100 μ m; bottom left, surface view of the epicutis showing many lanceolate-capitate pileocystidia and articulated inflated hyphal ends; bottom right, section through one of the epicutal "granules" showing the same structures clustered, the gelatinous coating which normally binds the clump together has been dissolved by the 5% KOH used in the mount, 10 scale divisions are 25 μ m for both lower photographs.

Clade 3c

Series *Foetens* Sarnari ad int. (Foetintinae ss. Str. Bon)

This group shares the strong odours, simple, yellow-brown cuticular pigments, browning flesh of the stipe and cream spore print found in the sister taxa of the *Pectinata*. Series *Foetens* differs in having generally larger basidiomata, pigment mainly membranal (rather than vacuolar), cylindrical to clavate pileocystidia of normal size rather than tiny lanceolate ones, and larger spore ornamentation which can form wing-like ridges.

Russula fragrantissima Romagn. sensu Shaffer

Shaffer, 1972, Mycologia 64: 1044.

Romagnesi, 1967, Russules d'Europe et d'Afrique du Nord: 350.

Description of Vancouver Island collections

Cap 6-16cm, spherical when young, becoming plane with a depressed centre, margin acute, not or rarely upturned, striate-tuberculate about 1/3 to occasionally almost 1/2 the radius. Colour pale ochraceous yellow to clear yellow-brown, sometimes with light reddish-brown marks or radial streaks especially in the centre, the centre usually a little darker than the margins, colours often darkening more with age. Surface radially moderately rugulose, viscid when wet and very sticky, especially when young, and leaving a glutinous residue on the fingers, drying subshining, sometimes becoming areolate toward margin, peeling only about 1/4 the radius with the trama immediately beneath tinted the cap colour.

Trama creamy white, unchanging when cut but browning where insect damaged and in the stipe.

Gills pale cream, bruising and spotting rust-brown, subdistant to close, narrowly adnexed to almost free, occasional lamellulae and forking, mostly towards the margin but sometimes also near the stipe, slightly decurrent at stipe and acute to narrowly obtuse at the margin. Shape somewhat ventricose (see Fig) with the deepest point about 1/3 in from the margin, deeper than cap trama even when very young, becoming up to twice the depth at mid-radius., usually developing red-brown spots in age. Both Shaffer and Romagnesi mention that the gills are often beaded with moisture, and this was also observed in these local collections.

Stipe. 4-11.4 x 1.2-4.9cm, generally shorter than cap diameter at maturity, ventricose, stuffed, developing 8-9 lenticular cavities, becoming hollow in age, and staining strongly brown inside. All collections of young buttons had a light blue-green layer of tissue inside the stipe rind at the base of the stipe and extending 1/4-1/3 up the stipe, a character not mentioned in other descriptions. Stipe surface cream, smooth to slightly rugulose, sometimes with broad grooves, turning yellow-brown to reddish-brown where handled and at the base.

Texture firm and not particularly brittle but becoming so in age.

Taste slightly bitter and becoming peppery to acrid even in the stipe.

Odour strong, of maraschino cherries or cheap almond essence, developing an oily, rancid or stale component as it ages.

Spore colour pale cream Romagnesi IIa.

Spores 6.5-9 x 5.8-7.5µm, broadly ellipsoidal to subglobose, L:W 1-1.35, average 1.17. **Ornamentation** of warts up to 1.4µm, a few to 1.8µm, none as high as 2µm, bluntly conical to peg-like, some isolated, most joined with a heavy partial to complete reticulum made up of narrow wavy ridges up to the height of the warts and unevenly amyloid, **Woo types** 2-3E. **Suprahilar patch** inamyloid to very weakly amyloid, a poorly defined pale area with tiny warts, or often with similar but lower ornamentation to the rest of the spore. **Hiliferous appendix** 1.5 to 2µm long, around

1.2µm wide at base. **Basidia** 30-54 x 10-15µm, clavate with a tapering base, 4-spored, similar in shape to those found in subgenus *Russula* rather than the narrow cylindrical shape associated with the *Pectinata*. Sterigmata 5-7µm long and around 1.5µm wide at the base. **Cheilocystidia** around 60-80 x 7-12µm, abundant in young caps but lost in older caps, gill margins almost sterile, more or less cylindrical to fusoid and tapering downwards, arising in the subhymenium, ends obtuse or mucronate or with a small button, yellow in 5% KOH, colourless to brownish pink in SV. **Pleurocystidia** abundant, fairly densely distributed, 50-100 x 6-8µm, cylindrical to narrowly clavate arising within or from the base of the subhymenium, protruding about 10-18µm beyond basidioles contents amorphous, yellow in 5% KOH and slowly grey to deep purple-brown in SV. **Subhymenium** about 20-35µm thick, pseudoparenchymatous, gill trama of sphaerocytes and frequent vascular hyphae.

Cutis 200-250µm thick at half-radius, in young but mature caps 250µm at the margin to 600µm over the disc with many vascular hyphae staining a granular dark brown in SV. In three layers: **Subcutis** 80-100µm thick (of a 250µm thick cutis section), of hyaline, interwoven radially aligned hyphae 1.5-4µm wide, embedded in a gelatinous matrix and many yellowish vascular hyphae with refractive contents staining dark brown in SV. **Epicutis** approximately 50µm thick. of more or less repent hyphae and free hyphal tips with many pseudocystidia 3-6µm wide and often over 100µm long, originating in the subcutis and generally being the terminal cells of vascular hyphae, with tips obtuse to strangulated or capitate, the latter the most common type. On the epicutal surface lie many long, narrow, curved, yellowish hyphae of uneven diameter but on average about 1.5µm wide. **Pileocystidia** uncommon, mostly in young caps, 38-100 x 5-8µm, narrowly clavate, with refractive contents staining brown in SV. In mature caps the pseudocystidia are so dense as to make it hard to pick out the pileocystidia. **Hypodermis** of densely packed radially aligned brown hyphae and flattened cells, with many vascular hyphae

Trama quite dense, of clusters of sphaerocytes bound by a hyphal mesh and frequent vascular hyphae.

Chemical reactions: FeSO₄ - greyish salmon to brownish pink; KOH - no reaction or slightly darkening the cuticle, orange-brown on stipe; NH₄OH - no reaction; guaiac - strongly blue-green; phenol - pinkish brown; SV - cutis and gills dark brown.

Habitat and tree associations: common under Sitka spruce in forested glades on beach dunes, in the spruce fringe behind the dunes and under old-growth Sitka spruce-western hemlock forest alongside an estuary, and inland/upstream from this area in lowland western hemlock forest with occasional Sitka spruce. Season late August to early November.

Collections: CR 980825-03 and CR010814-05 from under a large Sitka spruce in estuarine forest at Port Renfrew, collections made three years apart, N48 5767°, W124. 3933°. CR030924-01 from a stand of old-growth Sitka spruce, western hemlock and western red cedar at the corner of Island Road in estuarine forest at Port Renfrew, N 48.5660°, W 124.3990°. CR030927-01, from regeneration western hemlock forest in the Lizard Lake area upstream from the Port Renfrew estuary N 48.603833°, W 126.205833°. CR001011-56 in an open stand of Sitka spruce with salal and red alder, within the spruce fringe alongside the boardwalk at Wickanninish dunes; CR011031-RF and PJ010919-03 under closed canopy forest in the same area, and 021016-WD from a forested pocket within Wickanninish dunes under Sitka spruce, shore pine and western hemlock, Pacific Rim National Park, N 49.016317°, W125.673400°.

Notes The Vancouver Island collections agree on most characters, particularly the

| RFLP: | | | | |
|-------------|------------------|-------|----------|--------------|
| Collection | ITS1-F to ITS4-B | HinfI | AluI | Sau3A |
| CR010814-05 | 845 | 405 | 522, 250 | 285, 260,180 |
| CR030924-01 | 845 | 395 | 522, 260 | 305, 260 |
| CR030927-01 | 870 | 400 | 569, 220 | 285, 211 |

spores, with Shaffer's 1972 description of North American material, to which the reader should refer for additional information. Local collections peel only at the margin as in Romagnesi's description, rather than up to 3/4 as in Shaffer's, the

vascular hyphae and pseudocystidia do stain in SV, and the flesh is peppery, characters associated with Shaffer's 1972 description of North American *Russula laurocerasi*. Shaffer also notes that he made collections that had some characters of both *R. fragrantissima* and *R. laurocerasi*.

Russula foetens (Pers. ex Fr.) Fries has mostly isolated spore warts and a more foetid odour, but is otherwise similar to *R. fragrantissima* and *R. laurocerasci*, and these latter species have probably been mis-identified as *R. foetens* in some reports.

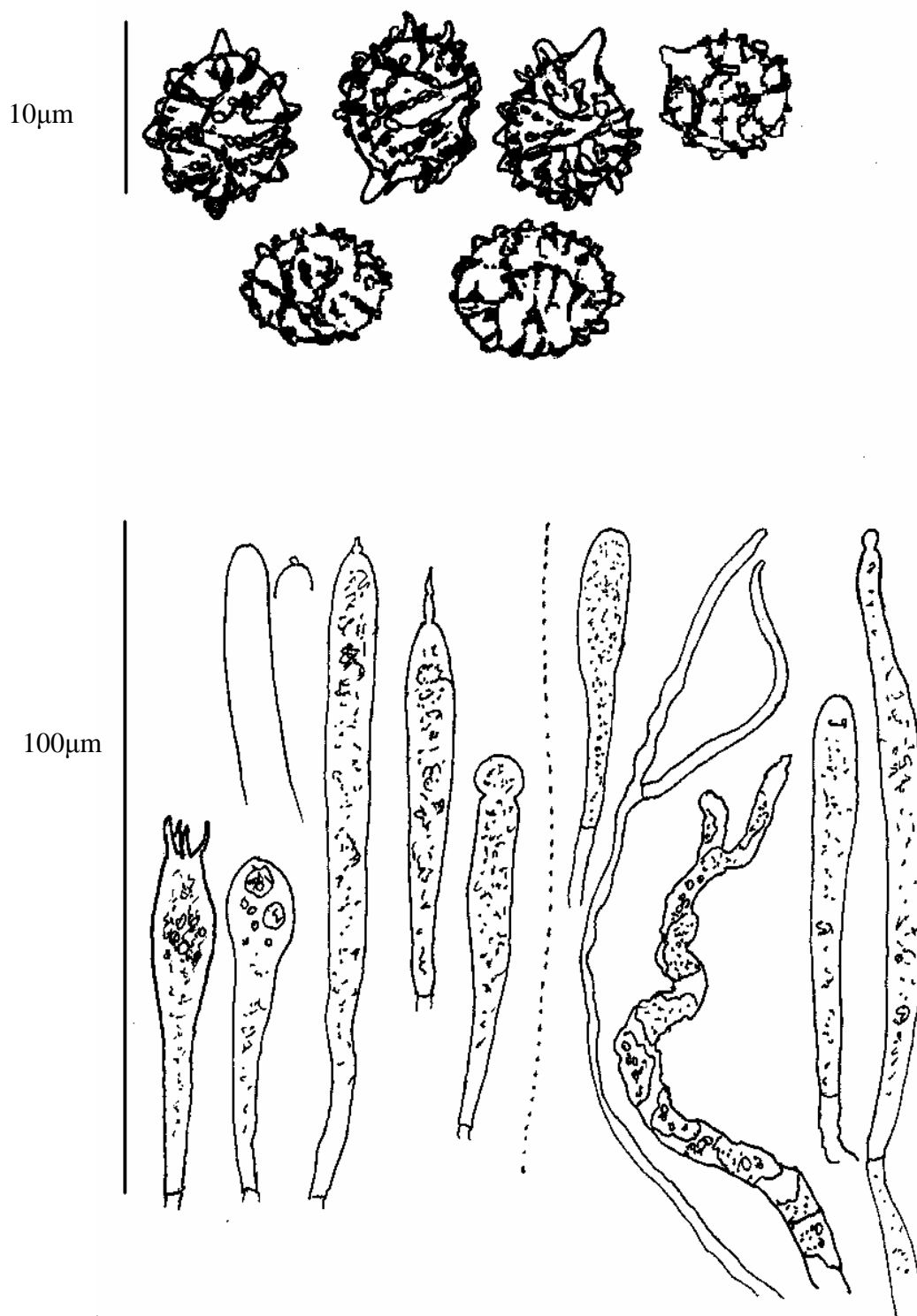


Figure 36. Microscopic characters of *Russula fragrantissima*: Top, spores with 10µm scale bar; lower left, basidia, basidiole and hymenial cystidia; lower right, pileocystidia, hyphal ends, laticifer and pseudocystidia in epicutis, lower scale bar is 100µm.

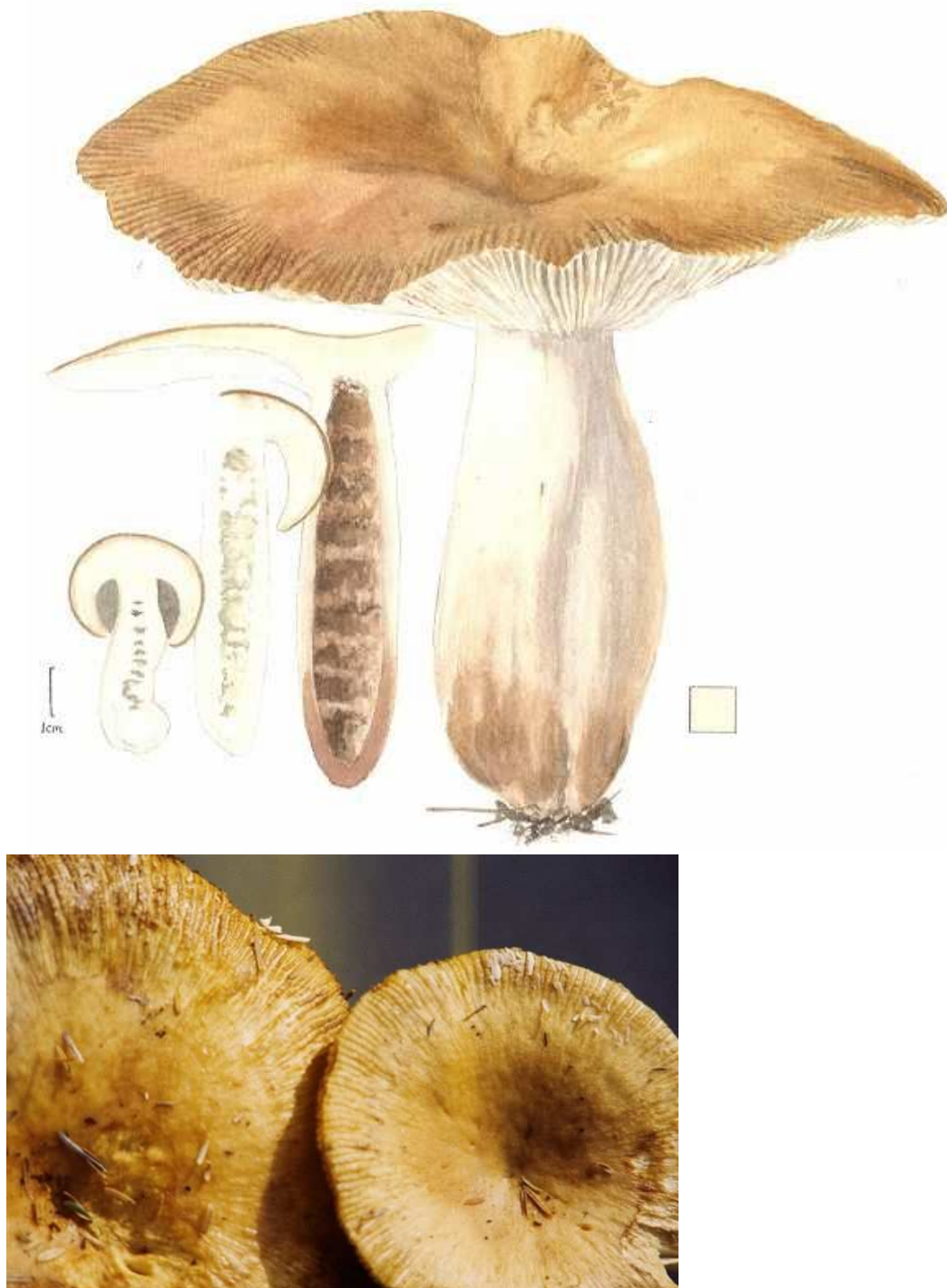


Figure 37. Macroscopic characters of *R. fragrantissima*: Top, illustration of sectioned immature stages in which the cavitation and discolouration of the stipe is evident, note the pale blue-green layer of tissue in the extreme base of the stipe in the buttons, also a mature basidioma in profile, the square is 1cm² and shows spore colour; bottom, surface of cap showing the ochraceous yellow colour and the tuberculate margins typical of the *Ingratae*.

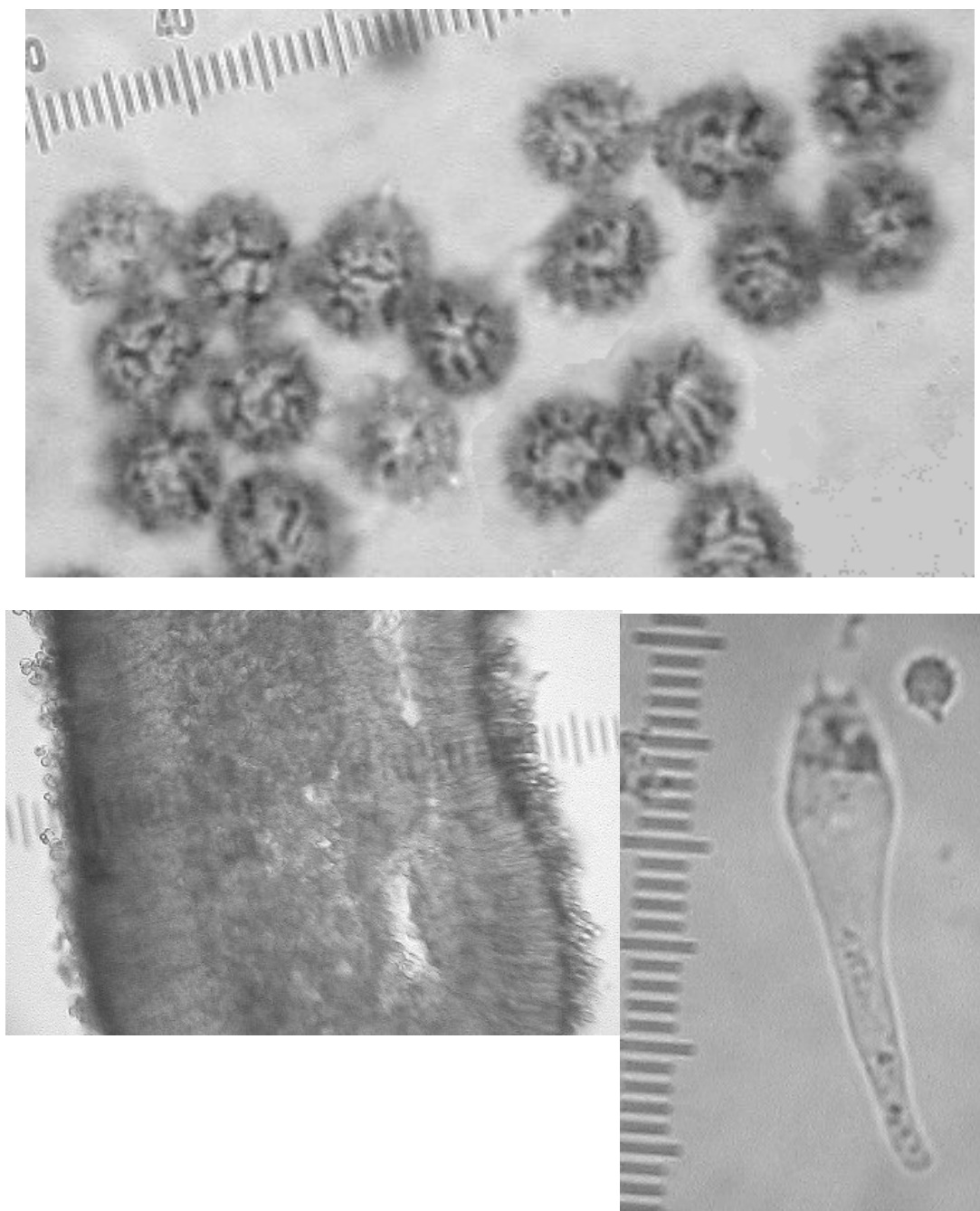


Figure 38. Hymenium of *R. fragrantissima*: Top, spores with 1µm division scale; bottom left, section of gill mounted in 5% KOH, white bar shows extent of subhymenium, 10 scale divisions are 25µm; bottom right, basidia with adjacent immature spore, scale as left.

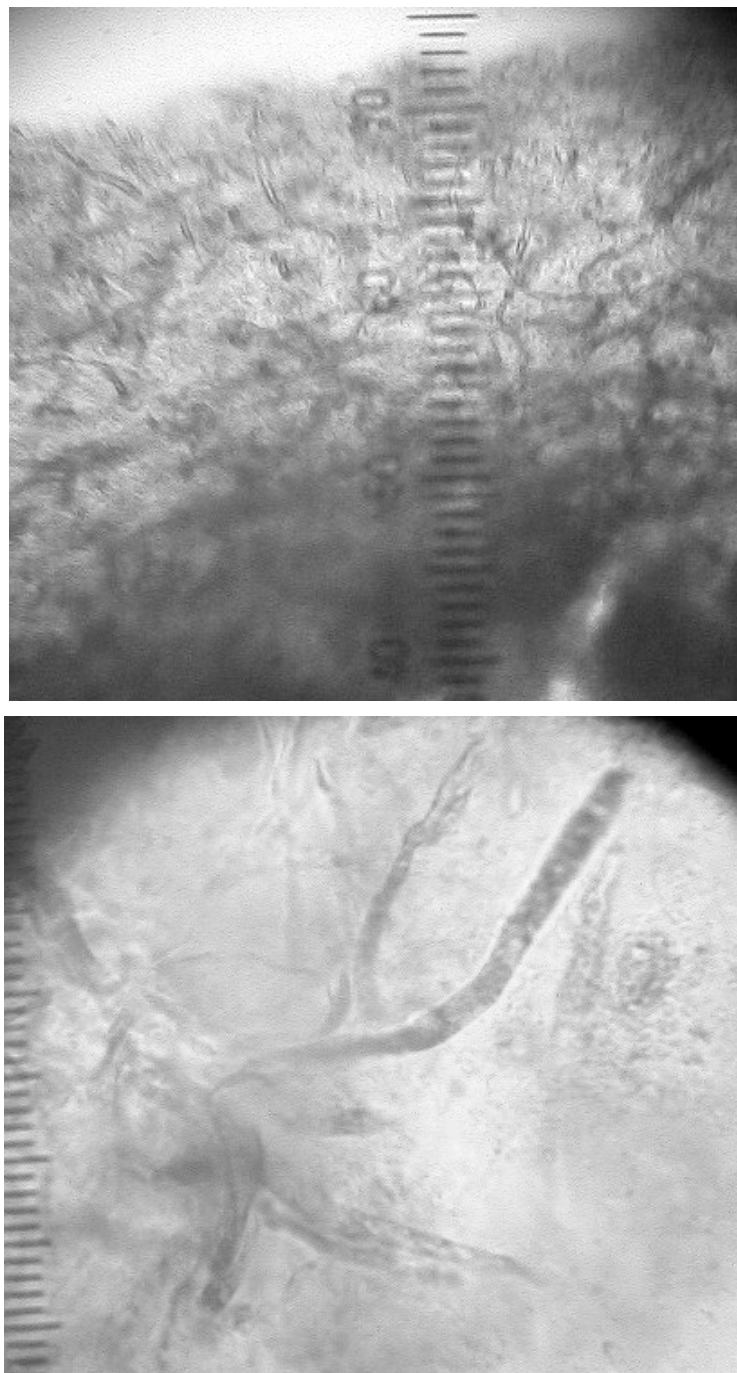


Figure 39 Cutis of *R. fragrantissima*: Top, section through entire cutis, 10 scale divisions are 100µm; bottom, surface view of epicutis with pileocystidia in SV, 10 scale divisions are 25µm.

Subsection *Farinipedes* Singer

Agaricales in Modern Taxonomy , Ed. 4:817, 1986

Russulas in this subsection share many of the general characteristics of the *Ingratae*, namely the simple yellow-brown cuticular pigmentation, the inamyloid to weakly amyloid suprahilar patch on the spores, and the lenticular cavities in the stipe trama. The *Farinipedes* differ in the white spore print, voluminous pileocystidia, and fruity rather than bleach, spermatic or benzaldehyde odours. The characters of this group have similarities with both subgenus *Ingratula* and subgenus *Russula*.

***Russula pallescens* Karsten**

Karsten 1889, Kritisk Ofversigt Finlands Basidsvampar: 463

***Russula farinipes* Romell**

Romell in Britzelmayr 1893, Hymenomyceten aus Südbayern 9:239, tav. 515, f. 106

Description of Vancouver Island collections

Cap 2.4-7.0cm, immature caps assumed to be convex, expanding to broadly dish-shaped with downcurved margins, eventually margins upcurved to form a deep bowl shape, all the while retaining a central flattened umbo. Margins tuberculate to almost 1/2 the radius, more or less radially rugulose over the rest of the cap. Colour cream to pale ochraceous yellow, fairly uniform in some caps, darker in the centre in others, with damaged areas light yellow-brown. Surface sticky to viscid when wet, drying matte, not peeling at all.

Trama pale yellowish cream, unchanging to becoming dull yellow where cut, very thin, 1.5-3mm at half-radius and thinning to a few cells thick outwards, virtually non-existent at the margin.

Gills whitish to pale cream with slight brownish spotting in age, distant, intervenose, acute at cap margin, adnate with a decurrent tooth at stipe, margin entire, more or less straight-edged or ventricose and deepest at half-radius, 3-7 mm deep depending on the size of the pileus, 4 to 5 times the depth of the cap trama at that point. Lamellulae very few, one or two per cap, not forked or only near margin.

Stipe 3.8-9.0 x 0.5-1.1cm, equal to or longer than the cap diameter, cylindrical but slightly widening at the apex, cream, becoming brownish-yellow on handling and at the base, otherwise unchanging where cut, pruinose at apex, longitudinally slightly rugulose, stuffed, with 12 to 16 small lenticular cavities which remain distinct into maturity but eventually converge, the stipe becoming hollow.

Texture quite tough and firm to average *Russula* texture, not particularly fragile, gills pliable.

Taste acrid.

Odour a complex but subtle mixture of fruity, perfume and fishy components.

Spore colour Romagnesi between 1a and 1b.

Spores 7-9 x 5.5-7µm, bean shaped to broadly ellipsoidal, warts hemispherical to bluntly conical, most up to 0.5µm but a few to 0.8µm, many small ones dotted between the larger ones but this character varies from spore to spore; warts isolated or 2-3 or more joined by fine lines, not forming a reticulum, **Woo types** A1-2, B1-2.

Suprahilar patch a pale, inamyloid to weakly amyloid well-defined area bordered with warts, often speckled with several minute warts radiating out from the hiliferous appendix. **Hiliferous appendix** 1.5-2µm long, about 1.2µm wide near the base.

Basidia 45-52 x 7-10µm, narrowly clavate to clavate, 4-spored but 2-spored ones common. Sterigmata 7-10µm long, slender, 1-1.5µm wide at the base.

Cheilocystidia variable in abundance, some parts of the gill with very few, others with similar density to that of the pleurocystidia on the gill face. **Pleurocystidia** abundant, 55-100 x 7-10µm, with yellow refractive contents, staining strongly blue-

black in SV, fusoid, ends acute, capitate, or with a short series of narrowing strangulations, arising in the inner regions of the subhymenium or the trama.

Subhymenium 20-30µm thick, pseudoparenchymatous. **Gill trama** of sphaerocytes of quite varying sizes, with frequent vascular hyphae.

Cutis 120-150µm over the disc, thinning to 60µm or less at the margin. **Subcutis** comprising about 1/2 to 2/3 the depth of the cutis, of repent, somewhat compressed hyaline to pale yellow hyphae 1-3µm wide, embedded in a gelatinous matrix, and becoming darker in the lower approximately 50µm, forming a sometimes distinct, sometimes gradual boundary with the trama. The subcutis contains abundant vascular hyphae 4-9µm wide, tortuous, with yellowish refractive contents. **Epicutis** 40-60µm thick, of more or less upright, loosely interwoven brownish hyphal ends and pileocystidia embedded in the gelatin, the uppermost surface is almost entirely of pileocystidia. Epicutal hyphae 1.5-5µm, sometimes nodulose, this being somewhat variable between basidiomata, but with undifferentiated terminal cells, inflated-articulate termini not seen. **Pileocystidia** abundant, voluminous, 55-150 x 5-9µm, unicellular, with pale yellow refractive contents that stain weakly to strongly grey in SV, tips acute, capitate or with a strangulated appendix, accompanied by occasional pseudocystidia, the terminals of laticiferous hyphae and with slightly stronger yellow highly refractive contents that stain purple-black in SV.

Trama of clustered sphaerocytes with hyphal mesh and frequent vascular hyphae.

Chemical reactions: FeSO₄ - pale brownish; KOH - orange-brown on cap cutis, no reaction on stipe; NH₄OH - bright ochre-yellow on cap, no reaction on stipe; guaiac - weakly blue-green; phenol - purplish-brown; SV - almost no effect on cutis, purple on gills.

Habitat and tree associations: The collection from Carmanah was found under old growth Sitka spruce, western hemlock and western red cedar, the collection assumed to be from the Sooke area was reported as from a second-growth western hemlock coastal forest, with blueberry.

Collections: CR020927-02 from Carmanah grove between the Fallen Giant and Heaven grove, N48.65700°, W124.697167°. 021020-02, brought in to the South Vancouver Island Mycological Society annual show 2002, location unrecorded but probably near the Sooke area.

Notes This mushroom is commonly regarded as *Russula farinipes* and may be that

| RFLP: | | | | |
|---------------------------|------------------|-------|----------|----------|
| Collection | ITS1-F to ITS4-B | Hinf1 | Alu1 | Sau3A |
| 021020-0 | | | | |
| (as <i>R. farinipes</i>) | 809 | 364 | 493, 252 | 300, 200 |

species, but in European literature it is reported as under broadleaved trees, particularly *Fagales*, whereas the very similar *Russula pallescens* is its equivalent from coniferous forests. Sarnari (1998) reports it as a rare northern species (in Europe). Morphological differences are that *R. pallescens* has a flattened umbo, slightly larger spores (7.2-9 x .4-7.4) with low warts and some ridges as opposed to those of *R. farinipes* with spores 6.4-8 x 5.8-6.7 with small, isolated, pointed warts. The cuticular hyphae of *R. pallescens* have oddly-shaped, sometimes inflated-articulate ends giving it a jigsaw-puzzle appearance in surface view through a microscope (Sarnari 1998) whereas those of *R. farinipes* are normal hyphae. In the Vancouver Island material, the epicutal hyphae were generally of the normal type, although the occasional oddly shaped, inflated element could be found. The spores of local material are closer to those of *R. pallescens* and the habitat is coniferous forest, although broadleaved trees such as red alder and many shrubs are common in forest openings and cannot be excluded as the host. The flattened umbo was quite apparent in the collection from the Sooke area, less so in the Carmanah collection. The mushroom is quite rare, with very few records from the Pacific Northwest. Grund (1962) collected this species once from coniferous forest in the White River Valley, Washington State. His description shows the spores to have some reticulation and to be of the size and ornamentation for *R. pallescens* rather than *R. farinipes*. Grund identified this species as *R. farinipes* because *R. pallescens* was unlikely to have been known to him, its description not being in the literature available to him. Local

collections are closer to *R. pallescens*, although the above description appears under both names, partly because *R. farinipes* is locally known, correctly or not, and partly because it is possible that both species do co-exist.

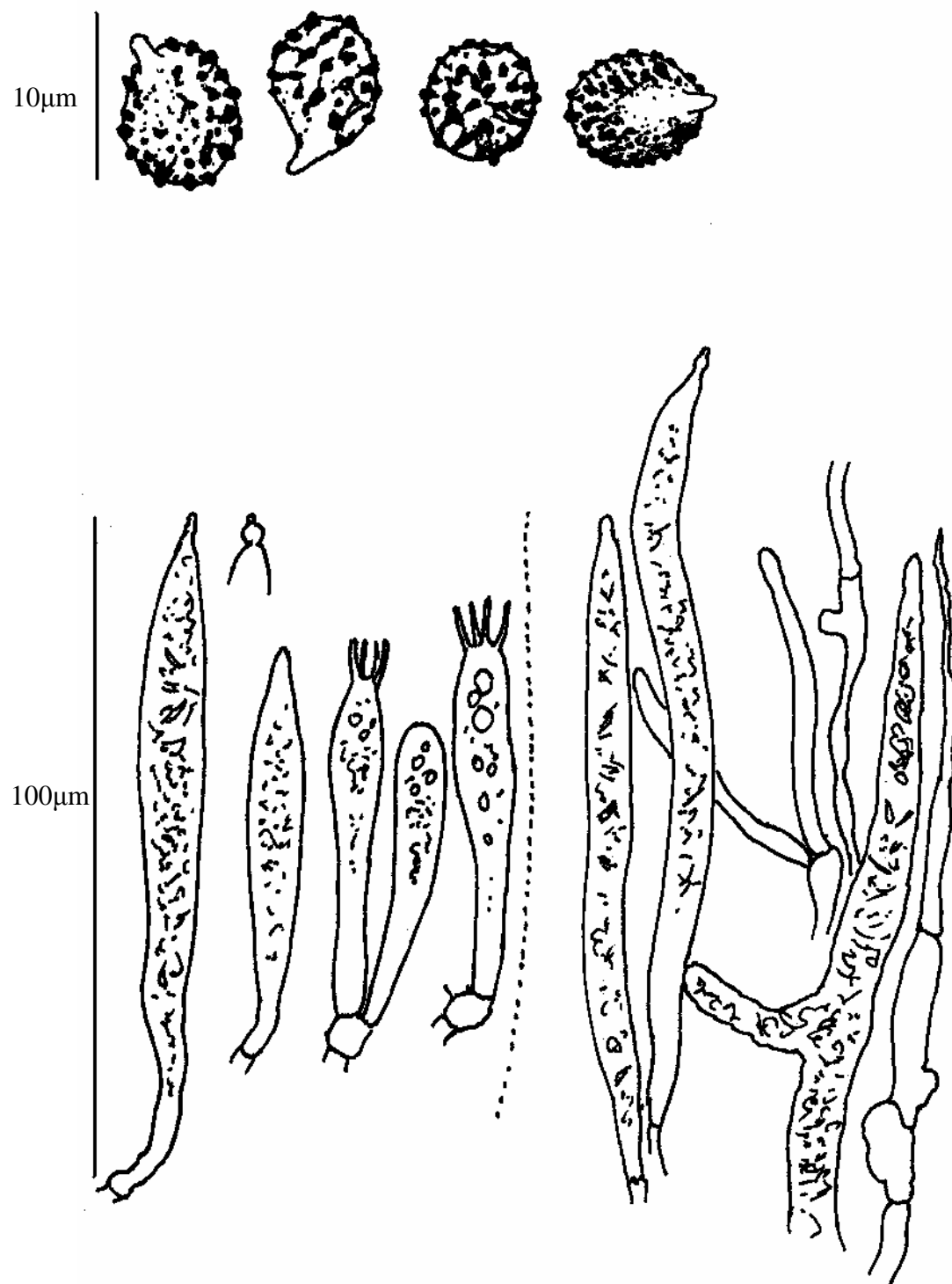


Figure 40. Microscopic characters of *Russula pallescens*; top, spores, bar is 10µm; bottom left, hymental cystidia, basidia and basidiole; bottom right, pileocystidia, epicutal hyphae and terminus of laticifer, bar is 100µm.



Figure 41 Macroscopic characters of *Russula pallescens*: Top, collection of mature basidiomata with one cut longitudinally to show lenticular cavities and the flattened umbo, lower left, cap of collection from Carmanah grove showing tuberculate margins and light browning where damaged by slugs, lower right, view of gills showing the distant spacing and interveining.

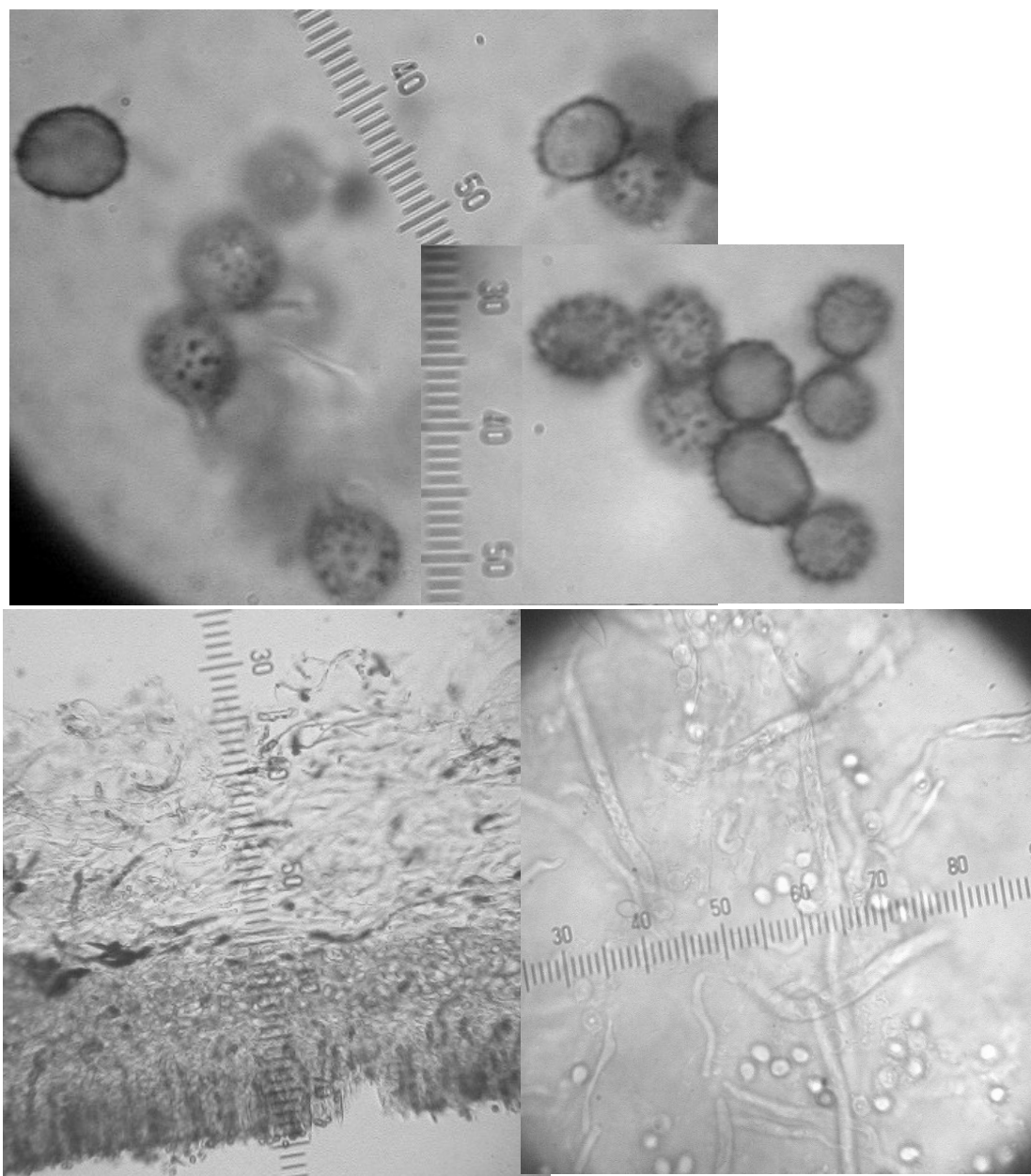


Figure 42 Characters of the hymenium and cutis of *R. pallescens*: Top, spores with 1 μ m division scale; bottom left, section through cutis and trama just beyond the half-radius point, showing some pileocystidia near the surface and many laticifers which appear dark in this view, below the cutis is the trama of sphaerocytes about 60 μ m thick at this point, and immediately below that is the subhymenium and hymenium, with the cystidia appearing dark, 10 scale divisions are 100 μ m; bottom right, a surface view of the cutis showing the pileocystidia, some spores are also visible, ten divisions on the scale are 25 μ m. Both mounts were in 5% KOH.

Subsection *Crassotunicatinae* Singer

***Russula crassotunicata* Singer**

Bull. Soc. Mycol. France 54:132. 1938

Description of Vancouver Island collection:

Cap 3.2-8cm, cream to pale ochre yellow, fairly uniform or slightly more ochraceous over the disc, developing yellow-brown stains where damaged and in age (fig. 43. Immature basidiomata tend to be pulvinate with inrolled margins, this shape is maintained into maturity with the margins becoming incurved rather than inrolled, in age the centre is depressed but the margins mostly remain downcurved to some extent. Margins smooth, not striate until well aged. The stature usually tends to be fairly squat and thick-fleshed. The cuticle is notable for its thick, up to 1mm, translucent, rubbery cuticle which peels 1/2 to completely, viscid when wet but more often with a matte, smooth appearance rather like frosted glass, a little pruinose when young or centrally, but this may become areolate in dry weather and at maturity, drying matte. Flesh white, bruising brown, white under the cuticle.

Gills whitish to pale cream, developing dark brown stains in age and where damaged, arched to plane, narrowing at stipe and cap margin, about equal in depth to that of the cap trama at half radius (about 5mm on an average sized cap) adnate to slightly decurrent at the stipe, acute at the margin, edges entire, close to subdistant, frequent lamellulae not regularly distributed.

Stipe 1.9-7.5 x 0.7-2.6cm, cylindrical or clavate, firm, longitudinally rugulose, white but developing dull yellow bruising where handled and cut, particularly the rind, eventually browning, solid when young, developing usually three lenticular cavities which become irregular and eventually extend to create a hollow stipe in age. The cavitation is intermediate between that of other subgenus *Ingratae* where generally

more than three regularly spaced cavities develop and that of subgenus *Russula* in which usually three rather irregular cavities develop.

Texture firm, slightly elastic and not very brittle.

Taste peppery, the intensity varies between collections.

Odour not distinctive or more often of coconut, sometimes with fruity, yeasty or rubbery components, becoming fishy in age.

Spore colour white, Romagnesi 1a.

Spores 8.3-11.5 x 6.3-10µm, L:W 1.1-1.56 with a mean of 1.27 (n = 49), subglobose to broadly ellipsoidal. **Ornamentation** of rounded to bluntly conical or triangular warts, some quite heavy, many tiny ones in between, 0.2 -1µm, isolated or less commonly two to three joined, no reticulum, **Woo type** A2, occasionally B2.

Suprahilar patch inamyloid, unornamented or with a few tiny dots, surrounded by small warts, hiliferous appendix quite large, 1.8-3µm long, 1.1-1.3µm wide at base, in one case 2µm. **Basidia** 4 spored, 35-55 x 9-12µm, clavate but relatively slender.

Sterigmata 5-9µm long and 1.7-2.2µm wide at the base. **Pleurocystidia** 45-125 x 9-12µm protruding 10-35µm, originating in the subhymenium greyblack / purple / deep pink / not reacting / in SV, contents yellowish and refractive in KOH, mostly fusoid, some unevenly cylindrical, tips tapered, often the taper begins in the upper 2/3, sometimes at a slight shoulder, and ends with small appendage. **Cheilocystidia** 75-110 x 10-13 numerous, protruding around 25-50µm and forming a fringe along the gill margins, more or less fusoid with long tapered tips sometimes ending in a small appendage or button. Both types of hymenial cystidia and the vascular hypahe stain dark purple in SV. **Subhymenium** 25-40 µm thick, interwoven but with a few parenchyma shaped cells, gill trama of remarkably even-sized sphaerocytes with occasional vascular hyphae.

Cutis 300-600µm at half-radius, an ixodermis consisting of a thick subcutis and a relatively thin epicutis which becomes broken up at maturity or dry weather. **Subcutis**

of tightly to loosely interwoven gelatinized pale yellow-brown hyphae 2-5µm wide, occasional inflated septate hyphae up to 13µm wide, often with thickened walls up to 0.8µm in parts, and with a tapering terminal cell, laticiferous hyphae 4 -7µm wide with yellowish refractive contents frequent in the basal layers, black in SV. **Epicutis** 60-100µm thick, of hyphal ends embedded in a fairly tenaceous brownish matrix that adheres the hyphal ends in clumps, sometimes incrusting them, and which renders it very difficult to see them individually. By dampening the cutis of a dried basidioma and scraping the surface with sharp forceps some of the epicutis can be loosened and spread thinly on a slide with 5% KOH for viewing. The inflated-thick-walled hyphal ends make up a large part of the epicutis, the rest being of bluntly terminating laticifers, refractive tapering pileocystidia and the tapering termini of ordinary hyphae. One collection in particular (CR030924-06) is somewhat unusual in that the cuticle is thinner than most of the other collections of *R. crassotunicata* at 300-350 and has an overgrowth of narrower mostly thin-walled hyphae 1-2.5 wide forming a pubescent layer over the centre of the cap. **Pileocystidia** 18-75 x 5-9µm, aseptate, with yellowish refractive SV negative contents, tapering, cylindrical with strangulate ends or short-cylindrical with rounded ends, infrequent and sometimes deeply embedded. **Hypodermis** a few layers of brownish, flattened cells.

Trama of individual and clusters of sphaerocytes bound by a thickish hyphal mesh with numerous laticifers.

Chemical reactions: FeSO₄ -greyish to grey green; KOH -no reaction to slightly yellowish on cap surface, no reaction on stipe; NH₃OH -no reaction; Phenol -slowly brownish purple; SV -brownish purple on the gills, grey-brown on the cuticle, cystidia and vascular hyphae purple to dark grey; acid-fuchsin stains vascular hyphae pink and the epicutal compactions blue-grey.

Habitat and tree associations: In coastal forests and coastal mountains with western hemlock, from August through November. In the Clayoquot area it was recorded from forested pockets in the dunes, the spruce fringe, old growth and second growth (circa 50 year old) rain forest. The substrate may be the forest floor or often on

accumulations of woody debris in advanced decay stages. It appears to require a moist climate. I have not found it in the coastal Douglas fir zone.

Collections: CR000831-02 and CR030924-06, fruiting in moss over a deep litter of very decayed coarse woody debris in an area with many old stumps under regeneration western hemlock and Sitka spruce, China Beach park, N 48.4373°, W 124.0926°. CR000919-01, in sheltered coastal stand of regeneration western hemlock with red alder, Cape Beale trail, Bamfield, N 48.826517°, W 125.145400°. CR001011-07a, near boardwalk with salal under western hemlock in old growth Sitka-spruce-western hemlock-western red cedar sheltered coastal stand on Meares Island, Clayoquot Sound, N 49.1510°, W 125.8600°. CR001012-15, on steep slope with much decayed coarse woody debris under western hemlock and shore pine with salal and huckleberry understory, southwest corner of Kennedy Lake Park just off Grice Bay main logging road, N 49.016883°, W 125.581533°. CR011112-LB.RF. on a decayed log in an old-growth Sitka spruce-western hemlock-western red cedar stand with abundant and diverse understory shrubs along the Central Beach trail at P.R.N.P. south of Tofino N 49.053°, W 125.7155°. One inland collection; CR980818-01, from Elk River Valley, Strathcona Park, amongst western hemlock, Douglas fir and western red cedar, N49.8190°, W 125.8810°.

| | ITS1-F to | RFLP: | | |
|----------------|-----------|----------|--------------|---------------|
| Collection | ITS4-B | Hinf1 | Alu1 | Sau3A |
| CR011112-LB.RF | 827 | 365, 257 | 565, 234 | 300, 226, 159 |
| CR030924-06 | 832 | 374, 244 | unsuccessful | 375, 200 |

Notes: *Russula crassotunicata* can be distinguished from other white-spored, peppery, whitish capped Russulas by its thick peelable elastic cutis, locally often 1mm thick or more when fresh, brown bruising and firm pulvinate cap with margins that rarely become uplifted. A similar species, *Russula compacta* has reticulate spores and a cutis that is thinner and peels only up to 1/2 the radius. *Russula crassotunicata* has been found throughout the Pacific northwestern coastal and coastal mountain forests (Shaffer 1970, Singer 1957, Thiers 1998), and the Vancouver Islands collections closely match these other descriptions of this species,

but extend slightly the range of spore widths (from 7.0-9.3µm in Shaffer 1970). Singer mentions that the distribution of *R. crassotunicata* is predominantly along the west coast, but extends through the boreal forests as far as the Great Lakes region. While Singers' 1957 redescription is thorough, Shaffers' (1970) adds further detail and excellent drawings of the spores, hymenial cystidia and cutis hyphal ends and should be referred to for more information. The epicutis has been described by Shaffer as lacking a gelatinous matrix but being compacted into yellowish brown masses, or by Singer as incrustated with a brownish (in KOH) substance. Whatever the substance, it occasionally leaves an acid and alkali resistant residue on the hyphal ends that appears as an incrustation where the compaction is broken apart.

This species bridges subgenus *Ingratula* of clade 3 and subgenus *Russula* of clade 5. It has the strong browning reaction, lenticular cavities in the stipe, tapered pileocystidia and inamyloid suprahilar patch on the spores of the *Ingratula*, with the separable cutis, coconut odour, incrustations staining in acid fuchsin, smooth cap margins and just three cavities in the stipe, all of which are more characteristic of subgenus *Russula*. Singer placed it in subsection *Crassotunicatinae* within what is now the subgenus *Ingratula*, and it would be appropriate to raise it to the level of section.

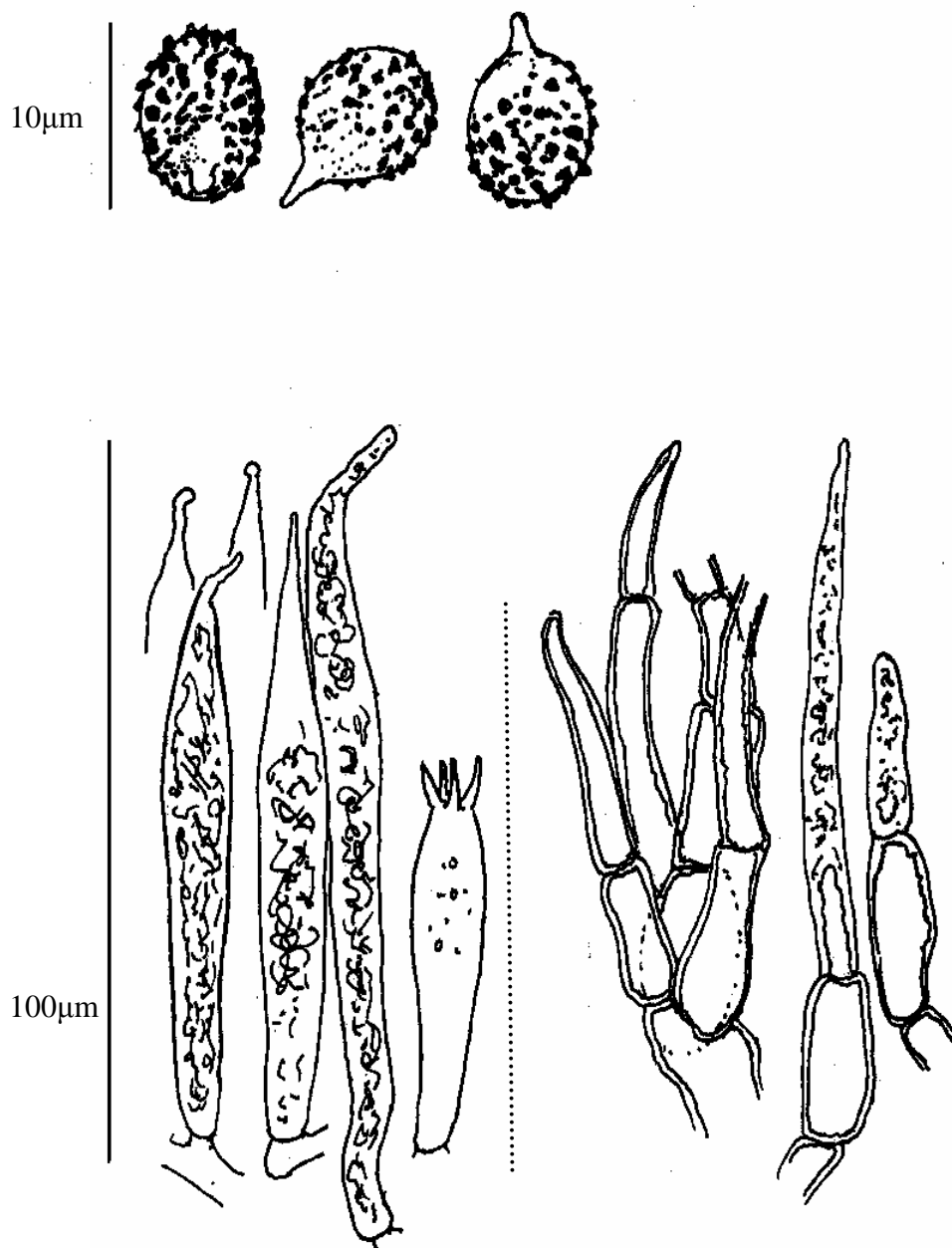


Figure 44 Microscopic characters of *Russula crassotunicata*: Top, spores with 10 µm scale bar; bottom left, hymenial cystidia and basidia; bottom right, inflated thick-walled hyphal ends and pileocystidia from epicutis.

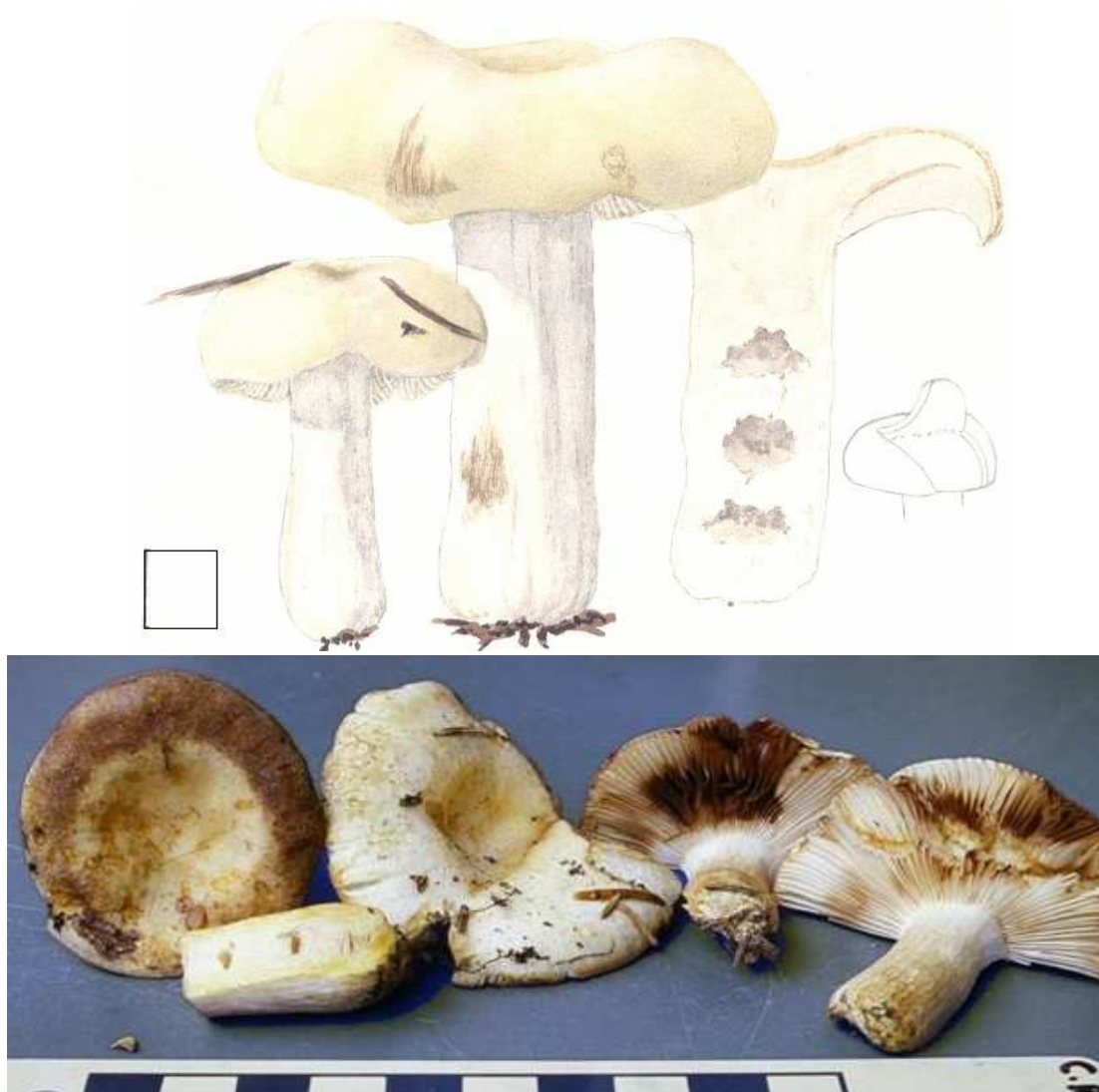


Figure 45 *Russula crassotunicata*: Top, illustration showing profiles of immature, mature and a section through basidiomata, the square is 1cm² and shows spore colour; bottom, a collection from the P.R.N.P. near Tofino, of mature basidiomata showing a considerable amount of bruising on the gills, cap and stipe, the three lenticular cavities within the cut stipe trama, and the initial yellowing that occurs where cut. The black and white scale in the foreground is in 1cm divisions.

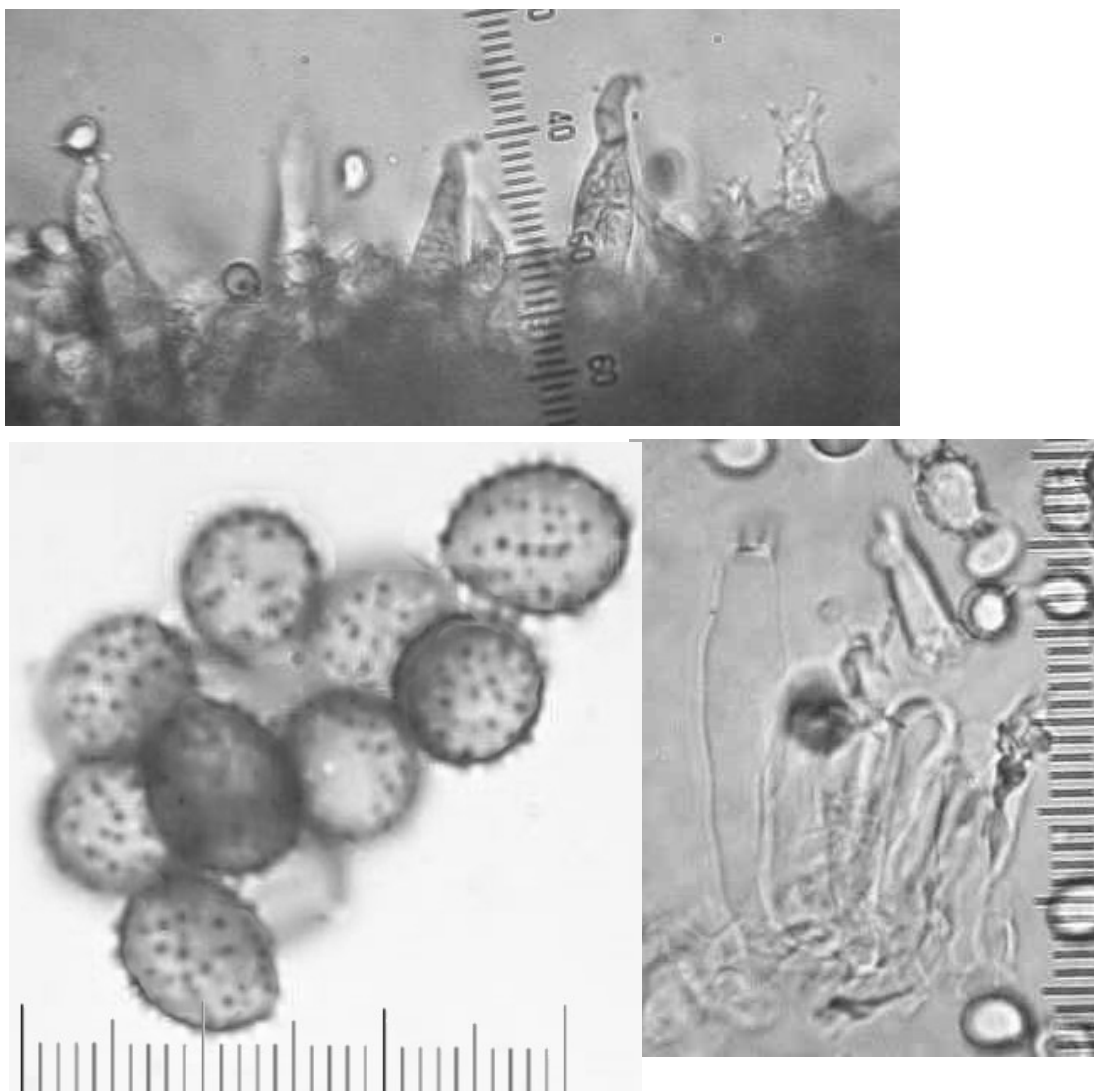


Figure 46 Top; gill margins of *R. crassotunicata* showing cheilocystidia and basidia; below left, spores with 1 μm division scale, composite photograph of two depths of focus; right, basidia and basidioles, 10 divisions on scale are 25 μm .

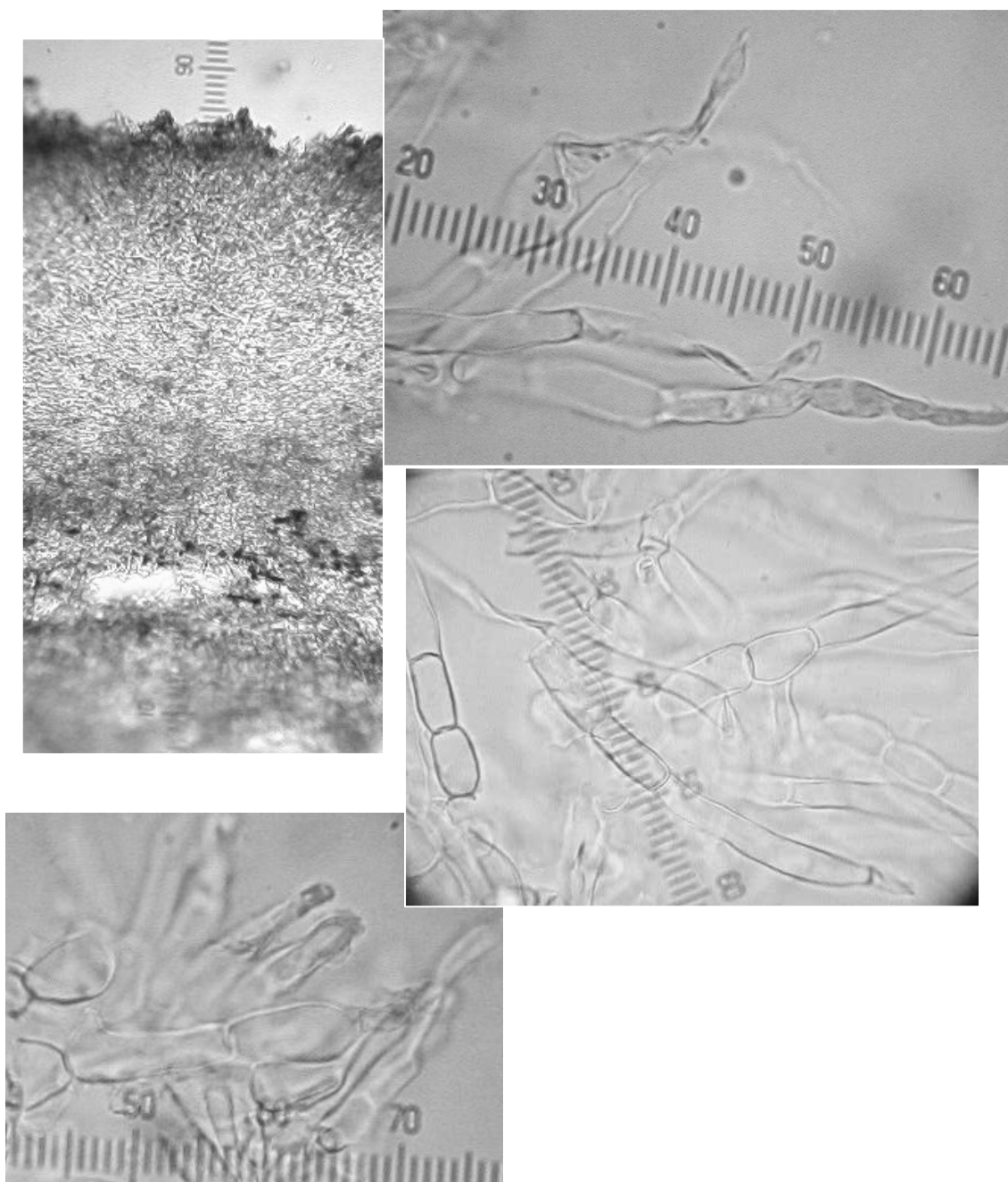


Figure 47. Cutis of *R. crassotunicata*: Top left, section through cutis showing the thick interwoven subcutis and the epicutal hyphae embedded in a dark matrix, 10 scale divisions are 100 μ m; top right, pileocystidia; lower two photographs show thick-walled inflated hyphal ends found in the upper subcutis and epicutis, note that two of the hyphal ends in the bottom left photograph appear incrusted with a yellowish substance that adheres the epicutal hyphal ends in clumps, 10 scale divisions are 25 μ m for the latter three photographs.

Clade 4a

Subgenus *Amoenula* Sarnari

Russula smithii Singer

Bull. Soc. Mycol. France 54:140. 1938

Not yet found on Vancouver Island, but potentially it could exist here since its host tree is Douglas fir.

Description excerpted and interpreted from Singer's original Latin description and Grund's 1965 translation of it, supplemented by photomicrographic illustrations and additional information from examination of the holotype.

Examined: one basidioma, small section of cutis from about half radius, one piece of gill tissue, small piece of cutis of one of the broken off pieces, which was from near the cap margin.

Cap 8-15cm diameter, convex at first, later depressed, dark red-brown to purple-brown to very dark brown centrally, pea green to Lincoln green (a deep clear leaf green without a blue or yellow bias). Singer described the centre as reticulate-venose, it is not entirely clear if this referred to texture or pigment, but on examining the holotype the cutis over the disc was wrinkled radially, with the wrinkles interweaving to form a reticulation, and Singer noted that this is under the gluten. Surface viscid becoming sub-viscid and sub-smooth, pruinose when dry (the dried specimen appears minutely velutinous) margin smooth, not peeling easily. **Trama** white becoming pale yellowish, greenish-brown under the cutis at the margin. Singer noted that the dried pilei were irregularly applanate with a central depression, blackish brown centrally merging through olivaceous to green at the margin. (Even after 45 years the greenish tint remains apparent, though neither bright nor strong and a little brownish.)

Gills cream becoming tinged yellow-green, close, narrowly adnexed at stipe, rounded at cap margin, strongly anastomosing, subochraceous in dried basidiomata and only about 4mm deep.

Stipe 6-8 x 2-4.5cm, firm, hard, cylindrical or broadening slightly at the base, solid, surface pruinose-fibrillose at first, white but with a rose-pink flush at the apex and over most of the surface.

Texture firm to hard, not brittle. In the herbarium specimen, very hard.

Taste mild.

Odour not recorded.

Spore colour white, presumably *Romagnesi Ia* or close.

Spores 8-11.5 x 7.5-10µm, subglobose to short-ellipsoidal, ornamentation of rounded to peg-like warts, some incompletely amyloid, mostly isolated, occasionally two or three joined with lines, not forming a reticulum, small dots interspersed, warts 6-1.2µm but mostly 0.9-1.2µm, **Woo types** 2A, 3A, 2B and 3B. (Singer described the spores as type VI, VIII, seldom IV, and rarely IIIb in his own key). **Suprahilar patch** lightly amyloid, irregular in outline and bordered by small warts.

Subhymenium well developed, 40-60µm thick, interwoven, gill trama of sphaerocytes. **Basidia** 2- or 4-spored, clavate, 37-55 x 10-15µm. Ripe basidia and cystidia protruding well beyond basidioles, to 1/3-1/2 their length. **Pleurocystidia** and cheilocystidia numerous, thin-walled, empty or with refractive contents towards the tip in 3% KOH, 62-85µm long, width very variable, 5-17µm (Singer's measurements were 5.8-13.0µm). Shapes range from irregular to cylindrical to clavate to fusoid, often with constricted sections. Tips are rounded, broadly acute, elongated or capitate. Singer noted that the contents were granular towards the tip and that occasional ones were encrusted. Cystidioid hairs from the gill edge are an unusual character in *Russula*. They are not frequent, but are distinctive, and sometimes have refractive contents in the terminal cell. They are narrowly clavate, 4-

8-septate, sometimes constricted at the septa, sometimes with a side appendage or outgrowth, and around 70-90µm long and up to 11µm wide. Singer described the gill margins as heteromorphic, with cylindrical to acute-fusoid, frequently septate, cystidioid hairs 37-68 x 8-9µm, and with variously shaped septate hyphae with mostly acute tips, 3-4µm (-8µm) wide and sometimes bifurcate or laterally appendiculate.

Cutis interwoven, with no clear division between the subcutis and the tramal tissues, approximately 300-350µm thick at half-radius. **Epicutis** not really distinct from the subcutis, of free hyphal ends emanating from an interwoven layer, not forming a regular turf, just irregular free articulated hairs, constricted at the septa, upright to semi-repent, 90-110 x 2.5-9µm, the terminal cell frequently acuminate (narrowing to a point), basal inflated cells not seen. No refractive contents in any elements, no vascular hyphae seen, no granular cytoplasmic pigments, and no acid-resistant incrustations seen.

Trama of discrete clusters of sphaerocytes bound by a hyphal mesh.

Chemical reactions: KOH - transitorily pale reddish-brown on cap surface; SV - on gills, red with no darkening at all of the hymenial cystidia beyond the overall red, on cutis brown, no pileocystidia seen, no elements staining positively (grey, black or blue).

Habitat and tree associations: In the Olympic mountains under *Pseudotsuga menziesii* (Douglas fir). (In Singer's description it is listed as under *Pseudotsuga taxifolia*, an older name for *Pseudotsuga menziesii*.)

Collection examined: Smith A. H. 2466, holotype, collected 14th September 1935, from Boulder Creek, Olympic Mountains, Olympic National Forest, Clallam County, Washington State.

Notes: *Russula smithii* is known only from the single type collection and is therefore very rare. *Russula smithii* bears some similarities to *R. brunneola*, namely, the spore colour, the cap colour and texture and the close taxonomic position. The green tints

on some collections of *R. brunneola* were initially misleading in making an identification since that colour is not mentioned in the descriptions examined (and discussed under that species' description), and they were considered to potentially be *R. smithii*. Once the holotype of *R. smithii* was examined, it differed in the spore ornamentation, which consists of isolated warts and a lightly amyloid suprahilar patch (unusual in this taxonomic group), the presence of septate cystidioid hairs on the gill margin and in its lack of pileocystidia. I have personally not examined other members of subgenus *Amoenula* so can not adequately judge the taxonomic position Singer applied to *R. smithii*, however, the spores have a size, shape, ornamentation and amyloid suprahilar patch very like those of clades 8–10, and the relatively broad basidia are more in keeping with those clades. The septate cystidioid hairs of the gill margin are also seen in clade 9 (see *R. brunneoviolacea*), as are the hymenial cystidia in having refractive contents mostly at the tips. The firm trama is also found in several species in clade 8, for example *R. integra*, and the epicutal hyphae of *R. smithii* show similarities in septation and shape as those in clade 8, some species of which have few to no pileocystidia.

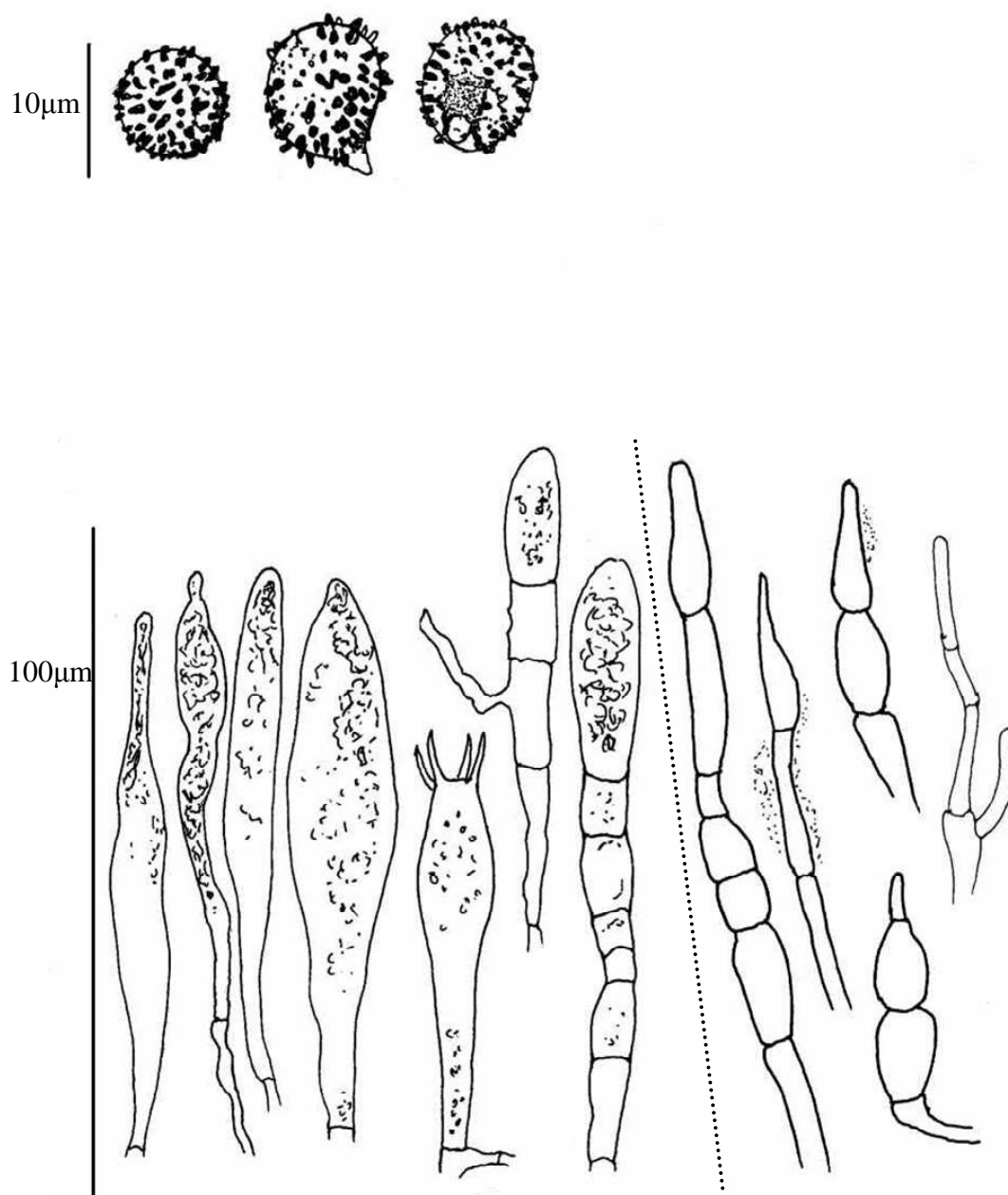


Figure 48. Microscopic characters of *Russula smithii* holotype 2466: Top, spores with 10µm scale bar, bottom left, hymenial cystidia, basidia, and two septate cystidioid hairs from the gill margin, marked 'c h'; bottom right, hyphal ends from the epicutis, lower scale bar is 100µm.

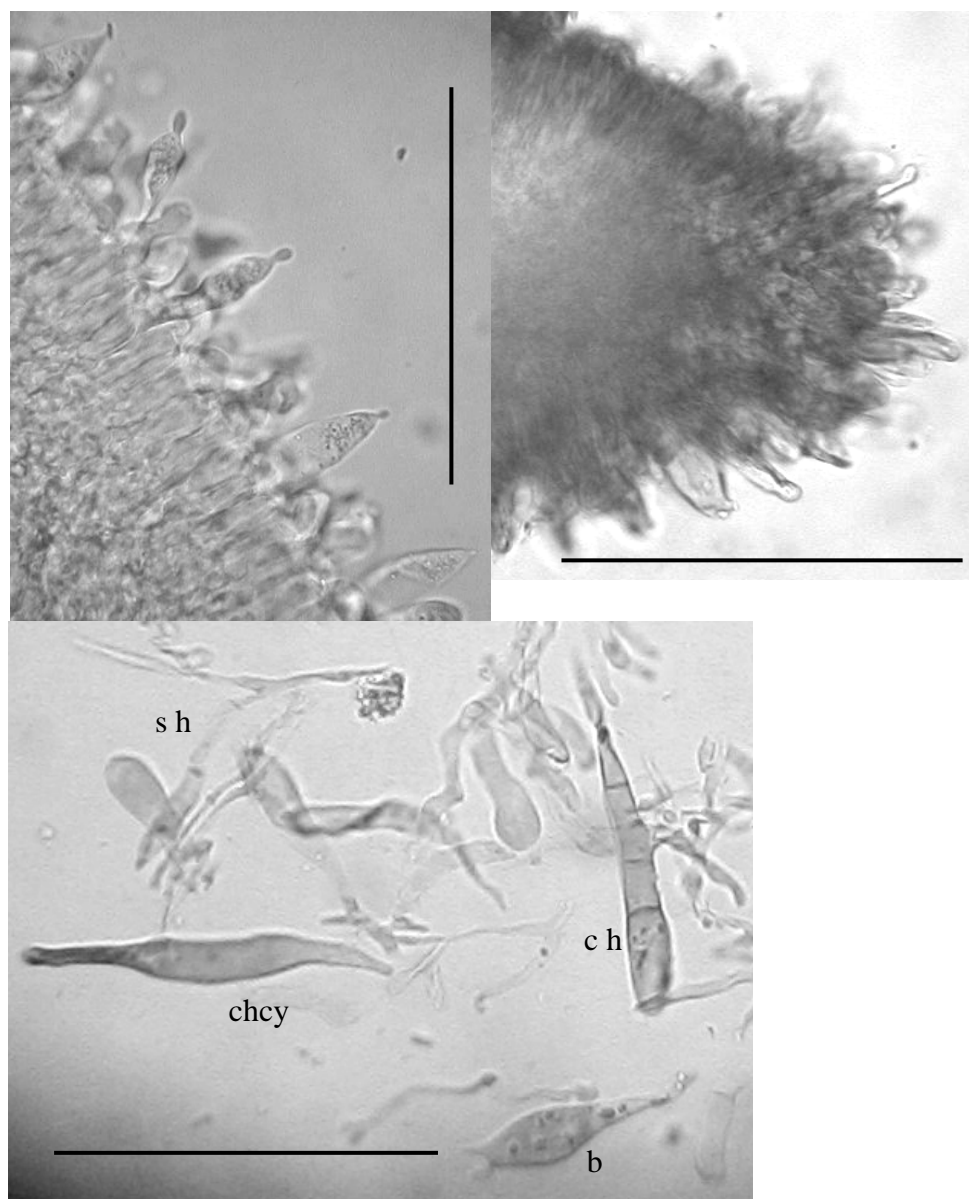


Figure 49. Structures of the hymenium of *R. smithii*: Top left, section through gill showing pleurocystidia protruding above the basidioles; top right, section through gill margin showing cheilocystidia, cystidioid hairs are not obvious except in crush mounts as in the lower photograph, this shows a septate acute-tipped hyphae (s h), a cheilocystidia (chcy) with its base to the right, a laterally appendiculate cystidioid hair (c h) with its base to the top, and a basidium (b). All scale bars are 100µm, the gill margin and crush mount were stained in Congo red.

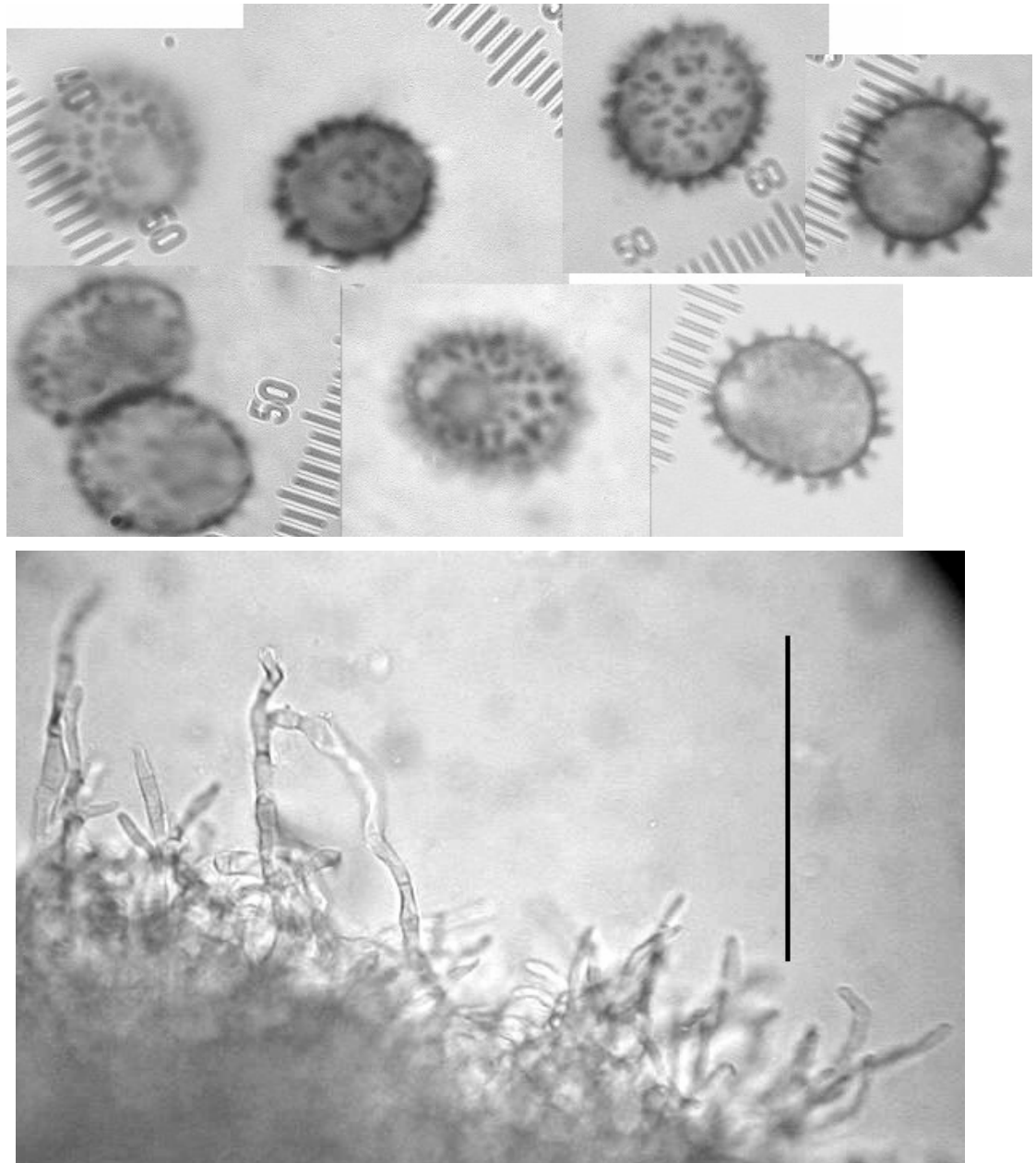


Figure 50. Top: spores of *R. smithii*, the middle two of the top row are composites of two depths of focus, the middle and right of the bottom row are the same spore in surface and equatorial view, note the lightly amyloid suprahilar patch and the variation in wart height between individual spores, scales are in 1µm divisions; bottom, epicutal hyphal ends of *R. smithii*, scale bar is 100µm.

Clade 4b**Subsection *Heterophyllae******Russula mustelina* Fries**

Epicr. Mycol. p351 1838.

Description of Vancouver Island collection:

Cap 9.8cm diameter, at maturity, plano-convex with a slight depression over the disc, mid to light yellowish-brown, slightly darker in the centre, slightly more pinkish-brown at the margin, glabrous, with a fine darker appressed, radially fibrillose texture, margins smooth, viscid drying almost matte. Flesh white, tinted pale vinaceous under the cuticle, unchanging, very firm, peelable to 1/3 the radius.

Gills deep cream with a pale orange cast when seen edge-on, subdistant, with occasional lamellulae, forking near the stipe and near the cap margin, and most gills anastomosed with their neighbour at the outer end. Gills are adnexed-notched at the stipe, falcate, the broader part closer to the stipe than the margin, and narrowly rounded at the cap margin with the cap cutis reaching about half-way around the end, leaving the lower part of the gill ends visible (fig. ??)

Stipe 6.1 x 1.4cm, ventricose, pale cream, white at the apex, firm, solid or at least stuffed with a firm trama, longitudinally finely rugulose, pruinose at the apex, unchanging to slightly yellowing where cut, becoming pale yellowish brown where handled and at the base.

Texture very firm and not brittle except for the gills.

Taste mild.

Odour not distinctive, but with a strong, unpleasant rotting meat smell after refrigeration for two days.

Spore colour light cream, Romagnesi IIa-b.

Spores 7.2-9.8 x 5-7.8µm, L:W 1.06-1.5 with a mean of 1.29, ornamentation of low blunt crests or rows of roughly hemispherical warts 0.2-0.5µm high, joined by fine connectives forming a partial reticulum, sometimes incompletely amyloid, occasional isolated warts, Woo type 1C. **Suprahilar patch** inamyloid, sometimes with fine warts, hiliferous appendix short, around 1-1.5µm long, 1.2µm wide at base. **Basidia** 4-spored, 50-62 x 8-10µm, narrowly clavate or widest in the upper 1/3 and then also with a long, narrow base, generally slender. Sterigmata 3-5µm long and 1.5µm wide at the base. **Pleurocystidia** 62-130 x 8-12µm protruding up to 40µm, originating in the subhymenium, contents refractive in KOH, grey in SV, but sometimes only in the upper half, overall mostly fusoid or clavate, sometimes contorted at the base, sometimes broadening gradually from the base to a shoulder, many with a capitum of varying size up to the full width of the cystidia, mucronate or with a long appendage with a series of constrictions, sometimes with the appendage emerging from a capitum giving it the shape of a minaret. **Cheilocystidia** very sparse, protruding around 15-20µm, similar to pleurocystidia but the irregularly distributed refractive material only light purplish grey in SV. **Subhymenium** 70-100µm thick, interwoven with occasional subspherical cells, dissolving into an amorphous material in 5% KOH, possibly gelatinizing, gill trama relatively narrow, of sphaerocytes with occasional refractive vascular hyphae.

Cutis 230-320µm thick at half-radius, 400µm on disc. **Subcutis** of interwoven hyphae 2.5-5µm wide, brownish in the more compressed lower layers, hyaline centrally, and light brown towards the epicutis, infrequent vascular hyphae 3-7.5µm wide, unstaining in SV. **Epicutis** not well differentiated from the subcutis, an interwoven layer of light brownish free hyphal ends that are repent or, more often, with the free part curving back down towards the surface, or upright and clustered, the hyphae mostly 2-4µm wide, with light greenish to brownish cytoplasm, ends undifferentiated or more or less tapered. Very few inflated or articulate elements in this collection. **Pseudocystidia** occasional, originating as vascular hyphae and rising to just below the epicutis or through it, 2-5µm wide. **Pileocystidia** frequent, 27-60 x

3-5µm, aseptate, mostly cylindrical or slightly tapering to an obtuse or capitate end, less often fusoid or narrowly clavate, often recurved like the hyphal ends, contents slightly refractive, not staining in SV. **Hypodermis** not distinct from the subcutis, merely the basal layers of the interwoven subcutis that are more compressed and lie directly on normal tramal tissues.

Trama of discrete clusters of sphaerocytes bound by a dense hyphal mesh and vascular hyphae, which are mostly in the trama beneath the cutis.

Chemical reactions: FeSO₄ - brownish salmon pink; KOH - no reaction on cap, slightly yellowish on stipe; phenol - dark brown; SV - pinkish on the gills and cap trama when fresh, brownish on dried tissue, brownish pink on the cutis, cystidia and vascular hyphae colourless to pale pinkish grey.

Habitat and tree associations: In moss (*Eurhynchium oreganum*) on the ground in dry regeneration Douglas fir forest with understory salal (*Gaultheria shallon*), dwarf rose (*Rosa gymnocarpa*), ocean spray (*Holodiscus discolor*) and orange honeysuckle (*Lonicera hispidula*).

Collections: OC 020717-01, of one basidioma, from dry Douglas fir forest, Highlands area, north of Matson Lake, Victoria, approximately N 48.4896°, W 123.5137°.

| Collection | ITS1-F to ITS4-B | RFLP: | | |
|-------------|---------------------|----------|----------|------------------|
| | | HinfI | AluI | Sau3A |
| OC020717-01 | 863 | 358, 272 | 471, 236 | 320, 260, 180 |
| OC020717-01 | | | | 340, 260, |
| (repeat) | 867 | 364, 260 | 515, 265 | 170 |

Notes: This collection of *Russula mustelina* constitutes a first record of this species for Vancouver Island. It matches the description given by Romagnesi (1967) and Sarnari (1998) for European material very closely, the hymenial cystidia range from about 20µm shorter but are otherwise as described. Grund (1965) collected and

described a *Russula* he identified as *R. mustelina* that was a chocolate brown colour centrally, had smaller basidia, pileocystidia not differentiated, hymenial cystidia with obtuse tips and smaller less well defined spore ornamentation. From his description I surmise that his collection was probably an immature basidioma rather than a local variation

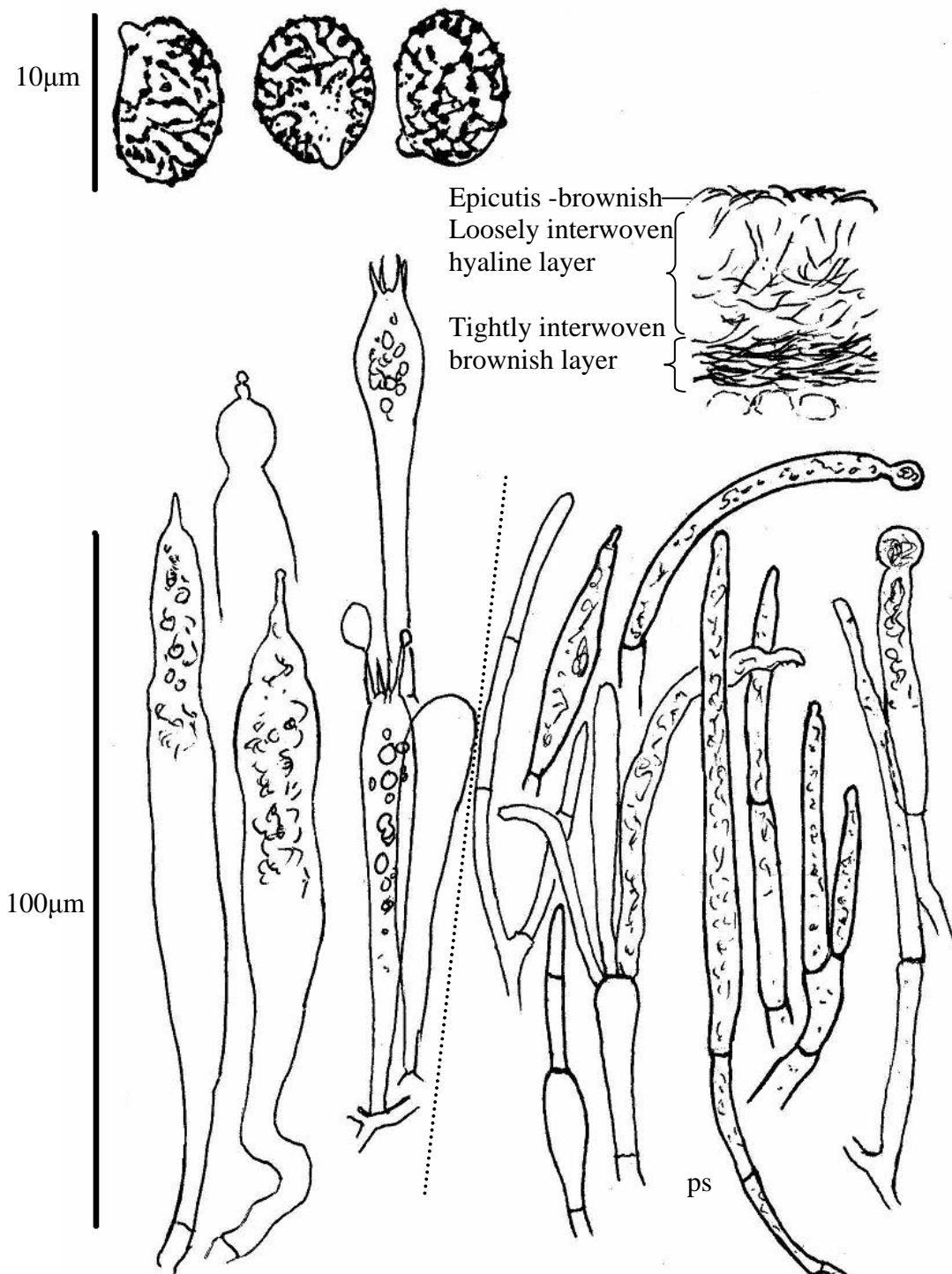


Figure 51. Microscopic characters of *R. mustelina*: Top, spores with 10µm scale bar; middle, diagram of section through cutis; bottom left, hymenial cystidia, basidia and basidiole; bottom right, hyphal ends, pileocystidia and a pseudocystidia (ps); bottom scale bar is 100µm.



Figure 52. Macroscopic characters of *R. mustelina*: Top and middle, gills, cap surface and profile of one basidioma; below left, detail of the gills in which a few lamellulae are visible and the anastomoses at the cap margin; below right, close up of the cap cutis showing the minute darker fibrillose-like surface texture. All photographs are of a 9.8cm diameter basidioma.

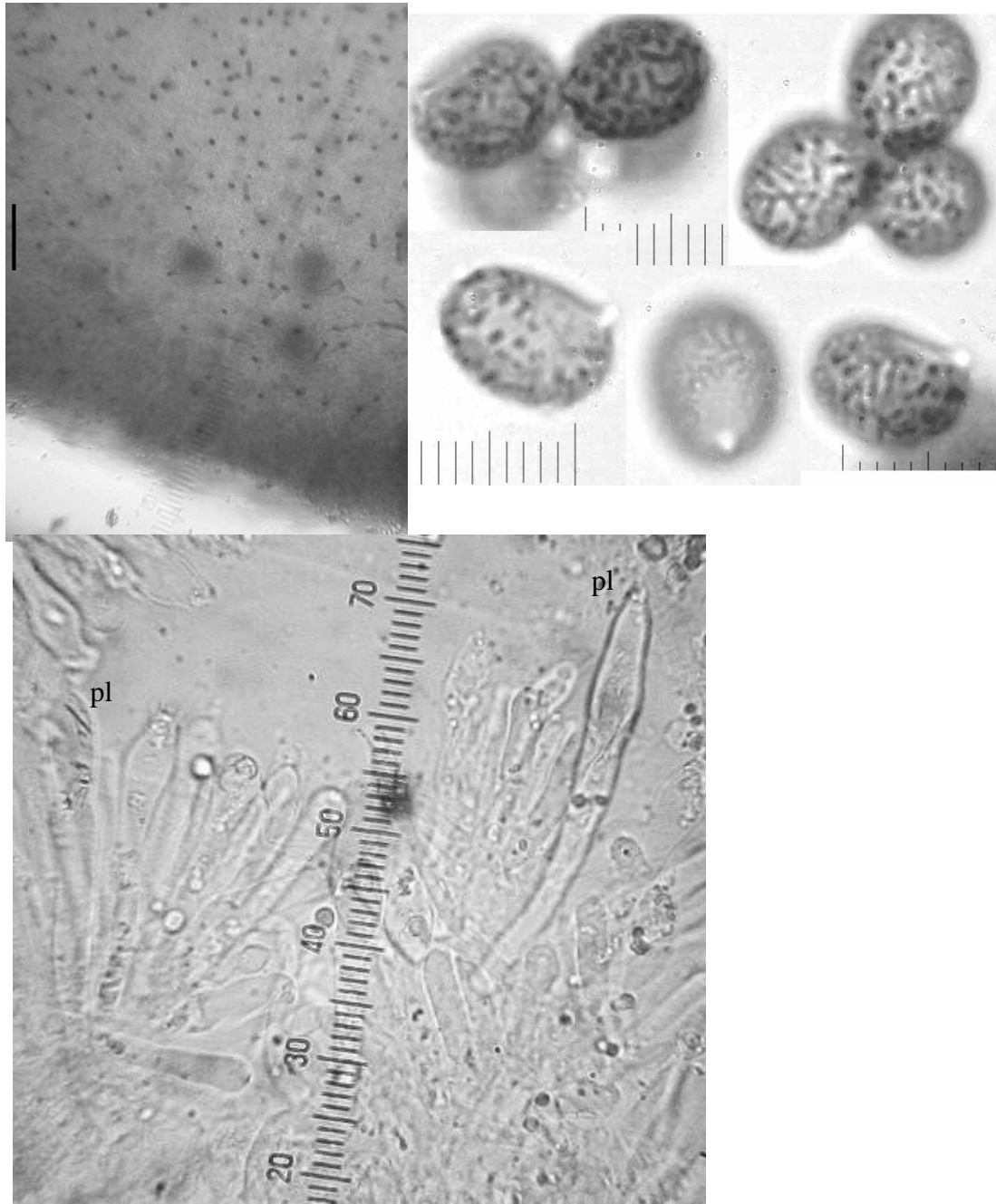


Figure 53. Hymenial structures of *R. mustelina*: Top left, face of gills showing the sparse hymenial cystidia (dark spots, stained with SV), scale bar is 100µm; top right, spores, scale is in 1µm division and applies to all spores shown; bottom, crush mount of gill tissue in which two pleurocystidia (pl), several basidia and basidioles can be seen, ten scale divisions are 25µm.

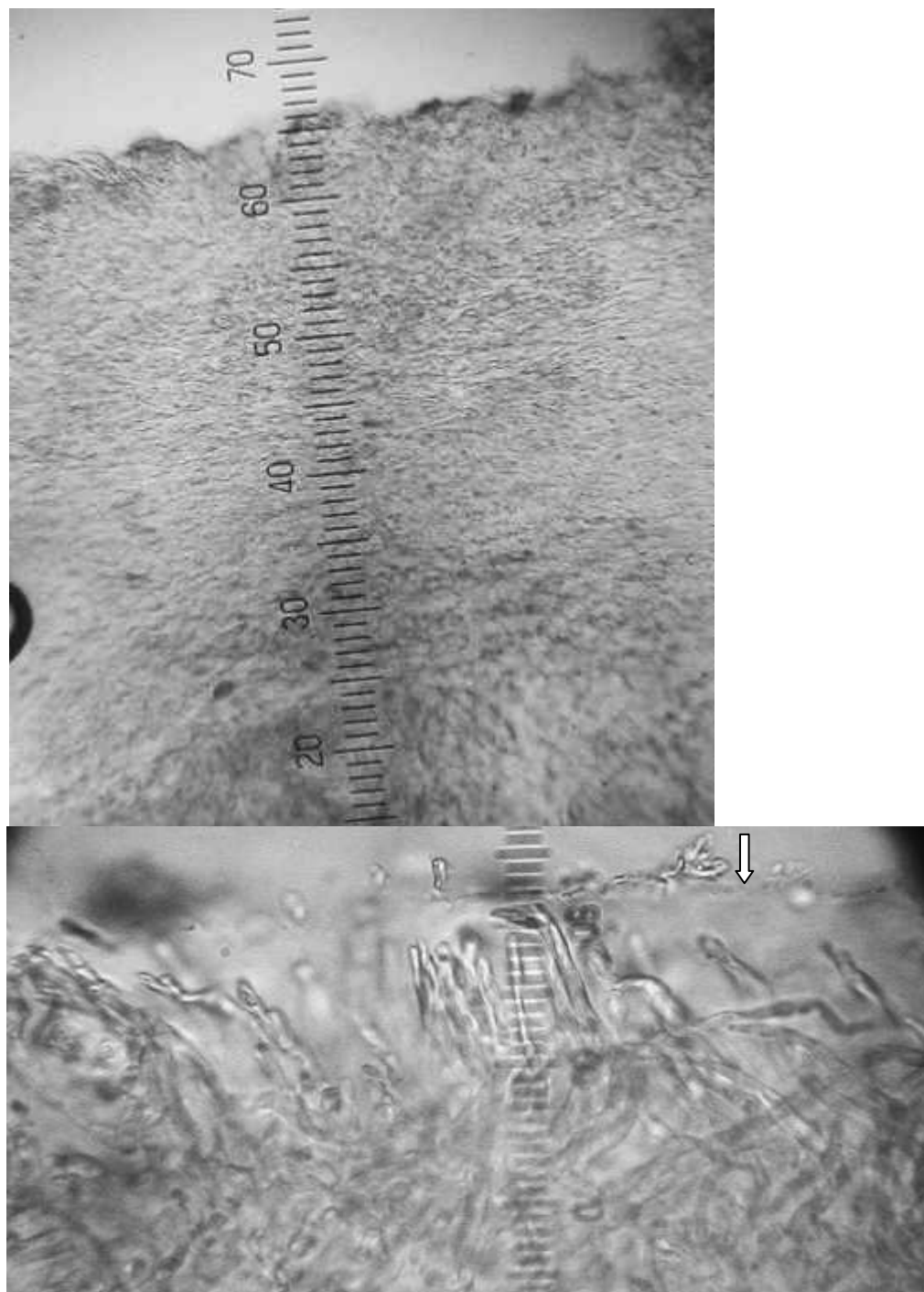


Figure 54. Cutis of *R. mustelina*: Top, section through the cutis near the disc, the subcutis- trama border is at about the level of the 24 mark on the scale, 10 scale divisions are $100\mu\text{m}$; bottom, the epicutis showing a tuft of upright hyphal ends beneath the viscid pellicle, the surface of which is marked with an arrow, the divisions on the scale are $25\mu\text{m}$.

Russula *brunneola* Burlingham

N. Am. Flora 9:233. 1915

Description of Vancouver Island collections:

Cap 5.2-15cm diameter, convex when young, becoming plane to shallowly cyathiform when fully expanded, margin smooth, becoming a little striate in age, sometimes with a narrow free margin. Colour variable but some shade of brown, when very young a light to dark yellow-brown to red-brown, the pigmentation becoming darker as it matures, becoming a velvety vinaceous brown to dark greenish-brown to almost black centrally and deep yellow-brown to olive-brown to olive at the margin; some basidiomata lack any greenish tints. As the cap ages, the colours lighten again, the surface becomes glabrous and the olive tints may be more apparent; over the disc the cap may remain darker or develop paler reddish brown areas. Overall, the redder tints tend to be centrally located while the greenish tints are toward the margin. Surface viscid, drying matte or with a low sheen, minutely radially rugulose, usually with a velvety bloom which is lost in age, the rugulosity becoming more apparent then and seeming to be a reliable character in this variable species. Cuticle peeling 1/4 to 1/3 the radius, flesh greenish or brownish under cuticle near disc, unchanging when cut but sometimes yellowish to pale brownish around insect larval channels.

Gills pale cream, browning slightly to strongly where damaged, close to subdistant, pliable at first but soon brittle, forking mostly near the stipe, sometimes with a few lamellulae, adnexed to adnate at stipe, arched and equal at first and subacute at cap margin, becoming more or less ventricose and rounded at the cap margin. Gill depth is approximately equal to double that of the cap trama at half radius, for instance in a mature cap of 12.5cm the gills are 10mm.

Stipe 3.6-9.0cm x 1.1-3.8cm wide, most are more or less cylindrical with a slight broadening near the base, surface longitudinally slightly rugulose, whitish, or more commonly with a grey, violet-grey, brownish-grey or, in those with green caps, grey-

green to green-grey bloom, sometimes with a pink flush at the base or apex, unchanging where cut but the surface browning slightly where handled and at the base, solid at first, then rind around 3-4mm thick and inner stuffed with a firm bread textured trama eventually developing generally 3 irregular cavities.

Texture Moderately firm and not brittle but becoming so in age, thick-fleshed.

Taste mild, sometimes nutty.

Odour not distinctive.

Spore colour pale cream, lighter than Romagnesi Ib, or on the green forms, pure white, Romagnesi Ia.

Spores 6.0-10 μ m (-11 μ m) x 5.25-8 μ m, L:W = 1.0-1.45, mean 1.22 (n = 90), variable in shape, size and ornamentation, with no distinct range related to population, yet the average L:W ratio is remarkably constant (fig. 55). Shape subglobose, bean-shaped, broadly ellipsoidal, ellipsoidal, or elongate. **Ornamentation** of warts mostly 0.1-0.3 μ m high, most under 0.5 μ m high but occasional ones to 8 μ m high, hemispherical to bluntly conical or low short ridges, isolated, 2-3 catenate, or with fine connectives between two or three warts but sometimes forming a partial reticulum. **Woo types** A-C1, A2, or B2. **Suprahilar patch** inamyloid, a relatively large area free of warts or with only minute punctae, occasional spores with a lightly amyloid area. **Hiliferous appendix** 1-1.8 μ m long by 1-1.8 μ m wide at the base, often quite short and stubby. **Basidia** 4-spored, rarely 2-spored, approximately 42-95 μ m long by 6-10 μ m wide, almost cylindrical to narrowly clavate. **Cheilocystidia** abundant, similar to pleurocystidia but less reactive to SV. **Pleurocystidia**, normally to sparsely distributed, 68-92 (-115) x 8-12 μ m (-14) μ m wide, protruding 20-30 μ m beyond basidioles or sometimes embedded up to the tip, the lower 1/3 not staining, the upper staining red to purple to grey in sulphovanillin but unevenly as if partly devoid of contents, (younger caps with more grey staining, older more red or pink). The shape very variable, more or less cylindrical to fusoid to clavate with the terminus expanded-obtuse, narrowed-obtuse, pointed or with strangulate-elongate or capitate

appendages, originating within the subhymenium or trama, occasionally almost from the middle of the gill. **Subhymenium** about 20-40 μ m, interwoven of hyphae of variable width, often with pseudoparenchymatous cells, the cells being 5-10 μ m diameter. **Gill trama** of sphaerocytes, some of which are quite large, reaching 42 μ m diameter, with a few hyphae interspersed. Microscope slides of gill tissue from some dried basidiomata contain many oil droplets, and when slicing the tissues, an oily substance is exuded with pressure from the razor blade.

Cutis 150-400 thick at half-radius, 220-500 μ m thick over the disc, (young caps with a thicker cutis than aged ones), the upper layers with a greenish granular pigment which dissolves in KOH, and a red amorphous cytoplasmic pigment, also some of the enlarged surface cells have a brownish cytoplasm. **Subcutis** of repent, interwoven hyphae 2-3 μ m wide, embedded in a gelatinous matrix, the lower part, approximately half the depth, more gelatinous and very densely interwoven, the upper half looser, vascular hyphae rare. No distinct hypodermium, the basal layers of the subcutis may incorporate openings or sphaerocytes 10-15 μ m deep by 10-30 μ m across so the transition to the tramal tissues is not abrupt. **Epicutis** of free hyphal ends and pileocystidia, sometimes clumped, in places a turf 60-150 μ m deep, particularly over the disc and in young basidiomata, in others reduced to a few free repent hyphal ends. Many hyphae have long tapering terminal cells 4 μ m at the base and narrowing to 2 μ m wide and 20-50 μ m long. Some hyphal ends are articulated with short chains of cells inflated up to 10 μ m wide or with a series of short clavate, lemon-shaped, tarsi-shaped or bulbous cells, or with the subterminal cells inflated and the terminal cell tapered, thus forming an ampullate structure. Sometimes the terminal few cells have darker contents. In areas where there are many inflated-clavate structures the epicutis is almost hymeniform. **Pileocystidia** variable in density but generally sparse, sometimes grouped, with refractive contents that stain grey to black in SV or sometimes unstaining, 15-80 μ m by 2.5-8 (-10) μ m wide, but mostly 4-5 μ m wide, cylindrical or more or less clavate or tapered, tips rounded, mucronate or capitate, mostly non-septate, some with one septum. Stipe surface with sparse caulocystidia similar to the shorter pileocystidia.

Trama mainly of sphaerocytes with hyphae interspersed, and rare vascular hyphae with refractive contents sometimes staining magenta in SV.

Chemical reactions: FeSO₄ - pinkish-brown to salmon; KOH and NH₄OH - no reaction to browner or yellowish green on cap, yellowish on stipe; guaiac - quickly blue-green; phenol - not much reaction to purplish-brown; SV - macroscopically, cutis stains pink, gills stain pink to deep red, microscopically, pileocystidia stain grey to blackish, pleurocystidia purple and cheilocystidia stain pale to deep pink to purple.

Habitat and tree associations: In small groups on the forest floor among regeneration or old growth stands of Sitka spruce and western hemlock, or in pure stands of either species; both tree species appear to be hosts.

Collections: CR980825-02, CR030824-02 and CR030824-02, under western hemlock, Sitka spruce, western red cedar, big-leaf maple, and red alder near the estuary at Port Renfrew, N 48.577167°, W 124.393333°. PJ 010919-04, in the spruce fringe inland of the beach under Sitka spruce, western hemlock and shore pine Wickaninnish, N 49.02167°, W 125.67467°. CR001011-53 and CR001011-54, Wickaninnish boardwalk under krummholtz of Sitka spruce only, N 49.017°, W 125.6740°. PJ 010919-20, Wickaninnish boardwalk in the spruce fringe inland of the beach under Sitka spruce, western hemlock and shore pine, N 49.02167°, W 125.67467°. CR021016-09, Sitka spruce krummholz, Wickaninnish boardwalk, N 49.017°, W 125.6740°. CR021016-16b, Sitka spruce krummholz along the Wickaninnish dunes, N 49.0215°, W 125.6745°. CR030927-03, regeneration western hemlock with occasional Sitka spruce, near Lizard Lake, Port Renfrew, N 48.6037°, W 124.2268°.

| Collection | ITS1-F to | RFLP: | | |
|-------------|-----------|----------|----------|---------------|
| | ITS4-B | Hinf1 | Alu1 | Sau3A |
| PJ010919-04 | 829 | 395, 249 | 344, 243 | 334, 274, 190 |
| CR030924-02 | 849 | 390, 290 | 515, 260 | 340, 247, 186 |

Notes: The greener form of *R. brunneola* was first thought to be a different species, possibly *R. smithii*, compared to the more identifiable tawny brown form. However the two were found together at Port Renfrew and seemed to intergrade. In particular a young tawny-brown specimen was collected which developed the dark vinaceous-olive velvety colouring and bloom after a day in the refrigerator. The greener form consistently has a pure white spore print whereas those with no green have an off-white print. Both have the greyish bloom on the stipe, though this varies in hue and can be close to white sometimes, but so far the green hues occur only when there is noticeable green pigment in the cap. The variation in stipe colouration is due to the balance of green and pink pigments, these colours are complimentary and so grey one another. Most of the green forms were found only under Sitka spruce, however, one specimen was found in a pure western hemlock stand near Lake Cowichan (not vouchered because of poor condition). Burlingham (1915) described the stipe colour as slate-violet, Shaffer (1970) and Thiers (1998) described it as yellowish white, purplish white or light reddish-brown, even though some of the collections examined were from the west coast including the Olympic peninsula, Washington State. I collected *R. brunneola* from Priest Lake, Idaho, which had a yellowish white stipe, so it seems the greenish-grey stipe colour may be a local variation. Ironically, perhaps the strongest defining character of this species is its variability, yet it cannot be broken up taxonomically since much variation exists within a collection and often within a basidioma. A superficially similar species with which it may be confused is *R. eleaodes*, however that species is in the *Xerampelinae* and has yellow spores, a green reaction with FeSO_4 and other characteristics of that group. *R. mustelina* is another pale-spored, mild, brownish species in subsection *Heterophyllae* but this species is rarely pruinose or velvety, is more robust, with a generally paler brown cap and slightly darker spores (Romagnesi IIb).

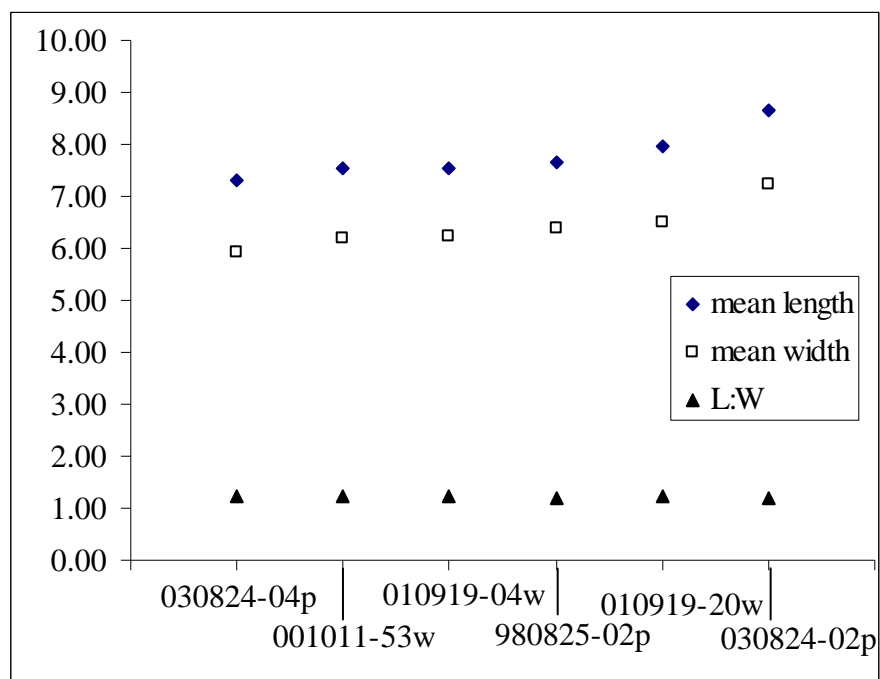


Figure 56 Chart of means ($n = 15$ for each) of spore length, width and L:W ratio for six collections of *R. brunneola*, the collection number of each is followed by a letter denoting the collection area, 'p' for Port Renfrew, 'w' for Wickaninnish.

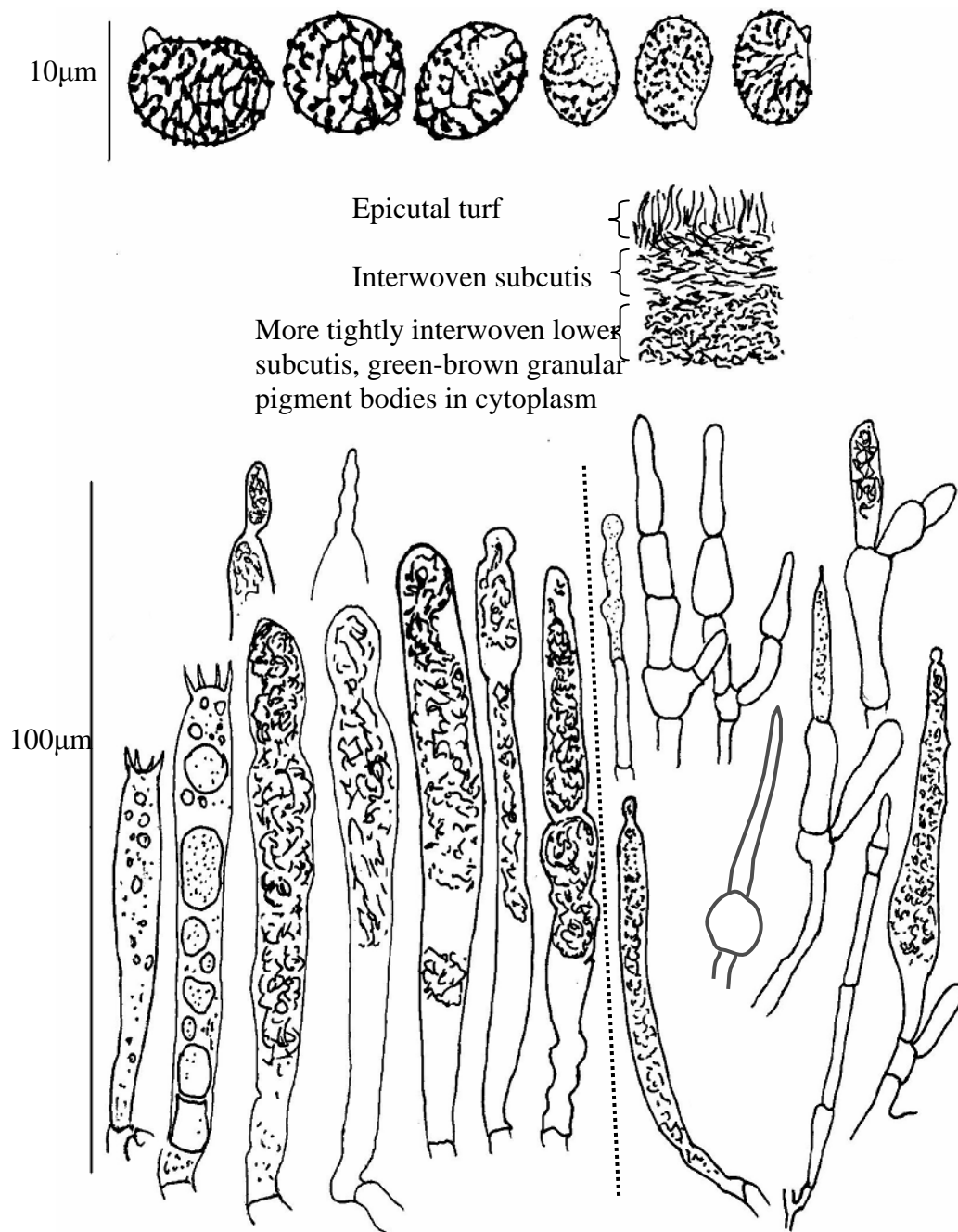


Figure 57. Microscopic characters of *Russula brunneola*: Top, spores with 10µm scale bar; middle, diagram of section through cutis; bottom left, hymenial cystidia and basidia; bottom right, pileocystidia and hyphal ends from the epicutis, scale bar is 100µm.



Figure 58. Overleaf, macroscopic characters of *Russula brunneola*: top, collection from the Wickaninnish area, with one basidioma having an unusually short stipe; middle left, cap surface of an olive-green tinted collection and middle right, detail of the greenish-grey pruina on the stipe surface; bottom, a collection from Port Renfrew showing the matte, finely velvety texture of the young caps, (the minute speckles are insect eggs) and pinkish-grey tints on the stipe.

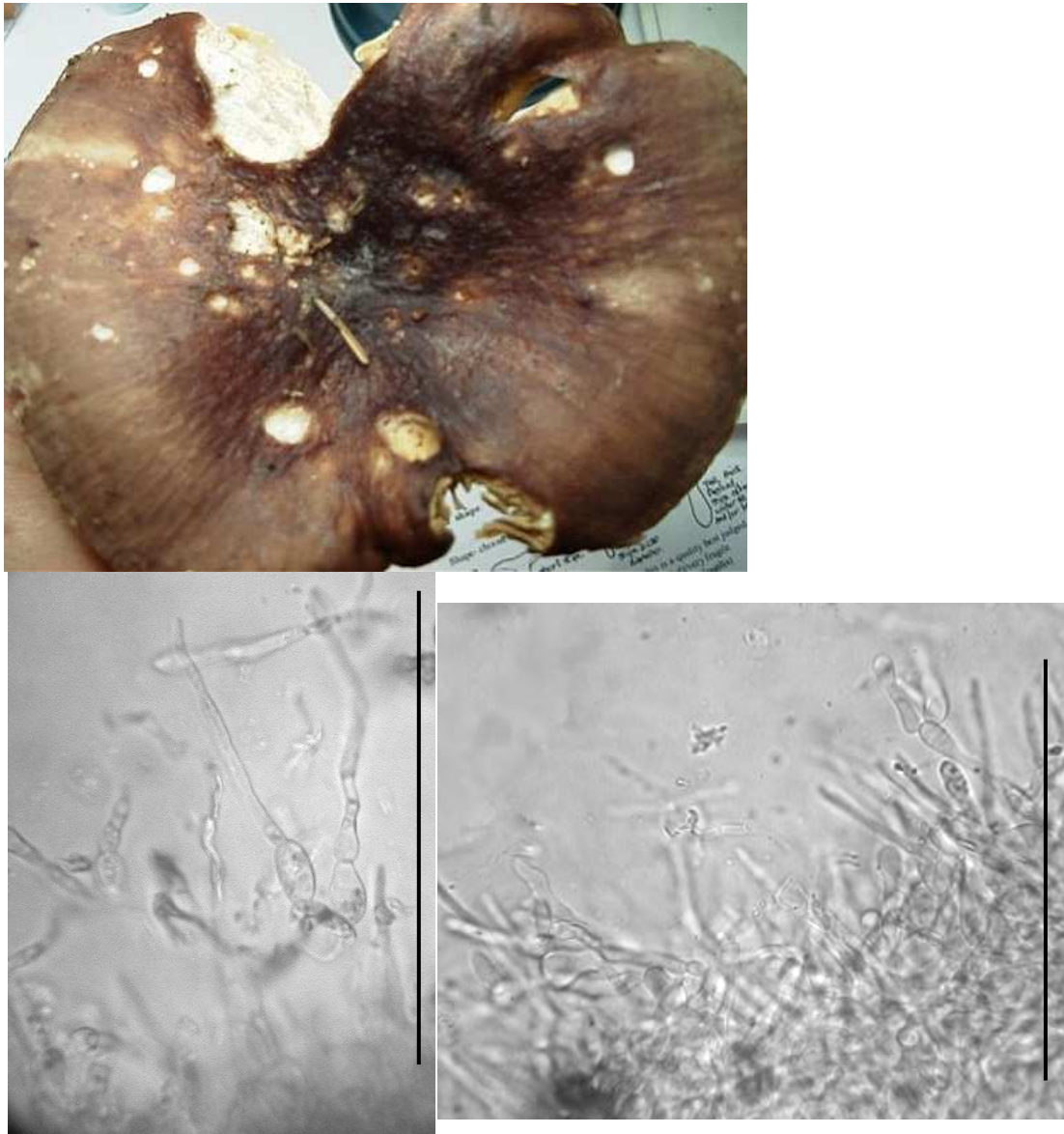


Figure 59 Cutis of *R. brunneola*: Top, surface view of a mature basidioma showing the typical radial rugulosity; bottom, two views of hyphal ends in the epicutis, on the left, two ampullate structures and be seen, on the right, many narrow or tapered hyphal ends and some articulated hyphae with variform cells. The scale bars for both lower photographs are 100µm.

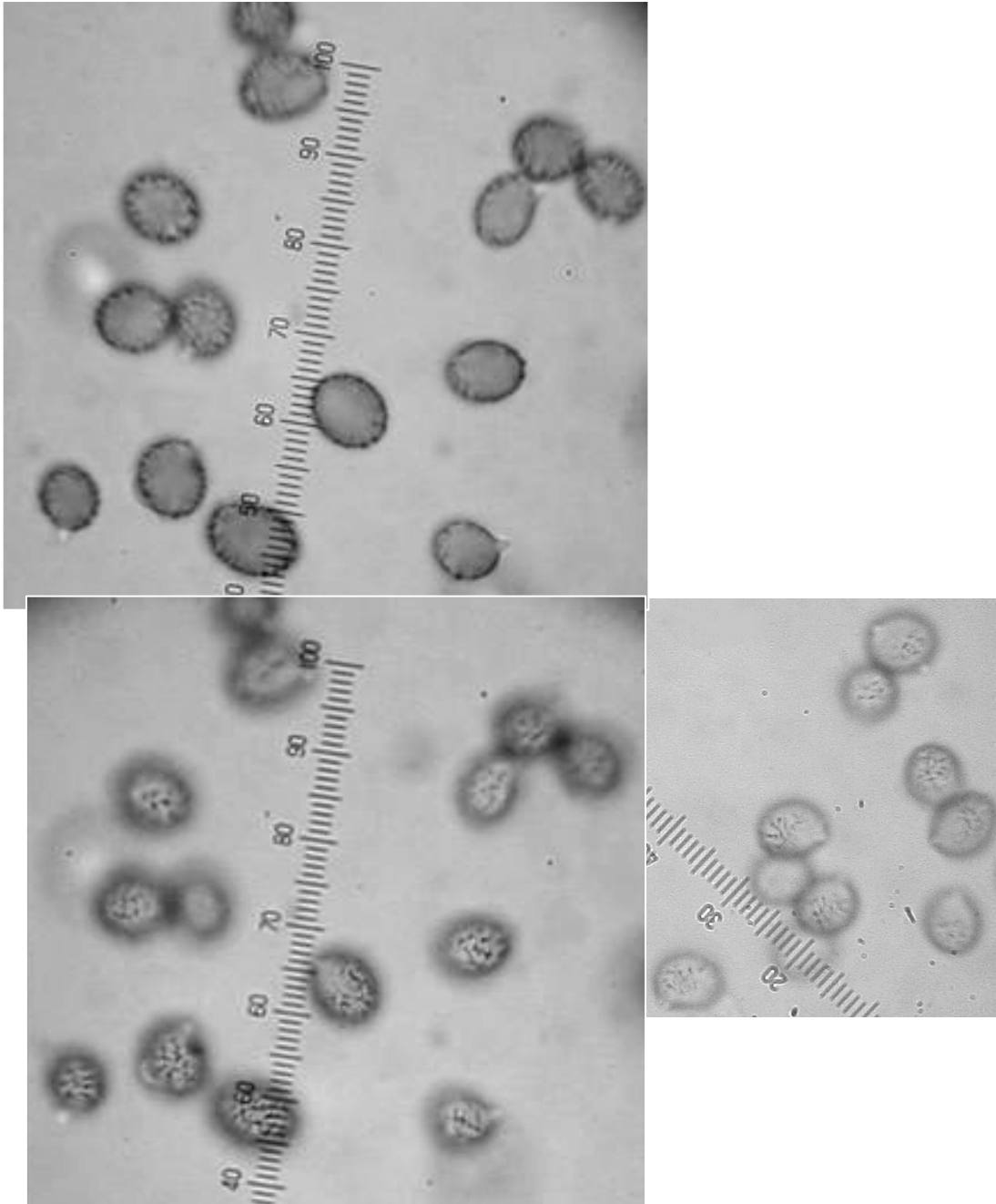


Figure 60. Spores of *R. brunneola*: the upper and lower left-hand photographs are of the same spores focussed at the equatorial and surface plane respectively, note that most have an inamyloid suprahilar patch but one at lower left has an amyloid patch, such anomalous spores do occur occasionally in many *Russula* species. On the right at the same scale are spores from another collection that are smaller with finer ornamentation. All scales are in 1 μm divisions.

Clade 4d

Subgenus *Heterophyllidia*

Section *Heterophyllae*,

Subsection *Griseinae* Schaeffer and Subsection *Ilicinae* (Romagnesi) Buyck

Ann. Mycol. 31:318, 1933 (Les Russules de Europe et d'Afrique du Nord.
Suppl. 1929, 1985);
Bull. Jard. Bot/ Nat. Belg., 60(1/2): 198, 1990.

Both these subsections combine in Clade 4d

Russula parazurea Shaeffer

Bull. Soc. Myc. Fr. 1934

Description of Vancouver Island collection:

Cap 5.3cm diameter, depressed in centre becoming uplifted towards the margins but not inverting at the edge. Colour, red brown to pink brown or grey brown toward the margin, darker brown to almost black in the centre, all overlain with a white pruina giving the whole a dusty, greyish appearance. Margin smooth, pulling away slightly from the edge of the flesh and exposing the end of the gills, peelable to 1/2 the radius. This collection was made in dry weather and the surface was dry and matte, but became viscid when wetted.

Gills light pinkish cream, not bruising brown except at the cap margin, close, occasional sub-gills, infrequent forking near stipe, narrowly adnexed, narrowly obtuse at the margin, ventricose, varying between 1/2 to 1 1/2 times the depth of the trama at half radius, edges entire.

Stipe 4.5 x 2 cm at mid-point, tapering downward, white, slightly rugulose, solid to stuffed with a firm trama, unchanging.

Texture firm, not brittle, gills pliable.

Taste mild with a very faint peppery aftertaste.

Odour not distinctive.

Spore colour pinkish cream, Romagnesi IIb but a little pinker.

Spores (6-) 7-8.5 (-10) μ m by 5-7.3 μ m, L:W from 1.04-1.33, subglobose, broadly ellipsoidal, or oblong, warts tiny, 0.1-0.3 μ m high, occasional ones up to 0.5 μ m, isolated or more commonly joined by fine to heavy lines in a partial reticulum, **Woo types** 1B and 1C. **Suprahilar patch** a small unornamented inamyloid to pale grey area, hiliiferous appendix 1.2-1.6 μ m by about 1.4 μ m at the base. **Basidia** 35-53 x 8-10 μ m, narrowly clavate, tapering very gradually from the widest point downward, some more bulbous in the upper 1/3, most 4-spored, some 2-spored. Sterigmata 5-7 μ m long. **Cheilocystidia** and pleurocystidia abundant, strongly staining black in SV, 65-100 x 7-11 μ m, arising from the inner layer of the subhymenium, narrowly fusoid to more less cylindrical, ends rounded, pointed or more often with a small capitum, contents refractive. **Subhymenium** 40-50 μ m thick, of tightly interwoven hyphae. **Gill trama** of sphaerocytes with occasional vascular hyphae.

Cutis up to 600 μ m thick, 40-70 μ m thick at cap margin, an ixotrichodermis. **Subcutis** basal layers of compacted and parallel hyphae, upper region of subcutis is more loosely interwoven, of hyphae 2-4 μ m wide. **Epicutis** of repent to upright hyphae 2-7 μ m wide, generally wider than subcutal hyphae, some hyphal ends of short chains of cells 2-4 times as long as the hyphal width, sometimes slightly inflated, sometimes with constrictions at the septa and swellings either side giving a tibiiform cell shape. Terminal cells lanceolate, tapered or cylindrical-sausage shaped. **Pileocystidia**, abundant, staining red or black in SV, 30-120 x 5-10 μ m, more or less cylindrical or

narrowly fusoid, ends pointed to tapering into a narrow extension or more often with a small capitum, aseptate. **Pseudocystidia** not seen.

Trama of sphaerocytes in discrete, medium to large clusters bound with hyphal mesh.

Chemical reactions: FeSO₄- brownish-pink; KOH - reddish orange on cap, no reaction on stipe; NH₃OH - no reaction; guaiac- slowly blue-green; phenol - brownish purple, SV - purple on gills and cutis, very pale pinkish on cap trama.

Habitat and tree associations: On a south-facing limestone slope with Douglas fir.

Collections: TT040904-02, Koksilah ridge, northeast of Burnt Bridge park, exact location not recorded.

Notes: This collection of one mushroom agrees with the description for *R. parazurea* in Romagnesi (1967) in most characters. The description in Thiers (1997) has a spore size for the California material as 6-10.5 x 5-6µm, whereas in Romagnesi the spores are only up to 8.5µm long and up to 6.5µm wide. In the Koksilah collection described above, the spores are closer to the California material in size, although most are under 10µm long, the ornamentation is not as reticulated as either the European or California descriptions and the wart size is closer to that in Romagnesi's description. Thiers (1997) describes the pileocystidia as poorly differentiated, whereas the Koksilah collection matches those illustrated in Romagnesi (1967) which are clearly differentiated.

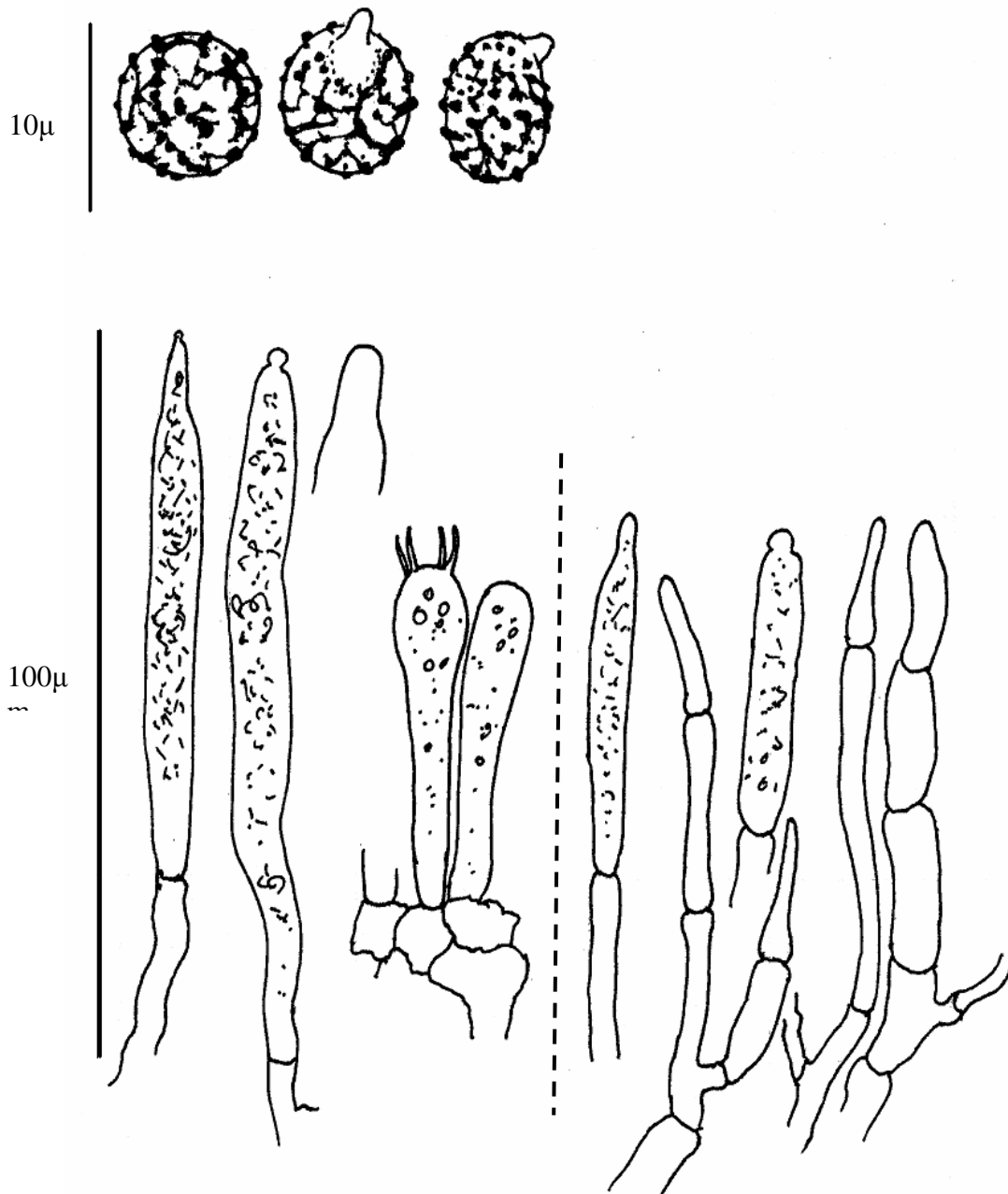


Figure 61. Microscopic characters of *R. parazurea*; top, spores with 10µm scale bar; lower left, hymental cystidia and basidia, lower right, pileocystidia and epicutal hyphae, lower scale bar is 100µm.

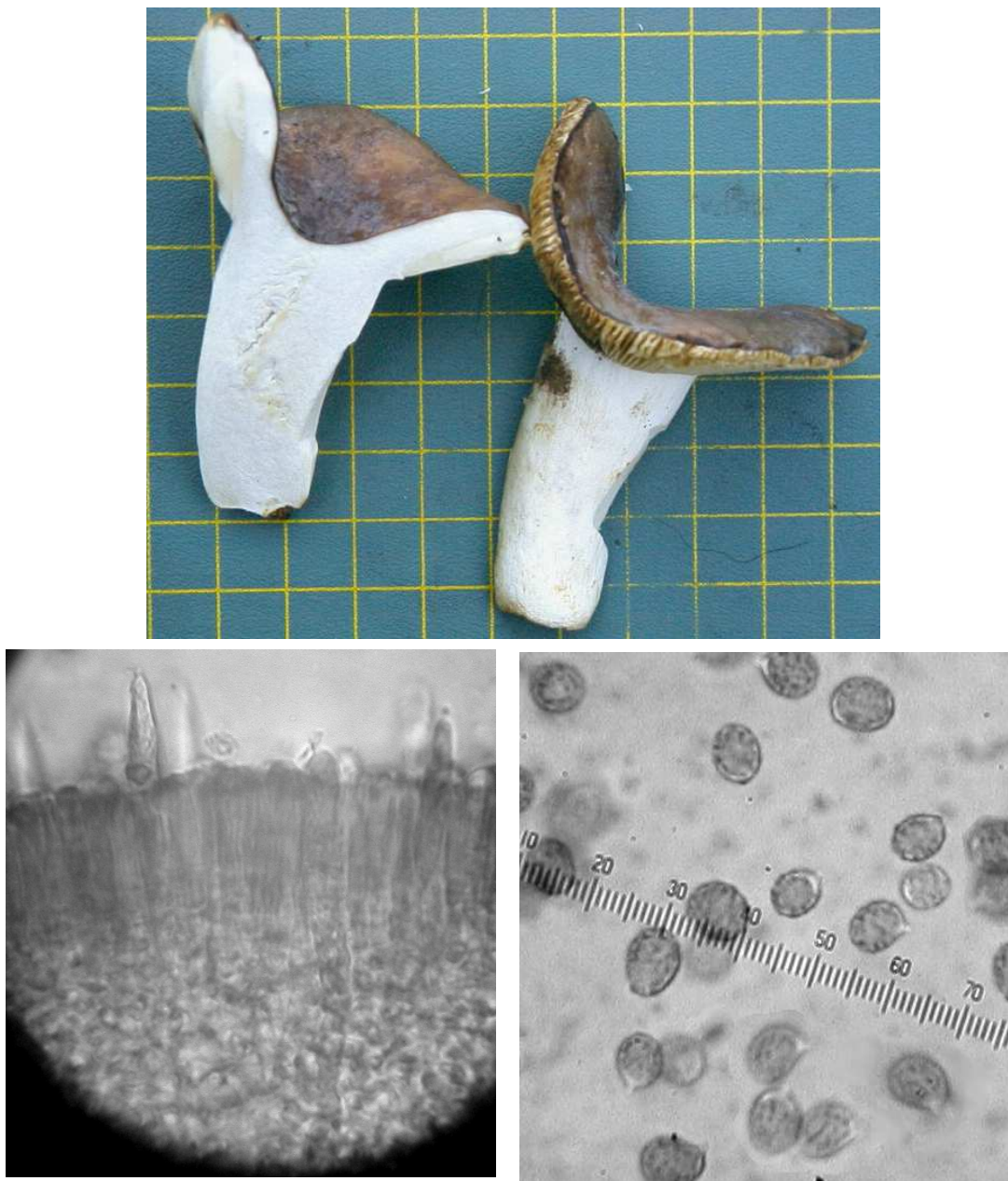


Figure 62. Top, *Russula parazurea* with 1cm² grid as background, note the bloom on the cap surface and the upturned margin in this early-stage mature specimen; bottom left, *Russula parazurea* hymenium showing several pleurocystidia, including the base of one in the foreground that originates in the inner layers of the subhymenium, bar is 100µm; bottom right, spores with 1µm division scale (right). show typical low ornamentation and inamyloid plage of the subgenus *Heterophyllidia*.

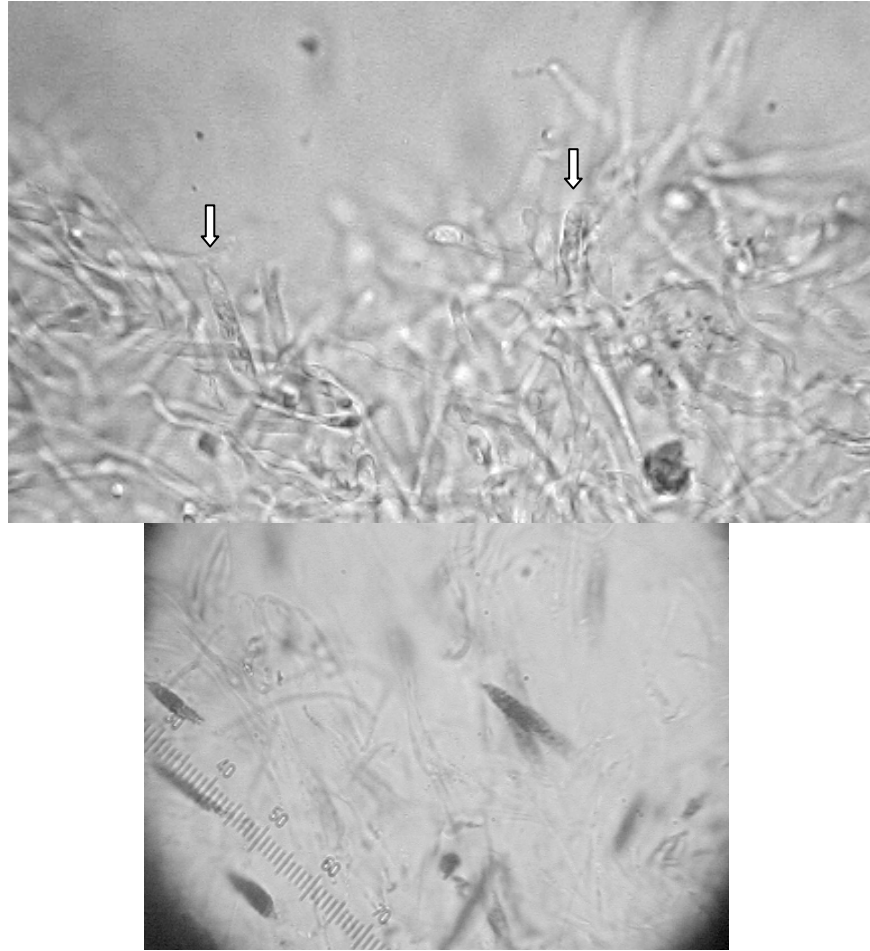


Figure 63. Two views of the cutis of *R. parazurea*, at top is a section through cutis showing pileocystidia (arrowed) and the hyphal ends which are mostly hair-like with no inflated basal cells; beneath is a surface view of the cutis in SV showing darkly stained pileocystidia. Ten divisions on the scale at lower left is 25 μ m, both photographs are the same scale.

***Russula medullata* Romagnesi**

Les Russules d'Europe et d'Afrique du Nord.: 307-310, 1967

Description of Vancouver Island collection:

Cap 6.5-9.5 cm diameter, plane when young, becoming depressed in the centre when fully expanded, but retaining a broadly rounded margin which remains smooth. Colour a mottled light to mid blue-grey to green-grey with patches of greyed pink, dull green, cream and light brown, in general, the margins more blue-grey and the disc lighter and more cream or light brown. The colours seemed to darken and develop more after collection and refrigeration, which may be natural aging or a bruising reaction. Surface viscid, drying subglossy and minutely radially rugulose. Cuticle peeling 1/3-1/2 the radius, cap trama whitish to pale greyish directly beneath. Cap flesh thicker, ca. 8 mm, at half radius than on disc or margin, unchanging where cut.

Gills subdistant to moderately close, frequent unevenly distributed subgills, forking and anastomoses near stipe and towards margin, pliable when young and fresh, adnate at the stipe and margin, gill margins entire. Colour cream, becoming deep cream.

Stipe 5.2-7.2 x 2.0-3.1cm, cylindrical or widening near the base, white, staining rusty brown near the base, stuffed with a firm, bread textured trama which eventually develops irregular cavities, (just two large ones in two of the basidiomata) and presumably eventually becomes hollow.

Texture firm, not brittle.

Taste mild but with a very faint hint of pepperiness.

Odour mild, not distinctive.

Spore colour deep cream, Romagnesi IId to IIIa.

Spores variable in shape, bean-shaped, ellipsoidal, subglobose or frequently elongate, $6.5-9 (-11) \times 5-8\mu\text{m}$, most are around $8 \times 6\mu\text{m}$, $L:W = 1.08$ to 1.6 . **Ornamentation** of warts mostly $0.1-0.3\mu\text{m}$ high, with a maximum about $0.5\mu\text{m}$, rounded to bluntly conical, isolated or very occasionally with fine connectives between two or three warts. **Woo types** A1, B1, A2, or B2. **Suprahilar patch** inamyloid, a relatively large area free of warts or with only minute punctae. **Basidia** 4-spored, rarely 2-spored, approximately $45-52\mu\text{m}$ long by $7.5-10\mu\text{m}$ wide, narrowly clavate, sterigmata around $5\mu\text{m}$ long and up to $2\mu\text{m}$ across near the base. **Cheilocystidia** abundant, $60-130 \times 10-12\mu\text{m}$. **Pleurocystidia**, average to sparsely distributed, staining red or grey in sulphovanillin, (younger caps with more grey, older more red), $80-115 \times 10-14\mu\text{m}$ wide, protruding $20-30\mu\text{m}$ beyond basidioles, fusoid to clavate with most commonly acute tips or sometimes with elongate and capitate tips. **Subhymenium** about $20-40\mu\text{m}$ thick, of small cells $5-10\mu\text{m}$ diameter, gill trama of sphaerocytes with a few hyphae.

Cutis $200-400\mu\text{m}$ thick, a gelatinised ixodermis. **Subcutis** with the upper half more loosely interwoven than the lower half. **Epicutis** not well differentiated from the subcutis, of repent hyphal ends and pileocystidia. Hyphal ends of chains of inflated, lemon-shaped or short cylindrical or irregularly shaped cells, sometimes with darker cell contents than in the generative hypha, and many with a lance-shaped terminal cell which tapers to a point. The majority of these hyphal end cells are $4-5\mu\text{m}$ wide, some reach $7-8\mu\text{m}$. **Pileocystidia** sparse, around $30-80 \times 4-10\mu\text{m}$ wide, most at the $4-5\mu\text{m}$ end of the range, cylindrical to clavate, tips rounded, mucronate or minutely capitate, mostly non-septate, some one septate.

Trama mainly of sphaerocytes, with binding hyphae interspersed.

Chemical reactions: FeSO_4 - buff; KOH - no reaction on cutis or stipe; SV - macroscopically, gills stain red or purple, cutis stains magenta then brown, pileocystidia stain lightly grey, becoming non-staining in older basidiomata, pleurocystidia and cheilocystidia stain red or grey, with more grey ones in the younger caps, more red in the older.

Habitat and tree associations: Around a small 2m tall *Pinus contorta* among kinnikinnick in the open coastal dunes beyond the margin of a pocket forest (a small area of forest in a dune swale.)

Collections CR021016-21 from the dunes at Wickaninnish, Pacific Rim National Park, N 49.0220°, W 125.6750°.

Notes: The published collections of species within subsection *Griseinae* Schaef. from the Pacific Northwest include *R. parazurea* J. Schaeff., *R. grisea* Persoon ex Fries and *R. basifurcata* Peck, all of which are similar to *R. medullata* J. Schaeff. The Wickaninnish collection, however, matches well the original description for *R. medullata* in Romagnesi (1967) and that of Sarnari (1998), and differs from both *R. grisea* and *R. parazurea* in spore and cuticle characters. Descriptions of the last two species in the American literature differ slightly from those in the European literature and may represent a local subspecies. *R. parazurea* differs from *R. medullata* in its paler spore print and reticulated spores. *R. grisea* has spores only slightly paler than this collection of *R. medullata*, whose spores are at the paler end of the described range, *R. grisea* also differs from *R. medullata* in the spore ornamentation-the warts are up to 1.25µm high and form chains and connections more frequently, *R. grisea* has a strong salmon reaction with FeSO₄ and its habitat is with broadleaved trees especially *Fagus*, on calcarous soils. Romagnesi noted that *R. medullata* is not rare and has been found with many broadleaved trees and with pines and firs. This collection of *R. medullata* shares several characters with *R. basifurcata*; the spores, in particular the occasional occurrence of large spores (up to 14.2µm in *R. basifurcata*) the hymenial cystidia protruding up to 30µm beyond the basidioles, and the size and shape of the pileocystidia. Differences include the paler cap of *R. basifurcata*, and its thinner, non gelatinised cuticle (60µm as opposed to 250-300µm) which separates only at the margin, the abundance of pileocystidia, plentiful in *R. basifurcata*, sparse in *R. medullata*, and the unchanging flesh of *R. basifurcata* as opposed to the browning, especially at the base of the stipe, in *R. medullata*. Grund (1965) described a collection of one specimen of *R. basifurcata* from Whidbey Island, Washington, U.S.A., which differs from the Wickaninnish collection of *R. medullata*.

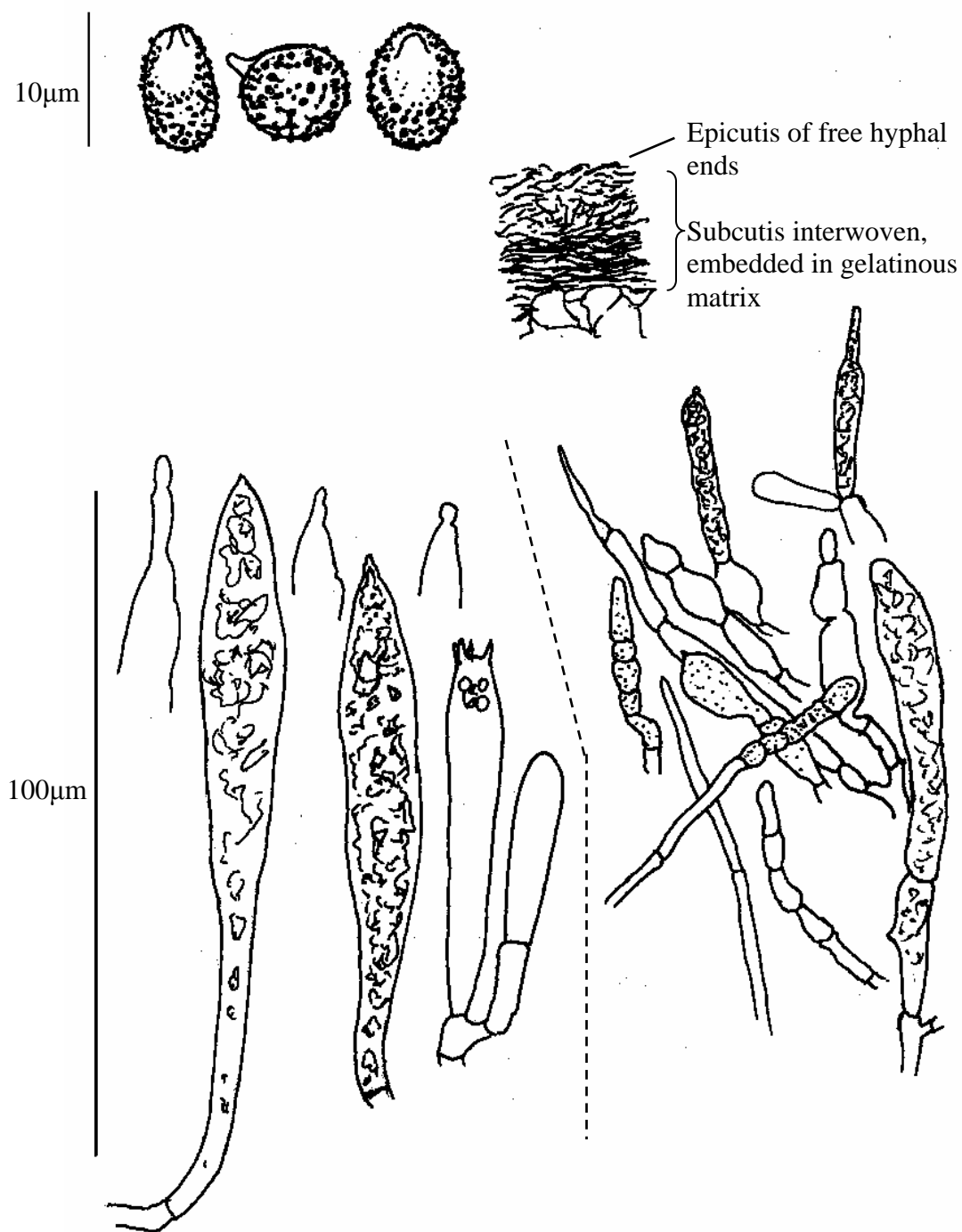


Figure 64. Microscopic characters of *R. medullata*: Top, spores with 10µm scale bar; middle, plan of cutis section in water; bottom left, hymenial cystidia and basidia; lower right, pileocystidia and hyphal ends in epicutis, lower scale bar is 100µm.



Figure 65. Macroscopic characters of *R. medullata*: Top, illustration of profiles and longitudinal section, small square is 1cm² and shows spore print colour; bottom, gills and a basidioma in its habitat. Note that the colours become more pronounced after collection and refrigeration.

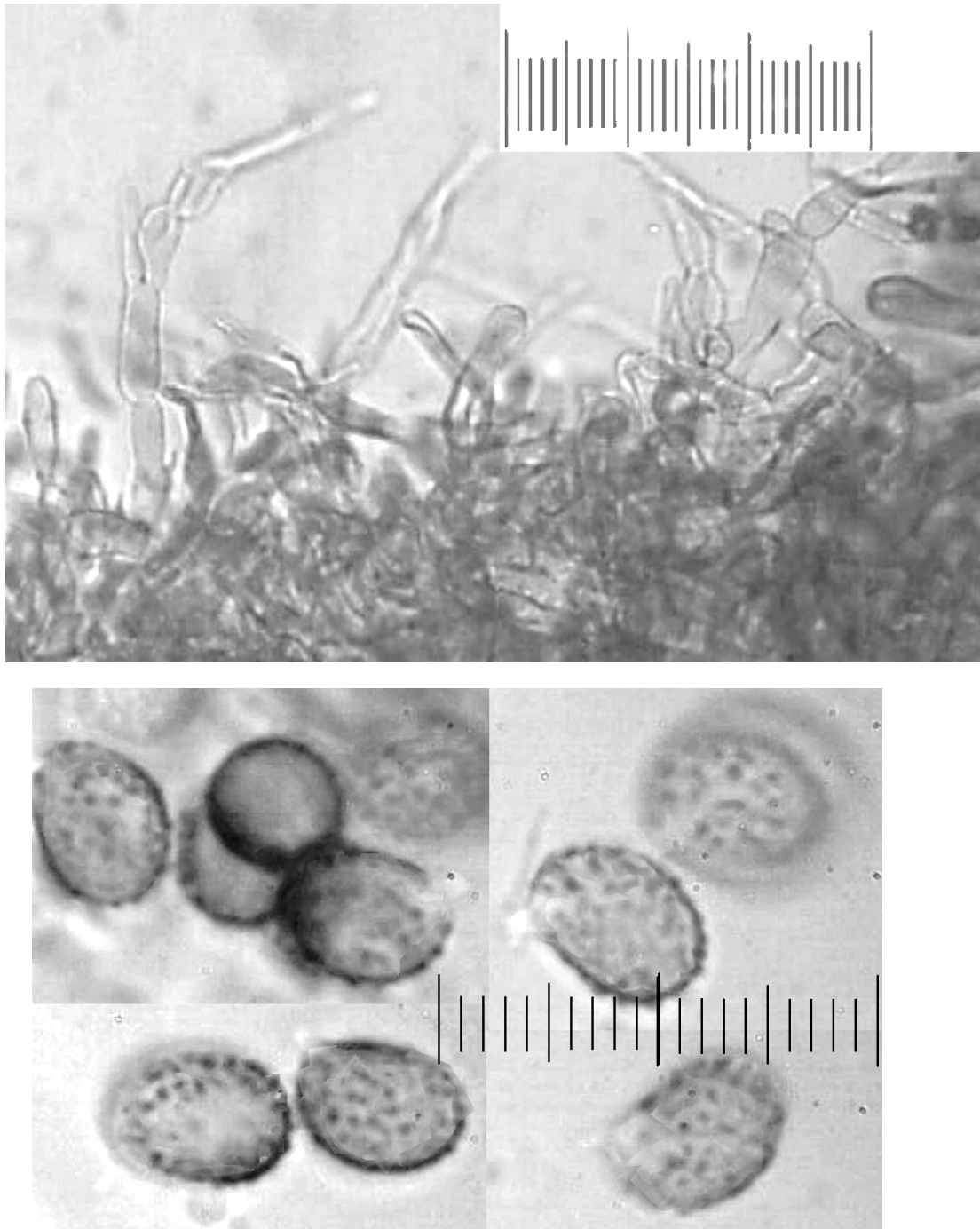


Figure 66. Microscopic characters of *R. medullata*: Top, articulated hyphal ends from the epicutis; bottom, spores, composite photograph of two depths of focus, both scales are in 1 μ m divisions.

***Russula cf. sublevispora* (Romagn.) Kuhn. –Romagn.**

Les Russules d'Europe et d'Afrique du Nord: 299, 1967

(*Russula ferreri* var. *sublevispora* Romagn., Bull. mens. Soc. Linn. Lyon, 9: 94, 1940)

(*Russula ferreri* Singer, Rev. Mycol. France, 1(6): 284, 1936)

Description of Vancouver Island collections:

Cap 11cm diameter, more or less plane but with about half of the margin slightly uplifted, margin smooth, cuticle peeling less than 1/4 the cap radius. Colours are a yellow brown (ochre) over the central area, mottled with brownish grey and purple, the purple increasing towards the margin and becoming more violet, overlain with a light greyish bloom. Cap surface matte and velvety when dry, towards the margins the surface texture becomes suede-like with minute granulations. Cap flesh white, 5-10mm thick at half radius, unchanging to slightly browning when cut.

Gills pale cream, occasionally developing red-brown spots, subdistant, some forking near the stipe, approximately equal to or up to 25% broader than the depth of the cap trama at half radius, adnate to notched at stipe, acute at cap margin, brittle.

Stipe 8 x 2.2cm, broadest at the apex and tapered downwards, mostly white with a faint flush of very pale pink, appearing almost pearlescent, surface longitudinally rugulose, stuffed, solid, developing yellow-brown stains where damaged and particularly around the base.

Texture firm, not brittle, the stature fairly robust.

Taste mild with a brief, fleeting hint of pepperiness.

Odour mild, woody, nutty, and in the base of the stipe where cut, faintly spermatic.

Spore colour cream, Romagnesi IIc.

Spores 7.25-9 (-10) x 5.75-8.3µm, L:W 1.11-1.5, mean 1.24 (n = 30), subglobose to broadly ellipsoidal. **Ornamentation** of fairly densely distributed small, blunt, isolated warts under 0.4µm high, strongly staining in Melzer's reagent, occasional fine connectives between 2 or 3 warts, and occasionally few catenate or joined warts. **Suprahilar patch** a pale smoothish oval area very faintly amyloid. **Woo types** A1 to B1. **Basidia** 4-spored, 30-52 x 8-12µm (most 8 to 10µm), narrowly clavate to slightly bulbous in the upper 1/3, often with one or two basidioles arising from the same basal cell. Sterigmata to about 5µm long and 1.5-1.8µm wide at the base. **Pleurocystidia** and **cheilocystidia** sparsely distributed, some patches of the gill with none. Both range from 35-70 by 7.5-8µm, and arise from deep in the subhymenium. Many pleurocystidia remain embedded in the hymenium completely or with just the tip protruding. Shapes are more or less cylindrical to narrowly clavate but often with constricted sections, tips tapered, mucronate or capitate, contents refractive, weakly staining pink or grey in sulphovanillin. **Subhymenium** around 15-25µm thick, pseudoparenchymatous. **Gill trama** of sphaerocytes with rare vascular hyphae.

Cutis 170µm thick near the cap margin to 400µm over the disc, an ixotrichoderm. **Subcutis** of densely interwoven light brownish hyphae 3-5µm wide and containing pigment granules that appear dark grey in water mounts. Occasional vascular hyphae 4- 6µm wide occur and some terminate in **pseudocystidia** in the epicutis. **Epicutis** of variable thickness, in patches just a few free upright hyphal ends, in others clumps of hyphal ends 3-5µm wide and cystidia, these clumps mostly in the outer half of the radius and being visible to the naked eye as a suede-like texture or little granules. **Pileocystidia** 18-62 x 5µm, fairly regularly dispersed over the surface, some longer and cylindrical with elongated capitate-strangulate tips, others narrowly clavate, around 25µm long, with rounded or mucronate tips, aseptate, filled with yellowish refractive contents that stain weakly grey or pink in SV. **Hypodermis** not distinct, although there is a fairly abrupt differentiation between the cutis and tramal tissue; the cuticular and tramal hyphae interconnect in small areas between clusters of tramal sphaerocytes.

Trama of larger (up to 80µm) sphaerocytes in loose small clusters interleaved with denser, small irregular cells all bound with a hyphal mesh, with occasional vascular hyphae reacting weakly with SV.

Chemical reactions: FeSO₄ - greyish to pinkish; KOH - orange on cap surface, no reaction on stipe; NH₄OH - no reaction; phenol - brownish pinkish purple; SV - stains gills and cutis pink, vascular hyphae and cystidia pink to grey.

Habitat and tree associations: Found in deep duff on the forest floor on a SE facing well drained slope with little to no undergrowth amid a mixed age stand of 30-40-year-old Douglas fir, western red cedar and occasional western hemlock saplings.

Collections: CR010909-03 from regeneration Douglas fir forest in the Kemp Lake area, Sooke, near a trail from the houses along Kemp Lake Road towards the lake, N 48.22.517°, W 123.46.822°.

| Collection | ITS1-F to | | RFLP: | | |
|-------------|-----------|----------|----------|-----------|--|
| | ITS4-B | Hinf1 | Alu1 | Sau3A | |
| | | | | 610, 346, | |
| CR010909-03 | 832 | 358, 321 | 500, 259 | 270 | |

Notes. This *Russula* keyed out to *R. sublevispora* in Romagnesi (1985) and matches the description very well except for the habitat and having slightly stronger spore ornamentation. In Romagnesi this is described as in grassy or muddy lanes through broadleaved woods. The Vancouver Island collection was found under mainly Douglas fir, but a number of *Russula* species recorded from Europe under broadleaved trees also occur with Douglas fir and other local coniferous hosts. Additionally, red alder is also a common tree in these sites and may have been present but overlooked, so too deciduous shrubs. The macroscopic and microscopic morphology of this *Russula* places it in the *Heterophyllae* yet the DNA restriction fragments are dissimilar to those of the others in this group, in particular the HinfI fragments. These show more similarity to members of subgenus *Russula* section *Russula* subsections *Russula* and *Sardoninae*. The cutis pigments show similarities to

those of *R. aeruginea/stenotricha* with a small amount of water extractable blue-grey and magenta pigment but the much stronger yellow pigment was more like that of *R. parazurea*, i.e., a brownish yellow strongly fluorescing yellowish in UV light.

Romagnesi first described *R. sublevispora* as a variety of *R. ferreri* Singer, but on checking Singer's original description it was apparent that that species differs in having reticulate spores but is otherwise similar. Both are closely related to *R. grisea*.

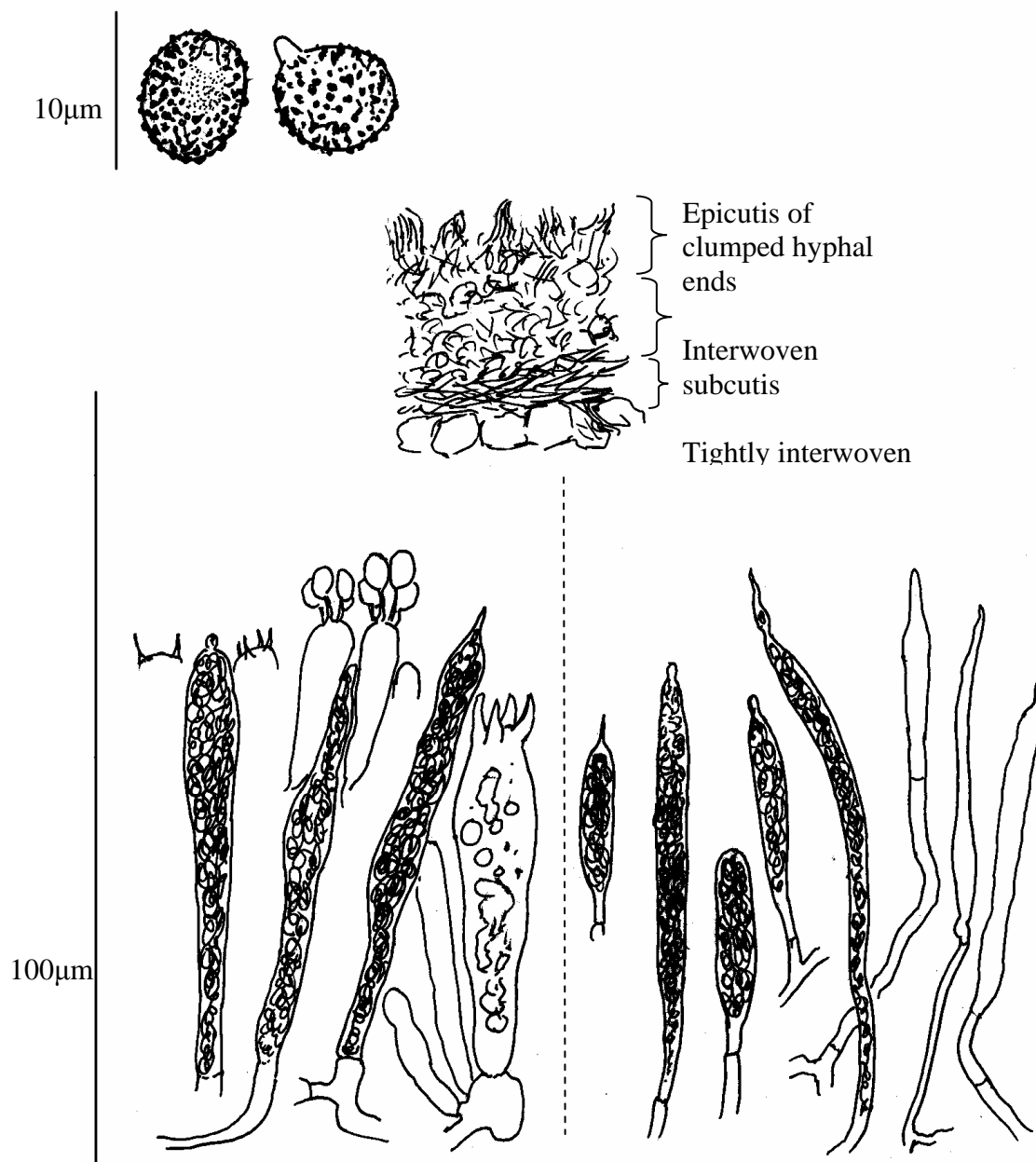


Figure 67. Microscopic characters of *R. cf. sublevispora*: Top. Spores with 10µm scale bar; middle, diagram of section through cutis; bottom left, hymenial cystidia (in SV) and basidia; bottom right, pileocystidia (in SV) and epicutal hyphal ends. Lower scale bar is 100µm.

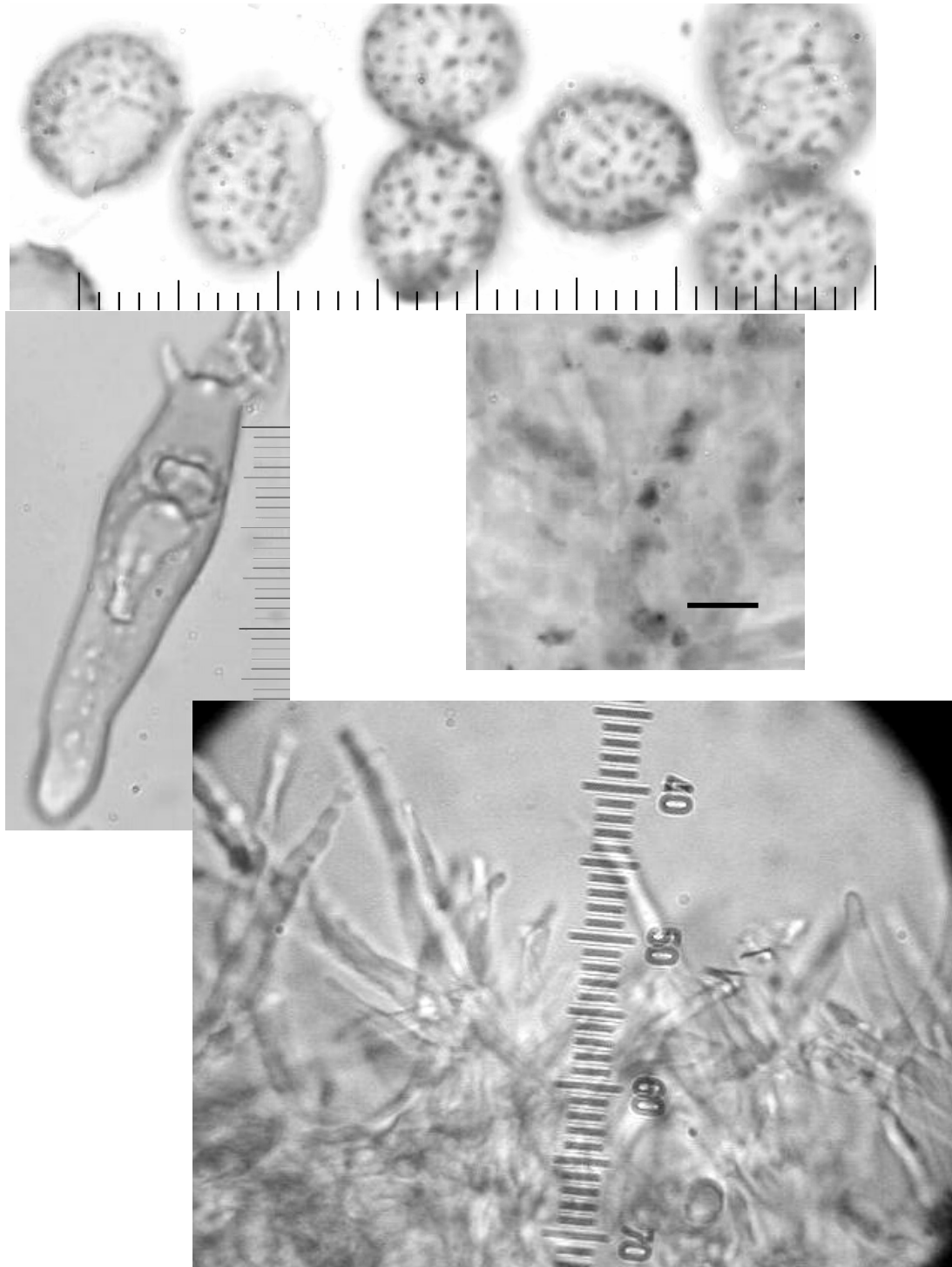


Figure 68 Epicutis and hymenial characters of *R. cf. sublevispora*: Top, spores with 1µm division scale; middle left, basidia with 1µm division scale; middle right, surface view of cutis in which the dark pigment granules show up inside the hyphae, scale bar is 5µm; bottom, cluster of hyphal ends from epicutis, 10 divisions on the scale are 25µm.

***Russula aeruginea* Lindbl. ex Fr.;**

***Russula cf. stenotricha* Romagn.**

Monogr. Hymen. Suec. 2: 198. 1863 Les Russules d'Europe et d'Afrique du Nord.: 290, 1967

These collections have been described together because it is not clear whether they represent one variable species, as has been assumed in several previous descriptions, or two species with many similarities.

Description of Vancouver Island collections:

Cap 3.6-10.5cm diameter, almost spherical with a flattened top, in some cases with a small central depression when young, and becoming shallowly centrally depressed with the edges flared unevenly. Colour grass green with tints of olive, yellowish green or, in the Koksilah collection, deep green, like a greyed viridian, sometimes minutely radially streaky, the colours usually strong but may fade somewhat in age, but never really pale, radially finely rugulose, viscid drying subglossy to matte. Margin smooth at first, becoming striate at maturity. Cuticle peeling at least half and sometimes completely, sometimes pulling away from the cap margin to expose the ends of the gills, flesh grey under cutis.

Gills close to subdistant, occasional anastomoses, occasional separate subgills, arched, becoming ventricose, depth increasing with age from about half to approximately equal that of the trama at half-radius, adnate at margin and adnate to almost sinuate at stipe, thin, pale cream, not or only slightly bruising brownish, brittle.

Stipe 3.0-8.5 x 1.2-2.5cm, more or less cylindrical, surface white or, in one button, with a green flush, sometimes with brown bruising at the base, stuffed with firm to bread textured trama, uncavitate, unchanging.

Texture ranges from quite firm to soft and pliable.

Taste mild or more often, slightly peppery especially in the gills.

Odour not distinctive.

Spore colour pale cream, Romagnesi IIa. The Koksilah collection IIc.

Spores subglobose to broadly ellipsoidal, mostly with little size variation within one collection with the exception of the occasional large spore. Three collections have spores of 5.5-8 (-9.5) x 5-7µm, L:W = 1 to 1.38, one collection from Lizard Lake near Port Renfrew has spores of 6.75-9 by 6.5-8µm. The Koksilah collection has variably shaped spores taken from the spore deposit of one mushroom, the majority are oblong but many are subglobose, 6-9.5 x 5-7.5µm, L:W averages 1.31 and ranges from 1.19 to 1.5. **Ornamentation:** Woo types B1, B2, C1, C2, D2; the Lizard Lake collection E1-E2, the warts mostly 0.2-0.8µm, rarely up to 1µm, rounded, isolated or more usually in chains forming a ridge, with some broad or fine connective lines, forming a partial reticulum. The reticulum on the Koksilah collection spores tends to be finer than that on the coastal collections. **Suprahilar patch** inamyloid or barely amyloid, appearing as a small unornamented region below the hilar appendage. **Basidia** mostly 4-spored, approximately 37-40µm x 10-12µm wide, clavate to bulbous in upper third. **Cheilocystidia** and pleurocystidia, abundant, cheilocystidia brownish purple in SV, protruding 20 to 30µm beyond basidioles, pleurocystidia purple to black in SV, some pink-staining ones in younger basidiomata, originating in the subhymenium, protruding about 10 to 25µm, both cystidia types 55-85 x 8-12µm, fusoid or cylindrical, often of uneven diameter, the tips rounded, broadly pointed or shortly mucronate. **Subhymenium** well differentiated, about 35µm thick, of small irregular cells, gill trama of sphaerocytes.

Cutis 150-230µm thick at half-radius, up to 350µm over the disc, an ixotrichoderm containing occasional vascular hyphae. **Subcutis** of repent interwoven hyphae gradually becoming more loosely interwoven toward the surface, the **epicutis** forming a loosely interwoven turf of hair-like hyphal ends, 1.5-4µm wide, with blunt or narrowed tips, and without the frequent septa or inflated cells common within the

subgenus. Cuticular hyphae and cystidia with dark pigment granules in the cytoplasm. **Pileocystidia**, abundant, 20-65 x 7-10µm, the predominant shape is clavate, relatively short and broad, mostly non-septate, occasionally with one septum, the Lizard Lake collection with some two-septate pileocystidia, and these 35-75µm long by 5-8µm wide. The Koksilah collection has pileocystidia 30-80 x 4-7µm, cylindrical, most with a small capitum and aseptate, strongly staining in SV but with some non-staining ones too. **Pseudocystidia** occasional, 3.5-6.5µm wide, more or less cylindrical with rounded ends or with a small capitum, refractive in KOH and greyish in SV.

Chemical reactions: FeSO₄ - weak, slowly light brownish pink; KOH - ochre on cap, yellowish on stipe; NH₄OH - no reaction; phenol - pale brownish pink; SV - cutis brownish or dull pink, gills and cap trama stain bright magenta.

Habitat and tree associations: The coastal type with clavate pileocystidia and more yellow-green cap colours in coastal stands of western hemlock with or without sitka spruce, usually solitary, uncommon. The more typical *R. aeruginea* type with cylindrical-capitate pileocystidia from Koksilah Ridge was under regeneration Douglas fir, also uncommon.

Collections: CR000919-03 (2 specimens,) Bamfield area; P.K.27/V/00 Clayoquot Island (2 specimens), CR010920-38b (1 specimen) CR021016-22 (1 specimen) Long Beach area, Pacific Rim National Park; CR030927-02 (1 specimen) Lizard Lake, Port Renfrew. TT040904-01 (3 specimens) from Koksilah Ridge.

| Collection | ITS1-F to | RFLP: | | |
|-------------|-----------|----------|----------|----------|
| | ITS4-B | HinF1 | Alu1 | Sau3A |
| CR021016-22 | 865 | 410, 267 | 480, 266 | 334, 274 |

Notes Romagnesi (1967) recognized *Russula stenotricha* as a separate species from *R. aeruginea*, basing his conclusion on the consistent characteristic of the pileocystidia, which are clavate and broad, generally 5-9 (-12)µm broad and 25-50µm long, and lack a terminal appendage in *R. stenotricha*, whereas in *R. aeruginea* the

pileocystidia are much longer, only 4.5-7 μ m wide and mostly capitate. Otherwise the two species are very similar. Romagnesi considered *R. stenotricha* to be closely related to *R. aeruginea*, whereas Sarnari (1998) considered it to be more closely related to *R. pseudoaeruginea*. However, this latter species differs in its epicutal hyphae of articulated, often inflated cells. In European literature *R. stenotricha* is reported as being found under broadleaved trees on chalky-clay soils but *R. aeruginea* is found under spruce and pine. The Vancouver Island collections all have the short, clavate pileocystidia typical of *R. stenotricha* and no articulated inflated epicutis hyphae, the spore print is slightly paler than is described for either *R. aeruginea* or *R. stenotricha*, and the habitat always includes western hemlock. *R. aeruginea* is included in Thiers' Agaricales of California (1997), Grund (1965) described a collection of *R. aeruginea* as var. *mutabilis* nom. prov., from Washington State, which had larger warts on the spores than the above collections and a variety of pileocystidia shapes that echoes the Lizard Lake collection. When compared with the Genbank sequence for *R. aeruginea*, a Vancouver Island collection had a slightly longer ITS region, and differing sizes for each of the three enzymes. The GenBank sequence could have a base-pair substitution at a Sau3A site, leaving the 544 nucleotide fragment intact. The 274 nucleotide fragment of the PRNP collection may be masking a second fragment only slightly smaller in size.

Shaffer (1970) made several collections of *R. aeruginea* from Michigan and commented on the variation in spore ornamentation and in the pileocystidia, which can vary between specimens in the same collection or even within the same pileus. One explanation for the variability in North American material compared with the two distinct forms found in Europe is that the North American *R. aeruginea* is a remnant ancestral species to the two European species *R. stenotricha* and *R. aeruginea*. The two types found on Vancouver Island in two different habitats may well represent two species rather than one variable one, so hopefully future collections will resolve this question.

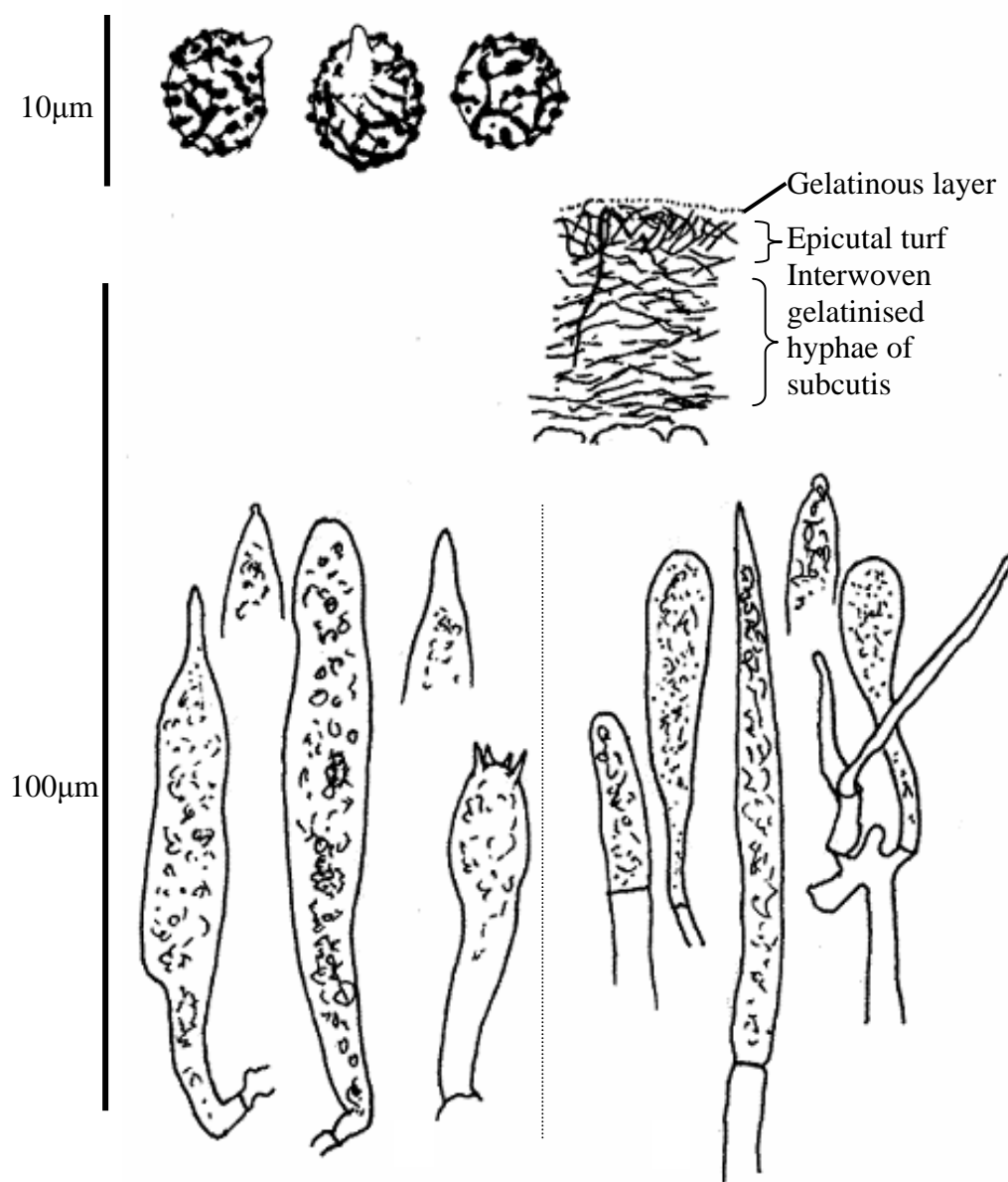


Figure 69 Microscopic characters of *R. aeruginea*: Top, spores with 10µm scale bar; middle, plan of cutis section in 5% KOH; bottom left, hymenial cystidia and basidia; lower right, pileocystidia and hyphal ends in epicutis, lower scale bar is 100µm.



Figure 70 Top and inset, *Russula auruginea* (*R. cf. stenotricha*) from the Long-beach area of the PRNP, shown alongside a 1 cm scale. Bottom, the more typical form of *R. aeruginea* from Koksilah ridge, the spore print is visible on the white paper and the mushrooms are on a 1cm grid mat.

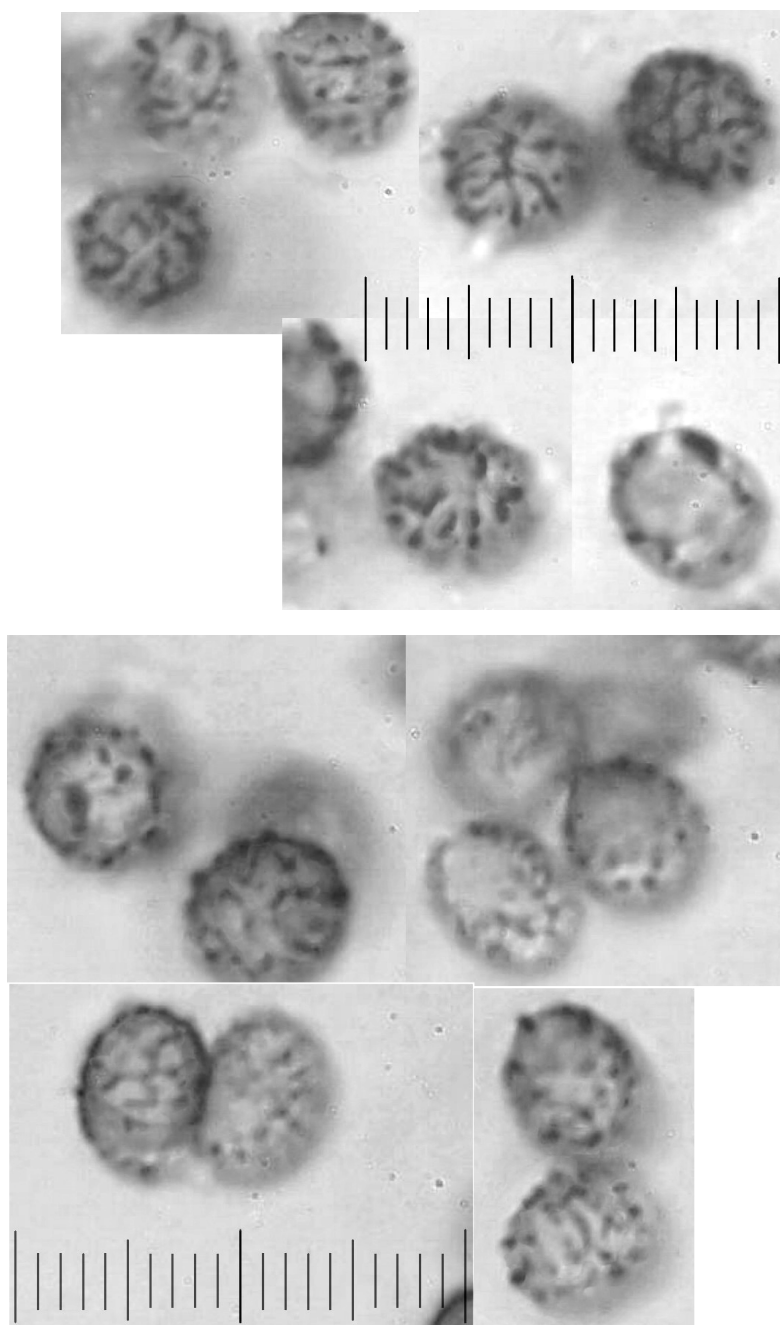


Figure 71 Spores of *Russula aeruginea*: Top, those of *R. aeruginea* (*R. cf. stenotricha*) from the Long-beach area of the PRNP, bottom, those of the more typical form of *R. aeruginea* from Koksilah ridge. In both sets the scale is in 1 μ m divisions.

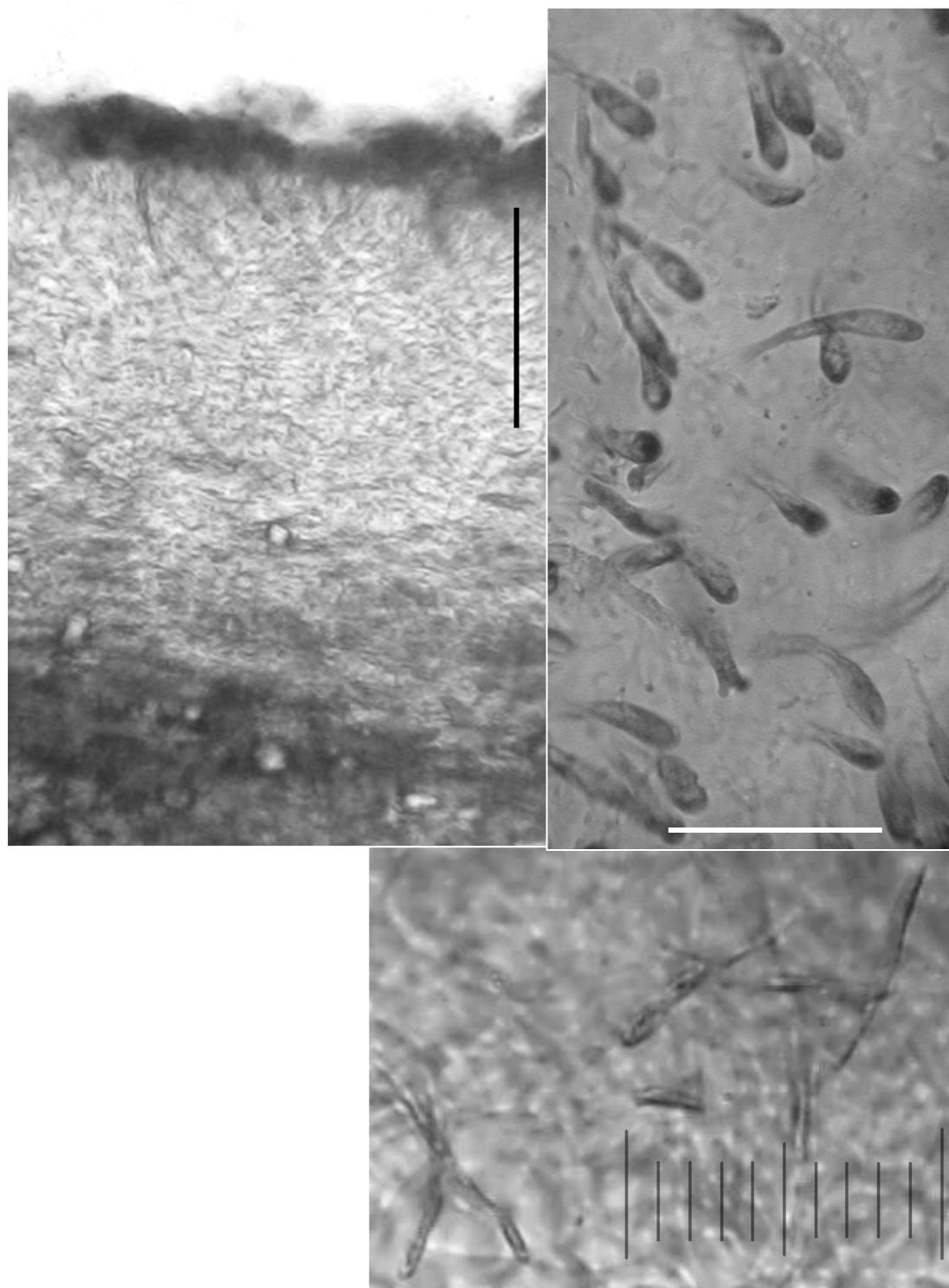


Figure 72 Cutis of *R. aeruginea*: Top left, section through cutis with scale bar of 100µm, top right, surface view of epicutis with scale bar of 50µm, both of *R. auruginea* (*R. cf. stenotricha*) from the Long-beach area of the PRNP; bottom, surface view of epicutis of *R. aeruginea* from Koksilah ridge with 10µm division scale.

Clade 5a

Subgenus *Russula*

Includes subsections *Russula*, *Consobrinae* and *Sardoninae* of Section *Russula* sensu Sarnari (1998).

Russula viscida Kudřna

Mycologia 5: 56. 1928

Description of Vancouver Island collection:

Cap 5.3-7.5cm, convex at first, becoming depressed in the centre and sometimes uplifted towards the margins, but with the margin remaining curved around the top outer edge of the gills, margins smooth. Colour brownish vinaceous, mottled with pallid, brown and dull brownish-yellow areas, viscid (but not exceptionally so), drying matte, minutely concentrically areolate near the margin. Cutis peeling less than 1/4 the radius. Cap trama pinkish under cutis, otherwise light cream, at least twice the depth of the gills at half-radius, unchanging when cut.

Gills arched, adnate, appearing slightly decurrent, fairly shallow, close to crowded, deep cream to ochre yellow, bruising yellow-brown, brittle, with some forking especially near the stipe.

Stipe 4.5-4.8 x 1.8-2.5cm, short and stocky, widest at the apex, very firm, stuffed, not cavitate in this collection, the rind about 1/4 the thickness of the stipe diameter. White, becoming yellow-brown where scraped and at the base, somewhat rugulose.

Texture firm, not brittle

Taste mild.

Odour mild, slightly fruity or nutty.

Spore colour not verified but estimated as cream, Romagnesi (1967) states it as about IIb.

Spores 6.2-9.8 (-11.2) x 5.2-8.5 (-10)µm, L:W 1.03-1.5, mean 1.27, most broadly ellipsoidal but some narrowly ellipsoidal, globose or bean shaped and occasionally large spores found, the overall impression is of fairly variable shape and size.

Ornamentation of warts under 0.5µm high, bluntly conical to crestate, joined in chains or by fine to heavy lines forming a nearly complete to complete reticulum,

Woo types C1 and D1. **Suprahilar patch** an irregular, strongly amyloid patch with warts bordering it sometimes giving it a raised appearance, and in some spores the patch forms an irregular collar around the base of the hiliferous appendix. **Hiliferous appendix** relatively large at 0.8-2.2µm long and about 1.4µm at the base, distinctly 2-tiered. **Basidia** 4- and 2-spored, very occasionally 1-spored, 35-52 x 9-15µm at the widest point, most are at the smaller end of the range, between 9-12µm, the rather more voluminous type (figure XX) are rather rare. Sterigmata 7-8µm long and about 0.8µm wide at the base. **Cheilocystidia** and pleurocystidia, 52-85 x 8-12 µm, sparse, weakly reacting to SV in dried material, light reddish brown to grey, refractive and yellowish in 5% KOH, projecting about 20µm beyond the basidioles, most fusoid, some narrowly clavate or irregularly cylindrical, sometimes with a contorted base originating from the subhymenium. Tips acute or with a short appendage.

Subhymenium about 30µm thick, of jigsaw-puzzle-like pseudoparenchymatous cells, gill trama of irregular sphaerocytes and vascular hyphae

Cutis 150-300µm thick at half-radius, subcutis about 100-150µm thick. **Subcutis** of interwoven hyphae 2.5-4µm wide, occasional ones to 5µm, basal layers with vascular hyphae 4-8µm wide, many of which stain grey in both SV and acid-fuchsin, others have brownish-yellow contents in SV and in water mounts. Some of these vascular hyphae terminate in pseudocystidia at or below the epicutis. The basal layers of the subcutis are interwoven with the upper layers of the trama so the division between the two tissues is not abrupt. **Epicutis** an upright to repent turf of yellowish brown hyphal ends, 3-5µm wide, some of which in acid mounts appear loosely incrustated with small granular or globular particles. Romagnesi (1962) and Bon (1988) mention dark to

yellow-brown pigment inclusions in the hyphal ends, these may not be immediately apparent save that the uppermost layer of the epicutis is somewhat browner; higher magnification reveals these end cells contain 2-3 greyish-yellow globules (a necropigment), almost the width of the hypha. The terminal cells may be clavate, undifferentiated or more commonly tapered, and subapical cells occasionally have diverticulae. **Pileocystidia** abundant, 50-112 x (3-) 6-7.5µm, cylindrical to narrowly clavate, 1-3 (- 6)-septate, end cells mostly cylindrical or a little inflated at the base or tip or both, some fusoid, tips obtuse, pointed or capitate. Most stain dark grey in SV, but some appear brownish-yellow, or often with the lower cell yellowish and the terminal cells black, occasionally vice-versa. Some of these have acid-resistant incrustations, especially those more deeply embedded in the epicutis.

Trama of discrete small clusters of sphaerocytes interspersed between thickish bands of interwoven hyphae, the latter being more abundant and denser than in most *Russulas*.

Chemical reactions: FeSO₄ - salmon-pink, KOH - bright red on cap cutis, no reaction on mid-stipe but red-brown at the very base of the stipe, guaiac - blue-green, NH₄OH - no reaction, phenol - brownish, SV - pinkish-brown on gills and cutis.

Habitat and tree associations: This collection was with madrone (*Arbutus menziesii*), with nearby Douglas fir and salal, spruce was absent.

Collections: CR981114-06, Koksilah ridge eastward of Burnt Bridge park, on a roughly south-facing limestone bluff, in young and mature regeneration Douglas fir with pine and madrone, N 48.6558°, W 123.7357°.

| ITS1-F to | | | | |
|-------------|--------|-------------|----------|-------|
| Collection | ITS4-B | RFLP: HinfI | AluI | Sau3A |
| CR981114-06 | 874 | * | 515, 254 | 189* |

* This collection amplified only on the second attempt, and then poorly; in the HinfI and Sau3AI digestions the larger DNA bands were not visible, a problem when there was insufficient DNA.

Notes: This species has the characteristics of the *Melliontinae* sensu Romagnesi (1967), in which it was placed by him and by Bon (1988). It also keys out to section *Paraincrustatae* subsection *Lepidinae* sensu Sarnari (1998) except for the positive reaction of the above species with SV. Sarnari created a new section, the *Viscidinae* (Sarnari) Sarnari in 1991 for this and related species. It is an unusual species in that the phylogenetic analyses described in Chapter 2 and in Miller and Buyck (2002) placed *Russula viscida* (based on sequence data from a European collection) in a clade with *R. ochroleuca* and *R. atropurpurea* basal to the peppery, pale-spored clade of Russulas which includes *R. fragilis* and *R. queletii*, rather than the higher clades with the *Lepidinae* or *Melliontinae*. It shares with *R. ochroleuca* similar reactions with SV and acid fuchsin, both having scattered occasional incrustations on cuticular hyphae, and is described as sometimes having a slight pepperiness to the gills when young, and both have reticulate spores. Like *R. ochroleuca*, *R. viscida* has cylindrical septate pileocystidia, a character usually associated with higher clades such as the *Tenellae*, which is why both species have traditionally been placed within the upper clades even though the pale spore print is more commonly found in the basal clades. The chromatograph of the Vancouver Island *R. viscida* has a pattern closer to that of *Xerampelinae* of clade 9.

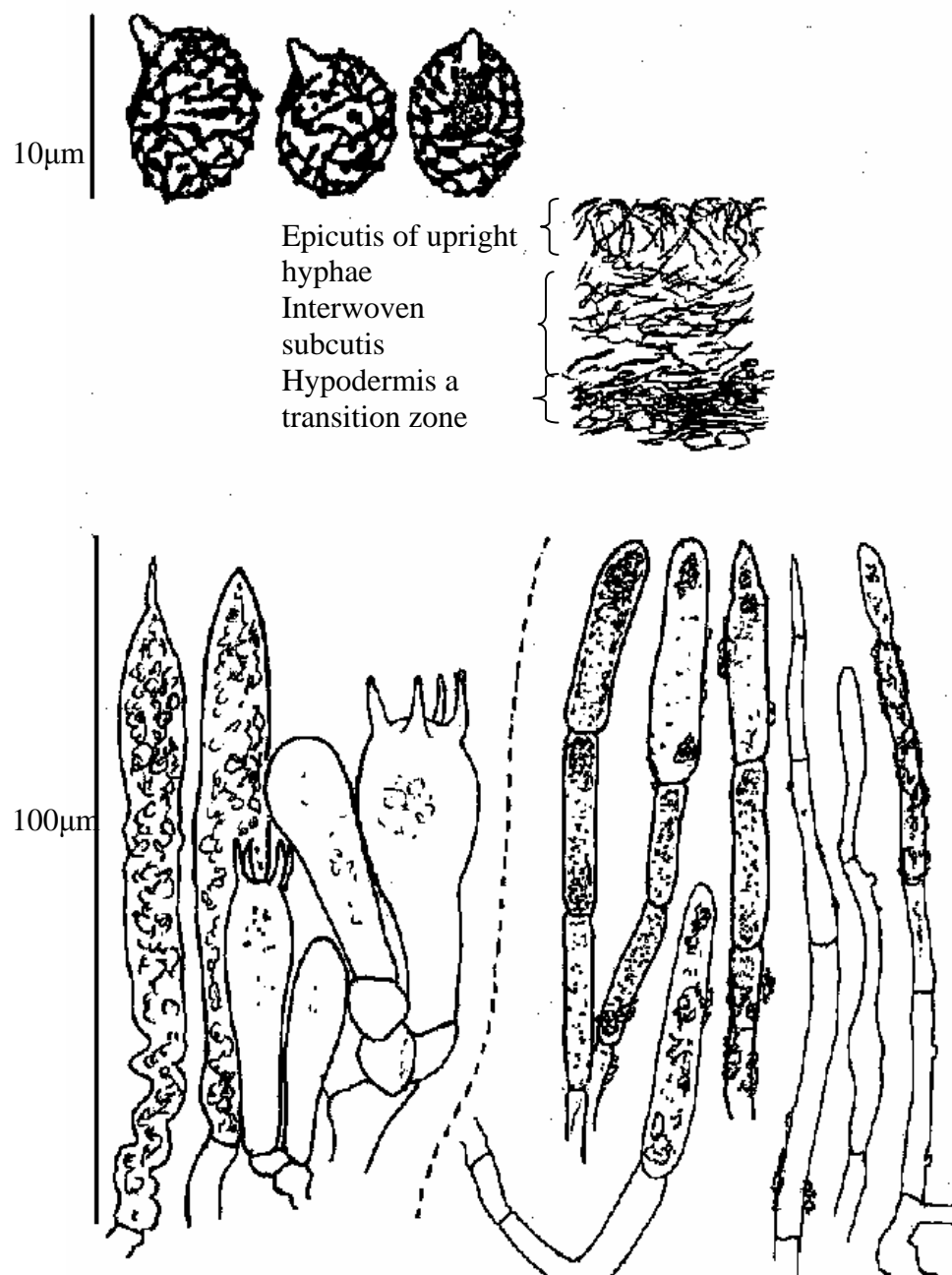


Figure 73 Microscopic characters of *Russula viscida*; top, spores with 10µm scale bar; middle, diagram of section through cutis; bottom left, hymenial cystidia and a normal and a large basidium with basidioles; bottom right, pileocystidia and epicutal hyphal ends.

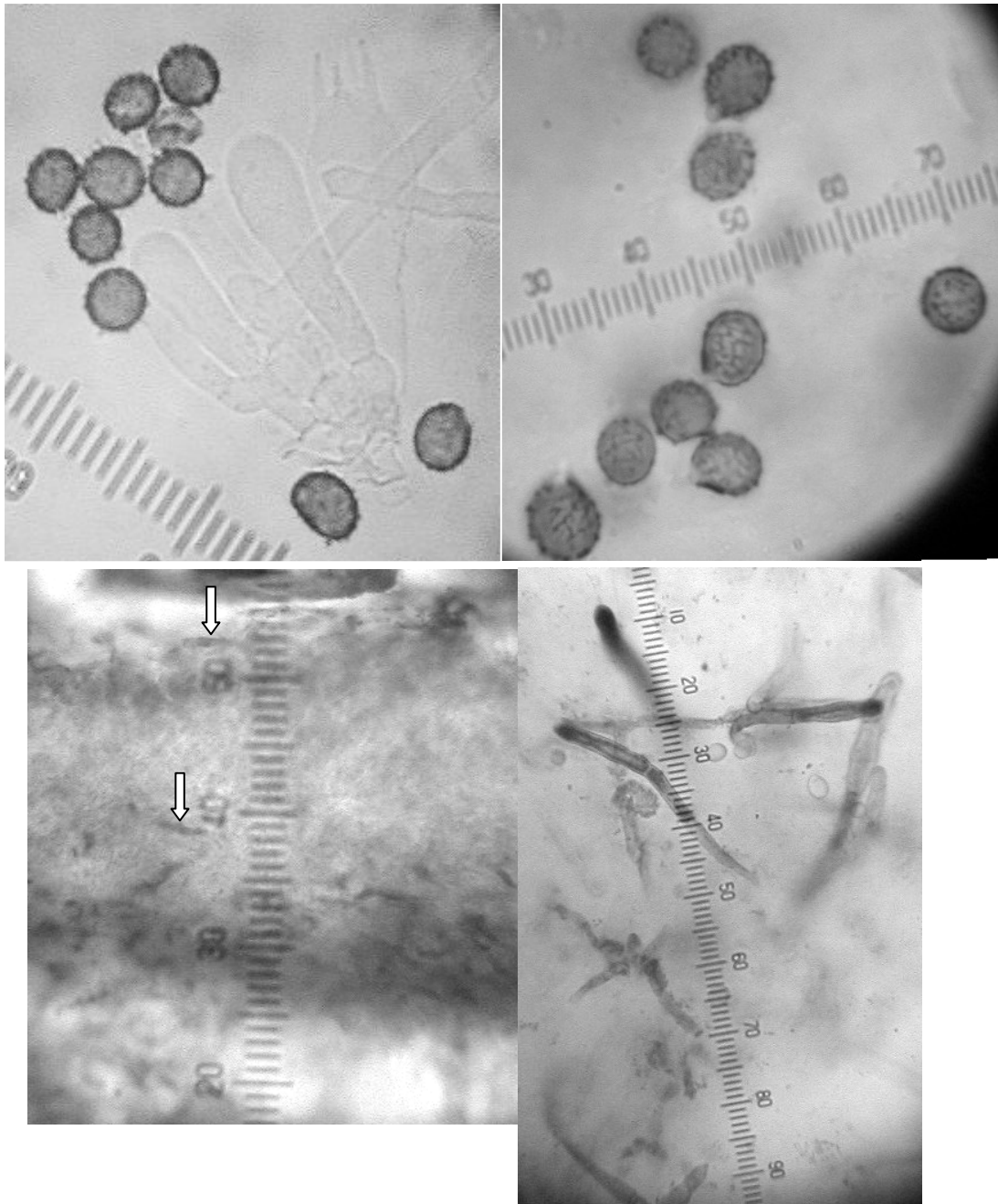


Figure 74 Hymenium and cutis of *R. viscida*: Top left, basidium and basidioles, 10 scale divisions are 25µm; top right, spores with 1µm division scale; bottom left, section through cutis of *R. viscida* in SV, in which pileocystidia at the surface and laticifers in the subcutis (arrowed) are darkly stained, 10 scale divisions are 100µm; bottom right, surface view showing several pileocystidia, some of which have cells that do not stain black in SV. Ten divisions of the scale are 25µm.

***Russula stuntzii* Grund**

Mycotaxon 9:97 1979

Description of Vancouver Island collection:

Cap 4.0-10.5cm, hemispherical to convex when young, becoming plane and eventually centrally depressed, sometimes retaining a low umbo, but long retaining a rounded margin, margin mostly smooth developing striations only in age. Colour a rather uniform pale slightly purplish grey, sometimes with a more violet cast, other times more towards pink, perceived colour varies with the light source (figure??), usually slightly darker or browner in the centre and occasionally almost white towards the margin, never with yellow or green hues, not discolouring much at maturity, viscid, drying subglossy, peeling 1/4 to 1/2 the radius. Flesh white, unchanging, white to slightly grey under the cuticle. The colour of dried basidiomata is light olive-brown.

Gills white to pale cream, unchanging when bruised, subdistant to close, occasional lamellulae, forking common, mostly near the stipe, adnate to adnexed, obtuse to subacute at the margin, about 5mm deep at half-radius on an averaged size mature basidioma of 6.5cm diameter, this depth being about 1.3-1.5 the depth of the cap trama. Gills pliable when young occasionally slightly greasy feeling as in the *Heterophyllidia*, margins entire.

Stipe 4.9-11.2 x 1.1-2.9cm, more or less cylindrical or widening slightly at the base or apex, white, when young a white pruina may overlay the pale cream surface, not bruising but turning buff-grey as if waterlogged in age, stuffed with a bread-textured trama that develops irregularly shaped and distributed cavities, rind firm, pale greyish, around 2mm thick.

Texture fairly firm and pliable when young, becoming fragile in age.

Taste sometimes slightly bitter at first, then peppery to acrid, sometimes the acidity is immediate.

Odour not distinctive to faintly fruity, sometimes also with a faint cedar component.

Spore colour pale buff, Romagnesi IIa but less yellow and more pink.

Spores 6.8-10 (- 11) x 6.2-8.9 μ m, L:W 1-1.43 with a mean of 1.17 (n = 50), globose, subglobose or broadly ellipsoidal. **Ornamentation** of conical warts, occasionally heavy, 0.8-1.4 μ m or sometimes up to 2 μ m high, isolated or with mostly fine connectives not forming a reticulum or at most a partial one, Woo type B3 -C3.

Suprahilar patch amyloid, more or less rounded but with irregular margins that are often more strongly amyloid or raised slightly, and sometimes with a lower but otherwise similar ornamentation to that of the rest of the spore. **Hiliferous appendix** relatively large, 2-2.8 μ m long by 1.2-1.7 μ m wide at the base. **Basidia** mostly 4-spored, occasionally 2-spored, 47-60 x 9-13 μ m, clavate and slightly bulbous in the upper 1/3 to 1/2. Sterigmata 5-8 μ m long and 1.5-2.5 μ m wide at the base.

Pleurocystidia abundant, 52-105 x 7-11 μ m, protruding 15-25 μ m, originating in the subhymenium or the outer gill trama, blue-black in SV (but reacting only weakly in one collection), contents refractive in KOH, fusoid to narrowly clavate, occasionally cylindrical, bases variable in length and shape, tips acute or mucronate, less often capitate. **Cheilocystidia** frequent, sometimes forming a microscopic fringe, protruding 15-50 μ m, similar to pleurocystidia in shape, blue-black in SV, sometimes with yellow granulations. **Subhymenium** 20-45 μ m thick, pseudoparenchymatous, sometimes also with a narrow layer of interwoven hyphae directly beneath the hymenium, gill trama of sphaerocytes with frequent vascular hyphae.

Cutis 170-250 μ m thick at half radius, an ixotrichoderm of three layers. **Hypodermis** of repent, tightly interwoven hyphae and numerous vascular hyphae, all greyish purple in SV and brownish in KOH. **Subcutis** of hyaline more loosely interwoven gelatinized hyphae 2-4 μ m wide, through which penetrate frequent upright vascular hyphae, about 4 μ m wide but sometimes broadening to 10 μ m, and extending into the

epicutis, dark grey in SV. **Epicutis** a turf of upright hyphal ends 1.5-5µm wide, some of which terminate in a small cystidioid cell with refractive contents, others undifferentiated, many with a capitate terminus, interspersed with abundant long cystidia lying along the epicutal surface for part of their length. **Pileocystidia** unevenly distributed, in small tufts of 6-7 or single, 60-230 x 5-10µm, but most in the mid-range width, 0-1-septate, cylindrical, tips mostly capitate, some obtuse, SV₊. Intermediates between the small cystidioid hyphal ends (from 10 x 3µm) to the larger-sized cystidia can sometimes be found. **Pseudocystidia** abundant, much more frequent than pileocystidia, generally regularly septate, sometimes with inflated sections up to 13µm or allantoid (sausage-shaped) cells, tips obtuse or capitate in roughly equal proportions, contents refractive, staining dark grey in SV.

Trama of irregularly sized and shaped clusters of sphaerocytes bound by a hyphal mesh with frequent vascular hyphae.

Chemical reactions: FeSO₄ - light greyish pink; KOH - no reaction to slightly pinker or browner on cap surface, no reaction to yellowish on stipe; NH₄OH - no reaction; guaiac -blue-green; phenol - brownish purple; SV - reddish purple on the gills, magenta then greyish purple on cuticle, cystidia and vascular hyphae grey to black.

Habitat and tree associations: in small groups of two or three but in one case trooping, on conifer logs that have brown cubical rot and become friable, with western hemlock, other trees within the habitats may include red alder, Douglas-fir or Sitka spruce. The primary host tree is probably western hemlock as that was consistently present in *R. stuntzii* habitats. October to February, generally ceasing fruiting after heavy frosts but in one case fruiting two days after a 20cm snowfall.

Collections: CR981029-RF8, on large cedar log of decay class 4, on a small section of more advanced decay, near western hemlock, Sitka spruce and western red cedar, Rain Forest trail east side of highway, P.R.N.P. south of Tofino, N49.446778°, W125.531694°. CR001024-01 on partially buried decayed log near old growth Douglas fir, western hemlock, red alder and big-leaf maple, Mystic vale, University

of Victoria grounds N4834598°, W123.3071°. CR001127-03 on very decayed moss-covered logs, possibly hemlock and woody debris in mature regeneration forest with some old growth Douglas fir, also western hemlock (mature and understory saplings), western red cedar and oregon grape, Royal Roads University woodlands, N48.434467°, W123.478867°. OC010218-01 from a buried decayed Douglas fir log amongst old growth and mature regeneration Douglas fir and western hemlock, Royal Roads University woodlands, exact location not recorded. BT021101-01 on decayed Douglas fir log and woody debris with old growth western hemlock, western red cedar and salal, Royal Roads University woodland, N48.433417°, W123.477417°.

ITS1-F to

| Collection | ITS4-B | RFLP: HinfI | AluI | Sau3A |
|-------------|--------|-------------|----------|---------------|
| CR001024-01 | 932 | 375 | 526, 262 | 445, 214 |
| BT021101-01 | 892 | 400 | 517, 286 | 421, 316, 221 |

Notes: *Russula stuntzii* has a distinctive colour that can be distinguished from *R. fragilis* by its distinctive nearly uniform colour with no traces of greens or dark, clear purples or violets, it tends to be firmer, larger, and usually has a straight stipe, whereas that of *R. fragilis* is often curved and the spore colour differs. *Russula stuntzii* has no clear yellow in the cap unlike *R. raoultii* and pale forms of *R. bicolor* and *R. silvicola*, both of which usually grow on wood. Grund's description of *Russula stuntzii* states that the spore print is white, and suggests that collections with pale salmon coloured spores could be *R. albiduliformis* Murr. or *R. pantoleuca* Singer but those species are mild, the former has SV negative cuticular cystidia and is milk-white, the latter a rare eastern species of oak woodlands with pale brownish or greenish tints in the mostly white cap. Thiers (1997) described *R. stuntzii* spores as white to pale yellow and the cap colour as ranging from white to greyish with purple tones. The Vancouver Island material all had pale buff coloured spores and purple or pinkish-grey caps, even old faded basidiomata retained some purplish-grey tints. The spores also extend the upper size limit by 1µm on the length and 1.4µm on the width, and the ornamentation ranges higher than the 1µm limit for Californian and Washington material, all other characters agree with Thiers and Grund's descriptions.

Grund first described *R. stuntzii* in his thesis in 1965 as *R. pallidolivida* nom prov. after finding it twice over a 3-year period. He considered it rare in Washington. On Vancouver Island the five collections were made in old-growth forests with ample decayed woody debris, a habitat rare in itself. Thiers (1997) noted that it is the only *Russula* species in California that often grows on well-rotted conifer logs, and that it is found in coastal and montane forests throughout the state.

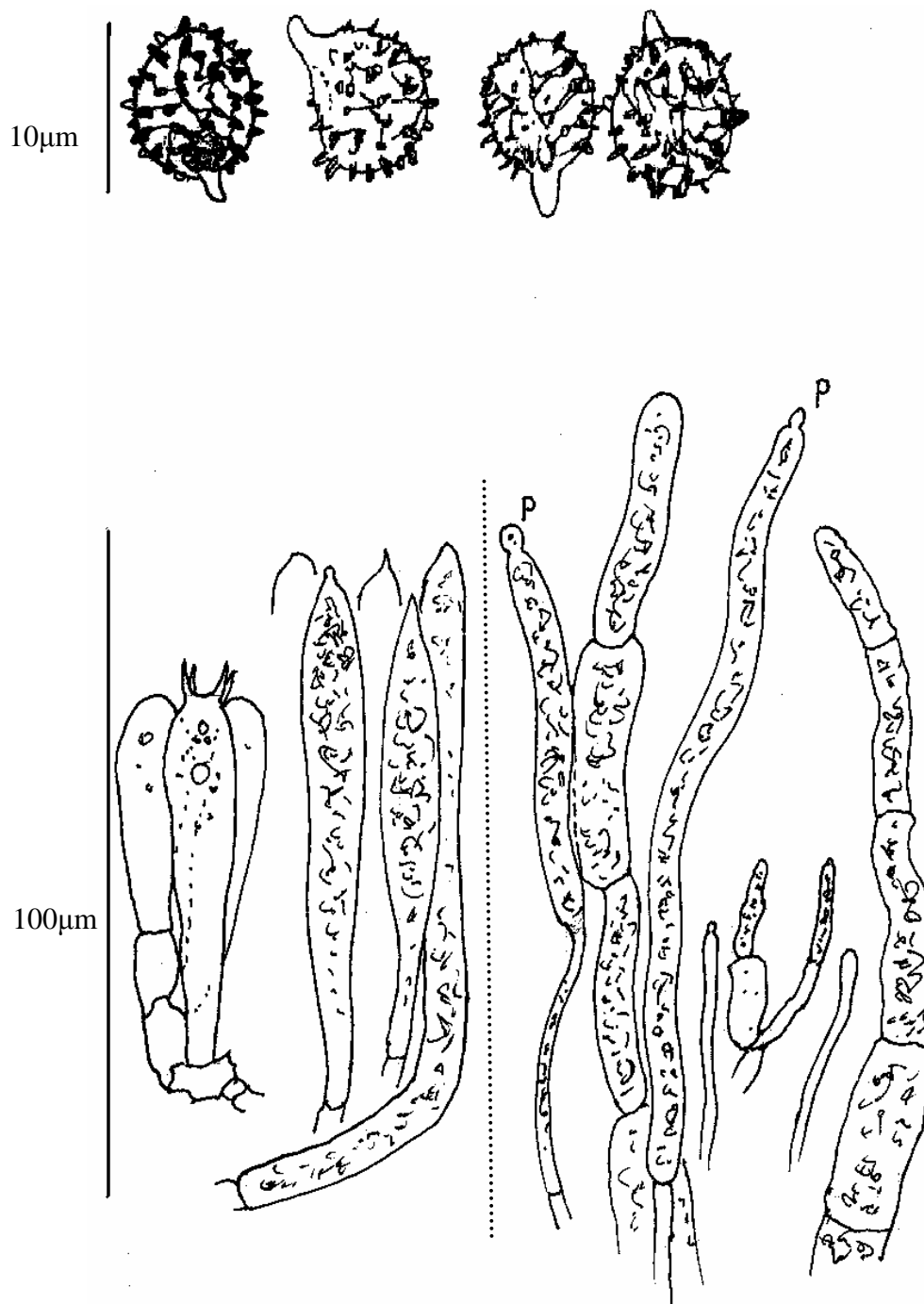


Figure 75. Microscopic characters of *Russula stuntzii*: Top, spores with 10µm scale bar; bottom left, basidium and basidioles and hymenial cystidia; bottom right, pileocystidia (marked 'p'), pseudocystidia and hyphal ends from the epicutis, scale bar is 100µm.



Figure 76. *Russula stuntzii*: Top, illustration showing profile of immature and mature basidiomata and a longitudinal section, the 1cm² square shows spore colour; bottom, in situ on rotten logs, on the left are buttons photographed in daylight, on the right, an immature and mature specimen photographed with an electronic flash, note that the colours appear pinker with the flash. (Photograph on the right by Bryce Kendrick).

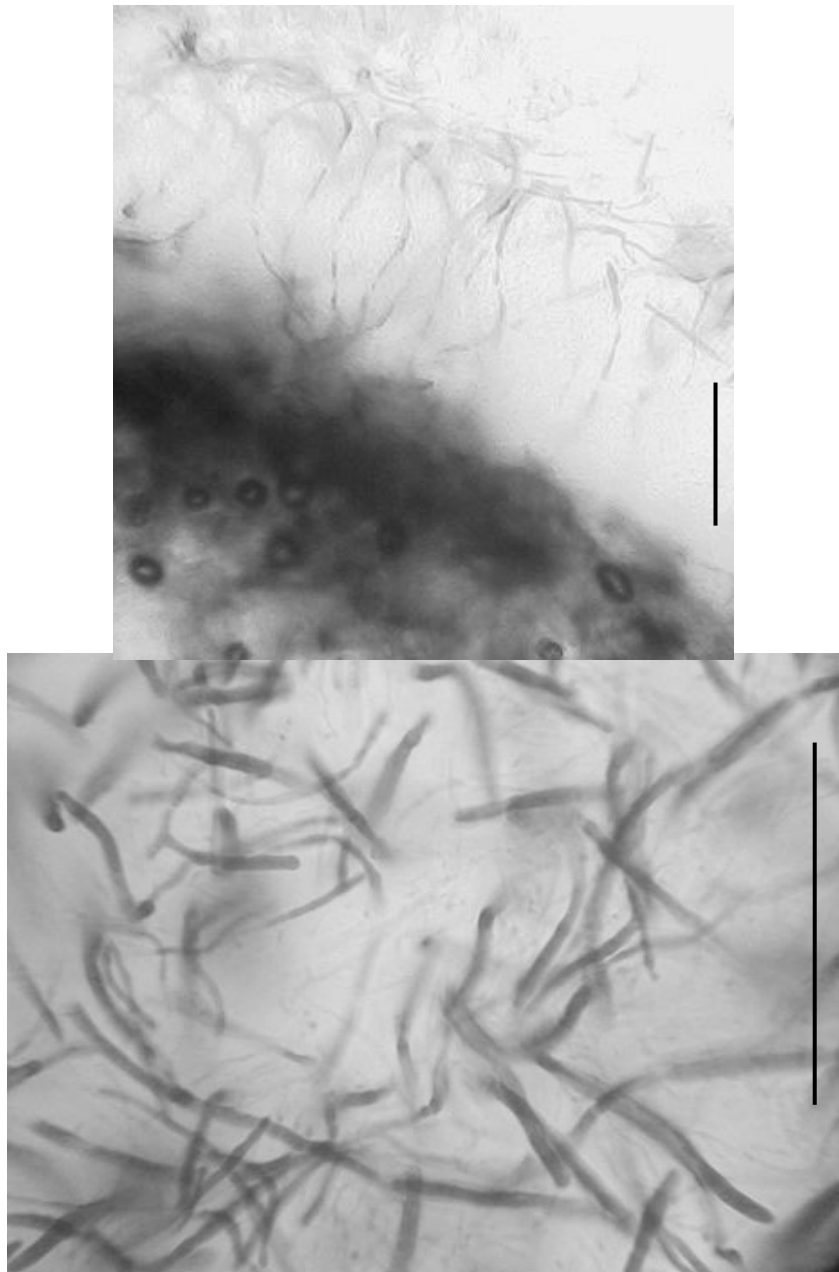


Figure 77. Cutis of *R. stuntzii*, top, section through the cutis in SV showing the many dark pseudocystidia arising at or below the basal layer of the subcutis and emerging at or near the epicutis, bottom, surface view of pileocystidia and pseudocystidia. Scale bars are 100 μ m.

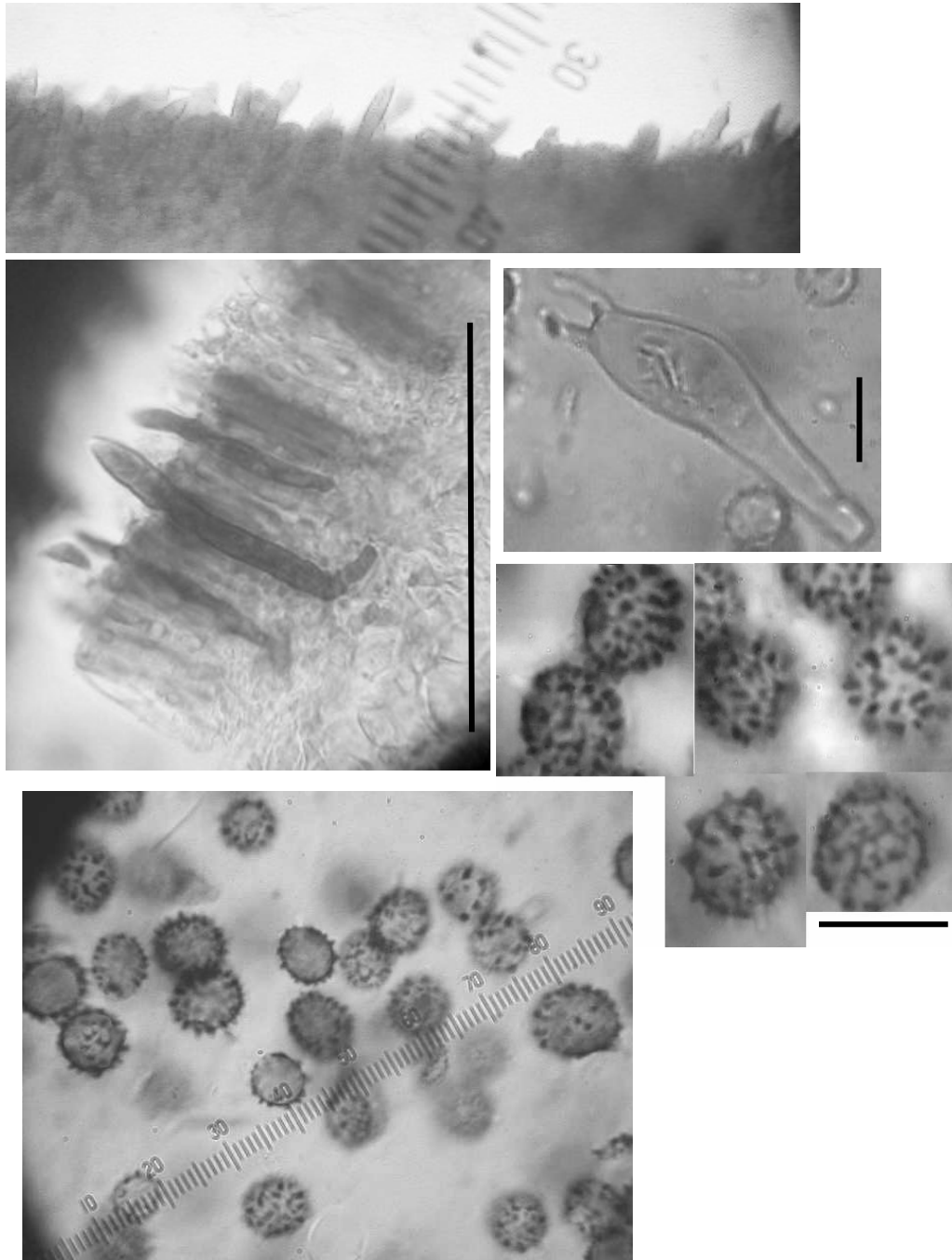


Figure 78. Characters of the hymenium of *R. stuntzii*: Top, gill margin with cheilocystidia stained with congo red, ten scale divisions are 100µm; middle left, section of gill showing pleurocystidia in SV, scale bar is 100µm, middle right, a basidium (2-spored) with 10µm scale bar; below basidium, details of spore ornamentation, composites of two depths of focus, scale bar is 10µm; bottom, spores in Melzer's reagent, 1 scale division is 1µm .

Clade 5b

Section *Russula*, Series *Atropurpurea*

Russula raoultii Quel.

Assoc. Franc. Av. Sci. Compte Rendu 14:449. 1886

Description of Vancouver Island collections:

Cap 2.5-6.0cm, convex with a small flattened umbo when young, becoming shallowly depressed at maturity and sometimes retaining a vestige of the flattened umbo. Margins smooth, becoming striate about 1/5 the radius from the margin in age. Colour pale yellow to cream over the disc, paler towards the margins which are whitish, sometimes a very faint pinkish tinge is discernible in the outer 2-3mm, but more often a greyish to greyish yellow occurs as the trama beneath the cutis discolours in age. This greying is more of a waterlogging rather than a bruising effect. Surface viscid drying matte to glossy depending on age. Cutis peeling 1/4 to 1/3, rarely to 1/2, flesh beneath white, unchanging where bruised but acquiring a yellowish-grey waterlogged appearance in age.

Gills white to very pale cream, occasionally with a slightly pinkish cast when young, close to crowded, sometimes subdistant, lamellulae occasional to frequent, absent in some basidiomata, lamellae generally with some forking. Shape arched to fusoid, equal to about 1.3 the depth of the cap trama at half-radius, acute at margin and stipe, very narrowly adnexed to free, margins entire and smooth on most collections, and it appears from microscopic examination that cuticular-like gelatinizing hyphae continue along the gill margins in many basidiomata. Gills not bruising, pliable when young, brittle in age.

Stipe 2.0-9.0 x 0.8-1.8cm, ranging from shorter to longer than cap diameter but most are longer, white, smooth, stuffed with soft bread-textured trama, becoming hollow

with age, unchanging when bruised but like the rest of the trama developing a greyish waterlogged appearance in age.

Texture soft and fragile.

Taste quickly very acrid.

Odour fruity and sometimes also of coconut, occasionally faintly reminiscent of the *Ingratae* (spermatoc-rubbery).

Spore colour white, Romagnesi 1a to paler than 1b.

Spores of two size ranges: collection CR021118-02 is within the range expected for *Russula raoultii*; 6-8 x 5-6.8µm, L:W 1-1.42 with a mean of 1.19 (n = 15); all other collections are 6.8-10 x 5.5-8µm, averaging 8.3 x 6.8 (n = 95) with a L:W of 1-1.45, mean 1.21. Spores are subglobose to broadly bean-shaped to ellipsoidal.

Ornamentation (for all collections) is of low short ridges or angular warts with blunt to pointed tips, 0.2 -0.8µm, rarely, the occasional wart may reach 1.0-1.2µm. Warts rarely isolated, most catenate or with fine to heavy connectives forming a complete reticulum or nearly so, **Woo types** D1, D2 -E2. **Suprahilar patch** amyloid, sometimes also with small warts. **Hiliferous appendix** around 1.8µm long, 1µm wide at base. **Basidia** mostly 4-spored but 2-spored ones common, 35-45 x 9-12µm, clavate to bulbous in the upper 1/3, sterigmata relatively large, 5 -10µm long and 2µm wide at the base. **Pleurocystidia** 32-75 x 6-11µm, occasionally to 100µm long or to 15µm wide, protruding around 20-25µm, originating in the subhymenium, brownish purple in SV, contents yellowish and refractive in KOH, fusoid, tips obtuse or mucronate, the appendage short, pointed or button-like, those with an apical exudate quite common. **Cheilocystidia** numerous, absent in occasional sections, reddish or black in SV, making up most of the gill margin which is otherwise nearly sterile, protruding around 30µm, similar to pleurocystidia in contents and shape, however many of them appear to leak their contents or exude them from the tip, eventually the protruding part becoming repent and agglutinated along the gill margin. This phenomenon occurs more in some basidiomata than in others. **Subhymenium** 20-

25µm thick, intermediate between interwoven and pseudoparenchymatous, i.e., an interwoven layer with many inflated cells. **Gill trama** of quite large sphaerocytes, up to 50µm across, with occasional SV+ vascular hyphae.

Cutis 100-200µm thick, occasionally to 300µm on the disc but more often towards the thinner end of the range, an ixotrichoderm. **Subcutis** about half the depth of the cutis, of tightly interwoven hyaline gelatinised hyphae 1-3µm wide, with vascular hyphae in the basal layers, many of which rise into the epicutis and terminate in clavate pseudocystidia. **Epicutis** a turf of upright undifferentiated hyphal ends 1-3µm wide, also some with non-refractive cystidiform end cells up to 9µm wide but mostly narrower, embedded in a gelatinous matrix. Vascular hyphae frequent, dark grey in SV. **Pileocystidia** numerous, 60-100 x 6-9 (-12.5) µm, 0-1-septate, clavate, ends mostly rounded, some capitate-strangulate, contents yellow, refractive, and unstaining to red to strongly blackening in SV, the reaction is strongest on fresh material and seems to decline after drying. **Pseudocystidia** frequent and similar in shape and SV reaction to pileocystidia. **Hypodermis** a distinct layer of compressed yellow-brown cells.

Trama of loose clusters of sphaerocytes bound by a hyphal mesh and frequent SV+ vascular hyphae.

Chemical reactions: FeSO₄ - light greyish pink; KOH - no reaction on cap surface, none to slightly yellowish on stipe; NH₄OH - no reaction; guaiac - rapidly blue-green; guaiacol - light purple; Phenol - slowly pink then brownish purple; SV - grey on the gills, deep pinkish on the cuticle.

Habitat and tree associations: On or near very decayed coniferous wood (class 5) in old-growth and mixed age stands of Douglas fir or Sitka spruce-western hemlock-western red cedar forest, often with the understory shrubs salal and huckleberry.

Collections: CR981013-06 from Cape Scott, near the San Joseph trail, in a mixed age stand of western hemlock with huckleberry understorey, N 50.768°, W 128.342°. CR 010920-10 from the PRNP Rain Forest trail (eastern side of the highway) on a decay

class 4 spruce log with salal and huckleberry under western hemlock and Sitka spruce, N 49. 446778° W 125. 531694°. CR001012-15, from the SW corner of Kennedy Lake Park, off Grice Bay main logging road in the Uclulet area, under western hemlock with salal and huckleberry, N 49.016883°, W 125.58153°. CR001108-05 and CR001127-04, both from Royal Roads University woodland amongst woody debris near an old-growth Douglas fir N 48.4358°, W 123.47893°. BT021101-02 and CR 021118-02 from Royal Roads University woodland on decayed logs in mature regeneration forest with western hemlock, western red cedar and salal, N 48.433250°, W 123.4780° and N 48. 434167°, W 123. 4765° respectively.

| Collection | ITS1-F to | RFLP: | | |
|-------------------------|-----------|----------|----------|----------|
| | ITS4-B | HinfI | AluI | Sau3A |
| CR021118-02 Royal Roads | 868 | 339, 272 | 527, 286 | 281, 200 |
| CR001127-04 Royal Roads | 873 | 344, 270 | 495, 286 | 326, 227 |
| CR001108-05 Royal Roads | 884 | 380, 279 | 485, 124 | 346, 254 |

Notes: This species differs from the following species; *Russula crenulata*, in its smaller, more fragile stature, its shorter more clavate 0-1-septate pileocystidia, and the coarser warts and reticulum on the spores. This latter character is difficult to visualize without a side-by-side comparison; the above collections have spores very like those of *Russula fragilis* but with lower warts, and *R. crenulata* has spores that resemble those of some of the *Heterophyllae* except for the amyloid ornamentation on the suprahilar patch. Shaffer (1975) considered American forms of *R. raoultii* as close to *R. silvicola* Shaffer, a red-capped species inhabiting woody debris, and in which all the characters agree except for cap colour. The characters are also very similar to those of *R. fragilis*, a species with many named colour forms, *R. fragilis* f. *nivea* Cooke is a white form and f. *raoultii* Quelet is pale yellow. However, there do not appear to be intermediates, as might be suggested by the subspecific taxon, at least locally, between the above *Russula* and *R. fragilis*. The Vancouver Island *R. raoultii* agrees with the descriptions in Romagnesi (1967) and Shaffer, (1975) for eastern North American collections with the exception of the larger spores. Romagnesi mentions the hymenial cystidia as often having a voluminous tip, which may or may

not be the same as the exudate described above; neither he nor Shaffer mention a gelatinous gill margin. Shaffer examined one collection growing in sphagnum from Michigan that had spores up to 10µm long and 9.0µm wide but was otherwise the same as other collections of *R. raoultii*. Vancouver Island collections represent a form or subspecies of *R. raoultii* with a larger range of spore sizes up to 10 x 8µm.

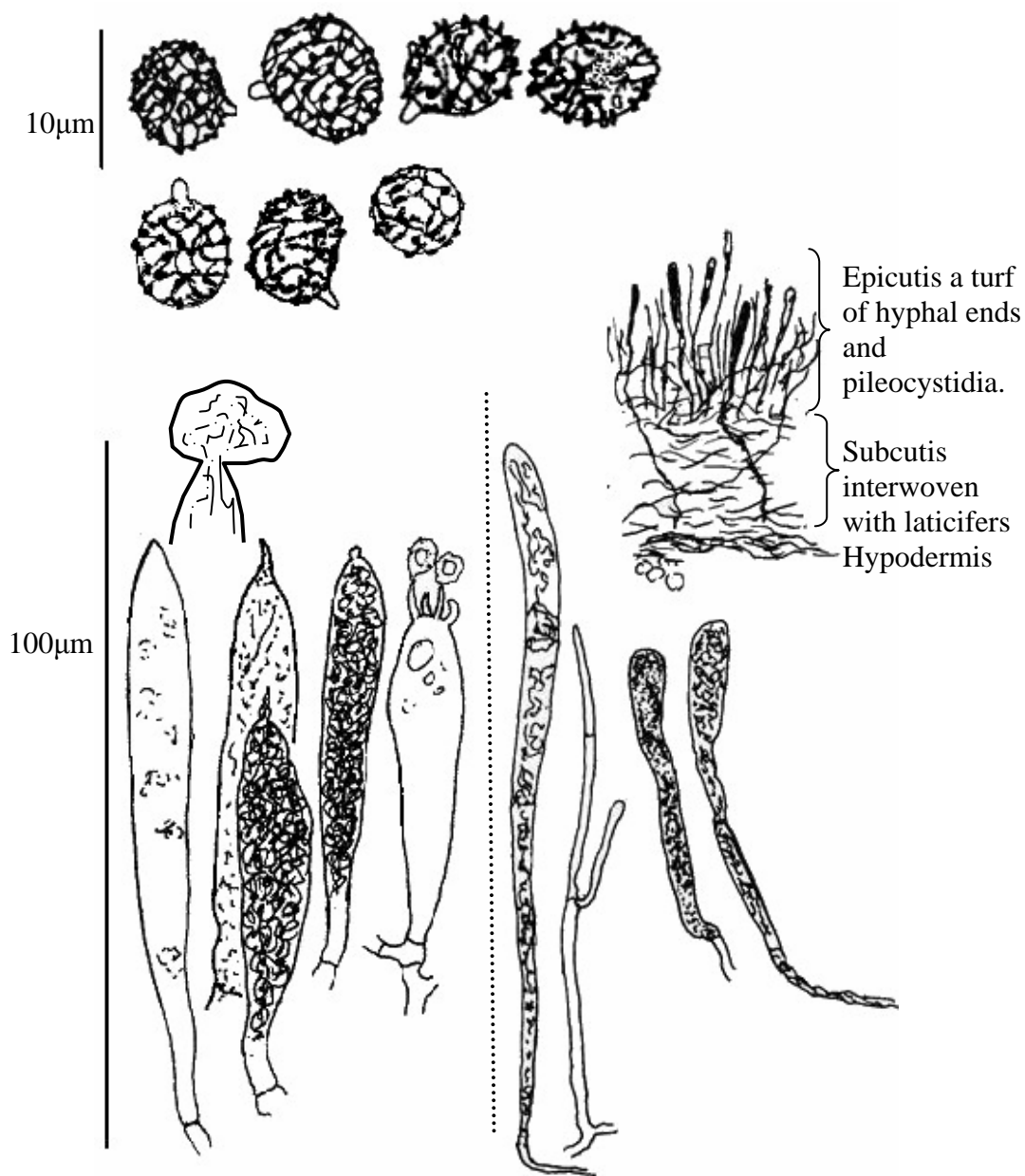


Figure 79. Microscopic characters of *Russula raoultii*: Top, spores with 10 µm scale bar; upper right, section of cutis; bottom left, hymenial cystidia in KOH and in SV (the darker two) and a basidium; bottom right, pileocystidia, epicutal hyphal end and pseudocystidia, scale bar is 100 µm.

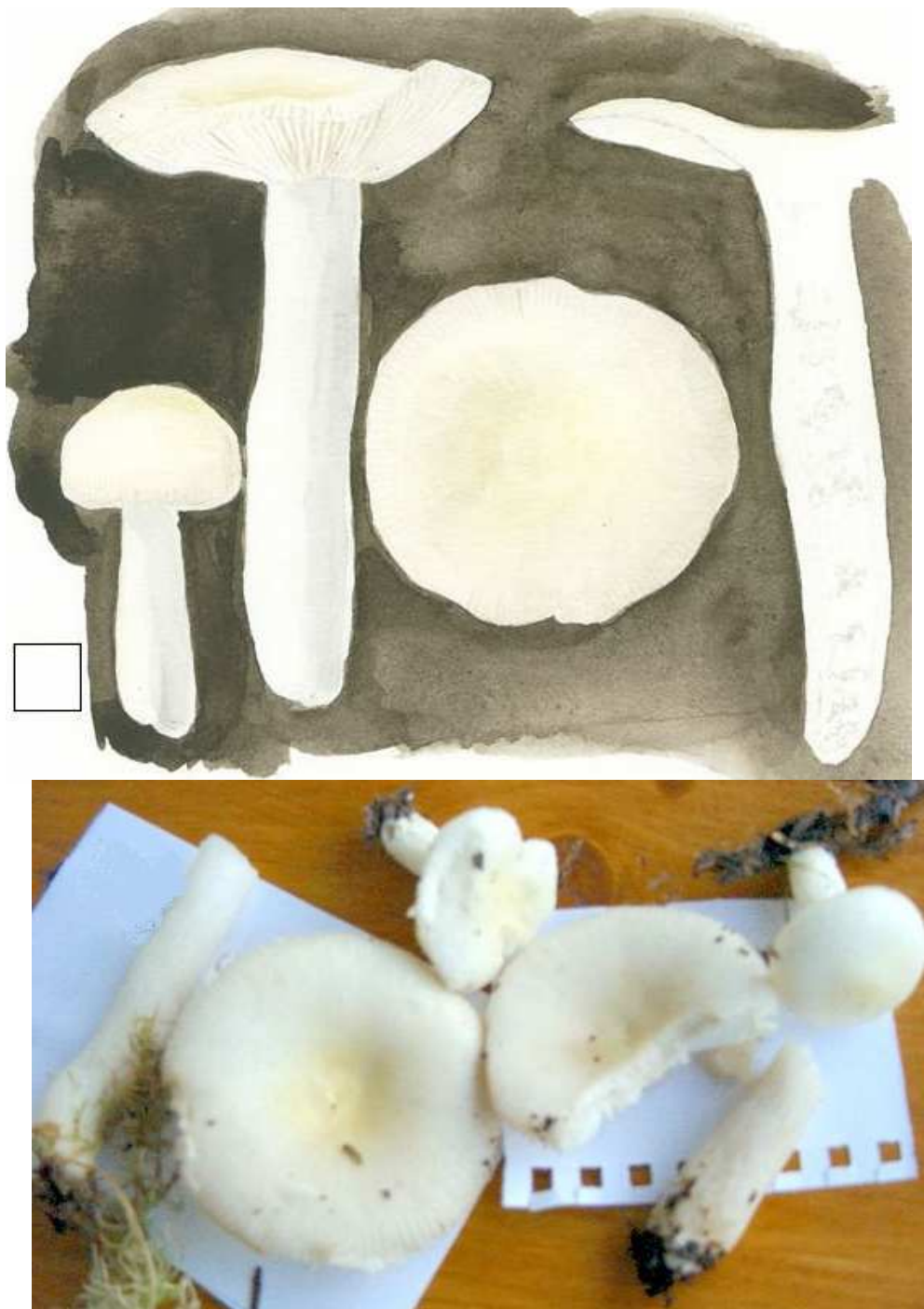


Figure 80. *Russula raoultii*: Top, immature and mature, in profile, top view and section, square is 1cm^2 and shows spore colour; bottom, a collection from the rain forest near Long Beach in the Pacific Rim National Park, which was growing amongst mosses and woody litter as seen from the stipe bases.

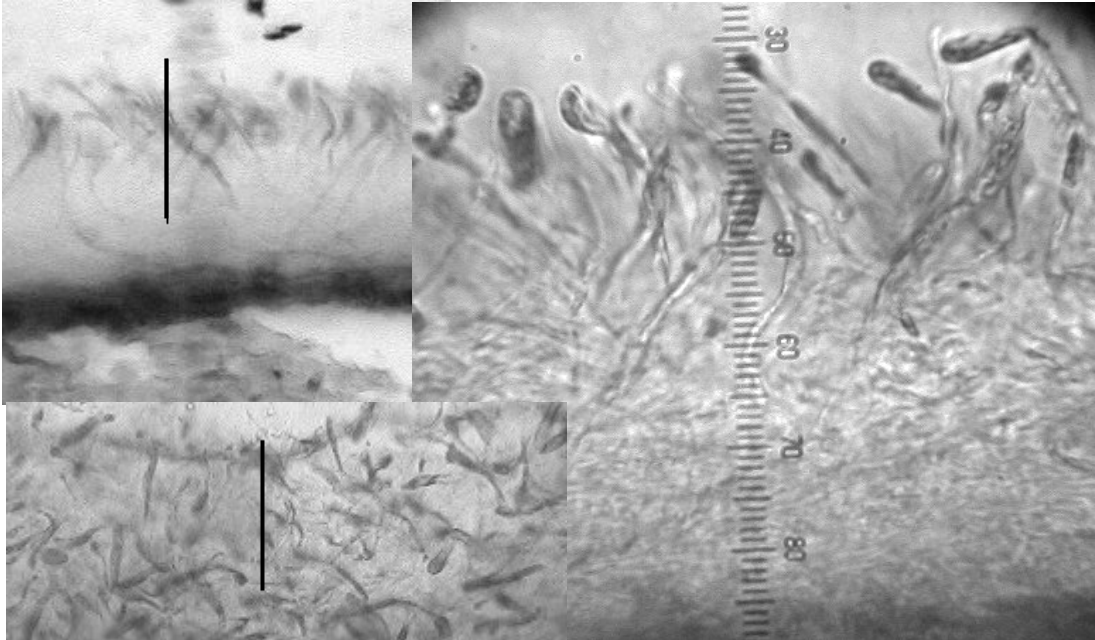


Figure 81. Cutis of *R. raoultii*: Top left, section through cutis showing darker hypodermium; bottom, surface view showing numerous pileocystidia and pseudocystidia scale bars are both 100 μ m; right, epicutis with many pileocystidia, 10 divisions on scale are 25 μ m.

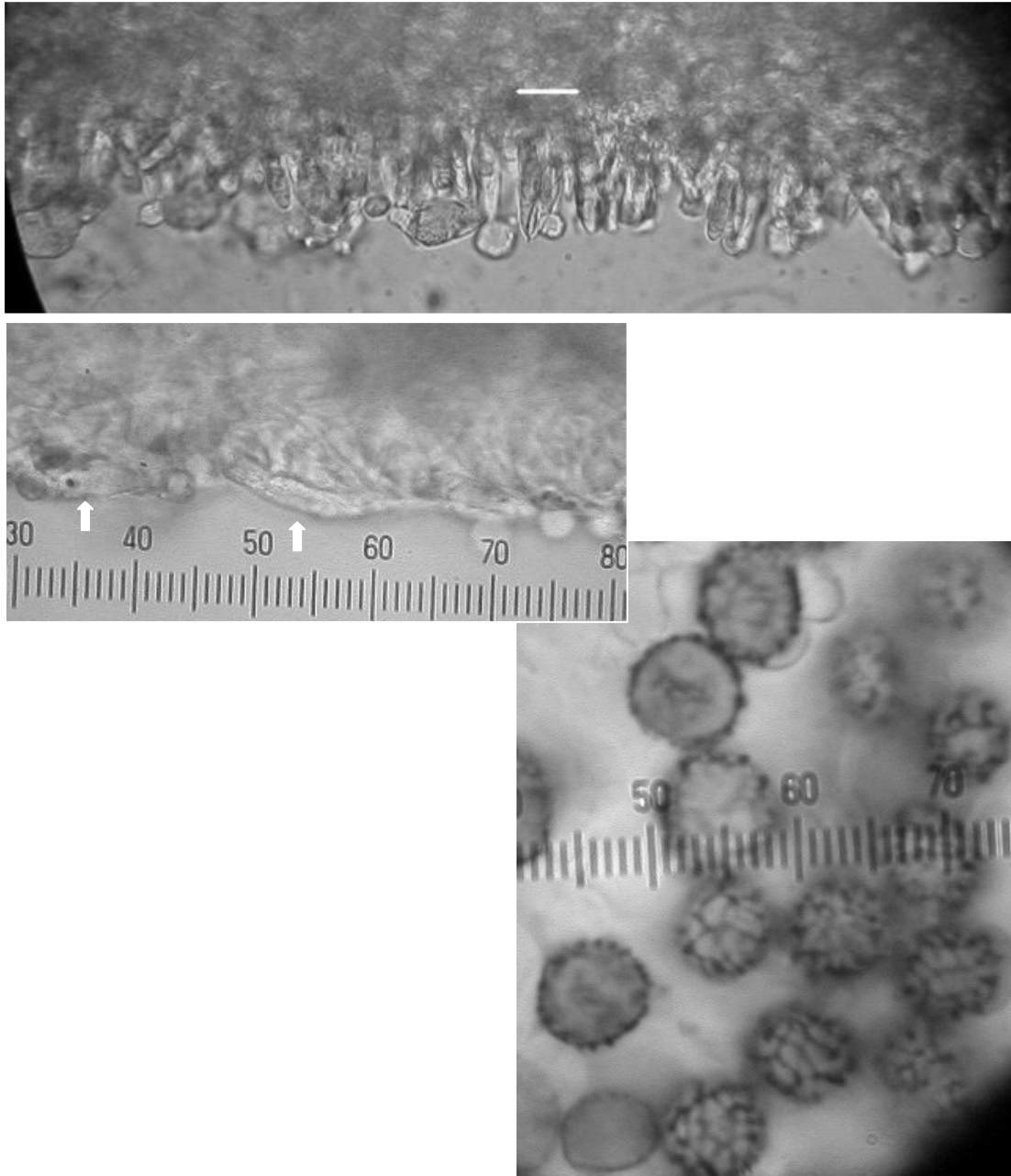


Figure 82. Hymenial characters of *R. raoultii*: Top, gill margins of a young basidioma, the cheilocystidia are erect but many have an exudate appearing as a refractive gelatinous blob at the tip, as if a remarkable number of tips have broken off and released their contents (scale bar is 25µm); middle, in maturity the cheilocystidia (arrowed) become adhered along their length to the gill edge by this gelatinous substance, 10 scale divisions are 25µm; bottom, spores with 1µm scale.

***Russula crenulata* Burl.**

Mycologia 5:310. 1911

Description of Vancouver Island collections:

Cap 4.9-8.9cm diameter, convex when young, becoming shallowly and broadly centrally depressed, unevenly uplifted towards the margins, but with the margin remaining downcurved, forming an adnate junction with the gills, margins smooth, not inrolled, cream with slight hints of pinkish tones, darker and more ochraceous in the centre, paler to almost white at the margins, viscid when moist, drying matte, peeling to 1/4 (Mill Hill collections) to 2/3 (Mesachie Lake collection) the radius. Cap trama white, firm, approximately equal in depth to that of the gills at half radius, about 7 mm, and maintaining more or less this thickness outwards to about 3/4 the radius, where it tapers to the margin, unchanging where cut or damaged.

Gills white to pale cream with warm, very pale orange cast when seen edge on, almost free to distinctly sinuate to notched at the stipe, even to slightly ventricose, approximately equal in depth to cap trama at half-radius, adnate at margin, pliable, margins entire and not always obviously crenellate to minutely unevenly fringed, subdistant to close with occasional short gills and a small amount of forking towards the margin, unchanging in colour where bruised.

Stipe 5-7.8 x 1.4-2.1cm, white, somewhat rugulose, unchanging when cut, slightly yellowing and with some light rusty stains at the base where bruised, stuffed with a firm, bread-textured trama, not cavitate and long remaining so, but developing a cavity in age, rind approximately 3-4 mm thick in the larger specimen and about 1/5 to 1/4 the diameter of the stipe in other specimens.

Texture firm but fairly brittle.

Taste initially mild, then on chewing, slightly to strongly peppery.

Odour mild, mushroomy, and with a slight coconut to rubbery smell.

Spore colour white, Romagnesi Ia.

Spores 7.8-9.5 (-10) x 6.0-7.5µm, L:W 1.18-1.45, average 1.29, narrowly to broadly ellipsoidal. **Ornamentation** of warts 0.4-0.6µm high, mostly low, small, rounded to bluntly conical, some catenate, some joined by fine to heavy ridges and lines forming an almost complete reticulum, and in the larger interstices of the mesh, the spore wall often bears light greyish amyloid areas. **Woo types** C 1-2, D 1-2. **Suprahilar patch** variable in shape, size, and amyloid reaction, on some spores one or two small irregular lightly amyloid patches occur on an otherwise unornamented area, in others a smaller version of the general spore ornamentation continues over an inamyloid area, making it difficult to detect any form of patch, and on others there is a combination of amyloid patches and small warts. **Hiliferous appendix** 1.4-1.8µm long and around 1.2µm at the base.

Basidia 37-50 x 8-13µm, narrowly clavate, becoming broader towards the upper 1/3 at maturity, mostly 4-spored. Sterigmata 3-7µm long and about 1µm wide at the base.

Pleurocystidia 50-120 x 7-10µm, arising at various levels within the subhymenium, protruding around 20-25µm (not including the appendage), beyond the basidioles, fusoid, tips acute, capitate or mucronate with the appendage generally short and slender, contents refractive and yellowish in 5% KOH, most blackening in SV, some merely stain dark pink. **Cheilocystidia** sparse, to frequent and clustered, similar in shape to pleurocystidia or sometimes rather broader, to 15µm, with contents less refractive and less reactive in SV than pleurocystidia, protruding up to 50µm. **Subhymenium** about 35-40µm thick, pseudoparenchymatous.

Cutis 150-250µm thick, the subcutis about 80-100µm thick, of hyaline interwoven repent, more or less parallel hyphae 1.5-2µm wide, embedded in a gelatinous matrix, and overlaying a more yellowish layer containing many vascular hyphae, some of which ascend to the epicutis as pseudocystidia. This lower layer grades into a sometimes poorly differentiated hypodermis. **Epicutis** a turf of slender erect hyphal ends about 2-2.5µm wide and numerous pileocystidia with little gelatinous matrix. **Pileocystidia** abundant, 50-120 x 7-12µm, cylindrical to clavate or often with bulbous ends, shorter ones aseptate,

most with up to 4 septa, also numerous cylindrical, regularly septate **pseudocystidia** emanating from the subcutis, most staining black in SV, but some showing much weaker reactions.

Trama of discrete and rather distantly separated clusters of sphaerocytes surrounded by hyphae with frequent vascular hyphae.

Chemical reactions: FeSO₄ - pale brownish pink; KOH - no reaction on cap or stipe; NH₄OH - no reaction; guaiac - brownish at first, becoming blue-green after several minutes, phenol - slowly grey-purple to brownish; SV - initially magenta on cap trama and gills, then brownish purple.

Habitat and tree associations: On Mill Hill in Garry oak woodland on rocky east-facing slope with mature oak trees, some broom and other small shrubs, no Douglas fir in the immediate area, but many nearby. At Mesachie Lake the habitat is a mixture of conifers and deciduous trees including Douglas fir and oaks.

Collections: CR030304-01 found on Mill Hill, near the top to the east side, N 48.457°, W 123.478917°. OC 040931-01, from the same habitat, about 100m NW of the former collection. JD021027-03, from the grounds of the Mesachie Lake Forest Research Centre, exact location unknown, brought in during a SVIMS foray.

| ITS1-F to | | | | |
|-------------|--------|-------------|----------|----------|
| Collection | ITS4-B | RFLP: Hinf1 | Alu1 | Sau3A |
| CR030304-01 | 865 | 380, 321 | 466, 260 | 632, 227 |

Notes: These collections are not as acrid, have lower spore ornamentation, and are firmer fleshed than is described for *R. crenulata*. The identification rests on the spore size and reticulations, habitat with oak and the distinctive septate pileocystidia, the gill margins are not crenulate in the Mill Hill collections but they are in the Mesachie Lake collection. Thiers (1998) comments that the crenulate margins may not be a reliable character. This species has since been found in the same general area (Mill Hill park just off the summit), in the fall of 2004 (O. Ceska, pers. comm.) It bears macroscopic and

spore similarities to *R. ochroleuca* but that species lacks pileocystidia. Other similar white-spored, none bruising species include *R. raoultii*, which has reticulate spores but they are smaller, and the pileocystidia are mostly aseptate; and *R. cremoricolor*, which has non-reticulate spores but a similar wart height to these Vancouver Island collections. Both are acid. Grund (1965) made four collections from coniferous forest that he identified as *R. crenulata*, that have little to no reticulation on the spores, he did not mention any crenellations on the gill margins nor septation of the pileocystidia, and they appear to be different from the Mill Hill collection. He also made one collection of what he provisionally named *Russula pallidostraminea* from Friday Harbour Laboratories on San Juan Island, that has similar trama characteristics and spore size with the low, reticulate ornamentation found in the above collections. A distinguishing feature of Grund's collection was the strong orange reaction with guaiacol, and brown with aniline, unfortunately neither test was administered to the Vancouver Island collections while fresh. There are several species of cream coloured, white-spored, peppery Russulas on Vancouver Island, and they may recognisably differ. However, matching them to a description is not always easy. A table summarizing the differences between peppery, white-spored yellowish-white Russulas of similar size-range and all with close to subdistant lamellae follows, and it can be seen that the above species has several character matches with all four species. The information was taken from Thiers (1997), Romagnesi (1967), (Sarnari 1998) Shaffer (1975) and supplemented from the original literature sourced from Woo (1997).

The weakly amyloid suprahilar patch on the spores and the solid stipe suggests that *Russula crenulata* has a close relationship with the *Heterophyllae* of clade 4, but has cuticular characteristics closer to the above species of clade 5.

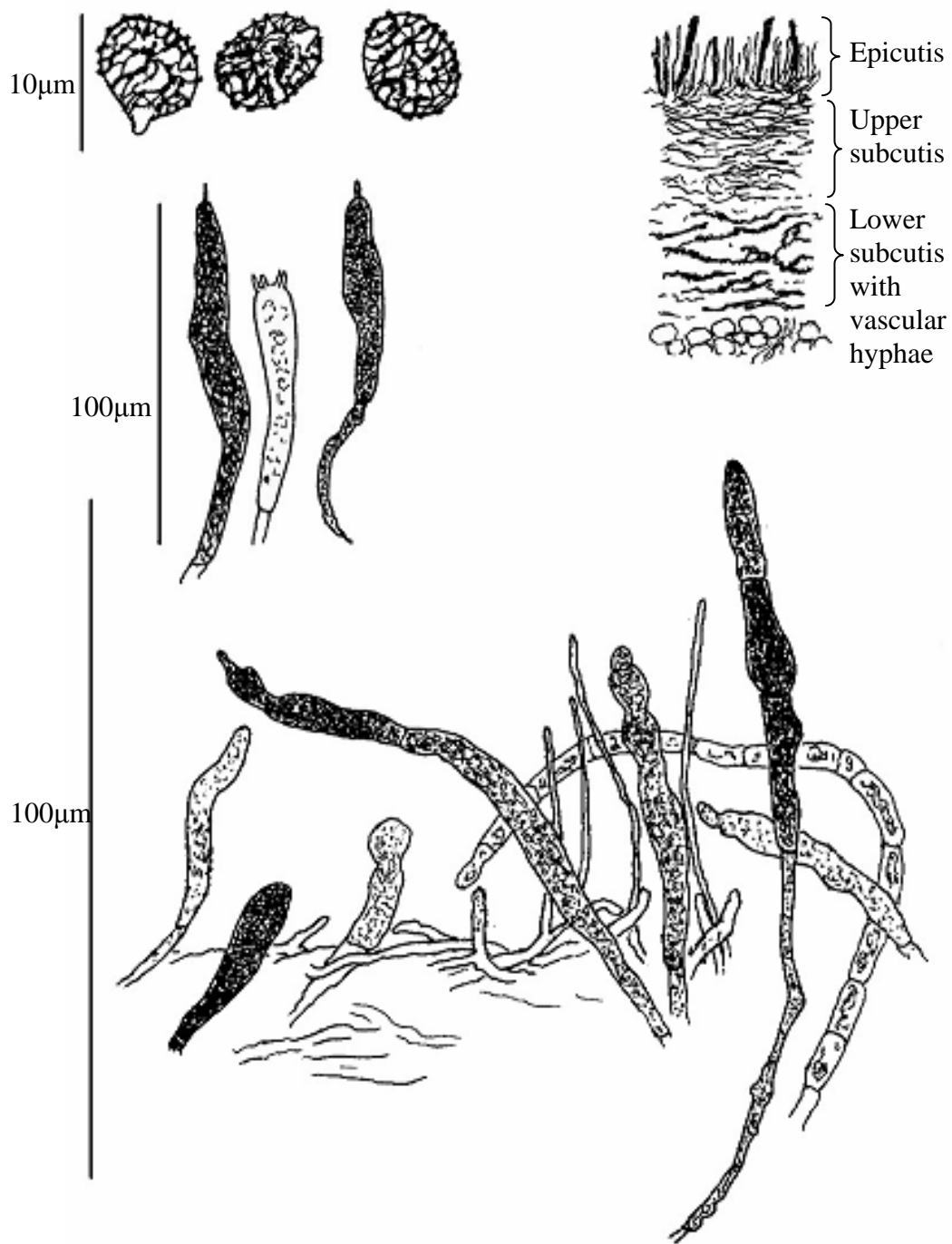


Figure 84. Microscopic characters of *crenulata*: Top left, spores with 10µm scale bar; top right, diagram of section through cutis showing epicutal turf, interwoven subcutis and more compact lower subcutis with laticifers; middle, hymenial cystidia and basidia with 100µm scale bar; bottom, cuticular hyphae and pileocystidia as seen in SV, scale bar is 100µm.



Figure 85 Macroscopic characters of *R. crenulata*; top, illustration showing general stature in profile and section, the 1cm² square shows scale and spore print colour; bottom left, pileus and bottom right, gills of the same mushroom.

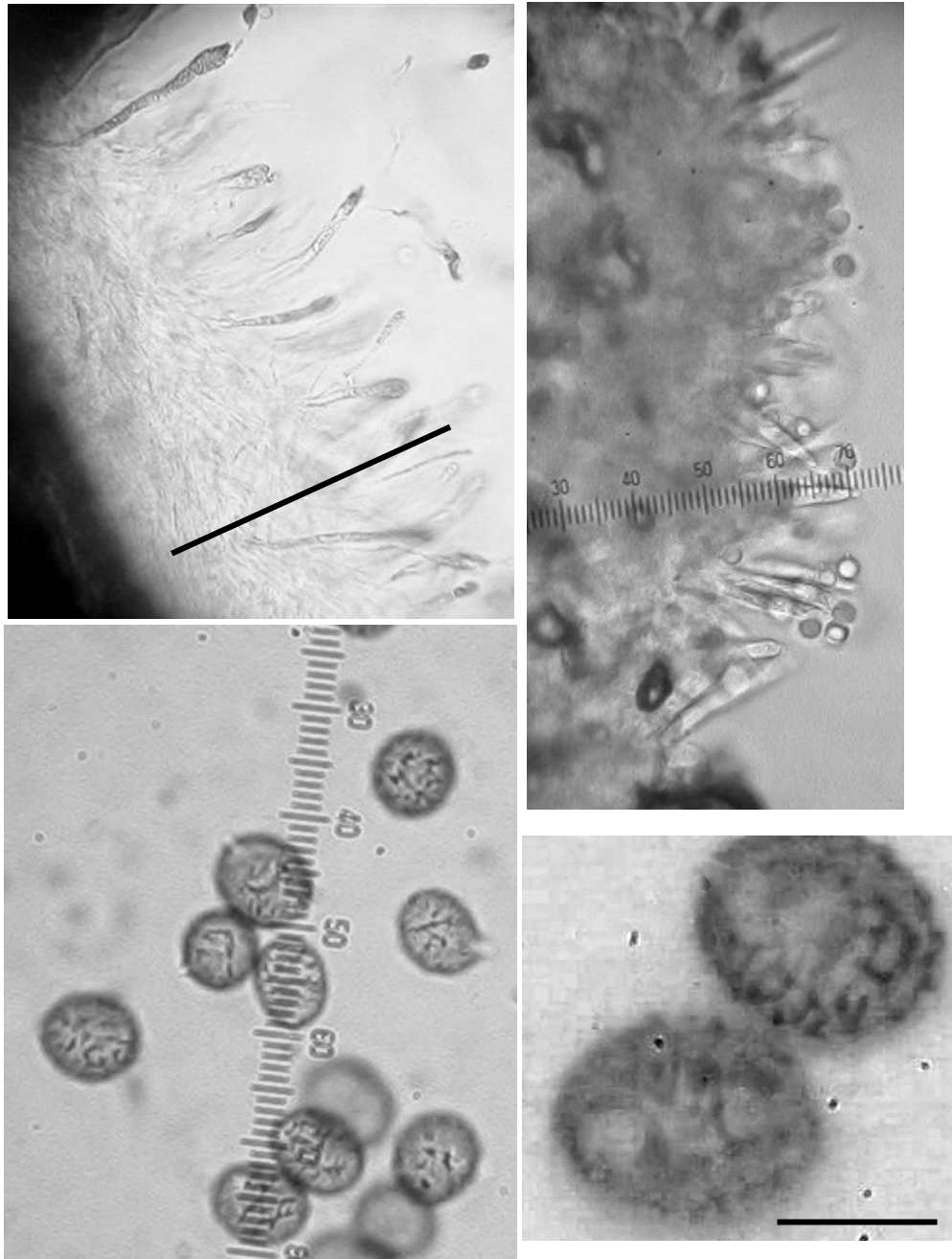


Figure 86. Microscopic epicutis and hymenial characters of *R. crenulata*: Top left, section through epicutis in SV showing several pileocystidia (scale bar is 100 μ m.); top right, cheilocystidia clusters which give the crenellated effect, 10 divisions on scale are 25 μ m; bottom left, spores (one division on scale is 1 μ m); bottom right, ventral view of two spores showing the patchy amyloid reaction of the suprahilar patch, scale bar is 5 μ m.

Table 3 Comparison of differential characters of four cream-capped peppery species of *Russula*, the information was derived from Burlingham (1913), Thiers (1997), Bon (1986) and Romagnesi (1967, 1985).

| | R. cremoricolor | R. crenulata | R. ochroleuca | R. raoultii |
|-----------------------------|-----------------------------------|------------------------------------------------------|----------------------------------------------|------------------------------------|
| Spore size | 7.6-9.5 x 5.7-6.7 (8.4) μ m | 8.2-10.4 x 6.5-7.6 μ m | 8-10.5 x 6.5-8.2 μ m | 5.7-7.9 x 5.4-6.8 μ m |
| Spores: reticulations | Some ridges only, not reticulate | Partial reticulations | Partial to complete | Complete |
| Wart height | 0.2-0.5 μ m | 0.8-1.2 μ m | 0.8-1.0 μ m (to 2.0 μ m, Singer) | 0.2-0.8 μ m |
| Suprahilar patch | Small warts | Not specified (patchily amyloid in V.I. collections) | amyloid | Uneven, low, diffuse ornamentation |
| Lamellar insertion at stipe | Subsinuous-adnexed | Adnate-adnexed | Adnate-notched | Adnate-adnexed |
| Peeling of cutis | 1/3-1/2 | 1/2 or more | To 1/4 | To 1/4 |
| Pileocystidia & septation | Numerous, septation not indicated | Numerous, 1-4 septate | No epicutal cystidia, subcutal ones aseptate | Frequent, 0-1 septate |
| Unusual epicutal hyphae | None mentioned | None mentioned | Fuchsin + incrustations | Long, slender hyphal ends |
| Habitat | Conifers & hardwoods | Oak-pine forest | conifers | Woody debris, conifers & deciduous |
| Stipe bruising | None | None | Ochraceous-brownish, \pm greying | None |
| Cap margin | Striate | Striate in age | Smooth | Smooth |
| Other notes | Interwoven subhymenium. | Gill margins crenellate | Mild to peppery | |

***Russula fragilis* (Pers. : Fr.) Fries**

Stirpium Agri Femsionensis Index: 57, 1825.

Epicrisis Myc. 359. 1838

Description of Vancouver Island collections:

Cap 2.2-9.4cm diameter; convex when young, becoming plane to shallowly depressed, with the margins often remaining downcurved, margin striate up to about 1/3 the radius. When first emergent often quite dark, either green or grey, becoming more pinkish-purple as it matures and in the presence of light. The centre of the cap may be almost black in early maturity grading into an olive green to a pink to purple margin. The colours fade in age and are washed out by rain, with the purple more soluble than the green, with the end result of a pale cap with greenish-grey, to brownish grey-green disc and tinges of purple to greyed pink towards the margin, sometimes becoming almost entirely pallid with merely a trace of pigment. Cutis often just sticky more than viscid, drying matte to subglossy, cutis peeling 1/3 to 3/4, or sometimes almost completely, the tissue quite elastic, trama white, often tinged purple or greenish-grey under the cutis, soft and fragile unchanging when cut.

Gills white to pale cream, unchanging when bruised, pliable, subdistant to close, with occasional to frequent lamellulae, shallowly adnexed to almost free at the stipe, subacute to acute at cap margin, sometimes with the cap cuticle curving around the end of the gills, ventricose to broadening towards the margin, equal to twice the depth of the trama at half-radius or sometimes 4–5 times the depth, 3-9 mm deep. Gill edges entire, neither eroded nor serrated in most basidiomata, more rarely with clustered to scattered protruding cheilocystidia forming an irregular fringe on parts of the gill margin.

Stipe 2.5-6.8 x 0.5-1.8cm, in general roughly equal in length to the cap diameter, more or less cylindrical to clavate, white, rarely flushed with pink, smooth, stuffed with a bready-textured trama, developing usually three irregular cavities, eventually becoming hollow,

fragile, unchanging when cut or bruised, aging pale greyish or pale yellowish-grey as if waterlogged, and when handled the flesh may collapse and turn slightly yellowish.

Texture sometimes fairly firm when young, becoming soft and fragile in age.

Taste immediately peppery to acrid, occasionally slightly bitter at first, then peppery.

Odour not distinctive to faintly fruity, of stewed apples or plums, sometimes of coconut.

Spore colour pure white in many collections, Romagnesi Ia, less commonly pale creamy-white, Romagnesi Ib.

Spores 7-9.5 x 5.5-8.3µm, L:W 1- 1.46, mean (n=64) 1.19, globose, subglobose or broadly ellipsoidal. **Ornamentation** of conical or peg-like, fine to heavy warts, 0.5-1.8µm, occasionally isolated, mostly connected by fine to heavy lines, 2-3 catenate sometimes forming short ridges, forming a partial to complete reticulum, **Woo type** C2, or C3, or D2, or D3. Some basidiomata with spore ornamentation mostly below 1.0µm, others with mostly higher ornamentation, commonly the wart height is in the range of 0.8-1.5µm. **Suprahilar patch** an irregular lightly amyloid patch bordered by, or sometimes including, small warts. **Hiliferous appendix** 1.6-2.1 x 0.9-1.2µm. **Basidia** most 4-spored, occasionally 2-spored, 26-47 x 8.7-12µm, clavate, bulbous in the upper 1/3, relatively short and broad. Sterigmata 5-10µm long, 1.7-2.1µm wide near the base. **Pleurocystidia** frequent to abundant, 37-90 x 7-13, originating in the subhymenium, protruding 5-25, fusoid to clavate, tips subacute, rostrate, mucronate, or with a short irregularly shaped appendage, contents refractive, yellowish in KOH, dark pink, purple to black in SV, entire hymenium initially bright magenta in SV. **Cheilocystidia** similar to pleurocystidia but protruding up to 30µm and reacting less strongly with SV. **Subhymenium** 20-30µm, pseudoparenchymatous. **Gill trama** of sphaerocytes with occasional to rare vascular hyphae.

Cutis 80-250µm thick, generally about 150-180µm thick at half-radius, an ixotrichoderm.

Subcutis about 1/2-2/3 the depth of the cutis, of hyaline gelatinised hyphae, 2.5-3.5µm wide, and including many vascular hyphae 2-7µm wide, grey in SV, giving rise to

frequent, narrowly clavate to cylindrical pseudocystidia with obtuse to capitate tips.

The lower layer of the subcutis stains greyish magenta in SV. **Epicutis** a turf of more or less upright undifferentiated hyphal ends, 1-3µm wide, embedded in a viscid matrix, with numerous pileocystidia and frequent pseudocystidia. **Pileocystidia** abundant, 20-137 x 3-8µm, clavate or cylindrical, sometimes in tufts of 2-3 arising from a common hypha, occasionally Y-shaped, tips obtuse or capitate, 0-2 -septate, contents greyish to purple in SV. Miniature versions of the pileocystidia are frequently found, around 2µm wide, and usually in small tufts, (fig, XX). **Pseudocystidia** frequent, of similar width and shape as pileocystidia, arising from the subcutis, SV+. **Hypodermis** of small flattened sphaerocytes and compactly interwoven hyphae.

Trama of discrete clusters of sphaerocytes bound by a hyphal mesh, with frequent yellowish refractive vascular hyphae 3-10µm wide, grey to black in SV.

Chemical reactions: FeSO₄ -light greyish pink; KOH -salmon on cap cutis, no reaction on stipe; NH₄OH -no reaction on cap or stipe; guaiac -slowly and weakly becoming grey-green, although in a few basidiomata, the reaction is faster; guaiacol -pinkish orange; phenol -slowly pinkish; SV -turning cutis and gills bright magenta at first, becoming more purple as the cystidia darken to purple of grey.

Habitat and tree associations: Widespread and common on or near coarse woody debris and on logs penetrated by tree roots, in association with *Tsuga heterophylla* in mature second growth and old-growth coastal forests, August to November. Found throughout Vancouver Island in coastal forests where western hemlock occurs. The white-spored form mostly occurs in the coastal western hemlock zone and the cream-spored form in the coastal Douglas fir zone.

Collections: CR980825-01 in a stand of mixed-age Sitka spruce, western hemlock and Douglas fir, Port Renfrew N 48.555667°, W 124.39233°. CR 980825-DF25 and CR 980916-01, from a single-species plantation of Douglas fir, Port Renfrew area, N 48.5997°, W 124.3325°. CR 980916-WC23 adjacent to a single-species plantation of western red cedar with understory western hemlock saplings N 48.5959°, W 124.3341°.

CR 981013-05 in a mature stand of western hemlock, western red cedar and understory salal, near San Joseph trail, Cape Scott, N 50.776°, W 128.3975°. CR 981014-02 on well decayed wood in an old-growth western hemlock and western red cedar stand north of Sayward N 50.3255°, W 126.0905°. PJ 981128-ER187 in Douglas fir-western hemlock-western red cedar mature forest, Saturna Island Ecological Reserve, N 48.786725°, W 123.16782°. CR 000919-06 on decayed log under western hemlock, western red cedar and understory salal and salmonberry, Cape Beale trail, Bamfield, N 48.820083° W 125.151533°. CR 001012-22 in a pocket forest in coastal dunes under western hemlock and Sitka spruce with kinnikinnik ground cover, Wickanninish, N 49.022°, W 125.674°. CR 010920rfb, on decayed wood under western hemlock, red alder and amabilis fir, Rainforest trail (west of road), Pacific Rim N. P., N 49.04°, W 125.68°. CR 011013-02, near woody debris under regeneration western hemlock and Douglas fir, Mesachie Lake area, N 48.815°, W 124.1358°. CR 021015-11 and 021015-09 on a large (1.5 m diameter) fallen cedar log at decay stage 4, with western hemlock, western red cedar, salal and huckleberry growing on top, Rainforest trail (east of road), Pacific Rim N. P. N 49.446778°, W 125.531694°. CR031026-01, on decayed logs in regeneration western hemlock forest west of Youbou, N 48.8960°, W 124.2765°. JD031130-01 Metchosin wilderness park, Victoria N 48.3675°, W 123.5776°. CR040930-01 on rotten wood in an area with western hemlock and occasional Douglas fir, Blueberry flats, near Sooke N 48.396° W 123.9664°. CR041114-02 Royal Roads University woodlands in a mixed-age stand of Douglas fir, western red cedar and western hemlock.

ITS1-F to

| Collection | ITS4-B | RFLP: HinfI | AluI | Sau3A |
|-------------|--------|-------------|----------|----------|
| CR980825-01 | 870 | 369, 224 | 569, 313 | 305, 234 |
| CR981014-02 | 827 | 369, 267 | 364, 289 | 345, 260 |
| CR031026-01 | 852 | 356, 258 | 487 | 335, 242 |
| CR031130-01 | 868 | 367, 255 | 500 | 354, 291 |

Notes: *Russula fragilis* can be a very variable species in colour, taste, size, and pileocystidia shape. Its growth on or near wood, with western hemlock (sometimes only small saplings), generally purple and dull green colours, white to creamy-white spores

and mostly peppery taste are reliable characters. It is not always acrid and fragile, although never robust or tough

In addition to the Vancouver Island collections of this species a collection from Whidby Island, north of Seattle, U.S.A., was examined and found to correspond more closely to the European concept of *Russula fragilis*, with a pale cream spore print, (Romagnesi 1b), rather than the pure white of many Vancouver Island collections. The Whidby Island collection also had a mixture of pileocystidia types, many were the clavate, septate ones considered diagnostic for *R. fragilis*, and others were the elongate, 0-1 -septate ones associated with descriptions of *R. atropurpurea*. A further collection from the Olympic peninsula had the pure white spore print (Romagnesi 1a) of most Vancouver Island collections, the typical slow, weak guaiac reaction of *R. fragilis* and clavate, 0-1 -septate pileocystidia. In both the above collections the spores were similar to those of the Vancouver Island collections. These collections from three areas of the west coast of North America appear to almost bridge the gap between *R. fragilis* and *R. atropurpurea*. Other similar closely related species include *Russula aquosa*, which grows in sphagnum, *R. violescens*, under conifers in marshy areas, *R. laccata*, a dark red-purple species that grows with willows, and *R. alnetorum*, that is associated with alder. In Europe, one distinguishing feature of *R. fragilis* is its odour of amyl acetate (like pears), which is rarely apparent in the Pacific Northwest forms, which also differ in their generally higher spore ornamentation and infrequently serrated gill margins. Neither the amyl acetate odour nor the fringed or crenellated margins stressed in many descriptions and keys are reliable characters in local collections.

The name *R. atropurpurea* has been used by Peck for a species in the *R. xerampelina* group, without regard for its previous usage in 1845 by Krombholz. Shaffer (1970) therefore considered it necessary to rename the original *R. atropurpurea*, and he chose the honorific epithet *krombholzii*. The current name has reverted to *Russula atropurpurea* (Krombh.) Britzelm. (Index Fungorum 2004), but both synonyms should be checked when looking for descriptions. Sarnari lists *R. atropurpurea* (Singer) Crawshay, 1930, and *R. atropurpurea* var. *atropurpurea* (Sing.) Singer, 1932, as synonyms for *Russula*

fragilis, so the difficulty in distinguishing between these species is not without precedent. Sarnari also lists 27 synonyms for *Russula atropurpurea*, clearly this is a variable species if collections have been thought a different taxa from the pre-existing published descriptions. *Russula fragilis* differs from *R. atropurpurea* in its weak reaction with guaiac, its subglobose rather than ellipsoidal spores, and its generally smaller, more fragile stature (sensu Bon 1988 and Shaffer 1970).

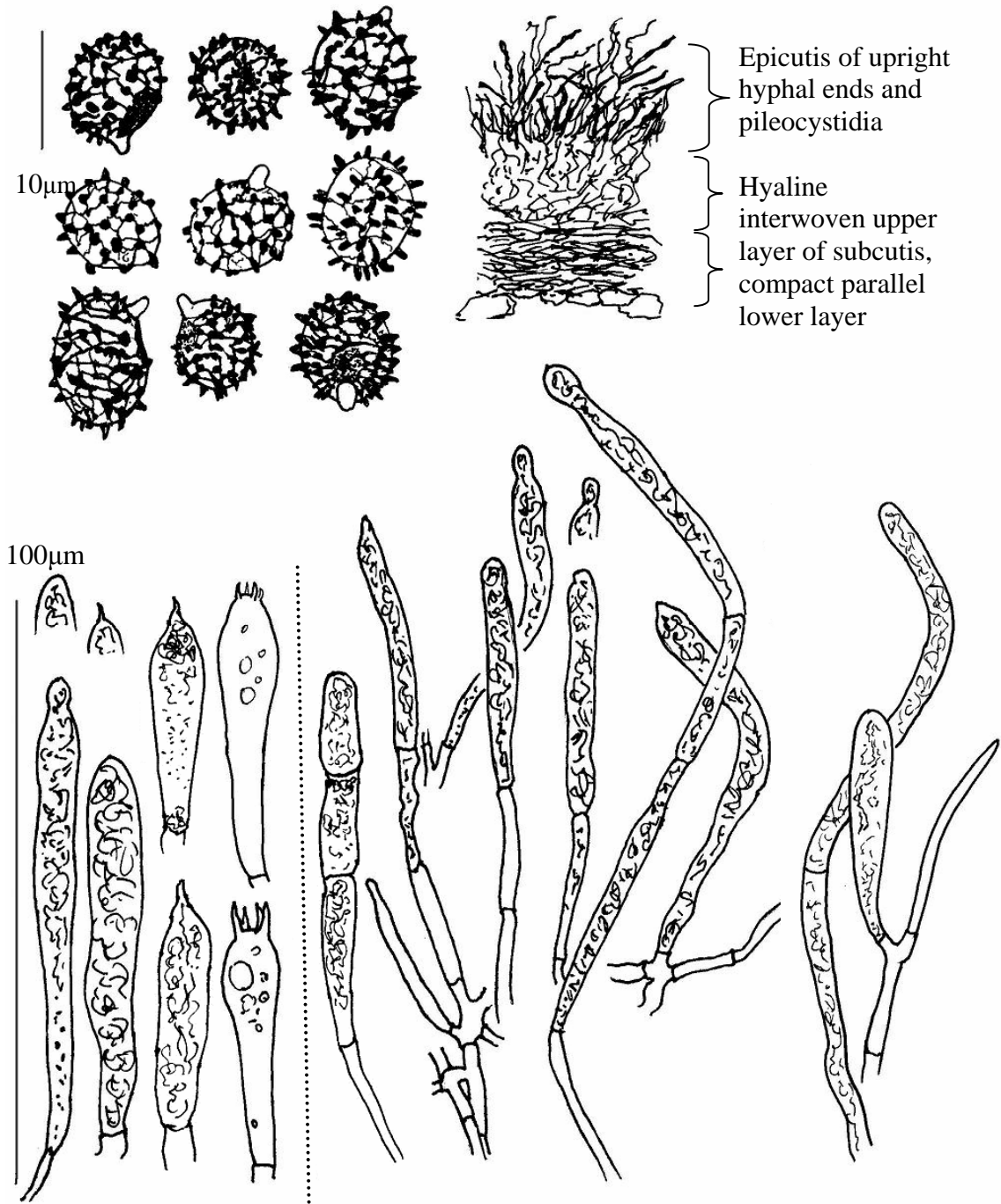


Figure 87. Microscopic characters of *Russula fragilis*: Top left, spores with 10 µm scale bar; top right, diagram of section through cutis; bottom left, hymenial cystidia and basidia; bottom right, pileocystidia and pseudocystidia from the epicutis; lower scale bar is 100 µm.



Figure 88. Macroscopic characters of *R. fragilis*: Top, photograph of the cap surface of three basidiomata set on a 1cm² grid; below, illustrations of profiles, longitudinal sections and a view of the gills, the squares show the spore colour and are 1cm².

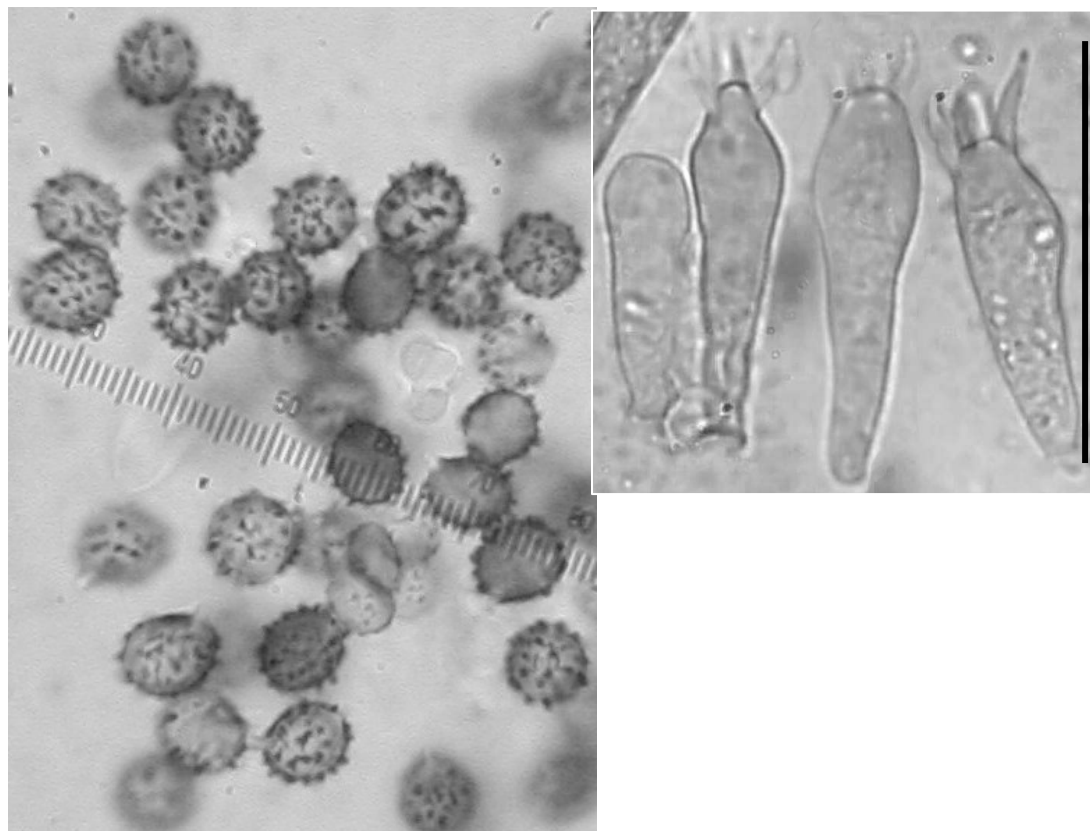


Figure 89 Hymenium of *R. fragilis*: Left, spores with 1µm division scale; right, basidia and basidiole, scale bar is 50µm.

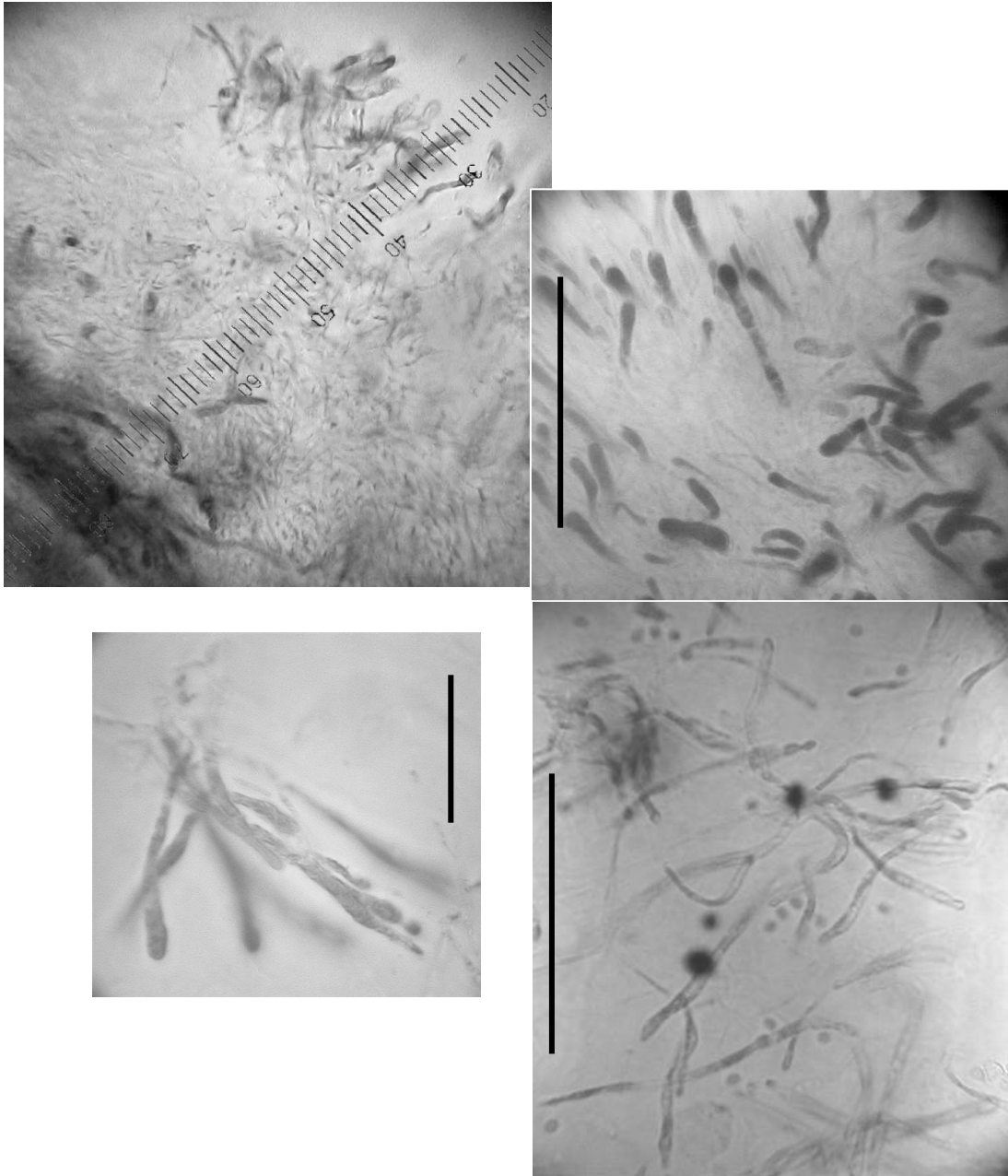


Figure 90. Cutis of *R. fragilis*: Top left, section through cutis in SV, with the compact lower layers of the subhymenium to the lower left between 76 and 82 on the scale, 10 scale divisions are 25 μm ; upper right, surface view of the cutis in SV of a basidioma with clavate, 0-2-septate pileocystidia; below right, surface view of the cutis in KOH of a basidioma with cylindrical capitate, mostly aseptate pileocystidia, both scale bars are 100 μm ; lower left, view of a tuft of miniature pileocystidia, arising from 3 hyphae, scale bar is 10 μm

***Russula fragilis* var. *mitis* nom. prov.**

Three collections of what appear to be *Russula fragilis* but are mild-tasting were found. Macroscopically and microscopically they are virtually identical and fall within the range of characters for *R. fragilis*, and this description can be referred to for information on these characters. All have pileocystidia that are narrowly clavate to cylindrical, very commonly capitate, and 0-1 septate, and the subcutis in water mounts tends to be pink. They have no more than a faint latent pepperiness and a nondescript to slightly fruity-peppery or coconut odour, two collections were on rotten logs under western hemlock, the third in a stand of red alder between the rain-forest boardwalk and the road, with much woody debris on the ground, and surrounded by old-growth Sitka spruce and western hemlock.

Two species of stirps *fragilis* with a mild taste and purplish cap that seem closest to these Vancouver Island collections have been described in the European literature: *Russula aquosa* Leclaire (Bull. Soc. Myc. France 48:303, 1932); and *Russula alnetorum* Romagnesi (Bull. Soc. Linn. Ly. 25: 183. *Russula aquosa* is found in moist habitats with or without sphagnum, and in moist coniferous forests, there is no mention of its occurring on rotten wood. Its spores are smaller by about 1µm in each dimension, with warts around 0.6-0.7µm high, and it has slightly longer hymenial cystidia than the Vancouver Island collections but is otherwise very similar. *Russula alnetorum* is associated with alders in Europe, and its spores are more narrowly ellipsoidal than those of *R. fragilis*, and have a rather elongated suprahilar patch, the hymenial cystidia also tend to be longer on average (ie. 80-85µm). Neither of these species has been recorded in North America to my knowledge, however, similar habitats and related host trees occur here.

In summary, the three Vancouver Island collections do not match exactly the descriptions for *R. fragilis* (in taste), *R. aquosa* or *R. alnetorum*, yet are not so different to discount them from being local varieties. Although alders were not recorded in the vicinity of two

of the collections, they are very common in both areas and may have been overlooked. The growth on rotten wood is typical of *R. fragilis* and until more collections are made that suggest otherwise these mild forms are considered a variant of *R. fragilis*.

Collections: CR 981014-03 on very decayed log, under old-growth western hemlock, with western red cedar and huckleberry, in roadside forest about 40K north of Sayward, N50.3255°, W126.0905°; **Spores** 8-9 x 6-7.8, mean L:W 1.23 (n=10), warts to 1.5µm high. CR000920-03 growing from broken branch on a decaying log, under old growth western hemlock with huckleberry, near the Pachina River close to Pachina Bay, N48.805083°, W125.1122°; **Spores** 7.9-9 x 6.7-7.6, mean L:W 1.17 (n=10), warts to 1.1µm high. CR011030-19 on the ground under a stand of alders adjacent to the Tofino road, with young western red cedar, amidst old growth Sitka spruce and western hemlock, Rainforest trail east side, PRNP, N49.446782°, W125.5317°; **Spores** 8-9.6 x 6.2-7.7, mean L:W 1.26 (n=10), warts to 1.4µm high.

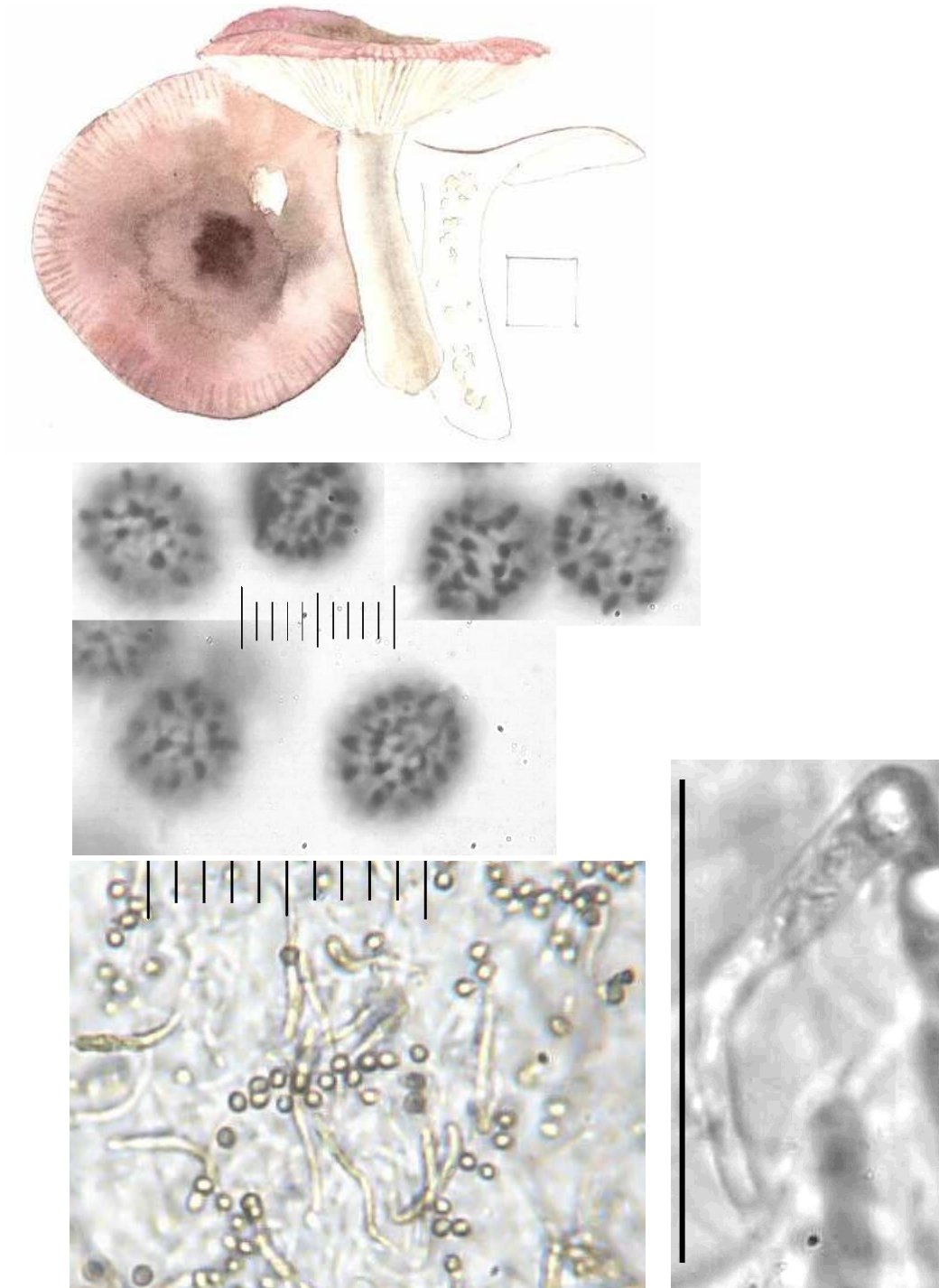


Figure 91. Characters of *R. fragilis* var. *mitis*: Top, illustration of profile, top and longitudinal section with 1cm² box showing spore colour; middle, spores with 1µm division scale, bottom left, surface view of cutis showing pileocystidia in water mount, round objects are spores stuck to the surface, scale is in 10µm divisions; bottom right, clavate round-tipped pileocystidia with 40µm scale bar.

***Russula laccata* Huijsman**

Fungus, 25:40, pl.8, f. I-II, 1955.

Description of the Vancouver Island collection.

Cap 2.9-4.7cm diameter, convex when young, becoming plane or with a slightly depressed centre when fully expanded, cap margin smooth, becoming striate in age, purple to violet with black on the disc when mature, spotted with pink, grey-pink and yellowish patches on immature basidioma, viscid when wet, drying subglossy. Cuticle peeling 1/3 to 1/2 the radius, trama beneath tinged purple, unchanging when damaged.

Gills white, becoming pale cream, pliable, moderately close, with occasional subgills, no forking seen, arched, adnate at the stipe, subacute at the cap margin, margins entire, not serrated.

Stipe 3.0-4.2 x 1.3 to 2.0cm, ventricose or widening near the base, white, one with a pale pinkish brown bruising at the base as if waterlogged, otherwise unchanging when bruised, stuffed with a breadly textured trama, becoming hollow in age.

Texture somewhat fragile.

Taste acrid.

Odour nutty with a rubbery component.

Spore colour very pale cream, Romagnesi Ib.

Spores 7.0-8.5 x 5.2-6.5µm, L:W = 1.21 to 1.5. mean 1.34 (n=30), ellipsoidal to bean-shaped. **Ornamentation** of warts mostly under 0.6µm (-0.8µm) high, rounded to bluntly conical, catenate or connected by a complete or almost complete reticulum, **Woo types** 1D-2D. **Suprahilar patch** amyloid, lilac-grey in Melzers' reagent, irregular in outline.

Basidia 4-spored, approximately 34-50 x 7.5 to 12.5µm, cylindrical to clavate, in general

more slender than those of *R. fragilis*. Sterigmata 4-7µm long, around 1.2µm wide near the base. **Cheilocystidia** and pleurocystidia, densely distributed, staining purple-black to black in sulphovanillin, 42-80 x 7-10µm, or occasionally to 12µm wide, protruding about 12µm beyond the hymenium, fusoid to clavate with acute, mucronate or shortly tapering tips. **Subhymenium** 20-35µm thick, pseudoparenchymatous, gill trama of sphaerocytes and frequent vascular hyphae.

Cutis 80 to 100µm thick at half radius, an ixotrichoderm with numerous erect hyphal ends, pileocystidia, and pseudocystidia. **Subcutis** of hyaline densely interwoven hyphae mostly about 3µm wide, and frequent vascular hyphae that give rise to pseudocystidia. **Hypodermis** of small, tightly packed sphaerocytes. **Epicutis** of erect hyphal ends 2 - 6µm wide, terminating in a tapered or narrowly clavate end cell, sometimes with refractive contents like small cystidia. **Pileocystidia** 20-28µm by 6-8µm wide, cylindrical to clavate, sometimes forked, tips rounded or with a short, blunt point, less often capitate, 0 - 2 - septate, mostly dark grey in SV but occasionally partially or completely none reacting. **Pseudocystidia** around 83µm long in the epicutis, narrowly clavate, septate, both staining and none-staining cystidia are apparent in SV.

Trama of sphaerocytes loosely arranged in clusters with a sparse hyphal network and frequent vascular hyphae interspersed.

Chemical reactions: FeSO₄ - light brownish pink; NH₄ OH - no reaction on cap or stipe; KOH - turns cuticle more orange, stipe no reaction; phenol - slowly brownish purple; guaiac - slowly, weakly blue-green; SV - gills and cap trama stain deep violet, pileocystidia unreacting or grey, pleurocystidia and cheilocystidia black.

Habitat and tree associations: Along the shore of Langford Lake, Victoria, close to the water, with willows, Douglas fir and western hemlock nearby. Found in late May.

Collections: OC030526-01 from the western shore of Langford Lake, Victoria.

| Collection | ITS1-F to | | | |
|-------------|-----------|-------------|----------|----------|
| | ITS4-B | RFLP: HinfI | AluI | Sau3A |
| OC030526-01 | 865 | 414, 374 | 456, 279 | 641, 238 |

Notes: This collection is very similar to *R. fragilis* (Persoon:Fr.) Fries except the spores are smaller and the pileocystidia are 0-1 septate, *R. fragilis* pileocystidia usually have more septa. Sarnari (1998) gives *R. fragilis* var. *alpestris* Boudier, *R. norvegica* Reid (nom. inval.) and *R. norvegica* var. *rubromarginata* Kühner as synonyms, indicating the affinity with the *R. fragilis* group. This collection has the slow reaction with guaiac and the pale cream rather than pure white spores typical of stirps *fragilis*, and the small spore size with low warts and reticulations of *R. laccata*. The local collection had a nutty-rubbery smell rather than the fruity-pear smell indicated in the type and were not as shiny when dry, but the habitat close to water with *Salix*, the microscopic and other macroscopic characters match the description given in Sarnari, 1998. The RFLP's of the rDNA were more like those of *R. betularum*, another species of moist sites, than those of *R. fragilis*.

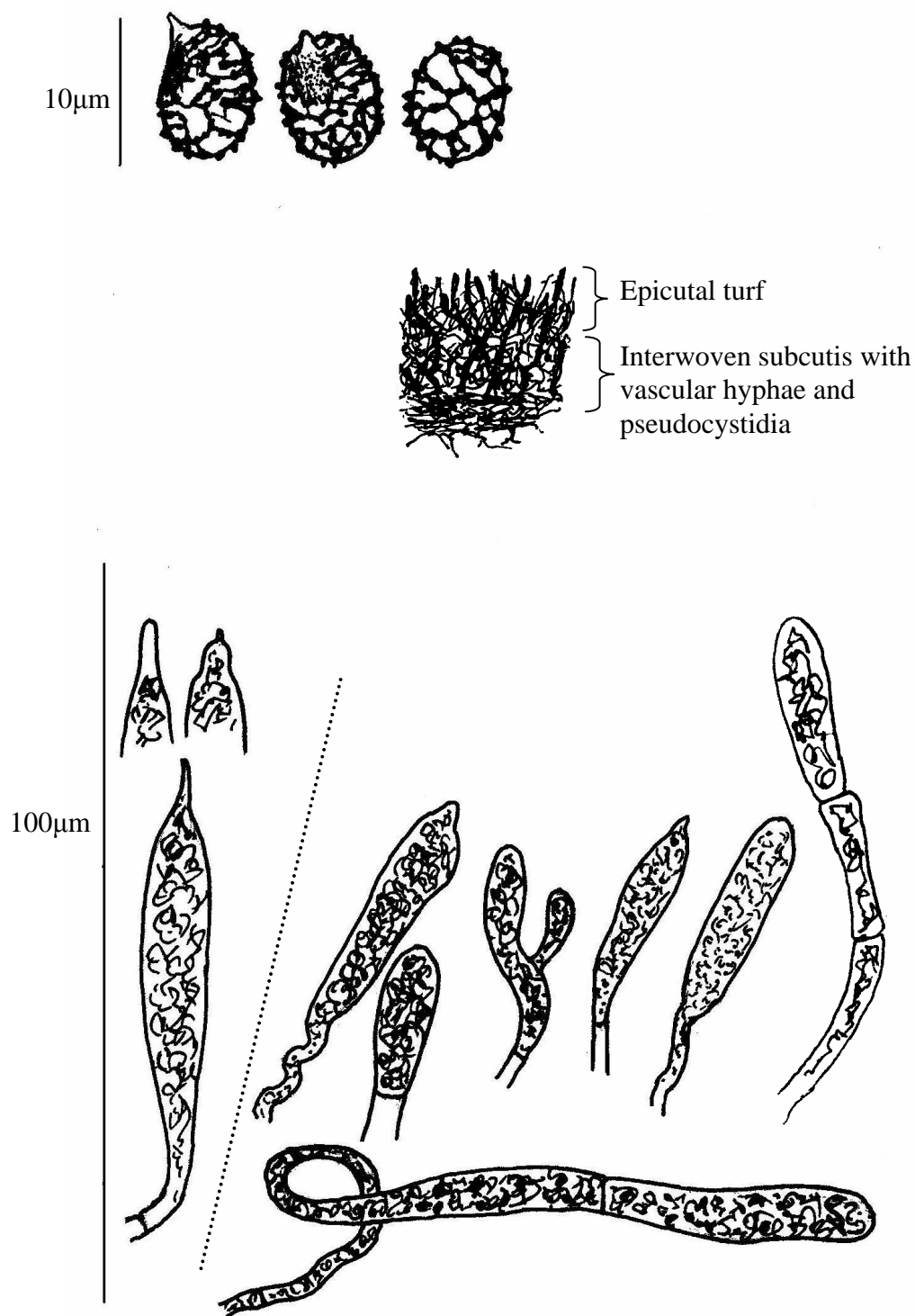


Figure 92. Microscopic characters of *Russula laccata*: Top, spores with 10 µm scale bar; bottom left, hymenial cystidia; bottom right, pileocystidia with pseudocystidia below, lower scale bar is 100 µm.



Figure 93. Characters of *R. laccata* cutis: Top, colour notes of cap surface of mature and young basidiomata; lower left, section through cutis with 100 μm scale bar positioned just above the hypodermis, arrow point is at level of gluten; lower right, surface view of cutis with pileocystidia stained in SV, scale bar is 100 μm

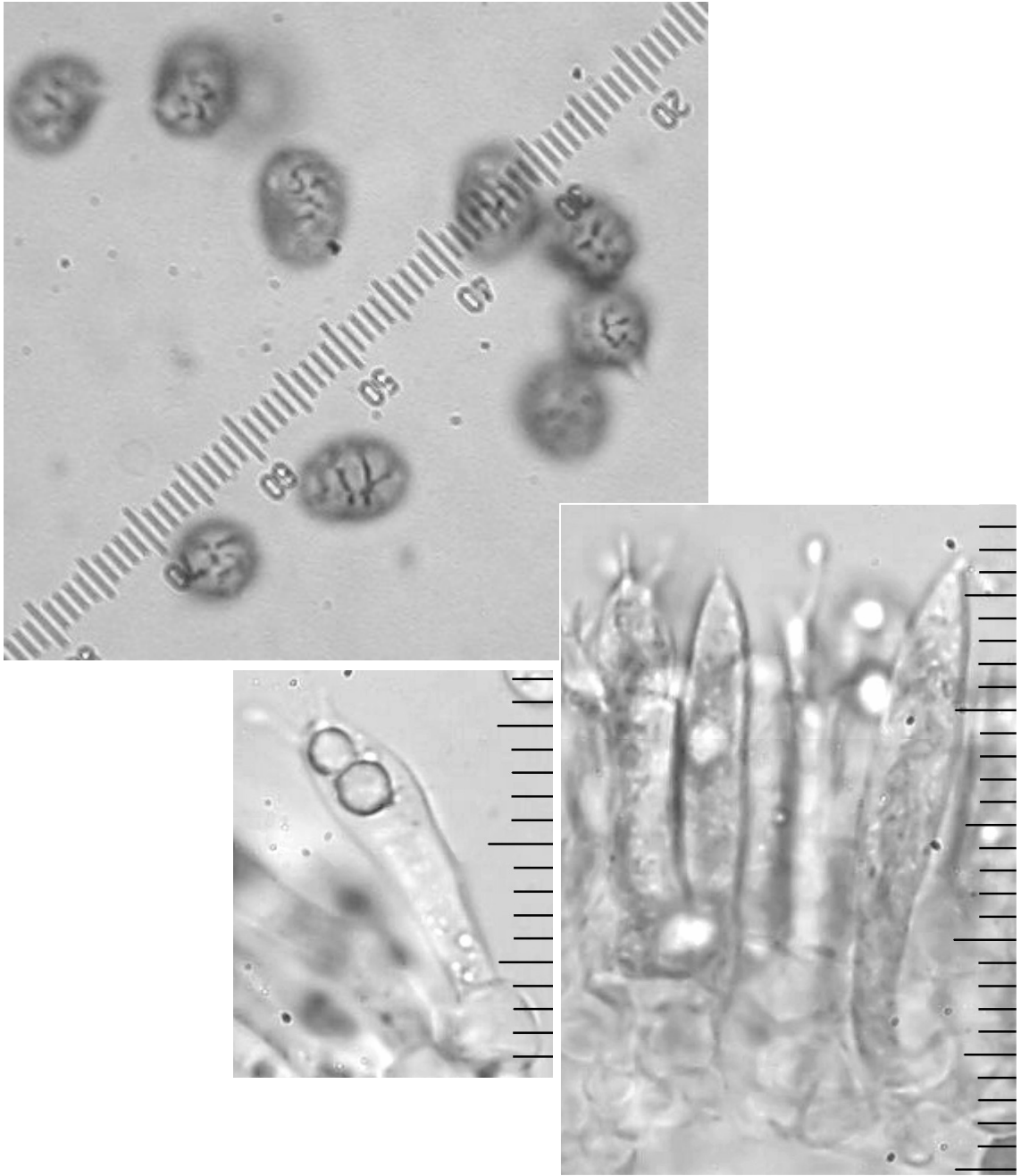


Figure 94. Characters of the hymenium of *R. laccata*: Top, spores with 1 μm division scale, below, basidia and below right, section through hymenium showing basidia, basidioles and two pleurocystidia and the subhymenial cells they originate from, 10 divisions are 25 μm for both lower scales.

***Russula silvicola* Shaffer**

Nova Hedwigia 51:229–234, 1975.

Description of Vancouver Island collections:

Cap 1.9-7.5cm diameter, convex to pulvinate when young, sometimes with a small flattened umbo, becoming plane to shallowly depressed, eventually shallowly infundibuliform, sometimes with a low umbo and often retaining rounded margins, margin smooth, striate in age. When very young pale yellow, developing pink to red blotches and becoming completely scarlet red or retaining some cream to light yellow orange areas, fading in age, sometimes to almost white in rainy weather. Two collections were cream with light pink blotches only (Fig. XX). Surface sticky to viscid, drying matte, cutis peeling 1/3 to almost completely, cap trama white, occasionally pink under the cutis, unchanging or becoming pale pinkish.

Gills white to pale cream, unchanging where bruised, subdistant to close, frequently forked near stipe or margin, with occasional lamellulae, narrowly adnexed to almost free, or adnate to slightly decurrent at stipe, subacute to obtuse at cap margin, ventricose with the broadest part towards the margin, depth 2-5 mm at half-radius, generally equal to 1.5 times the depth of the trama, margins generally minutely fringed, sometimes crenellate.

Stipe 2.7-8.3 x 0.6-2cm, in general longer than cap diameter, more or less cylindrical but widening at the base and sometimes the apex, surface white, smooth, longitudinally finely rugulose, stuffed with a breadly-textured trama, becoming hollow in age, unchanging to pale pinkish where damaged, becoming a light yellow-grey in age as if waterlogged.

Texture relatively firm and pliable when young, soon becoming soft and fragile.

Taste slightly bitter, slowly to quickly acrid.

Odour slightly fruity, of stewed rhubarb, with a rubbery component or sometimes a sort of waxy, coconut smell reminiscent of gorse flowers.

Spore colour white to slightly creamy white, Romagnesi Ia-1b.

Spores 7.2-11.2 x 6.5-8.8µm, L:W 1.03-1.36, mean (n=40) 1.21, mostly broadly ellipsoidal, occasionally subglobose, ornamentation of conical, peg-like or rounded, mostly heavy warts, 0.8-1.4µm high, isolated or connected by fine to heavy lines, some 2-3 catenate forming short ridges, forming an often relatively wide partial reticulum, less often a complete reticulum, **Woo types** C2, C3, D2, D3. **Suprahilar patch** amyloid, often only partially so, a light greyish irregular area in Melzers' reagent, often with a lower but similar ornamentation to that of the rest of the spore. **Hiliferous appendix** 1.2-2µm long, around 1.5µm wide near the base. **Basidia** mostly 4-spored, rarely 3 and 2-spored, 32-48 x 8-14µm, clavate, bulbous in the upper 1/3, relatively short and broad. **Sterigmata**, 3-8µm long, 2-2.5µm wide near the base. **Pleurocystidia** regularly and densely distributed, 38-80 x 6-13µm, originating in the subhymenium or the outer trama, protruding 12-20µm, fusoid, narrowly clavate to clavate, tips rounded, subacute, acute, mucronate, or with a short appendix or tiny button, contents refractive, yellowish in KOH, pink to reddish-brown to dark grey in SV. **Cheilocystidia** often very densely clustered, usually the only cell type discernible on the gill margins, up to 90µm long and 3.5-12µm wide, similar in shape to pleurocystidia but protruding up to 40µm, in some basidiomata the tips are very varied in shape and may be subacute, mucronate, capitate, or with a long, roughly cylindrical appendix 2-3µm wide, with walls that appear lumpy or pitted. Contents lightly to strongly refractive, variably staining in SV. **Subhymenium** 15-35µm, pseudoparenchymatous, gill trama of sphaerocytes, with many vascular hyphae.

Cutis 80-120µm, an ixotrichodermis with a pink pigment in the lower layers which dissolves slowly in water. **Subcutis** about 2/3-1/2 the cutis thickness, of parallel, interwoven, hyaline gelatinised hyphae 1.0-3.0µm wide, with many vascular hyphae 2.5-10µm wide, dark grey in SV, that sometimes give rise to pseudocystidia in the epicutis. **Epicutis** of erect free hyphal ends 1.0-3.0µm wide, undifferentiated or with slightly

inflated terminal cells up to 6µm wide, with abundant pileocystidia, embedded in a gelatinous matrix. **Pileocystidia** 20-120 x 3-11µm, most are clavate with slightly inflated rounded tips, but cylindrical ones are common, tips obtuse, 0-3 -septate, variously reacting with SV with some remaining yellowish, others dark grey, many having a gradation along the length with the terminal cells darkest. The walls appear incrustated slightly in places in SV. **Pseudocystidia** occasional, reacting similarly to pileocystidia in SV and of similarly shaped ends. **Hypodermis** of small flattened sphaerocytes and compactly interwoven hyphae with vascular hyphae.

Trama of discrete clusters of sphaerocytes bound by a hyphal mesh, with frequent vascular hyphae, 4-7µm wide, light grey in SV, grey to black in SV.

Chemical reactions: FeSO₄ - light greyish pink; KOH - yellow on cap cutis, orange on cap cutis, no reaction on stipe; NaOH₄ - no reaction on cap or stipe; phenol - brownish; guaiac - brownish initially, slowly turning grey-green to black; SV - brownish red on cutis and gills, cystidia reaction varied, pinkish to grey, weakest on the gill margins.

Habitat and tree associations: gregarious, on well decayed logs, occasionally the forest floor, in one case on the bark of dead and living trees, in old growth and mature western hemlock or Sitka spruce, often with huckleberry and salal. Douglas fir and western red cedar may be present also,.

Collections: CR981013-09a and -09a on well decayed log with mixed age Sitka spruce, western hemlock, red alder and western red cedar, near the beach, San Joseph trail, Cape Scott, N 50.768°, W128.342°. CR 981014-01 on log and bark of tree in old-growth western hemlock, north of Sayward, N 50.3255°, W126.0905°. CR981202-05 on log under regeneration western hemlock and Douglas fir, Thetis Lake park, Victoria, N 48.4715°, W123.4744°. JD021027-01 on forest floor under western hemlock and possibly Douglas fir, Cowichan lake area, exact location unrecorded. CR021113-02 on decaying large log under regeneration Sitka spruce and western hemlock, Gold Mine trail, near Uclulet, N 49.011°, W125.627°. CR001011-53a, N 49.015733°, W125.67335°; CR021016-10, N 49.0155°, W125.6745°; CR021016-12 and CR010615-

14, N 49.0215°, W125.6735°, all on decayed logs in areas with little undergrowth under Sitka spruce and western hemlock krummholz, Wickaninnish, PRNP. CR010930-01, on small log under western hemlock near eastbound one-way road between Bamfield and Cowichan Lake, N 48.875°, W124.5965°.

| ITS1-F to | | | | |
|--------------|--------|-------------|----------|----------|
| Collection | ITS4-B | RFLP: HinfI | AluI | Sau3A |
| CR981014-01 | 870 | 424, 365 | 565, 295 | 672, 208 |
| CR981202-05 | 884 | 409, 298 | 464, 221 | 343, 265 |
| CR001011-53a | 898 | 407 | 569, 322 | 609, 243 |
| CR021016-10 | 892 | 382, 347 | 513, 275 | 614, 200 |

Notes. These collections were at first thought mistakenly to be *Russula bicolor* Burl. or *R. simillima* Peck, however they differ from the former in the abundant pileocystidia, the higher ornamentation and stronger reticulation formation on the spores, and growth on wood. Thiers (1997) comments that *R. bicolor* inhabits coastal Sitka spruce forests but is rare. *R. simillima* is described as yellowish with salmon pink (in Thiers 1997) with the pink often at the margin, a description fitting some local collections of *R. silvicola*, in addition the spores are very similar in size and ornamentation. They differ in the cutis, which in some basidiomata of *R. simillima* has inflated cells, in the pileocystidia which are mostly aseptate, and in the yellowish stipe and slightly browner cap colours. Thiers also notes that *R. silvicola* is similar to *R. paxilloides* Earle, but that species does not become bright red, has infrequent pileocystidia and grows with oaks. The Vancouver Island collections of *R. silvicola* match well the original description by Shaffer, which is clear and well illustrated with drawings of the microscopic characters. It is closely related to *R. fragilis* and has probably had that name applied to collections in the PNW, particularly as there have been many colour forms of that species recognised including red, some of which have been published as separate species. In contrast with local collections of *R. fragilis*, *Russula silvicola* shows a remarkable consistency in the shape of the pileocystidia from one collection to another, even those from different habitats and areas. The local collections commonly have a mixture of yellow and pink colours in the cap, completely red ones are less common and seem to occur before or early in maturity,

subsequently fading. Shaffer commented on the variation in cap colour and also in spore size, yet these differences were uncorrelated with other characters.

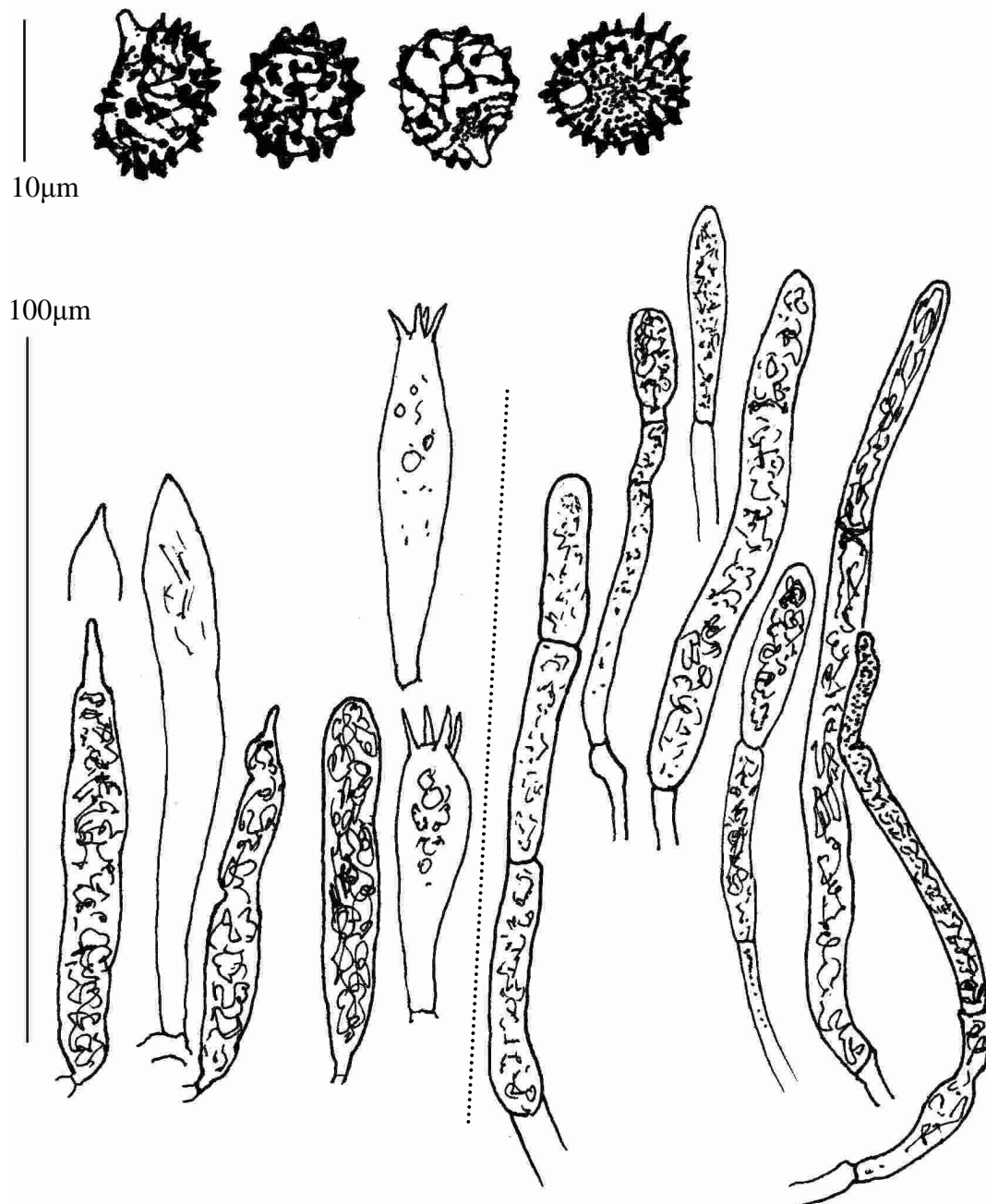


Figure 95. Microscopic characters of *Russula silvicola*: Top. Spores with 10µm scale bar; bottom left, hymenial cystidia, the larger one is typical of the cheilocystidia, and two basidia; bottom right, pileocystidia from the epicutis, the most common types are the clavate, septate ones as first, second and fifth from the left, bottom scale bar is 100µm.



Figure 96. Macroscopic characters of *R. silvicola* : Top, illustration showing profiles and top of young to mature basidiomata, and a longitudinal section, the square is 1cm² and shows spore print colour; bottom, a collection from the Cowichan Lake area that is exceptionally pale, photographed on a scanner for more accurate colour rendition.

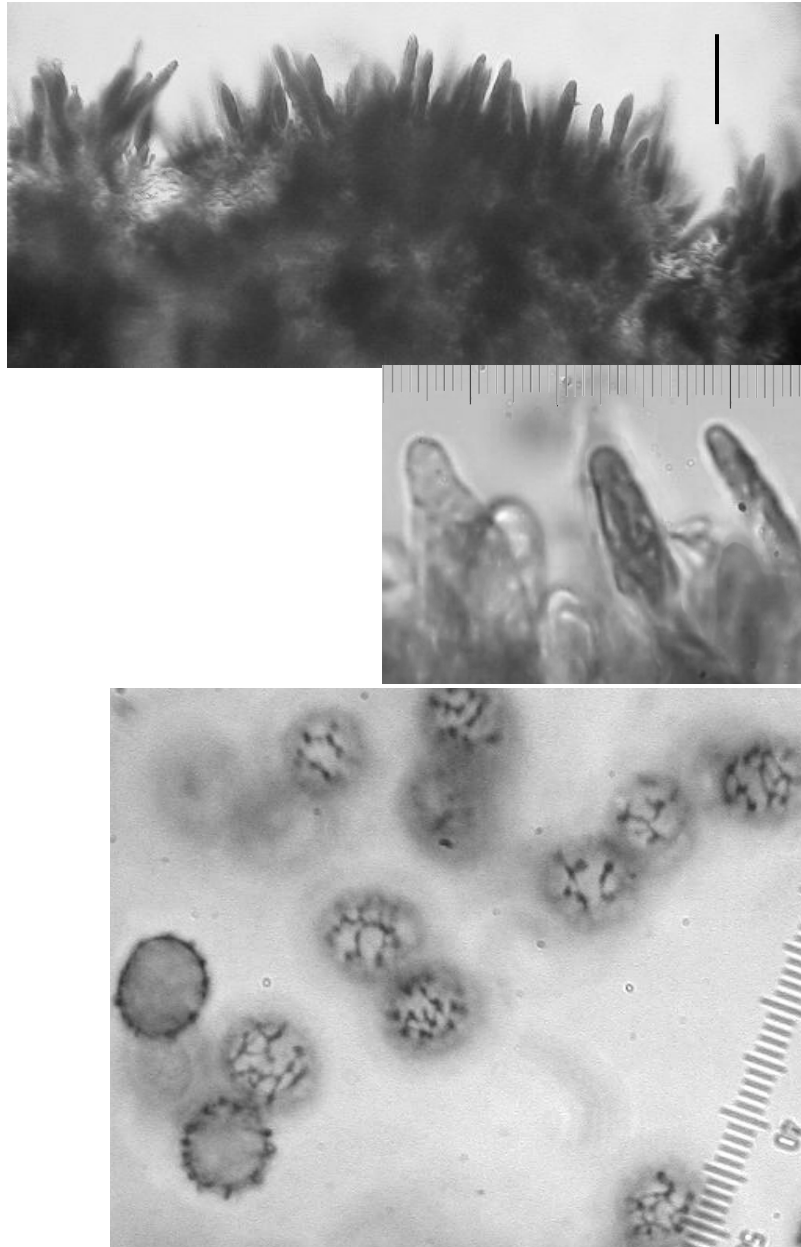


Figure 97. Characters of *R. silvicola* hymenium : Top left, cheilocystidia in situ stained with SV, scale bar is 50µm; lower right, close-up of hymenial cystidia tips, scale is in 1µm divisions; lower left, spores with 1µm division scale.

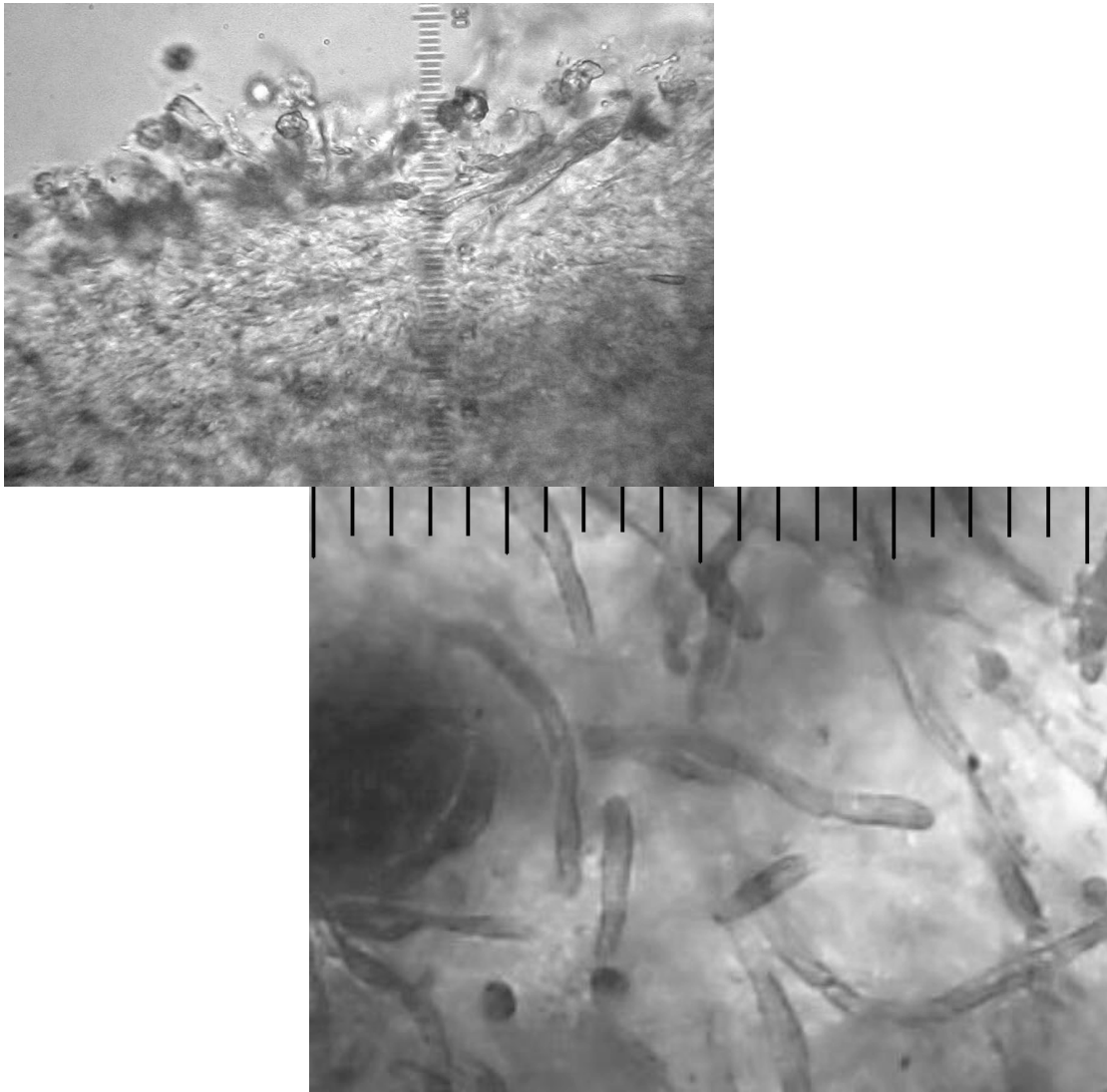


Figure 98. Cutis of *R. silvicola*: Top, section through cutis in water mount, 10 divisions on scale are 25µm; bottom, surface view of cutis showing pileocystidia stained in SV, one scale division is 10µm.

Clade 5d

Subsection *Sardoninae*

Series *Persicina*.

Russula cf. *luteotacta* Rea

British Basidiomycetes: 469, 1922

Description of Vancouver Island collections:

Cap 2.7-6.0cm diameter, a mixture of light cream and pink, in one collection almost entirely cream with only touches of rose pink, on the other a delicate light pink with a light brown tint over the disc, slightly viscid, drying matte. Pulvinate when young, soon becoming shallowly depressed with a curved, striate margin. Cutis peeling 1/3-2/3 the radius, flesh white, unchanging where cut.

Gills white, unchanging where damaged, subdistant to close, few to frequent lamellulae, forking not seen, falcate, broadest closer to the stipe, adnexed at the stipe, subacute to obtuse at the cap margin, about twice the depth of the trama at half-radius, up to about 6mm, becoming crisped in the dried basidiomata, but whether this character was not recorded when fresh.

Stipe 3.1-7.3cm x 0.9-1.9cm, cylindrical, longer than the cap diameter, stuffed, becoming hollow, white, staining bright yellow at the base, yellow-brown above the base, the upper half or so unchanging when cut, in the dried material the stipes are a strong red-brown. The stipe base stains red in SV.

Texture about average for a *Russula*, not particularly fragile, not noticeably firm, but rather thin-fleshed.

Taste acrid, sometimes after a few seconds of chewing.

Odour not distinctive to slightly fruity, of orange.

Spore colour white, Romagnesi 1a.

Spores 7-8.5 (-9) x (5.5) 6.1-7.5µm, L:W 0.96-1.32 with a mean of 1.18 (n=30), obovoid. **Ornamentation** of quite heavy warts, 0.6 -1.2 high, most often under 1µm high, isolated or joined in rows to form ridges, with a few fine lines, not forming a reticulum, **Woo types** B2, B3, C3. **Suprahilar patch** a roundish to elongate (up to 4µm long) lightly amyloid patch bordered by strongly amyloid warts and low ridges.

Hiliferous appendix around 1.3-1.5 long by 1-1.2µm wide near the base. **Basidia** 4-spored, 36-45 x 7-11µm, clavate, sometimes broadly so. Sterigmata 5-8µm long and 1.3-2µm wide near the base. **Pleurocystidia** abundant, 40-85 x 6-14µm, protruding 15-30µm, originating in the subhymenium, clavate to fusoid, tips obtuse when young, acute to shortly tapering, sometimes with a small terminal button when mature, contents yellowish refractive in KOH, black in SV. **Cheilocystidia** sparse to frequent, similar to pleurocystidia but protruding to 40µm. **Subhymenium** 15-25µm thick, interwoven, **gill trama** of sphaerocytes with uncommon narrow vascular hyphae around 2µm wide.

Cutis 80-120µm thick at half-radius, in two layers, **Subcutis** about half the depth of the cutis, of loosely interwoven of hyphae 2-3µm wide, the basal layers more compact and repent, with a pinkish hue in patches, and with vascular hyphae 5-7µm wide, and embedded in a gelatinous matrix. **Hypodermis** -none. **Epicutis** a tangled turf of mostly unbranched hyphal ends 1-3µm wide, some tapering, others with slightly refractive contents like small cystidia, sometimes contorted or strangulate, in a viscid matrix.

Pileocystidia 70-250 x 5-8µm, most are in the 70-125µm range, narrowly clavate to cylindrical, mostly with obtuse tips but some with a small capitum, arising from the lower subcutis. Many are aseptate, otherwise 1-3 septate. **Pseudocystidia** remaining embedded in the subcutis, merely the undifferentiated termini of vascular hyphae.

Trama of discrete clusters of sphaerocytes bound by a hyphal mesh. laticifers

Chemical reactions: FeSO₄ - no reaction; KOH - no reaction to pale orange on cap surface, no reaction to pale yellow on stipe; NH₄OH - no reaction; phenol - pale brownish pink; SV - greyish on the gills and cuticle, cystidia and vascular hyphae grey to black with some red, red at the base of the stipe.

Habitat and tree associations: on the forest floor under red alder with salmonberry, huckleberry and salal, in openings of regeneration western hemlock and Sitka spruce coastal forest.

Collections: BT000919-07 and CR000919-08, near the Cape Beale trail on the western side of the Bamfield inlet, N48.822117°, W125.150583° and N48.824183°, W125.150583° respectively.

Notes: These collections are closer to the *R. queletii* group than to the *R. fragilis* group, as they share similarities in the spores, pileocystidia and the yellow flesh within the base of the stipe. The former group has cream to yellow spores, not white, and usually purple and greenish tints in the cap. The European *R. luteotacta* has firmer flesh, barely peels, has more distant gills and more of the flesh stains yellow, albeit slowly, and it is found under broadleaved trees, particularly *Carpinus* (Hornbeam) in moist copses often near ponds (Bon, 1988, Romagnesi 1967). Romagnesi (1967) described *R. luteotacta* form *immutabile* that lacked the yellow bruising reaction. The spores, epicutis, colour and pileocystidia of the Vancouver Island collections match the descriptions for the European *R. luteotacta* and the habitat amongst alders in moist coastal forest is similar. Romagnesi placed *R. luteotacta* in subsection *Persicinae* of section *Piperinae*, which places it in clade 5d.

Peck described *R. luteobasis* from North America (Torrey Botanical Club Bulletin 31:179, 1904) as a rosy colour that became paler with a yellowish centre and a yellow base of the stipe, but this species is mild, has yellow spores and has incrustated primordial hyphae in the epicutis. *Russula alborosea* Reumaux, a species described from France, is macroscopically similar to the above Vancouver Island collections and is found under

Fagus and oaks in calcareous clay soils, the spores are larger at 7-10 x 6-8 μm , and the pileocystidia are shorter, up to 90 μm . This species is placed in the *Emeticinae*.

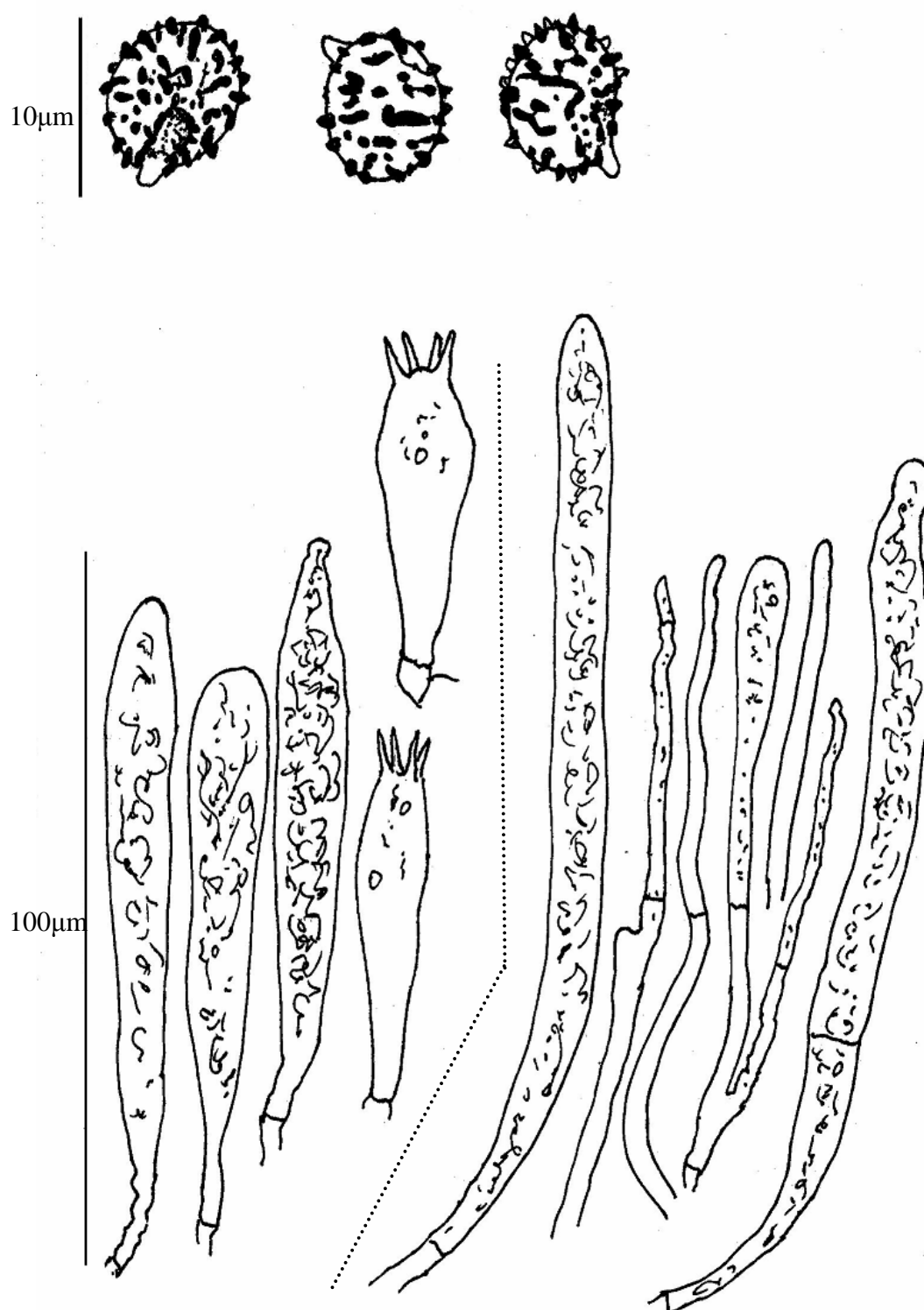


Figure 99. Microscopic characters of *Russula* cf. *luteotacta*: Top, spores with 10µm scale bar; bottom left, hyphal cystidia and basidia; bottom right, pileocystidia and epicutal hyphal ends, lower scale bar is 100µm.

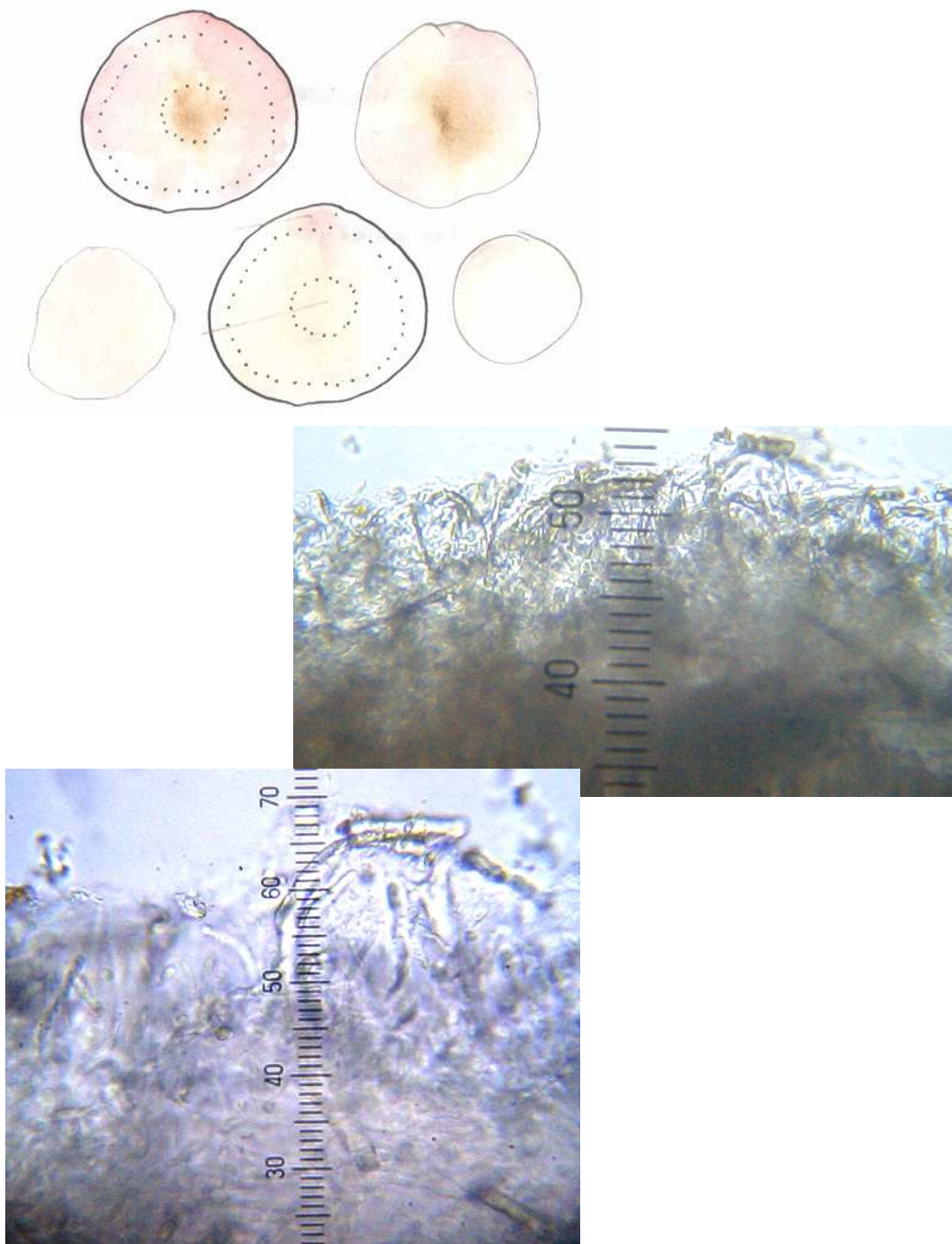


Figure 100. Characters of the cutis of *R. cf. luteotacta*: Top, field colour notes of the caps of two collections; middle, section through cutis in water of a young basidioma at about 1/2 radius, 10 scale divisions are 100 μ m, and on this section there is almost no trama, the subcutis-subhymenium boundary is about at the 40 mark; bottom, a section of cutis at higher magnification showing a pileocystidia, hyphal ends and a vascular hypha at lower right, 10 scale divisions are 25 μ m.

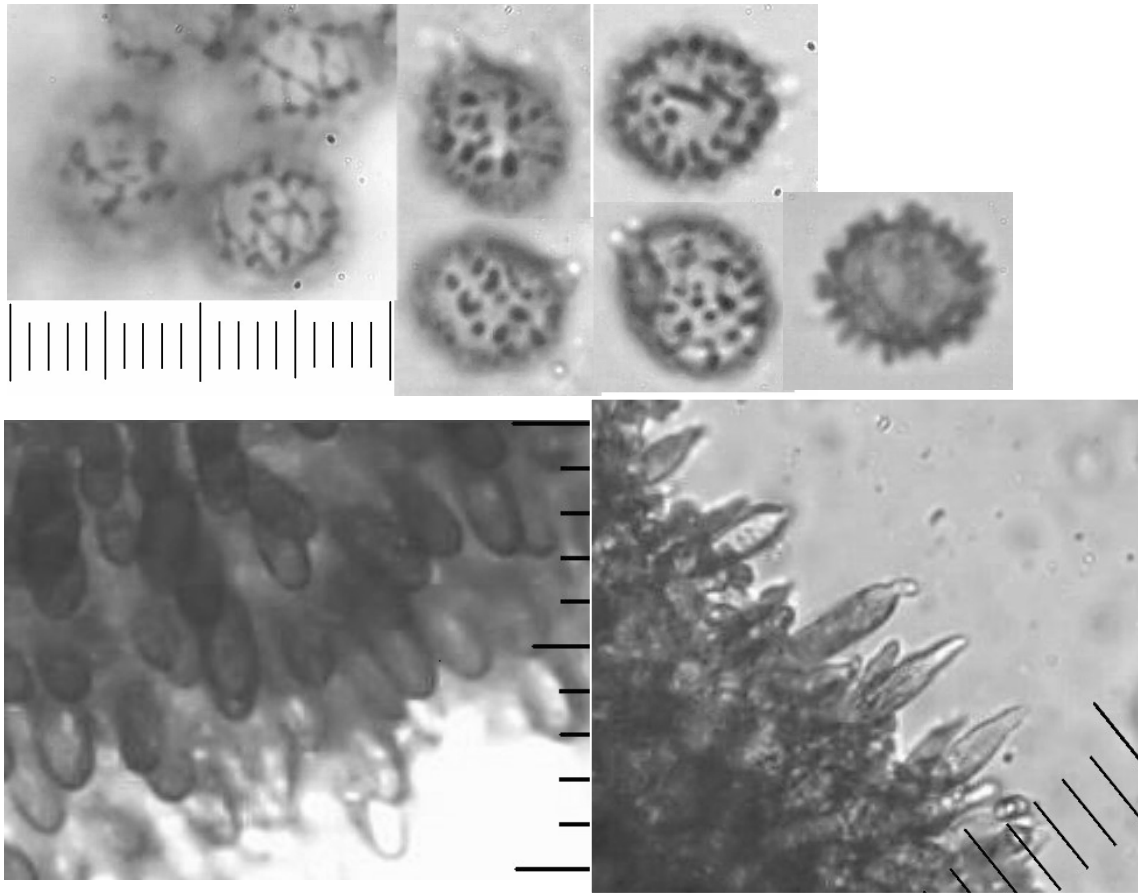


Figure 101. Characters of the hymenium of *R. cf. luteotacta*: Top, spores with 1µm division scale; bottom left, pleurocystidia stained in SV of a young basidioma; bottom right, cheilocystidia stained in Congo red, of a mature basidioma, scale is in 10µm divisions for both photographs.

Clade 5e

Series *Sardonias*

Russula queletii Fries

Mém. Soc. Émul. Montbéliard, Sér. 2, 1: 185, 1872.

Description of Vancouver Island collections:

Cap 2.7-11cm diameter, convex when young, becoming plane with a central depression, margins smooth, striate only in age, rounded and curving over the gill ends until fully expanded. Colours range from deep red-purple to purple to violet, to a grey or brownish violet or purple, with a blackish to olive to brownish centre, very dark in young basidiomata, fading markedly to greyish or brownish pink, grey, grey-green or a mixture of these colours, sometimes remaining darker in the centre, otherwise the centre fading to brownish or dull yellowish. Although there appears to be variability in colour, the principal pigments are magenta and blue-green, usually with the greenish hues centrally and the magenta throughout or more towards the margin. Surface viscid to sticky when wet, drying subglossy to matte, sometimes minutely velvety to bumpy over the disc, usually with a pale pruina in younger basidiomata. **Cutis** peeling 1/2 to 2/3, flesh beneath tinted pink or dull violet, cap flesh creamy white, unchanging where damaged.

Gills pale cream to cream, (lacking lemon yellow tints), close to subdistant, sometimes becoming distant in age, occasional lamellulae and forking. Adnate or sometimes slightly decurrent in age, generally narrowest at stipe, broadening slightly outwards or of more or less of equal depth in the outer 2/3, obtuse at cap margin, depth roughly equal to that of cap trama at half-radius, brittle and fairly soft.

Stipe 2.4-9 x 0.7- 2.1cm, on average approximately equal in length to cap diameter, stuffed with a bread- textured trama which develops several small irregular cavities when young, becoming hollow. **Stipe** surface usually partially or completely deep pink to violet, occasionally white, pruinose, unchanging when cut or browning slightly, greying

as if waterlogged in age. The base of the stipe stains bright yellow and when cut shows a thin layer of yellow tissue just under the stipe cutis at the tip (fig XXX).

Texture firm and quite hard at first, becoming soft and fragile by late maturity.

Taste mostly peppery rather than acrid, occasionally more intense.

Odour mild and slightly fruity, of stewed apple or sometimes like jam, the strength of the odour is weather dependent and reduced by cold or dry conditions.

Spore colour pale to deep cream, somewhat variable between collections, generally slightly darker than that of European material; Romagnesi IIc-IIIc.

Spores 6.9-10.5 x 6-8µm with means of 8.5 x 7µm, L:W 1.07-1.39 with a mean of 1.23, (n=94), warts 0.2-0.7µm on most spores, occasionally to 1.0µm. **Warts** bluntly conical, sometimes crestate, often quite heavy, in some spores mostly isolated, in others also with low connections between 2-4 warts forming irregular lines and crests, rare spores with almost all the warts in connected groups, not forming a reticulum or sometimes a broken one. **Woo types** A2-B2, rarely to C2. **Suprahilar patch** an amyloid, commonly elongate area around 3µm long, bordered by low broad warts. **Hiliferous appendix** 1.6-1.9µm long, 1-1.5µm wide near the base. **Basidia** 4 spored, 32-50 x 9-12µm, clavate to slightly fusoid, not particularly bulbous. Sterigmata 6-8 µm long and about 0.7µm wide at the base, slender. **Pleurocystidia** 45-92 x 9-15µm protruding 20-30µm, originating in the subhymenium, fusoid, tips acute, mucronate, small-capitate, or sometimes with a slender extension, contents yellowish and refractive in KOH, deep purple to black in SV.

Cheilocystidia sparse to numerous but clustered, around 50-60 x 6-8µm, protruding about 10µm or less, roughly but irregularly cylindrical with tips similar to pleurocystidia, reddish to purple in SV. **Subhymenium** 25-45 µm thick, interwoven, sometimes incorporating a few cells, **gill trama** of hyphae and sphaerocytes with abundant vascular hyphae 5-8µm wide in the thicker, upper part of the gill, narrowing to nothing towards the gill margins.

Cutis 60-100µm thick at half-radius, up to 400µm thick on disc, an ixotrichoderm with a turf of hyphal ends and numerous pileocystidia and pseudocystidia. **Subcutis** comprising about half the depth of the cutis, of tightly interwoven repent hyphae 2-4µm wide with pinkish contents, and a network of numerous vascular hyphae, staining red or grey in SV. **Epicutis** more loosely interwoven, of semi-upright hyaline hyphal ends 4-6µm wide, pileocystidia, and abundant pseudocystidia whose terminal 50-100µm or more lie on the surface and give the cutis its minutely bumpy texture, all embedded in a gelatinous matrix. The hyphal ends often have refractive contents in the terminal cell. **Pileocystidia** 32-70 x 3-8µm, 0-1 septate, cylindrical, occasionally bifurcate or diverticulate, tips usually obtuse, sometimes capitate, with refractive and often banded contents, weakly to strongly staining in SV. **Pseudocystidia** arising from the lower subhymenium or hypodermis, septate, with terminal cells similar in shape and contents to pileocystidia. It is quite common in pseudocystidia and sometimes pileocystidia to have a terminal cell 25-30µm long, while below that septa occur at greater distances apart. **Hypodermis** of flattened cells and vascular hyphae.

Trama of discrete clusters of sphaerocytes generally under 40µm diameter, bound by a hyphal mesh and numerous vascular hyphae.

Chemical reactions: FeSO₄ - pale pinkish; KOH - reddish orange on cap cutis, yellowish to salmon pink on the coloured stipes, no reaction on the white part and inner trama; NH₄OH - no reaction; phenol - very slowly brownish (after 4-5 minutes); SV - initially magenta on the gills turning brownish-grey, purple on the cuticle, cystidia and vascular hyphae grey to black.

Habitat and tree associations: Under coastal Sitka spruce just above the highest tides, in sandy soil with seashell fragments.

Collections: CR981013-04, under western hemlock, western red cedar and salal Cape Scott and San Joseph trail junction, N50.7725°, W128.414°, CR981013-04a and -04b, along the shoreline forest of Sitka spruce, western hemlock and salal, San Joseph trail, Cape Scott, N50.773°, W128.403°.

CR981029-01 and -01b, at base of Sitka spruce, Combers Beach Spruce trail, Long Beach area, PRNP, N49.045°, W125.70633°. CR001011-43, CR001114-02, CR001114-05, PJ 010919-05 and CR021016-01 under Sitka spruce and western hemlock shoreline forest along the trail to Florencia bay, Wickaninnish, PRNP, in the vicinity of N49.0125°, W125.6755°. CR011030-02, under small Sitka spruce, Long beach picnic area, PRNP, N49.0445°, W125.702°.

| ITS1-F to | | | | |
|-------------|--------|-------------|----------|----------|
| Collection | ITS4-B | RFLP: HinfI | AluI | Sau3A |
| CR981029-01 | 832 | 388, 349 | 460, 280 | 253 |
| CR981029-02 | 800 | 364, 325 | | 368, 269 |
| PJ010919-05 | 849 | 408, 352 | 486, 292 | 359, 270 |
| PJ010919-05 | | | | |
| (repeat) | 854 | 388, 371 | 489, 259 | 346, 227 |

Notes: The amount of reticulation on the spores of the above collections is sometimes greater than is given in descriptions for *R. queletii* by Bon (1988), Romagnesi (1967) Sarnari (1998), or Thiers (1997), and the spore prints are a shade or two darker. It is not clear whether the above collections of *R. queletii* and those described below as *R. cf. fuscorubroides* are actually two species or a single variable species. The average spore size differs by almost 0.5µm in length and 0.3µm in width with *R. queletii* having the larger dimensions ($p < 0.001$, $\alpha = 0.05$ for each dimension). None of the above collections had a red reaction with either KOH or NH₄OH so they are neither *R. sardonias* nor *R. cavipes*. *Russula sardonias* Fries has fairly narrow pileocystidia, under 6µm wide, lemon yellow tinted gills and a pink reaction with ammonia (Sarnari 1998). *Russula fuscorubra*. *Russula torulosa* Bresad. is very similar to *R. queletii* but larger and more robust, with a shorter stipe. It has reticulated spores and occurs on sandy soils with pines, rarely spruce (Bon 1988, Sarnari 1998).

Other purple capped, cream-spored, peppery Russulas include *Russula placita* Burl., with more reticulated spores and occurring under Douglas fir. *Russula gracilis* Burl., a small fragile species with a purple, violet and green cap colours that fade and often a pinkish

stipe, the spores are pale yellow: Romagnesi Ila-b, with low ornamentation 0.2-0.4 μm high of isolated warts, and Thiers (1997) reports it from coastal forests in California. *Russula mordax* Burl. has more brownish tints in the cap, is quite large, up to 13cm across the cap, and occurs under Douglas firs (Burlingham 1936). This latter is closer in appearance to the *R. cf. fuscorubroides* described below.

Russula pelargonia Niole has a purple to greyish purple cap sometimes with olive tints and a purple to lavender stipe and is distinguished by its odour of geraniums (pelargonium), the spores are reticulated and 6-8.6 x 5-8 μm , slightly smaller than any of the collections from the Clayoquot area, Romagnesi (1967) reports the habitat as under *Populus* and other broadleaved trees and Woo (1989) describes Pacific northwest collections as in Douglas fir-western hemlock forest. *Russula queletii* and *R. fuscorubroides* may also have pelargonia-like odour components sensu Bon (1988).

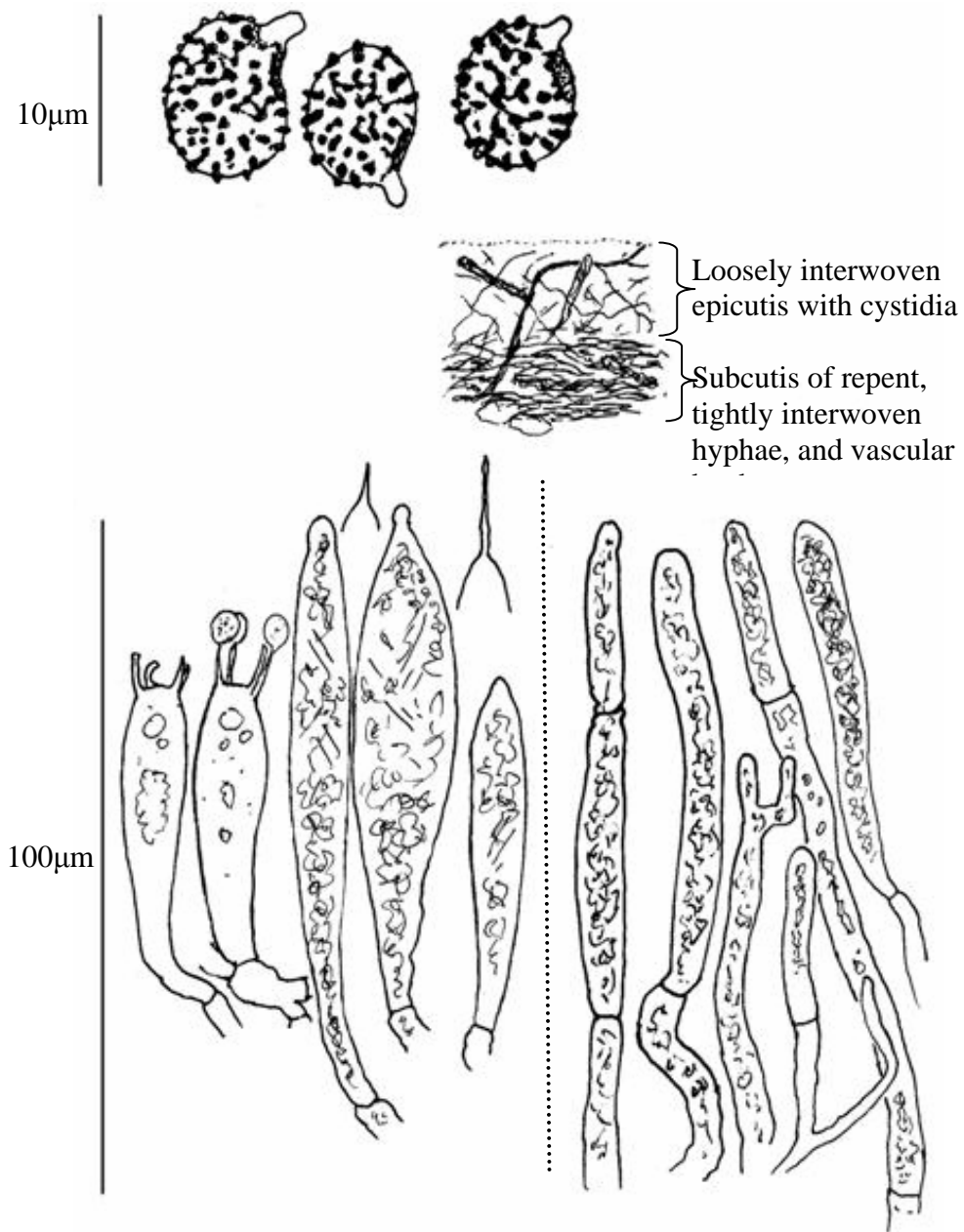


Figure 102. Microscopic characters of *R. queletii* : Top, spores with 10µm scale bar; middle, diagram of section through cutis; bottom left, basidia and hymenial cystidia; bottom right, pseudocystidia, pileocystidia and hyphal ends from the epicutis, lower scale bar is 100µm.



Figure 103. Macroscopic characters of *Russula queletii*: Top, several basidiomata in habitat (under shoreline Sitka spruce), photograph by A. Ceska, inset, a faded specimen; below, illustrations of two collections showing the yellow tissue at the stipe base, the squares are 1cm² and show spore colours: below left, diagram of cavities in a young stipe.

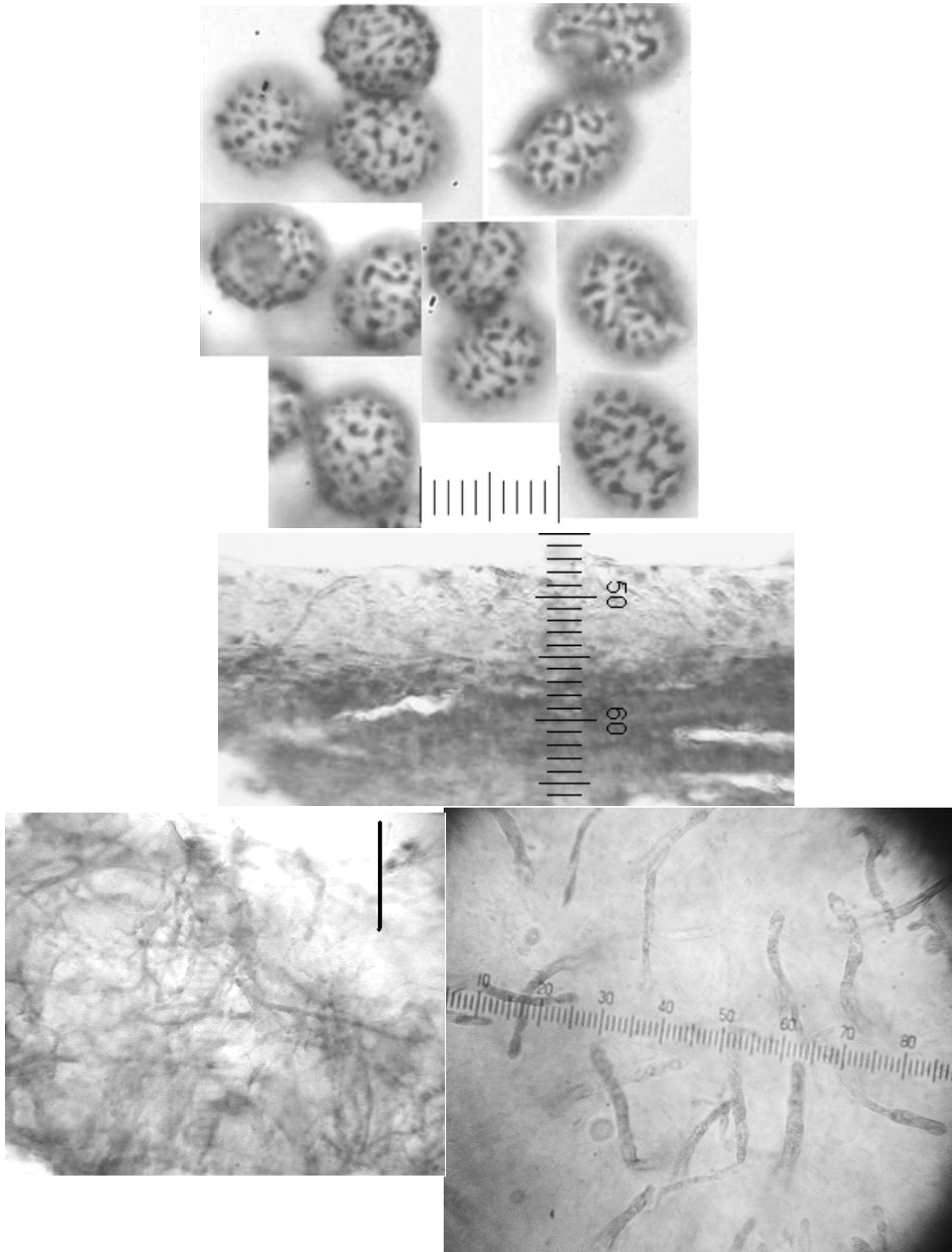


Figure 105. Characters of the hymenium and cutis of *R. queletii*: Top, spores with 1µm division scale; middle, section through cutis, 10 scale divisions are 100µm; bottom left, vascular hyphae in the hypodermis, scale bar is 100µm; bottom right, pseudocystidia and pileocystidia in the epicutis.

Russula queletii cf. var. *flavovirens* (Bomm.-Rouss.)

One collection of *Russula queletii* had an almost entirely green cap (fig. XX) with mere traces of purple at the margins. These basidiomata had pink flushes on the stipe and the characteristic bright yellow bruising at its base, and were microscopically almost identical to the purple-capped *R. queletii* found in the same habitat, but differing in the following characters:

Cap green throughout but darkest in the centre, mottled with yellow-green, becoming greyer towards the margins with purplish tints at the very margin, peeling less than 1/4.

Odour mild but slightly sour. Spore print light orange, Romagnesi IIIc. **Spores** 7-9 x 6-7.9µm, L:W 0.96-1.33, mean 1.18 (n=30) warts up to 0.7µm, occasionally to 1µm, mostly isolated, sometimes 2-3 joined with usually heavy lines or ridges, Woo A2-B2, rarely B3. The spores tend to have a slightly broader shape on average than those of the purple *R. queletii* but have the same ornamentation.

Collections: CR981029-02, in Sitka spruce krummholz at the top of the beach, Combers beach trail, Long Beach area, PRNP, N49.0435°, W125.7035°.

| ITS1-F to | | | | |
|-------------|--------|-------------|--------------|----------|
| Collection | ITS4-B | RFLP: HinfI | AluI | Sau3A |
| CR981029-02 | 800 | 364, 325 | unsuccessful | 368, 269 |



Figure 106 Illustration of profiles, cap surface and longitudinal section of *Russula queletii* cf. var. *flavovirens*, the square shows spore print colour and is 1cm².

***Russula cf. fuscorubroides* Bon**

Bull. Soc. Mycol. France 91 (4). 1975.

Description of Vancouver Island collections:

Cap 4.6-11.3cm diameter, mid to dark purplish red, black or nearly so over the disc when young, then sometimes with brownish or olivaceous tints, not fading much, peeling less than 1/4 the radius, viscid when wet, drying subglossy and minutely bumpy when viewed with a hand lens, more so near the centre. Hemispherical when young, becoming plane with a central depression, margins eventually unevenly uplifted. Margins smooth when young becoming striate to 1/4 the radius when fully mature. Flesh creamy white or pinkish under the cuticle, unchanging when cut.

Gills deep cream when young, becoming pale cream at maturity, unchanging to bruising brownish where damaged, subdistant to distant in larger basidiomata, adnate at stipe, subacute at margins, ventricose, approximately equal to depth of trama at half-radius in early maturity, almost twice the depth in age, forking and presence of lamellulae varying from none on some basidiomata to many on others.

Stipe 3-8.8cm x 1.1-3.2cm, more or less cylindrical or broadening at the base, white or with a flush of pink at the base or less commonly over most of the surface, pruinose when young, surface longitudinally rugulose, unchanging when cut but yellowish brown stains developing near the base. In age the flesh becomes slightly greyish and soft.

Texture firm when young and early maturity, becoming quite fragile in age.

Taste immediately acrid.

Odour faint, slightly fruity, of apples or plums.

Spore colour light cream, Romagnesi IIa-c.

Spores 7-9.4 (-10) x 5.8-7.6 (-8) μ m, with means of 8.1 x 6.7 μ m, L:W 1.02-1.34 with a mean of 1.2 (n=65), broadly ellipsoidal. **Ornamentation** of fairly heavy conical to pyramidal to crestate warts mostly 0.4-0.9 μ m high, occasionally to 1.2 μ m high, in general isolated, sometimes in rows or clustered, 2-3 catenate or with a low, often broad connection that appears weakly amyloid, not forming a reticulum, smaller warts sometimes scattered between the larger ones. **Woo types** A2-3 to B2 -3. **Suprahilar patch** an irregular amyloid area bordered by small or normal sized warts, hiliferous appendix 1.4-2.1 μ m long, around 1.2 μ m wide at base. **Basidia** 4 spored, 37-53 x 8 - 12 μ m, clavate to bulbous in the upper 1/3. Sterigmata up to 10 μ m long and 1 μ m wide at the base. **Pleurocystidia** 60 -140 x 8-12 μ m, occasional broad ones to 21 μ m wide, protruding 20-40 μ m, originating in the subhymenium or outer trama, narrowly fusoid or almost cylindrical, tips mostly tapered, acute or occasionally with a tiny capitum, contents refractive, yellowish in KOH, dark grey to black in SV, tips acute, sometimes with a tapering extension. **Cheilocystidia** patchily distributed, generally shorter up to 60 μ m, and more irregularly shaped than pleurocystidia, protruding around 25 μ m, sometimes agglutinated. **Subhymenium** 20-50 μ m thick, pseudoparenchymatous, gill trama of fairly spherical sphaerocytes 20-40 μ m diameter, with occasional vascular hyphae 5-8 μ m wide.

Cutis 90 -120 μ m thick, an ixotrichodermis. **Subcutis** of tightly interwoven repent hyphae with pinkish-brown contents 2- 4 μ m wide, laticiferous hyphae frequent, staining red or grey in SV, and terminating in the epicutis as pseudocystidia, all embedded in a gelatinous matrix. **Epicutis** of repent to semi-upright hyphal ends 3-5 μ m wide, undifferentiated or with irregularly shaped, slightly inflated, strangulated or nodulose terminal and subterminal cells. **Pileocystidia** 26-100 x 4-8 μ m, common, sometimes distributed in clusters, cylindrical or narrowly clavate, sometimes diverticulate, occasionally forked or branched, ends obtuse or capitate, 0-3 septate but the majority aseptate or with one septum separating a shorter terminal cell, contents yellowish and refractive, sometimes banded. In the case of banded contents, there are frequently narrow breaks in the refractive material that can appear like septa, this is less apparent if the cutis is mounted in Melzers' reagent. Sometimes the hyphal wall forms a small asymmetrical

shoulder just below a septum. **Pseudocystidia** numerous, septate, arising in the lower subcutis, contents, width and terminus similar to those of pileocystidia. **Hypodermis** of flattened sphaerocytes and repent hyphae.

Trama of small to large discrete clusters of sphaerocytes bound and permeated with a comparatively dense hyphal mesh.

Chemical reactions: FeSO₄ - pale pinkish; KOH - brownish orange on cap surface, no reaction on stipe; NH₄OH - no reaction; guaiac - blue-green; guaiacol - pinkish; phenol, - brownish purple; SV - grey on the gills, purple on the cuticle, cystidia and vascular hyphae grey to black.

Habitat and tree associations: In coastal western hemlock forest but inland of the Sitka spruce dominated coastal fringe, associated with western hemlock and possibly also amabilis fir, and often alongside trails where there are young trees.

Collections: CR981013-07, on a very decayed stump under mixed-age western hemlock and Sitka spruce, San Joseph trail, Cape Scott, approximately N50.773°, W128.403°. CR000919-02 alongside the Cape Beale trail, Bamfield, under young western hemlock, N48.82658°, W125.1458°. CR001012-22 and -23, along the roadside of Grice Bay mainline logging road near Kennedy Lake Park, under red alder, western hemlock and amabilis fir, N49.016883°, W125.58153°. OC010920-RFB and CR021015-21b, in young stand of western hemlock-amabilis fir at the edge of the seaward side rainforest trail, PRNP, N49.05°, W125.7095°.

ITS1-F to

| Collection | ITS4-B | RFLP: Hinf1 | Alu1 | Sau3A |
|--------------|--------|-------------|----------|----------|
| CR021015-21b | 874 | 385, 329 | 500, 361 | 349, 269 |
| CR001012-23 | 865 | 395, 365 | 482, 295 | 361, 208 |
| CR000919-02 | 865 | 412, 369 | 474, 285 | 364, 275 |

Notes: This species was first identified as *Russula queletii* with which it morphologically very similar, the slight differences in colour and habitat from collections also identified as

R. queletii from the coastal spruce fringe suggest either a variant or a different species. These collections of *R.cf. fuscorubroides* have on average a redder cap than local *R. queletii*, and only a yellow-brown rather than bright yellow staining at the stipe base. *Russula fuscorubroides* is perhaps the closest identification, a species preferring acidic soils but usually associated with *Picea*, often in habitats with *Vaccinium* also present. A rough test with pH strips dipped into the moisture squeezed from a handful of rainforest soil showed that they are generally acid, around pH 4-5, whereas the spruce fringe along the upper shoreline is pH 5-6. The above collections have slightly paler spores than the IId for *R. fuscorubroides* given in Bon (1988).

Russula torulosa is a very similar species that may have quite large basidiomata on a par with the above collections, it has in general more reticulations and fewer isolated warts on the spores than the above collections and is associated mainly with pines on neutral to calcareous sandy soils, rarely with spruce on acid soils. *Russula fuscorubra*, another associate of spruce on calcareous soils has darker and more reticulate spores and broader pileocystidia (8-12µm wide). *Russula punicea* Thiers, is an evenly coloured dark red species found under coastal Sitka spruce in California, it has yellow spores, a white stipe lacking any coloured flushes and spores with similar but slightly lower ornamentation (0.3-0.7µm high) to the above collections. Thiers (1997) reports that *R. punicea* is known from only one collection so the full range of variation within this species may not have been observed. Other acid tasting dark red to purple species that may be found in coastal forests include *Russula mordax* Burl. a reddish brown species, rare in California (Thiers 1997) and considered by Singer to be synonymous with *Russula badia* Quélet. It has clavate to subclavate pileocystidia, spores 8.5-11µm long with isolated spines 0.4-1µm high and heavy ridges (Thiers 1997), and a spore print of Romagnesi IIId-IVa (Romagnesi 1967 for *R. badia*).

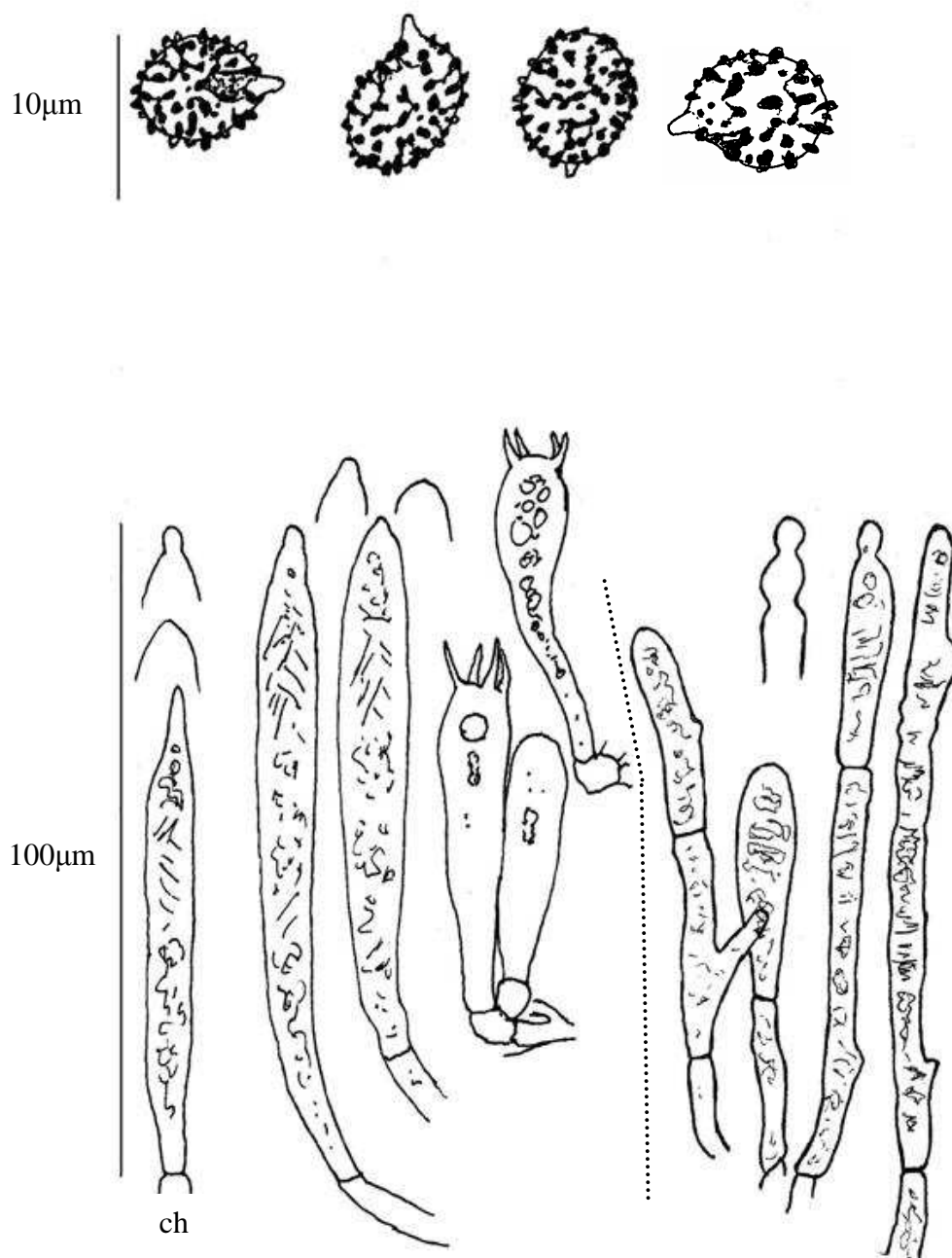


Figure 5. Microscopic characters of *R. cf. fuscorubroides* : Top spores with 10µm scale bar; bottom left, cheilocystidia (ch), pleurocystidia and basidia; bottom right, pileocystidia, lower scale bar is 100µm.



Figure 6. Macroscopic characters of *R. cf. fuscorubroides* : Top, illustrations of a collection from Cape Scott (left) and Bamfield (right), showing profiles of mature and immature basidiomata and a longitudinal section, the squares are 1cm² and show spore print colour; bottom, photograph of mature basidiomata in situ alongside an unpaved road beneath red alder, western hemlock and amabilis fir.

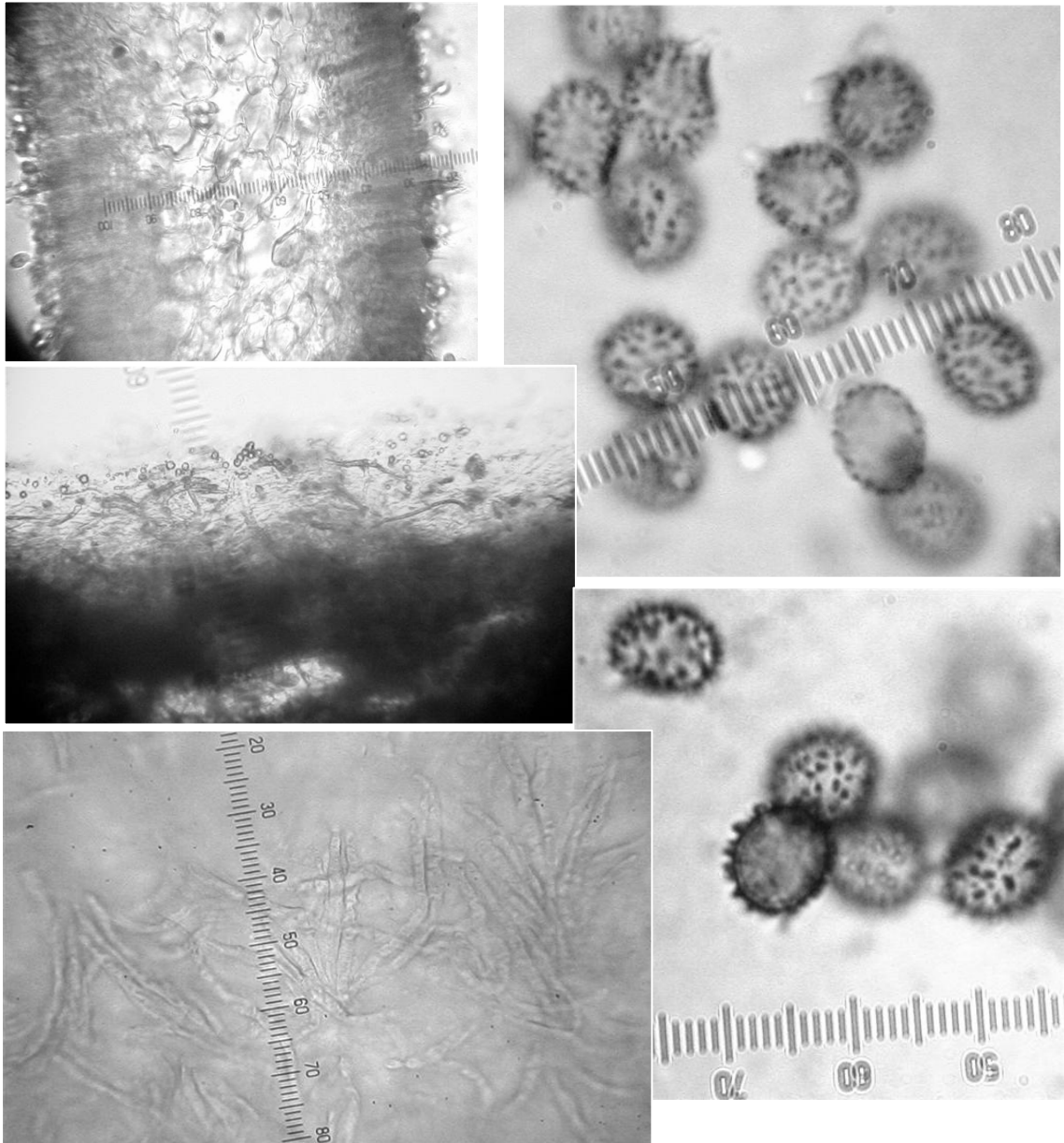


Figure 7. Hymenial and cuticular characters of *R. cf. fuscorubroides*: Top left, section through a gill which shows the lamellar trama of sphaerocytes, 10 scale divisions are 25µm; right, two photographs of spores with 1µm division scale; middle left, section through cutis, 10 scale divisions are 100µm; bottom, surface view of cutis in Melzers' reagent showing pileocystidia and pseudocystidia, 10 scale divisions are 25µm.

***Russula cavipes* Britzelmayer**

Hymenomyceten aus Sudbayern 9:17, 1893.

Description of Vancouver Island collections:

Cap 3.3-10.1cm diameter, convex at first, soon becoming plane with a central depression, at maturity the margins often lobed, wavy and unevenly uplifted, margin smooth, striate in age. Colour deep vinaceous, black over the disc or occasionally yellow-brown, fading quite dramatically to a purplish grey-brown, often with pale olive to yellowish brown patches, eventually becoming pale pinkish-brown, viscid when wet, or drying drying matte to slightly velvety over the disc. Cutis peeling 1/4 to 1/3, cap trama cream, tinted greyish under the cutis, becoming greyish in age but otherwise unchanging where damaged.

Gills pale to deep cream, becoming yellowish, unchanging where bruised, subdistant to close, lamellulae occasional to frequent, and forking common, adnate at stipe, acute at cap margin, ventricose, approximately equal in depth to cap trama at half-radius.

Stipe 3.1-8cm x 0.8-2cm, in general roughly equal in length to cap diameter, cylindrical or more often somewhat clavate, white or with a slight pinkish flush, unchanging or bruising yellow-brown at the base, becoming yellowish to greyish as if waterlogged in age. Surface pruinose, longitudinally finely rugulose, cortex stuffed with a breadly-textured trama which is solid at first but develops irregular cavities and eventually becomes hollow.

Texture firm and not brittle when young, becoming soft and fragile in maturity.

Taste slightly bitter at first, then peppery to acrid and of apple at the same time.

Odour slightly fruity, of stewed apples.

Spore colour pale cream; Romagnesi IIa or slightly paler.

Spores 7.8-11.5 x 6.2-8.6µm, L:W 1.03-1.37, mean (n=30) 1.23, broadly ellipsoidal to obovate, occasionally slightly pyriform. **Ornamentation** of bluntly conical to crestate, sometimes incompletely amyloid, often heavy warts, 0.5-1.1µm high, these often in rows connected by fine to heavy lines, catenate, or forming short ridges, forming a partial reticulum or zebroid pattern, interspersed occasionally with small isolated warts, **Woo types** C2 to C3, and E2 to E3. **Suprahilar patch** an irregular often eccentric amyloid patch bordered by warts, and sometimes containing one or two. **Hiliferous appendix** 1.6-2.6 x 1.3-1.5µm. **Basidia** most 4-spored, some 2-spored, 42-62 x 10-13.6µm, clavate to bulbous in the upper 1/3. Sterigmata 6-10µm long, 1.5-2.3µm wide near the base. **Pleurocystidia** frequent in young basidiomata, sparse in old ones, (as if the basidia multiply as the gills enlarge but not the cystidia), 62-120 x 7-13.6µm, originating in the subhymenium, protruding 15-30µm, narrowly clavate or fusoid, tips acute, subacute or with a small capitatum or short appendix, contents yellowish and refractive in KOH, dark grey to black in SV. **Cheilocystidia** abundant, becoming sparser in age, generally a little shorter than pleurocystidia, around 60 µm, otherwise similar in shape and contents. **Subhymenium** 30-50µm thick, pseudoparenchymatous. **Gill trama** of sphaerocytes, or with occasional vascular hyphae.

Cutis 90-170µm thick, an ixotrichoderm of two layers, with a pink pigment mostly in the epicutis and which appears to be dissolved in the gelatinous matrix. **Subcutis** brownish (in water mounts), about 1/3 the depth of the cutis, of parallel interwoven hyphae 2 -5 µm wide, and many vascular hyphae 5-8 µm wide, which frequently terminate in the epicutis or at the surface in pseudocystidia. **Epicutis** of loosely tangled semi-upright hyaline hyphae 1.5-3.5 wide which may be tortuous and strangulated subapically, with slightly clavate or capitate ends up to 5 µm wide, sometimes with refractive contents, also abundant pileo- and pseudocystidia, embedded in a pink stained gelatinous matrix. **Pileocystidia** frequent to abundant, 40-100 x 3-9µm, most around 6 µm wide, cylindrical to clavate, 0-2 -septate, tips obtuse or capitate, in age forked tips are quite common, contents refractive, light grey to black in SV, the reaction stronger in mature and aged basidiomata. **Pseudocystidia** abundant, sometimes more frequent than pileocystidia, arising from the subcutis, most around 6 µm wide, septate, shape and contents similar to

pileocystidia. **Hypodermis** compactly interwoven and including small flattened sphaerocytes and numerous vascular hyphae, the basal layers of the subcutis are interwoven with the upper layers of the trama near the cap centre, so the division between the two tissues is not abrupt.

Trama of discrete clusters of sphaerocytes bound by a hyphal mesh and frequent vascular hyphae, 5-7µm wide.

Chemical reactions: FeSO₄ salmon pink; KOH bright red to red-brown on cap cutis, pink to red on stipe trama; NaOH₄ - pink to red on stipe trama; phenol - brownish; guaiac - blue-green; SV- red to magenta initially, quickly turning grey-brown on gill, brown on cutis, grey to black on all cystidia and vascular hyphae.

Habitat and tree associations: on ground under mature Douglas fir, grand fir and western red cedar in moist streamside soil.

Collections: CR001102-01, CR001102-03, CR011015-01, CR021201-01, all from the same area in moist bottomlands by the river Millstream, under mature Douglas fir and western red cedar with understory western hemlock and an old-growth grand fir (*Abies grandis*) about 20m away, N48.452433°, W123.48382°.

ITS1-F to

| Collection | ITS4-B | RFLP: HinfI | AluI | Sau3A |
|--------------|--------|-------------|----------|----------|
| CR 021201-01 | 857 | 391, 354 | 491, 295 | 349, 260 |

Notes: The Vancouver Island collections of *Russula cavipes* are distinguished from similarly coloured species such as *R. gracilis*, *R. pelargonica*, *R. queletii*, *R. torulosa* and *R. fuscorubrioides* by the pink to red reaction of the flesh of mature basidiomata with alkaline solutions particularly ammonia (household ammonia). The only other species with this reaction as far as is known is *Russula sardonica*, which prefers sandy soils with pine, has lemon yellow tints in the gills and flesh, a coloured stipe, lower spore ornamentation (up to 0.5µm) and slightly narrower cuticular cystidia. Occasionally, immature individuals of *R. queletii* also show this red reaction in dry weather. The above

collections of *R. cavipes* match descriptions given for European material (Romagnesi 1967, Sarnari 1998), with three exceptions: the guaiac reaction should be null or weak, not blue-green, the spores, which are more crestate to zebroid, and the pileal cystidia, which, at a maximum of 9µm, are narrower than the 6-11µm of European material. These exceptions bring the collections closer to the descriptions of *R. sardonica*, and the Vancouver Island material appears to be intermediate between these two species.

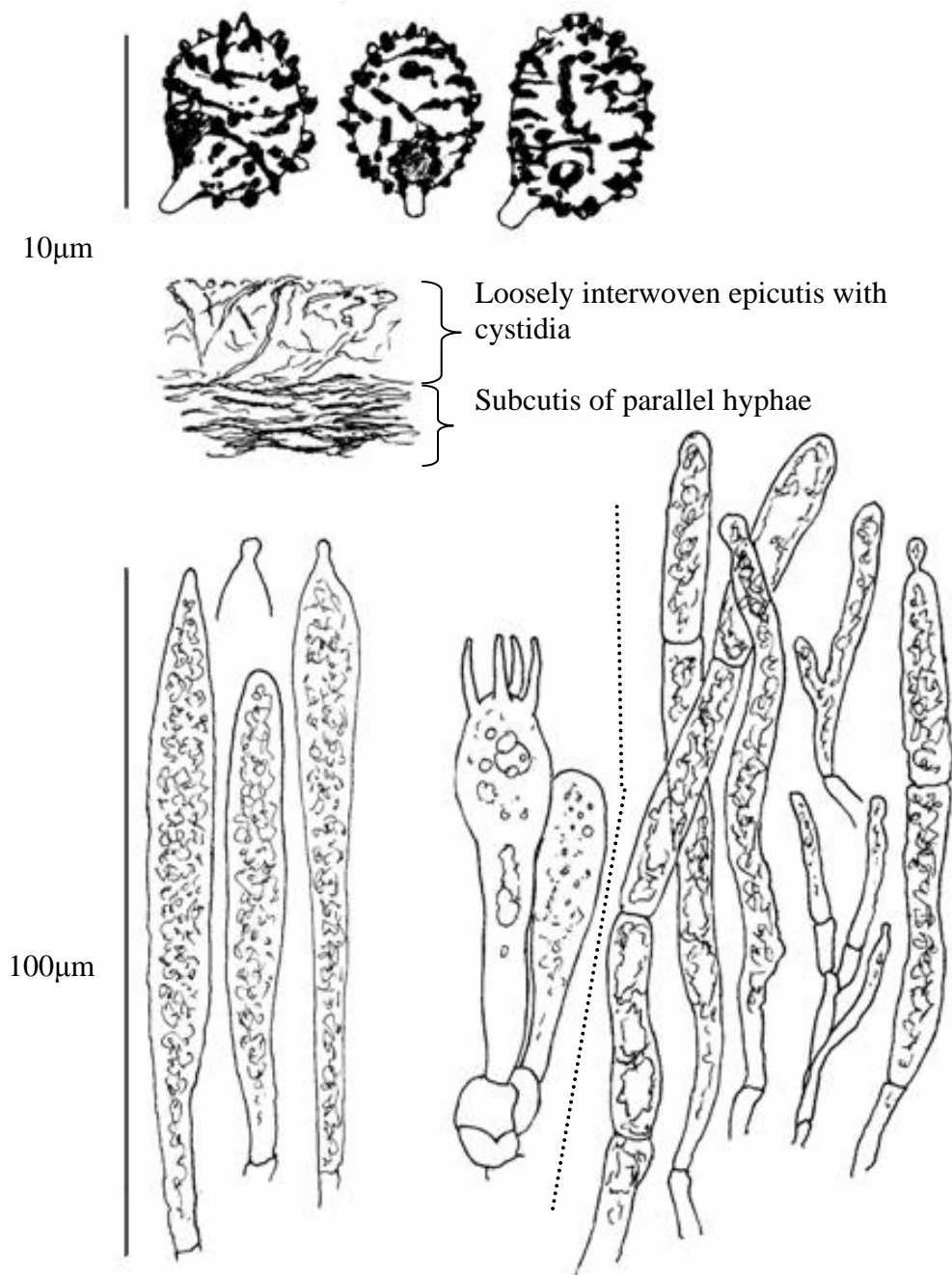


Figure 107. Microscopic characters of *R. cavipes* : Top, spores with 10µm scale bar; middle, diagram of section through cutis; bottom left, hyphenal cystidia and basidium; bottom right, pseudocystidia, pileocystidia and hyphal ends from the epicutis, lower scale bar is 100µm.

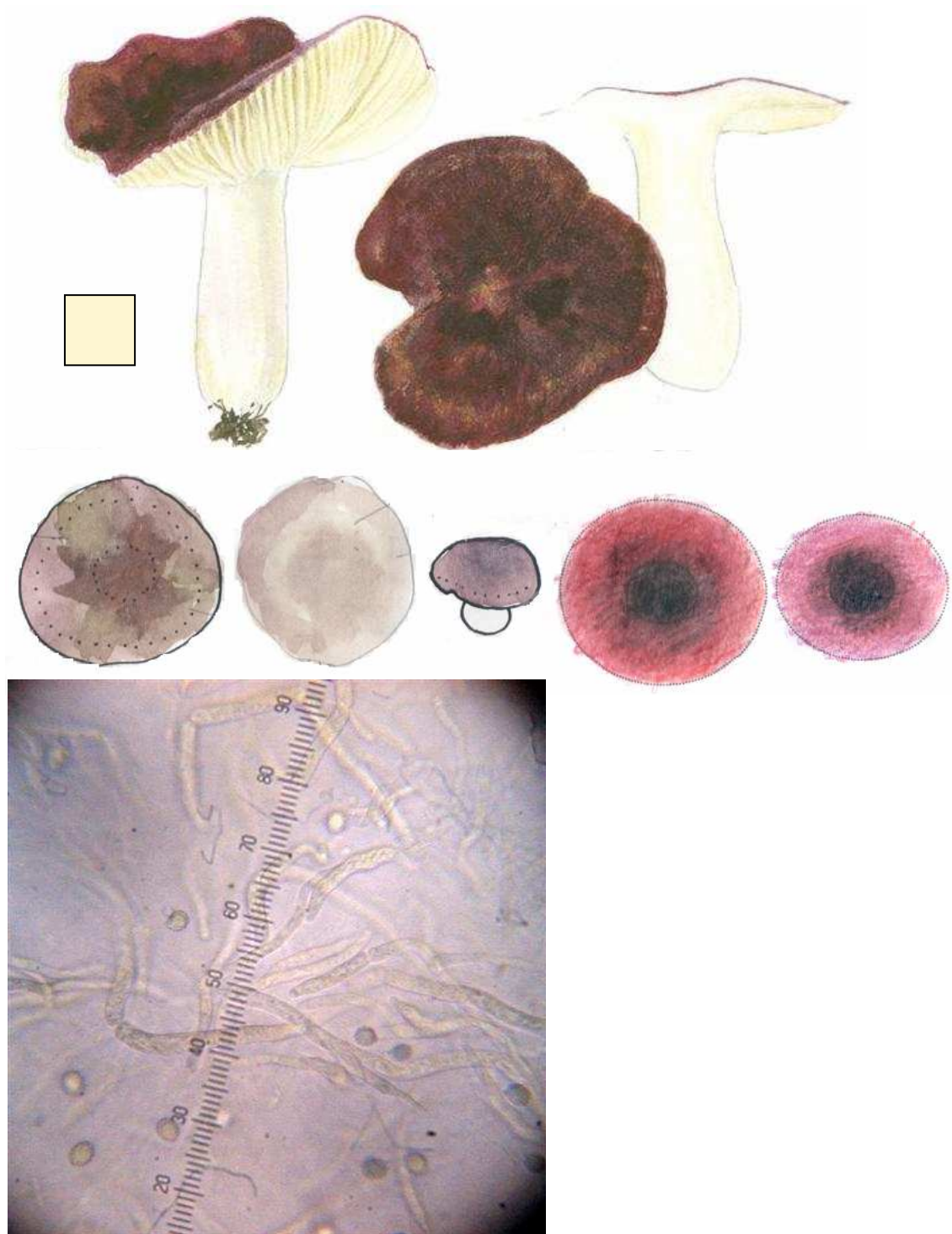


Figure 108. Macroscopic and cuticular characters of *R. cavipes*: Top, illustration of early mature basidiomata in profile and longitudinal section, with 1cm² square showing spore colour; middle, a row of cap colour notations from field data sheets of various stages of maturity; bottom, surface view of the epicutis in NH₄OH showing pileocystidia, ten scale divisions are 25µm.

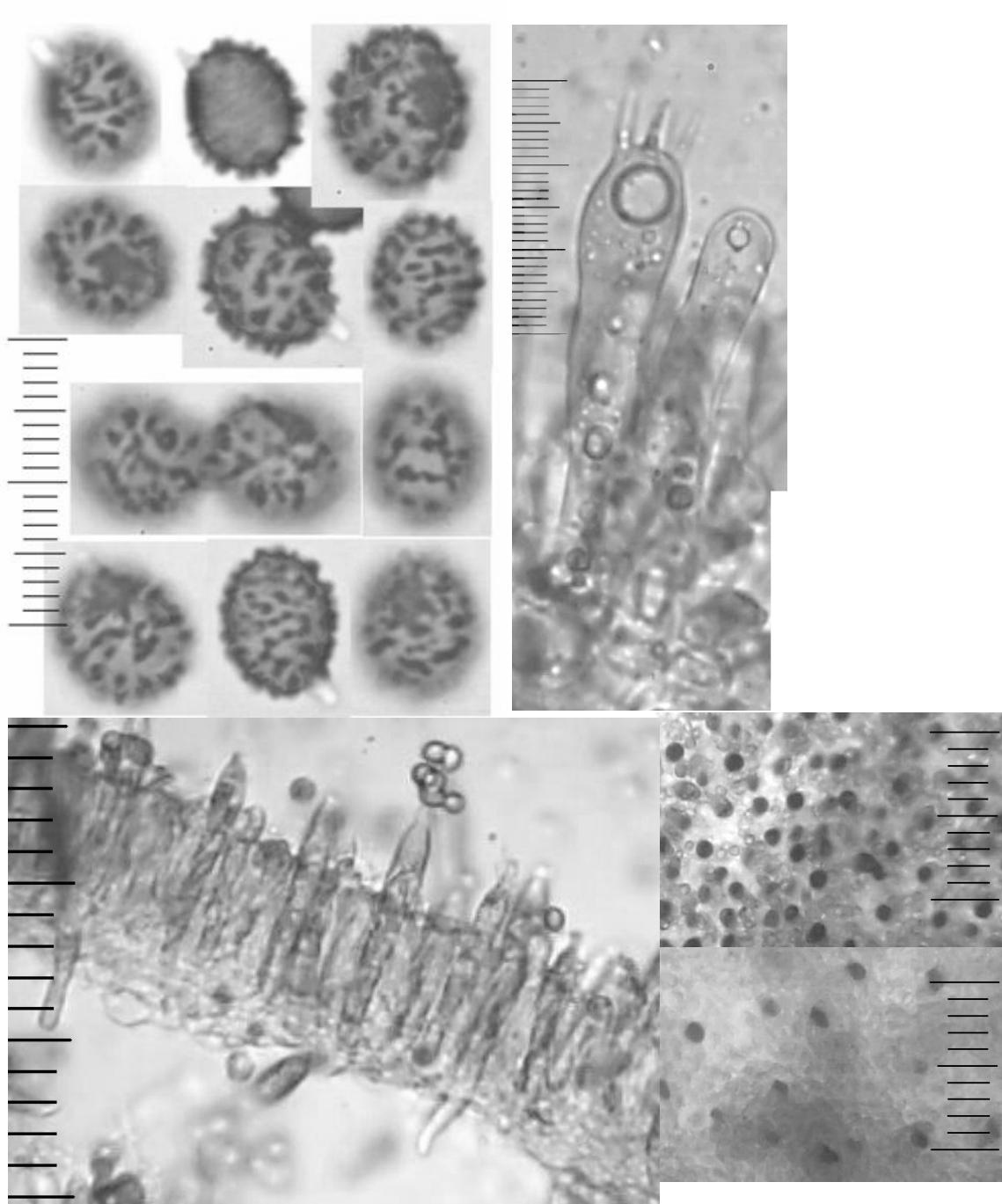


Figure 109. Hymenial characters of *R. cavipes*: Top left, spores and top right, basidia, both with 1µm division scales; bottom left, section through hymenium showing pleurocystidia, scale is in 10µm divisions; bottom right, paired photograph of surface of gill stained in SV showing a denser distribution of cystidia (dark spots) in a young basidioma (upper) than in an old one (lower), scale is in 10µm divisions.

Table 1. Comparison of principle differential characters of the purple capped *Sardoninae*.
Information derived from Bon (1988), Romagnesi, (1967) and Sarnari (1998).

| Species | Spores (μm) | Spore type, colour | Pileocystidia tip -shape, width, septation | Habitat: soil type, host | NH ₄ | Other |
|--------------------------|-----------------------------|-----------------------------|------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------|---------------------------------------------|
| <i>R. torulosa</i> | 8-9 6-8 | x BC2-D1 IIId-IIIa | Strangulate- nodulose, 4-8.5 μm , \pm aseptate | Sandy, calcareous or basaltic <i>Pinus</i> (<i>Picea</i>) | - ve | Firm, stipe short, coloured. |
| <i>R. fuscorubra</i> | 7.7-9 6.5-7.5 | x C2 IIIb-c | Obtuse, 8-12 μm , 0-1 septate | Calcareous <i>Picea</i> | - ve | Firm, stipe coloured |
| <i>R. fuscorubriodes</i> | 8-9.5 6.5-8 | x B2 (B3,C2) IIId | Obtuse 6-8 (10) μm 0-3 septate | Acid <i>Picea</i> \pm <i>Vaccinium</i> | - ve | Firm, stipe coloured |
| <i>R. queletii</i> | 7.3 -10 6.7-9 | x A2-3 IIc-d | \pm Capitate 5-8 or 12- 14 μm 0-1 septate | Calcareous <i>Picea</i> | - ve | Fragile, stipe coloured |
| <i>R. sardonina</i> | 7-9 5.8-7.6 | x C2-D2 IIIa | \pm Capitate 4-6 μm , 0-3 septate | Sandy <i>Pinus</i> | pink | Firm, stipe coloured, gills yellow |
| <i>R. cavipes</i> | 7.2-9.5 6.5-8 | x C2-3 IIa | Capitate or obtuse 6-11 μm \pm aseptate | Moist <i>Abies</i> , (<i>Picea</i>) | pink | Fragile, stipe white \pm pink flush |

| Species | Spores (μm) | Spore type, colour | Pileocystidia tip -shape, width, septation | Habitat: soil type, host | NH ₄ | Other |
|----------------------------------------------|-----------------------------|--------------------------|-------------------------------------------------------------------------|-------------------------------------------------|-----------------|--------------------------------------------------|
| <i>R. violacea</i> (<i>Violaceinae</i>) | 7.5-8.2 x 6.2-7.2 | A2-B2 IIa-b | Obtuse \pm clavate, 5-12 μm , 0-3 septate | <i>Populus</i> , <i>Betula</i> , conifers | - ve | Small, fragile, stipe white, menthol odour |

Observations in brackets are uncommon. Spore types refer to Woo codes, spore colours to those of Romagnesi (1967).

Clade 6

Subsection *Violaceinae* (Romagn.) Sarnari

Russula pelargonia Niole

Annals Mycologici. 39:66. 1941

Description of Vancouver Island collections:

Cap 4-4.8cm diameter, almost hemispherical when young, becoming more or less plane with a depressed centre and rounded, smooth margins that become striate in age. Colour is slightly greyish purple to pinkish-brown, approaching dull violet at the margins or with tints of brown, dark brownish red centrally. Viscid, drying matte to subglossy, peeling about 1/3, flesh white, unchanging, to pinkish under the cuticle.

Gills pale cream, unchanging where bruised, subdistant, subgills and forking rare, adnate or sometimes slightly decurrent at stipe, obtuse and broadest at cap margin, about equal in depth to the cap trama at half-radius, pliable.

Stipe 5.4-7.5cm x 1.1-2.0cm, generally longer than cap diameter, white with a flush of pink, longitudinally rugulose, unchanging where damaged but developing yellow-brown stains at the base, and becoming greyish as if waterlogged in age, stuffed with a bread-textured trama that develops several irregularly shaped cavities along its length, eventually becoming hollow.

Texture slightly firmer than average.

Taste slowly peppery, not very intense.

Odour of cooked apple or plums or of *Pelargonium* (geraniums), according to individual (human) sensitivity.

Spore colour pale cream, Romagnesi IIa or slightly lighter (but darker than 1b).

Spores 6.6-8.8 x 5.7-7.1µm, L:W 1.08-1.4 with a mean of 1.23 (n=30), ellipsoidal, occasionally subglobose. **Ornamentation** of low conical warts generally below 0.6µm high, connected by fine to heavy lines, forming a partial reticulum, the heavy connections often linking rows of warts in latitudinal bands. **Woo types** C1-2 to D1-2. **Suprahilar patch** weakly to patchily amyloid, irregular, sometimes bordered by warts, on some spores scarcely different from the rest of the spore surface. **Hiliferous appendix** 1.2-1.4µm long, 0.9-1.1µm wide at base. **Basidia** 4-spored, rarely 2-spored, 32-43 x 8.4-10.5µm, clavate to almost fusoid, tapering gradually from the widest part. Sterigmata 5-7µm long and 1.3-1.9µm wide at the base. **Pleurocystidia** frequent, 7-12 x 50-100µm originating in the subhymenium or outer trama, protruding 20-30µm, fusoid, occasionally cylindrical, tips subacute or frequently bottle-shaped to capitate, sometimes with a short, broad, wavy extension, contents yellowish and refractive in KOH, purple in SV and often banded or crumpled in appearance. **Cheilocystidia** numerous, protruding around 25-40µm, often more cylindrical than fusoid, ends obtuse or subacute. **Subhymenium** 20-30µm thick, interwoven. **Gill trama** scarcely differentiated from subhymenium, of compact cells and hyphae with vascular hyphae.

Cutis 150-180µm thick on disc, an ixotrichoderm of two layers. **Subcutis** of tightly interwoven parallel pinkish-brown hyphae 2-5µm wide, with numerous vascular hyphae that give rise to pseudocystidia, which terminate at any level between the subcutis and the epicutis. **Epicutis** around 2/3 the thickness of the cutis, of tangled, semi-upright hyaline hyphae 2-3µm wide with undifferentiated tips, or often with the end cell or two with refractive contents, all embedded in a gelatinous matrix. The whole epicutis is permeated with pseudocystidia and the upper 1/3 with pileocystidia that often lie along the surface. **Pileocystidia** abundant, originating in the epicutis, 25-150 x 3-6µm, 0-3-septate, cylindrical to clavate, the majority capitate, sometimes diverticulate or with irregularly shaped short outgrowths, contents refractive and greying in SV. **Pseudocystidia** frequent, regularly septate, sometimes about every 30-50µm, others more distant, with contents and

termini similar to those of pileocystidia. **Hypodermis** interwoven and incorporating flattened sphaerocytes and a network of vascular hyphae, interwoven with the subcutis.

Trama of discrete clusters of sphaerocytes bound by a hyphal mesh and numerous vascular hyphae.

Chemical reactions: FeSO₄ - barely reacting; KOH - orange-pink on cap surface, no reaction on stipe; NH₄OH - no reaction; phenol -brownish; SV - reddish brown on the gills and cutis, cystidia and vascular hyphae grey or purple, not always strongly staining.

Habitat and tree associations: Under Douglas fir on a limestone slope.

Collections: CR981114-02 with Douglas fir and salal on limestone bluffs north of Koksilah river, N48.6539°, W123.7302°.

| ITS1-F to | | | | |
|-------------|--------|-------------|----------|---------------|
| Collection | ITS4-B | RFLP: Hinf1 | Alu1 | Sau3A |
| CR981114-02 | 865 | 382, 329 | 510, 305 | 368, 294, 154 |

Notes: This Vancouver Island collection of *R. pelargonia* is comparable with collections from Metaline Falls area, Washington State, with the exception that the latter reach up to 8cm diameter (Woo 1997).

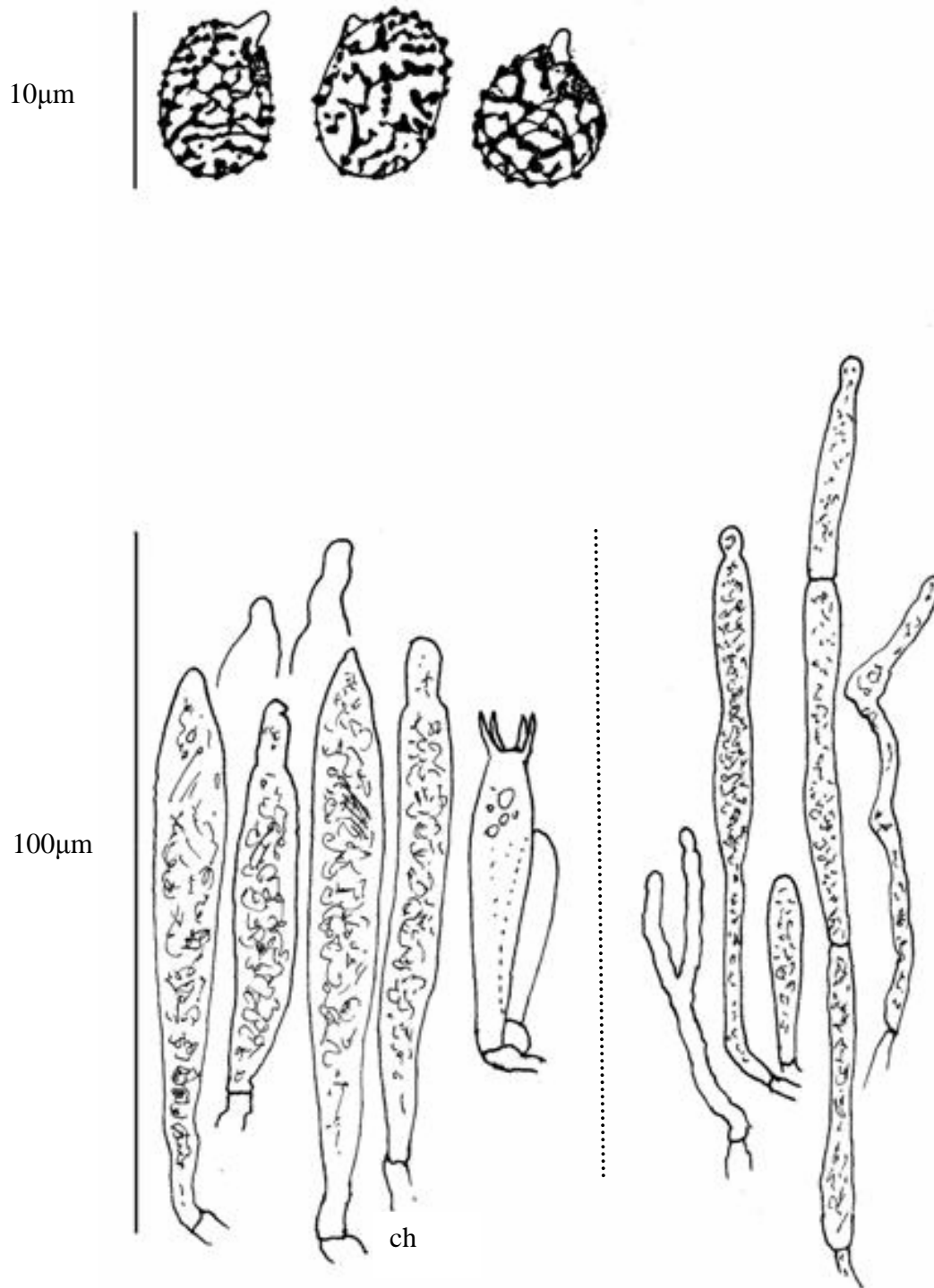


Figure 110. Microscopic characters of *Russula pelargonia*: Top, spores with 10µm scale bar; bottom left, three pleurocystidia, a cheilocystidia (ch) and a basidium; bottom right, hyphal ends, pileocystidia and a pseudocystidium from the epicutis, lower scale bar is 100µm.

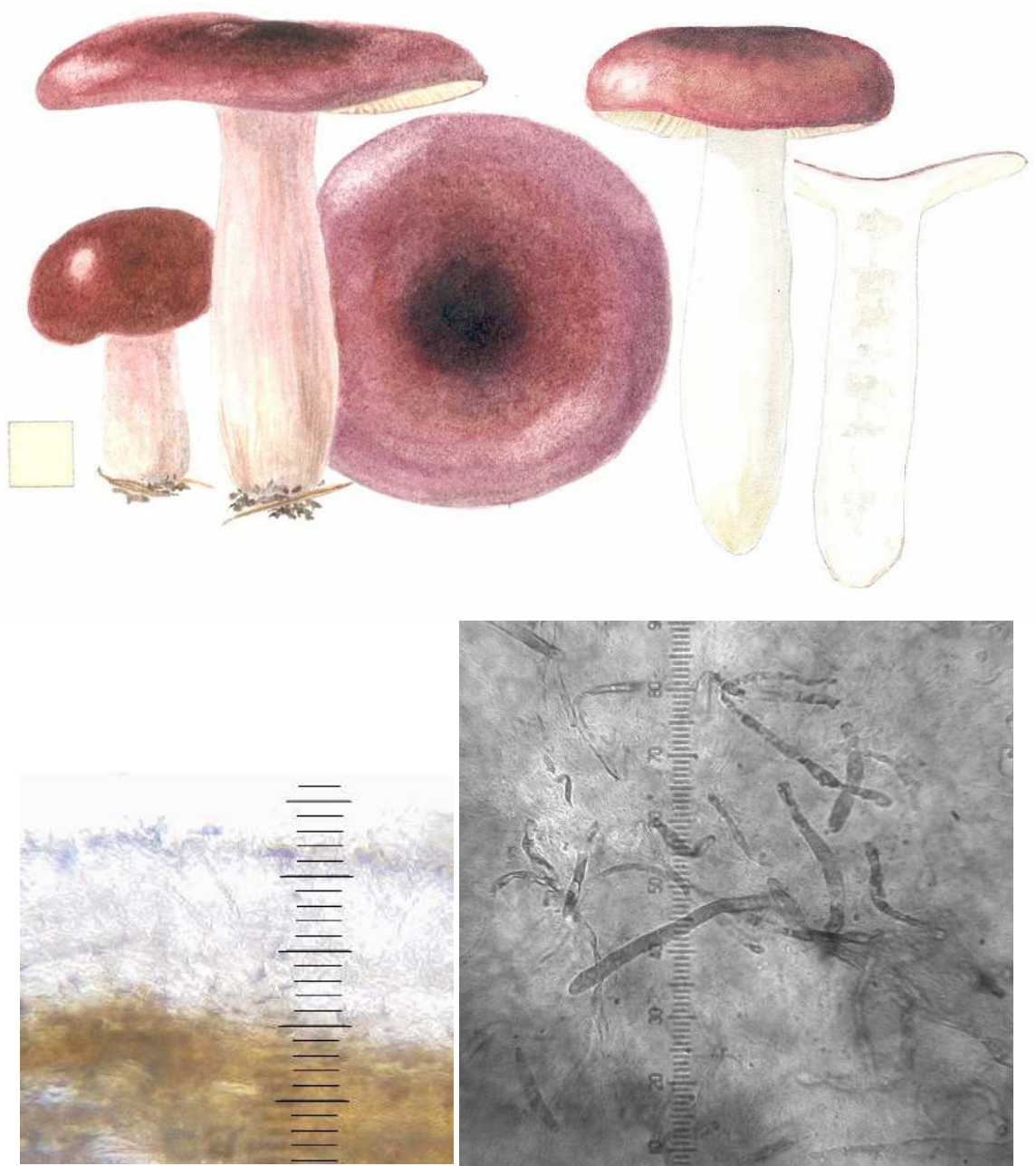


Figure 2. Macroscopic and cuticular characters of *R. pelargonia*: Top, illustrations of young and mature basidiomata, the three on the left are of a collection from Washington State, the other, including the longitudinal section, is from Vancouver Island, the square is 1cm² and shows spore print colour; bottom left, section through cutis, 10 scale divisions are 100µm; bottom right, pileocystidia on the surface of the cutis, stained with SV, 10 scale divisions are 25µm.



Figure 3. Characters of the hymenium of *R. pelargonica*: Top left, fragment of the hymenium with basidia and basidioles, scale bar is 10µm; top right, spores, the leftmost two photographs are of the same group of spores at two depths of focus, the scale is in 1µm divisions; bottom left, cheilocystidia on the gill margin, scale is in 10µm divisions; bottom right, a pleurocystidia stained in SV which shows the banded cell contents, scale bar is 10µm.

Subsection *Sardoninae*

Series *Sanguinea*

Russula sanguinaria (Schumach.) Rauschert

Česká Mykol. 43(4): 204. 1989

Basionym *Agaricus sanguinarius* Schumach., *Enum. pl.* (Kjbenhavn) 2: 244. 1803

synonyms: *Russula rosacea* (Pers.*ex* Secr.) S.F. Gray em.Fries,

Russula sanguinea (Bull.) Fries Epicr. Myc. 351. 1838

Description of Vancouver Island and Saturna Island collections:

Cap 2.7-12.2cm diameter, convex when young, usually with a small central indentation, becoming plane to shallowly centrally depressed but long retaining a downturned (but not inrolled), smooth margin, often irregular in diameter to almost lobed and with some parts of the cap upturned while others are flat or downturned. Surface bright carmine red, more intense over the disc, sometimes with paler or white to cream areas especially near the margin, slightly viscid, soon drying matte, margin smooth until old or dry. Cutis not peeling or only at the very margin, flesh beneath pink, otherwise white, unchanging to becoming slightly yellow or greyish when damaged.

Gills white at first, becoming a warm deep cream at maturity, bruising yellow, close to subdistant, with occasional lamellulae and occasional to frequent forking throughout the radius, adnate to narrowly decurrent at stipe, arched, shallow, half to equal the depth of the trama at mid-radius, subacute to obtuse at cap margin with the edge of the cap curving down as far as the gill lower edge in parts.

Stipe 2.3 to 7.4cm by 0.8 to 2.4cm, \pm cylindrical or broadening slightly towards the base, solid, with firm unchanging or lightly greying trama, surface white or more often flushed partly or entirely with pink, paler than the cap, pruinose, bruising bright yellow which turns to dull brownish yellow.

Texture Quite firm.

Taste slightly bitter then peppery to acrid.

Odour varied, in some collections not distinctive, in others fruity, of apples or plums and vanilla.

Spore colour between a deep cream and pale orange, Romagnesi IIIa.

Spores broadly ellipsoidal to obovoid, sometimes broadly tear-drop shaped, 6.6-8.5 (-8.9) x (5.2-)5.7-7.5µm, L:W = 1.03-1.41, mean 1.21 (n=40). **Ornamentation** of warts mostly 0.4-0.7µm high, convex to bluntly conical, isolated or in short chains with a few heavy connectives, not forming a reticulum, Woo B2, occasionally C2. **Suprahilar patch** amyloid, in Melzer's reagent, a small light grey irregular patch bordered by small warts. **Basidia** 4-spored, approximately 36-44µm long by 10-11µm wide, clavate to slightly bulbous in upper third, often relatively slender, sterigmata 4-10µm long, around 2µm wide near the base. **Pleurocystidia** abundant and sometimes densely distributed, 63-100µm by 6.3-14µm wide, arising from the subhymenium or occasionally the trama, protruding about 18 to 30µm, cylindrical to fusoid with subacute to acute apices, occasionally mucronate or with a small capitum, contents sometimes banded, in KOH filled with yellow globular contents, almost black in SV. **Cheilocystidia** frequent, often forming a fringe along the gill edge, 33-70µm by 5-7.5µm wide, protruding up to 42µm beyond basidioles, similar in shape to pleurocystidia. **Subhymenium** about 15-20µm thick, interwoven to pseudoparenchymatous, hyphae around 3µm in diameter, gill trama of sphaerocytes with many vascular hyphae.

Cutis 80-250µm thick, a gelatinised ixodermis of two layers. **Subcutis** of repent, interwoven hyphae 1-3.5µm wide, appearing red in SV and water, the colour quickly dispersing into water mounts, and with many vascular hyphae that are dark grey in SV. **Epicutis** of repent, interwoven, hyaline hyphae with a few free undifferentiated ends and many pileocystidia and pseudocystidia. **Pileocystidia** frequent but sometimes patchily distributed, 57-120µm by 5-10µm wide, cylindrical, sometimes diverticulate, tips obtuse

or occasionally capitate, mostly non-septate, with strikingly banded contents weakly to strongly staining in SV. **Pseudocystidia** abundant, ranging from 4-11 μm wide but most 5-7 μm wide, sometimes branched near terminus, ends blunt, tapering or with a small capitum, strongly refractive in KOH and with banded or bubbled contents in SV.

Trama of sphaerocytes in loosely defined clusters with many SV+ vascular hyphae.

Chemical reactions: FeSO_4 - salmon pink; KOH - turns both cap and coloured parts of stipe orange, NH_4OH - no reaction on cap, slightly grey on stipe flesh; Guaiac - quickly blue-green; phenol - immediately bright pink, becoming brown; SV - gills dark purple-grey, cutis pink-grey.

Habitat and tree associations: In three collections, associated with *Pinus contorta* in either a dry or boggy area, with or without western hemlock and Douglas fir, the Saturna Island collection from East Point park with Douglas fir, *Pinus* not seen.

Collections: OC 981031-GL1, under shore pine, western hemlock and western red cedar, near Glintz Lake, Sooke area, exact location not recorded, this collection is a much deeper red (dark blood red) than the others but is otherwise the same. PJ 981124-03 along the side of the road under mature *Pinus contorta*, Douglas fir, western red cedar and western hemlock, Cliffside Road, Saturna Island, N 48.780706°, W 123.05717°.

PJ981130-3a from scrubby regrowth with Douglas fir near the lighthouse, other conifers across the road, East Point Park, Saturna Island, N 48.780712°, W 123.04574°.

CR011111-01 on ground beneath a stand of *Pinus contorta* (shore pine) adjacent to the parking lot, Royal Roads University, N 48.436667°, W 123.474583°. OC031010-01 on ground near shore pine Rithet's Bog, Victoria, N 48.4895°, W 123.3815°.

ITS1-F to

| Collection | ITS4-B | RFLP: Hinf1 | Alu1 | Sau3A |
|-------------|--------|-------------|----------|---------------|
| PJ981124-03 | 839 | 404, 364 | 482, 300 | 337, 254, 225 |
| CR030110-01 | 853 | 392, 354 | 471, 263 | 277, 196 |

Notes: *Russula sanguinaria* (as *R. sanguinea* or *R. rosacea*) has been fully described from both Europe and North America (Singer 1957, Hesler 1961, Bills and Miller 1984,

Romagnesi 1967, Sarnari 1998). Grund (1979) distinguished a variety, *R. rosaceae* var *macropseudocystidia*, from Washington State in which the hymenial cystidia were in the same size range as this Vancouver Island collection, but it differs from this collection in its polished cutis, which may be environmentally affected. Bills and Miller's description fits well with the Vancouver Island material, including the larger sized pleurocystidia (up to 160µm long), except local collections have slightly larger spores and shorter basidia. Singer (1938) described a similar species: *Russula americana* from the Olympic peninsula, that has larger spores, (9-11 x 8.2-9.5µm) than *Russula sanguinaria*, and a habitat with *Abies* and *Tsuga* species rather than *Pinus* (but see notes under the description of Vancouver Island collections of *R. americana* var. *modicaspora* nom prov.). One of the Saturna Island collections had no mention of shore pine in the habitat description, but it does not differ from the other three collections in spore size or other characters, and is not likely to be *Russula americana*. Vancouver Island collections also agree well with Romagnesi's (1967) description of European material. *Russula sanguinaria* is a very distinctive mushroom with its vivid red dry cap, pink to red stipe with yellow staining at the base, firm flesh and habitat usually with pines.

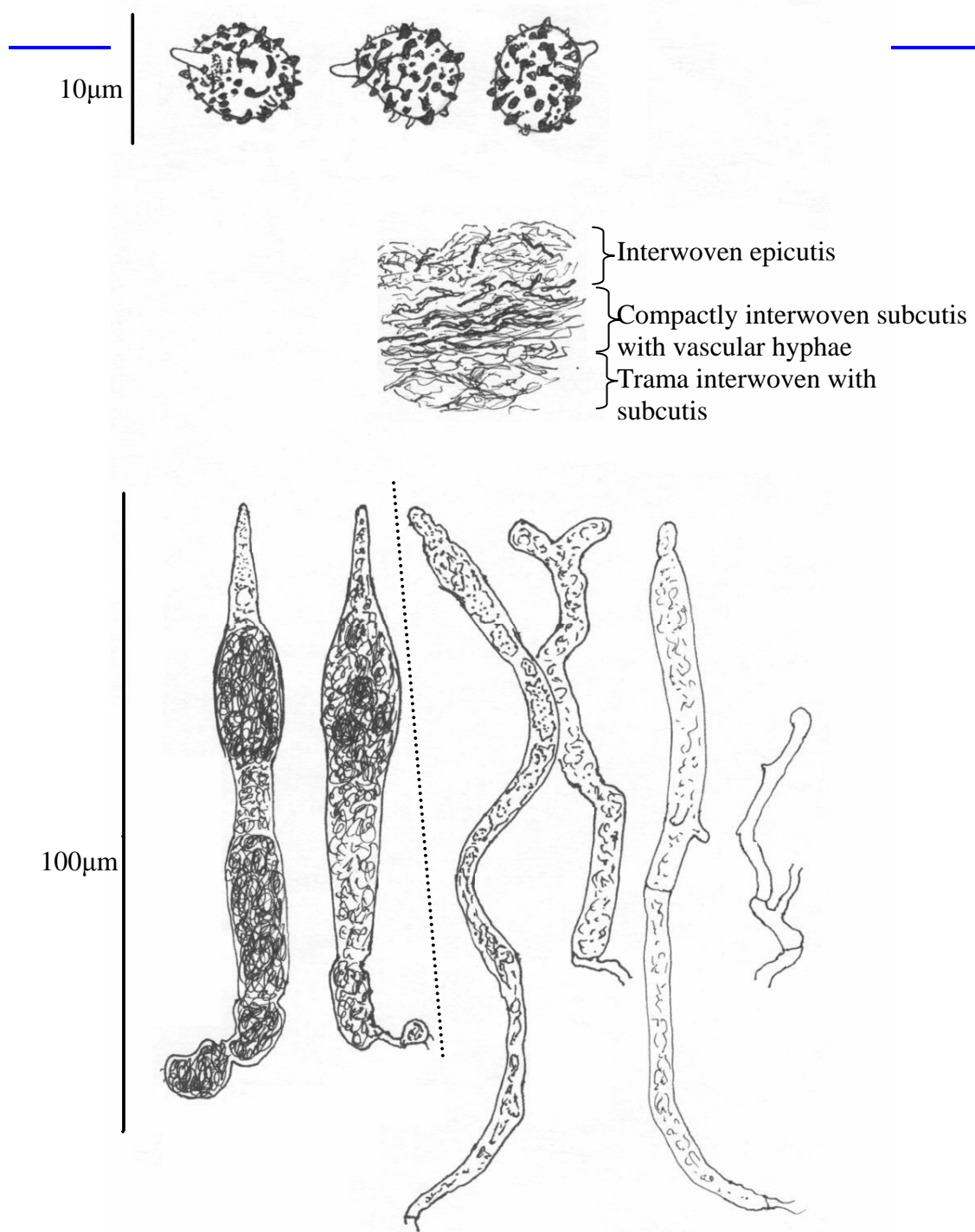


Figure 111. Microscopic characters of *Russula sanguinaria*: Top, spores with 10µm scale bar; bottom left, hymenial cystidia (in SV); bottom right, pileocystidia and epicutal hyphal ends, lower scale bar is 100µm.



Figure 112. Macroscopic characters of *R. sanguinaria* : Top, in situ under shore pine; below, collection made under pine in Rithet's Bog, Victoria, the grid is in 1cm² squares, inset square shows spore print colour. Note the yellow bruising reaction on the stipes of several basidiomata.

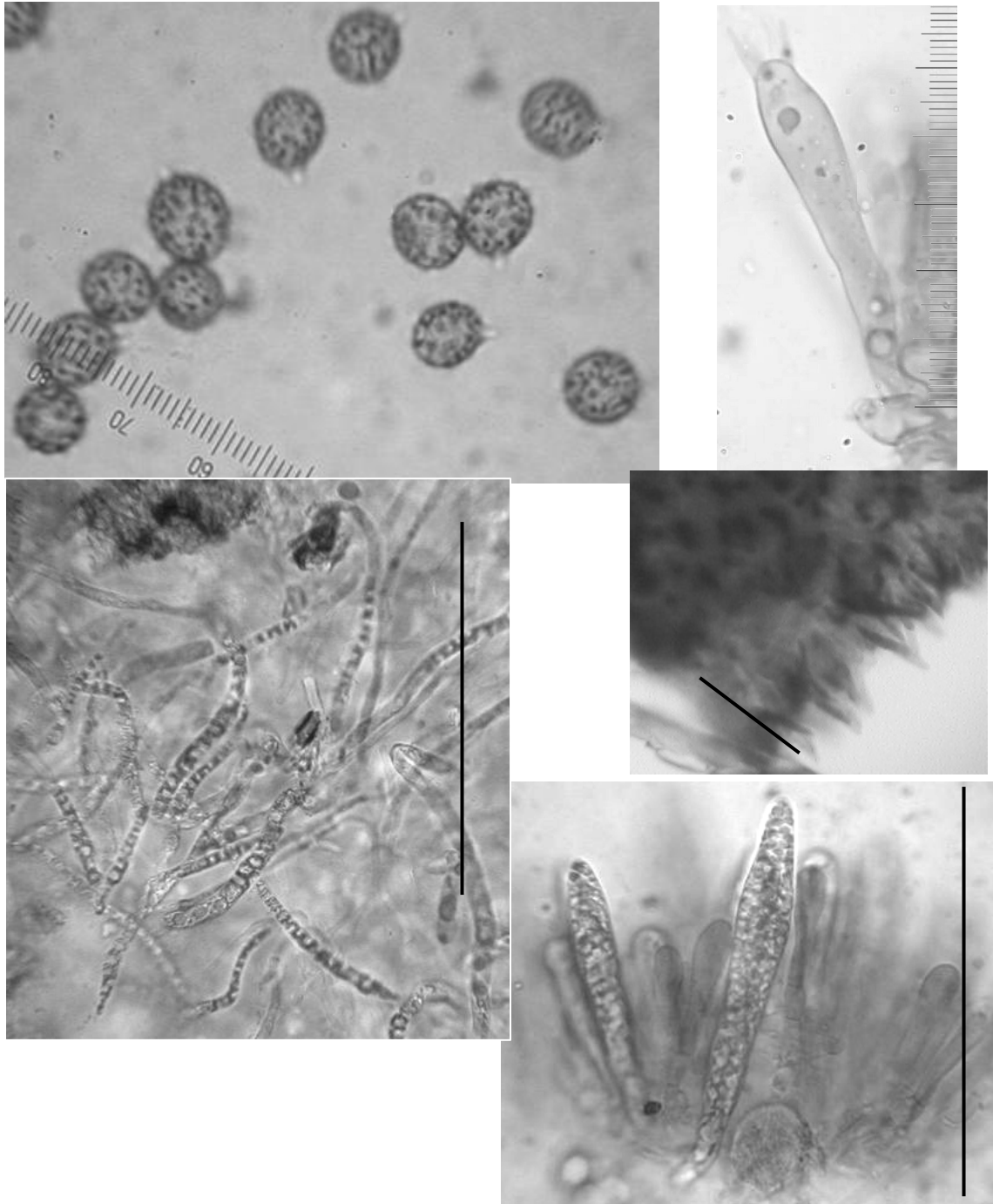


Figure 113. Hymenial and cuticular characters of *R. sanguinaria*: Top left, spores with 1µm division scale; top right, basidia with 1µm division scale; middle right, edge of gill showing cheilocystidia in SV with 100µm scale bar; bottom right, pleurocystidia in KOH showing the refractive globular contents, basidioles are also visible, scale bar is 90µm; bottom left, surface view of cutis in KOH showing the banded contents of pileocystidia, scale bar is 100µm.

***Russula americana* var. *modicaspora* nom. prov.**

Basionym: *Russula americana* (Singer) Singer

Bull. Soc. Mycol. France 55: 264. 1939.

Description of Vancouver Island collections:

Cap 1.8cm to 5.6cm diameter, convex with a flattish umbo when young, becoming plane to shallowly depressed but retaining a small umbo, margins remaining somewhat curved until quite mature, eventually uplifted, smooth at first but developing striations at maturity. Surface bright scarlet red, a little darker over the disc when young and sometimes fading centrally to a pinkish yellow, but usually a fairly even red, viscid, drying glossy. Cutis peeling from less than 1/4 up to 1/2, flesh beneath pink, trama white, unchanging when damaged.

Gills white at first, becoming a pale cream to deep cream at maturity, sometimes developing brownish bruising, generally subdistant, sometimes close, rarely forked or with lamellulae, adnate to narrowly adnexed at the stipe, subacute to rounded at the margin, ventricose to broadening outwards, at least equal in depth to the trama at half-radius, in mature basidiomata more than twice the depth. In mature basidiomata the gills appear quite broad when the cap margins are uplifted.

Stipe 3 to 8.5cm by 0.7 to 2.5cm, usually longer than cap diameter, fusoid to clavate, stuffed with a bread-textured trama that soon develops a series of 6-8 cavities that are more irregular in shape than lenticular, eventually becoming hollow. Stipe surface flushed with pink to red, paler than the cap, usually only the base white, slightly pruinose at the apex, somewhat rugulose, bruising brown at the base but unchanging to lightly greying in the rind when cut, developing a greyish waterlogged appearance in age.

Texture about average for *Russula*, not as hard and firm as *R. sanguinaria*, softer, but more pliable than fragile.

Taste often bitter at first then peppery to acrid, gills more acrid.

Odour not distinctive or slightly fruity, sometimes with flowery or nutty components, in several older basidiomata faintly like dental disinfectant (thymol), in one collection rather like ladybird beetles (*Coccinellidae*).

Spore colour variable in shade between collections, light to mid buff rather than deep cream or yellow, Kibby and Fatto (1990) shade C to E, Romagnesi IIIa to IIIb or occasionally as light as IId but with less yellow and more pink.

Spores 7-9.5 x 6-7.5µm, L:W = 1.03 to 1.38, mean 1.19 (n=61), subglobose to broadly ellipsoidal. **Ornamentation** of mostly isolated conical to peg-like warts 0.2 -1.0µm high, occasionally to 1.2µm, occasionally 2-3 warts catenate and forming a short ridge, occasionally with fine lines joining 2-3 warts, not forming a reticulum, Woo B2-B3.

Suprahilar patch an irregular amyloid patch, sometimes relatively small, bordered by small warts. **Basidia** 4-spored, approximately 28-48µm long by 9-11µm wide, clavate to slightly bulbous in upper third. Sterigmata slender, 5-9µm long, around 1-1.5µm wide near the base. **Pleurocystidia** frequent, 37-100 x 5-14µm, occasionally to 18µm wide, arising from the subhymenium, protruding about 18-30µm, fusoid, mostly with acute apices, occasionally mucronate or with a small capitum, or an apical exudate, filled with yellow refractive contents, sometimes banded or with bubbles, black in SV.

Cheilocystidia frequent to sparse, sometimes forming a fringe along the gill edge, other times embedded, 50-87 x 8-12.5µm, protruding up to 35µm beyond basidioles, similar in shape to pleurocystidia. **Subhymenium** about 12-25µm thick, in parts appearing interwoven, in others pseudoparenchymatous, in parts with an interwoven layer below a cellular layer, gill trama of fairly spherical sphaerocytes about 20-40µm diameter, interspersed with many vascular hyphae.

Cutis 120-220µm thick, a gelatinised ixotrichodermis of two layers. **Subcutis** 40-110µm thick, of tightly interwoven parallel hyphae appearing brownish red in water, with many vascular hyphae 5-8µm wide with yellowish refractive contents, dark grey in SV.

Epicutis up to 120µm thick, of tangled, fairly densely packed upright to semi-repent hyphal ends 2 -5µm wide, and pileocystidia and pseudocystidia, embedded in a gelatinous matrix, the whole of which is pink in water mounts from the release of red

pigment, the origin of which is hard to determine. **Pileocystidia** patchily distributed, more frequent on younger basidiomata, 48-130µm by 5-8µm wide, commonly narrowly clavate, sometimes cylindrical, occasionally diverticulate, tips obtuse or capitate, 0-3-septate, contents refractive, weakly to strongly staining in SV, some banded to bubbled but in general these are fewer or less striking than those of *R. sanguinea*. **Pseudocystidia** abundant, ranging from 4-11µm wide but most about 5-7µm wide, ends obtuse or with a small capitum, strongly refractive in KOH and with banded or bubbled contents in SV.

Hypodermis of small flattened cells beneath the subcutis.

Trama of sphaerocytes scattered to clustered within a hyphal mesh, and common SV+ vascular hyphae.

Chemical reactions: FeSO₄ - no change to pinkish; KOH - turns both cap and coloured parts of stipe orange, stipe flesh unreacting or yellowish to slightly greenish; phenol - brownish, sometimes weak; SV - gills dark purple-grey, cutis dark purple, vascular hyphae and cystidia mostly reacting strongly, purple to black, rarely reddish.

Habitat and tree associations: In wet areas such as seeps, sphagnum or skunk cabbage sometimes in the habitat, otherwise just wet forest duff, with western hemlock, western red cedar often present, other trees in the vicinity may include red alder, Sitka spruce, Amabilis fir and big-leaf maple. October and November.

Collections: CR981029-br and CR021015-14, from the same site in a small patch of sphagnum with understory western hemlock, under old-growth Sitka spruce and western red cedar, at the northern part of east-side rainforest trail loop, near Tofino, N 49.0490°, W 125.6975°. CR981118-01, in a seep between clumps of sword fern in a mixed age stand of western hemlock and Douglas fir, on the east slope of Mount Douglas, Victoria. CR001012-20/21, under western hemlock, red alder and Amabilis fir, by the Grice bay mainline Logging road, near Uclulet, N 49.016883°, W 125.58153°, CR001102-02 from bottomlands near river, amidst skunk cabbage, western hemlock, big-leaf maple and western red cedar, Mill Hill park, approximately 30' from N 48.452433°, W 123.48382°.

| Collection | ITS1-F to | | | |
|-------------|-----------|-------------|----------|---------------|
| | ITS4-B | RFLP: Hinf1 | Alu1 | Sau3A |
| CR981118-01 | 856 | 382, 278 | 493, 320 | 311, 230 |
| CR001012-21 | 872 | 417, 366 | 500, 413 | 346, 254, 200 |

Notes: Singer's description of *Russula americana* is consistent with these Vancouver Island collections with the following two main exceptions: The spores of local collections are consistently smaller, those of *R. americana* are given as 9-11 x 8.2-9.5µm; and the gills of *R. americana* are described as frequently forked and becoming subdecurrent in fully mature basidiomata, both these characters can be quite variable but were not observed in any of the local collections, other notations of gill shape and colour agree very well. The spores of these Vancouver Island collections were nevertheless larger by about 0.5-1.0µm in the longer dimension than the spores of local collections of *R. sanguinaria*. Some texts describe *R. americana* as identical to *R. sanguinaria* (= *R. sanguinea*) in all but spore size, however, this is not strictly true. Singer's description mentions the greater fragility of *R. americana*, and its different habitat, which is under *Abies* and *Tsuga*. Singer's collections were made in Oregon, Washington and California, usually in river valleys, but he does not mention anything about his collections growing in damp or wet areas. Side by side, *R. sanguinaria* and *R. americana* var. *modicaspora* are easily distinguishable, the latter is taller and more slender, grows with western hemlock (and possibly *Abies*) rather than pines, is generally in wet areas, does not stain yellow on the stipe, and has a more evenly coloured and shiny cap with the epicutis an ixotrichodermis.

Russula renidens Ruotsalainen, Sarnari and Vauras, described in Sarnari (1998), is a red-capped, red-stiped species that matches the above collections extremely well in general stature and in spore colour and size, the spore ornamentation is of smaller warts to 0.5µm on average but is otherwise similar, and cuticular characters differ. It may include darker reds and yellow hues in the cap and is found in similarly wet patches and streamsides, sometimes in sphagnum, but under birch.

Other local peppery red-capped species include *Russula silvicola*, which has white spores and a white stipe, *R. cf. luteotacta*, which stains yellow at the base of the stipe, has whitish spores, different pileocystidia and is much paler, *R. bicolor*, with white spores and more yellow on the cap, *R. rhodopoda* which is mild to only slightly peppery and can have a darker red cap and reticulate spores, *R. queletii* and *R. cf. fuscorubroides*, which have more purple and often greenish tints in the cap and are never such a brilliant red as *R. americana*. *Russula paludosa*, found in Northern California in boggy areas tends to be broader capped, is only weakly peppery, has more yellow in the cap and the spores are reticulate, and *R. californiensis* is paler but otherwise somewhat like *R. sanguinea*; however, the stipe is white with just flushes of pink, and the spores have very small warts up to 0.5µm high and are reticulate.

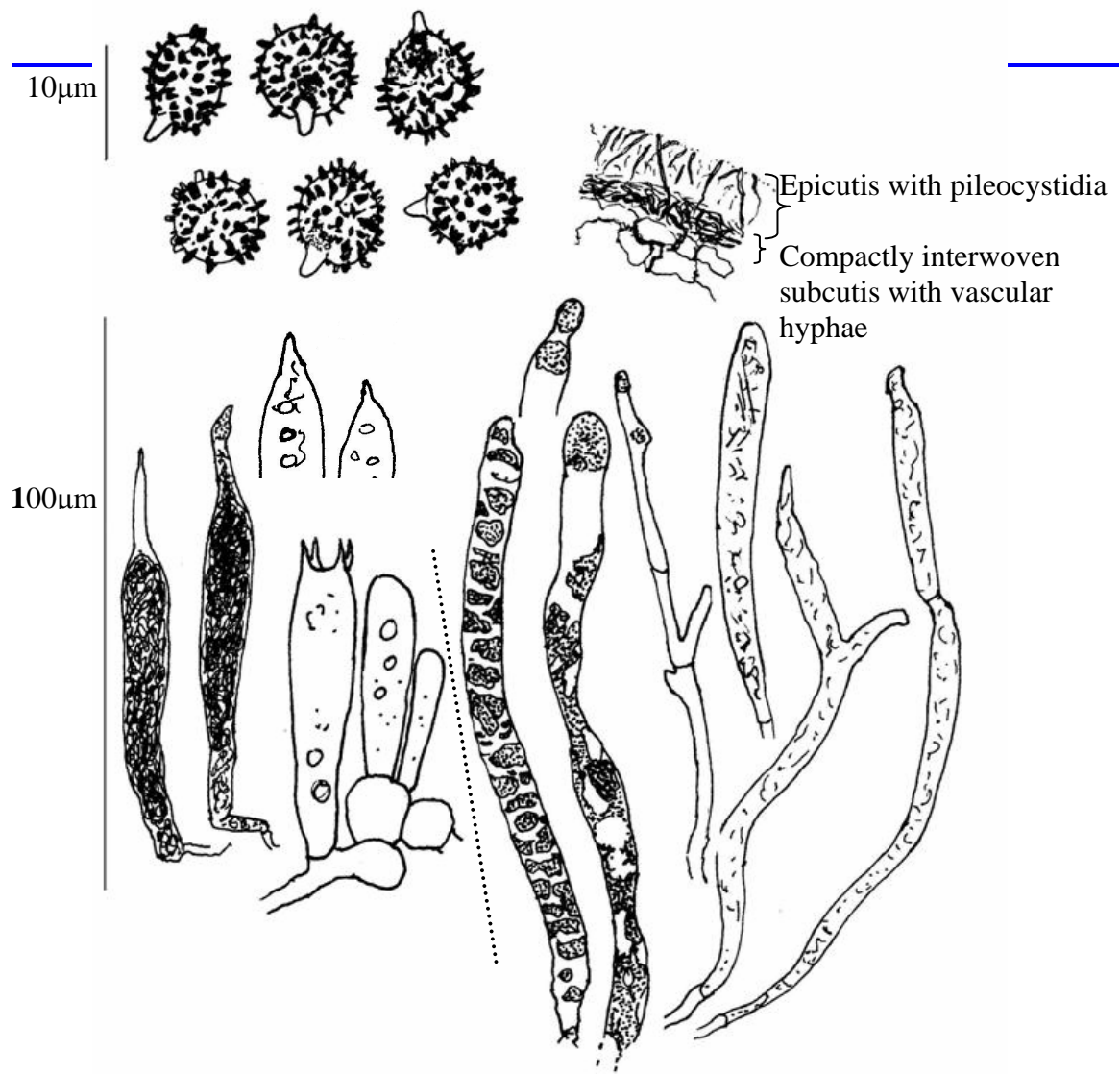


Figure 114. Microscopic characters of *Russula americana* var. *modicaspora*: Top, spores with 10µm scale bar; middle, diagram of section through cutis; bottom left, hymenial cystidia (in SV) and in KOH, (tips only shown), and basidium with basidioles; bottom right, pileocystidia and hyphal ends as they appear in SV and, far right, in KOH, lower scale bar is 100µm.



Figure 115. Macroscopic characters of *R. americana* var. *modicaspora* : Illustrations of profiles and longitudinal sections of two collections, the upper one with immature and mature basidiomata, the small squares are 1cm² and show the spore colour.

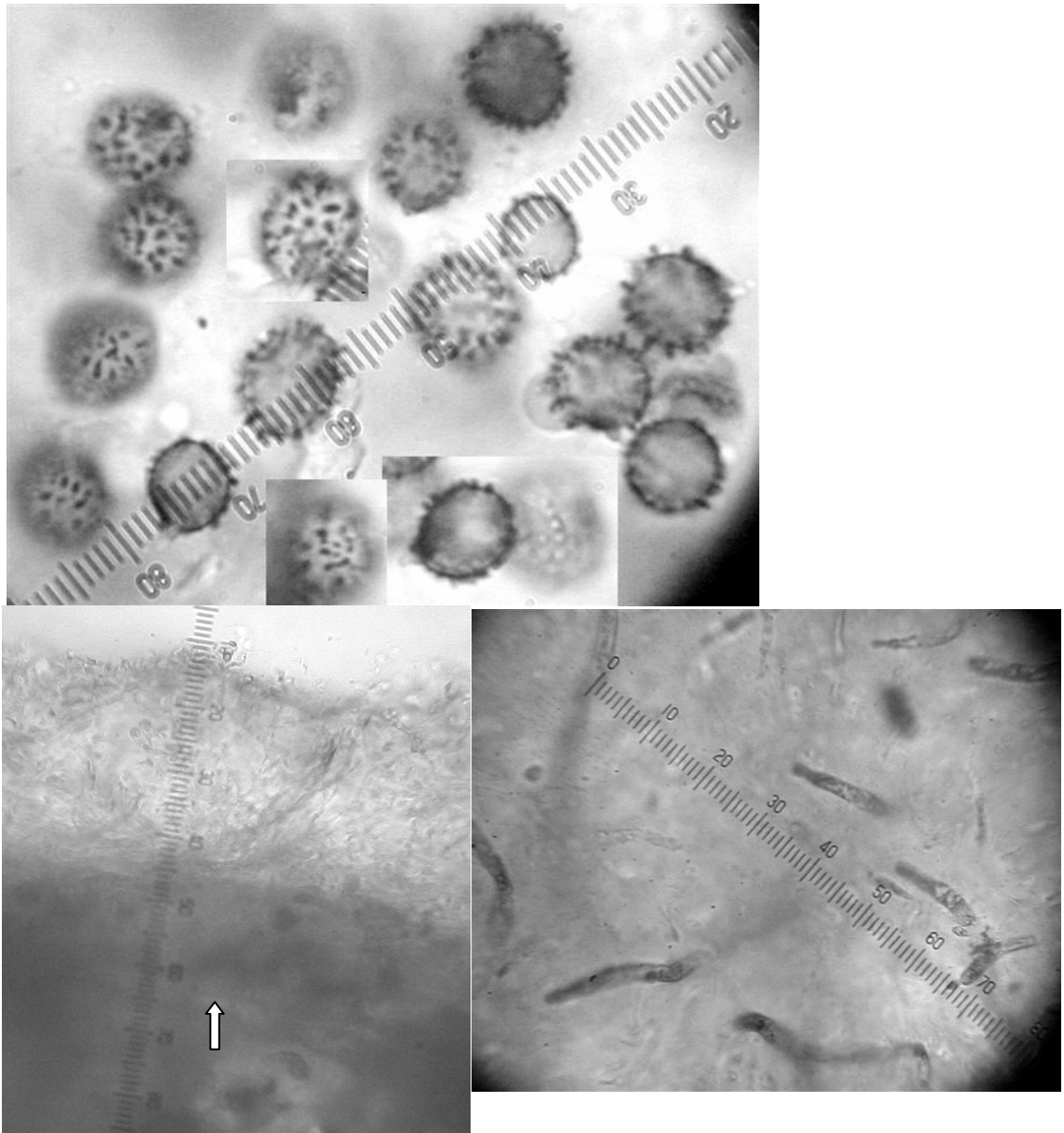


Figure 116. Hymenial and cuticular characters of *R. americana* var. *modicaspora*: Top, composite photograph of spores with 1μm division scale; bottom left, section through cutis showing the lighter epicutis above a darker subcutis, the base of the subcutis is arrowed; bottom right, surface view of cutis in SV showing the darkened pileocystidia, 10 scale divisions are 25μm.

Clade 7a

Subgenus *Incrustatula* Romagnesi

Section *Amethystinae* Romagnesi

Subsection *Chamaeleontinae* Singer

Beih. Bot. Centralbl. 49 (2): 236. 1932

Russula lutea (Huds.: Fr.) Grays

Nat. Arr. Brit. Pl.: 618. 1821

Description of Vancouver Island collection:

Cap 4-7cm diameter, plane, soon becoming uplifted at the margin, finally centrally depressed with a low central umbo, margin striate to tuberculate, viscid drying matte except at the margin where it is subglossy over the striations, Colour a bright egg-yolk yellow, sometimes with orange patches toward the centre, becoming pale yellow at the margins. One specimen greying in patches on the cap surface. Cuticle peeling almost completely. Cap trama whitish, pale yellow under cuticle, unchanging when bruised.

Gills adnexed, ventricose, depth to 1cm at mid-radius (where cap trama is about 2mm deep) obtuse to somewhat rounded at the cap margin, occasional forking toward the stipe, subdistant to moderately close, no subgills. Light orange at maturity, unchanging where damaged.

Stipe 5-9 x 1.1-1.5cm, cylindrical to fusoid, white, surface slightly longitudinally rugulose, stuffed with soft bread-textured trama, becoming hollowed in age, rind about 1.5mm thick, flesh unchanging when bruised but browning slightly in age at the base.

Texture average to soft and fragile.

Taste mild.

Odour like a chanterelle, weakly of apricot.

Spore colour brownish yellow-orange, Romagnesi I^{Ve}. While a spore print is being obtained, the mushroom leaves rusty stains on the paper where moisture has seeped out from it.

Spores 7-8.2µm x 6-7.2µm, L:W 1.13-1.23, with a mean of 1.17, (n= 30), subglobose to broadly ellipsoidal. **Ornamentation** of bluntly conical warts, mostly 0.5 to 0.8µm high, occasionally to 1µm, isolated or often short to long catenate, frequently forming one or more chains running around the circumference of the spore, or zig-zags roughly parallel to the suprahilar patch margin. Occasional spores are zebroid, reticulum partial to none. **Woo types** 2A-2B, occasionally to 2C. The spores are strongly yellow when mounted in water and viewed under the microscope, and it can be seen that the warts on the spores are filled with yellow pigment. Broken, empty spores remain yellow indicating a cell wall pigment. **Suprahilar patch** amyloid, an irregular patch bordered by and containing small warts. **Basidia** mostly 4-spored, but 2-spored ones quite frequent and 1-spored basidia occasional, 33-43µm x 11-13µm, broadly clavate to bulbous in upper third. Sterigmata up to 8µm long. Many basidia close to the gill margins have alongside and originating from the same basal cell one or two roughly clavate structures without refractive contents and with one or two septa. These structures appear to function as packing or spacers between basidia. These are more apparent in some mounts than others and should not be confused with basidioles which have refractive or oil drop contents even while quite immature, and also often originate from the same cell as more mature basidia. **Pleurocystidia** and **cheilocystidia**, sparsely and unevenly distributed, 47-80 x 7-11µm, not or scarcely protruding beyond basidioles, arising from deep within the subhymenium or the central trama, cylindrical to narrowly clavate, tips acute, often with a small sharp projection, very occasionally with a long narrow projection especially in the older specimen, contents refractive in KOH, staining dark red to grey in SV.

Subhymenium 20-30µm thick, of small irregularly shaped cells 5-8µm in diameter, **gill trama** of sphaerocytes with occasional hyphae, vascular hyphae rare.

Cutis 60-150µm thick, an ixotrichodermis, the glutinous matrix of which forms a layer 5-10µm thick over the epicutis, and is visible in sections because of the debris trapped at its surface. **Subcutis** of repent, interwoven hyphae 1.5-3µm wide, the lower portion of which has more yellow pigment than the upper, with occasional laticifers in subcutis, weakly greying in SV in fresh material, unreacting in dried material. **Epicutis** a turf about 25µm deep, of erect hyphae 2-4µm wide, with yellowish cell walls and containing bright yellow pigment globules, terminating in a clavate, bottle shaped, capitate or cylindrical terminal cell 3-8µm wide and 7-22µm long, often with a similarly enlarged cell beneath. Amongst these are numerous primordial hyphae and rare cystidium-like hyphal ends. **Primordial hyphae** 3-8µm wide are common in the epicutis of younger basidiomata, becoming sparser with age, their incrustation appears as an uneven, refractive, gelatinous layer over parts of the surface: it takes up acid fuchsin less strongly than do the cell contents, does not darken in SV, and is sometimes hard to discern. **Pileocystidia** rare, possibly part of the primordial hyphal system rather than true cystidia, 15-42µm long by around 3µm wide, cylindrical with rounded ends, with yellowish refractive contents that are often banded or bubbled, not staining in SV. **Pseudocystidia** rare, 3-6µm wide, most with rounded ends, contents as for pileocystidia, not staining in SV. Both cystidial forms more frequent on the younger specimen. **Hypodermis** none.

Trama of aggregations of sphaerocytes, binding hyphae and occasional laticifers staining purple in SV.

Chemical reactions: FeSO₄ - light pinkish, KOH and NH₃OH - no reaction on cap or stem, guaiac - at first brownish pink, very slowly turning blue-grey; phenol - brownish-purple, guaiacol -purplish red, SV - at first red, gradually turning purple-grey.

Habitat and tree associations: in fairly dry conditions under *Quercus garryana*, in May. Rare.

Collections: OC040528-01 found under Garry oaks with some madrone in Beacon Hill Park, Victoria. N48.416°, W123.363° This is the first collection in 7 years of a yellow *Russula* under oaks.

Notes: This Vancouver Island collection is identified as *Russula lutea* sensu Phillips (1981) and Romagnesi (1967), who considered this species a variety of *R. chamaeleontina*. Phillips mentions the apricot odour. The spores in these two descriptions are mostly with isolated warts whereas those of this V.I. collection have more catenations.

This collection was initially thought to be *R. flaviceps* because of its habitat with oaks, and the similarities with Grund's (1965) description of that species. *Russula flaviceps* differs from *Russula lutea* in its slightly paler, larger spores with higher ornamentation, thicker cutis (sensu Grund), bluing reaction of the pileocystidia in SV and sometimes peppery to bitter taste. Another mild yellow species, also reported by Grund is *Russula gilva*, which has incrustated primordial hyphae in the cutis and is also in subsection *Chamaeleontinae*. It differs from *R. lutea* in its less vivid cap colours and lighter spore colour.

In mounts of cutis from a mature specimen stained with fuchsin or methylene blue the incrustations are difficult to see, due to the presence of bacterial colonies and other debris in the surface gluten that also take up the stain. In water mounts the debris is less visible and the incrustations appear as yellowish droplets, many of which seem to be shed into the mounting fluid when fresh material is observed.

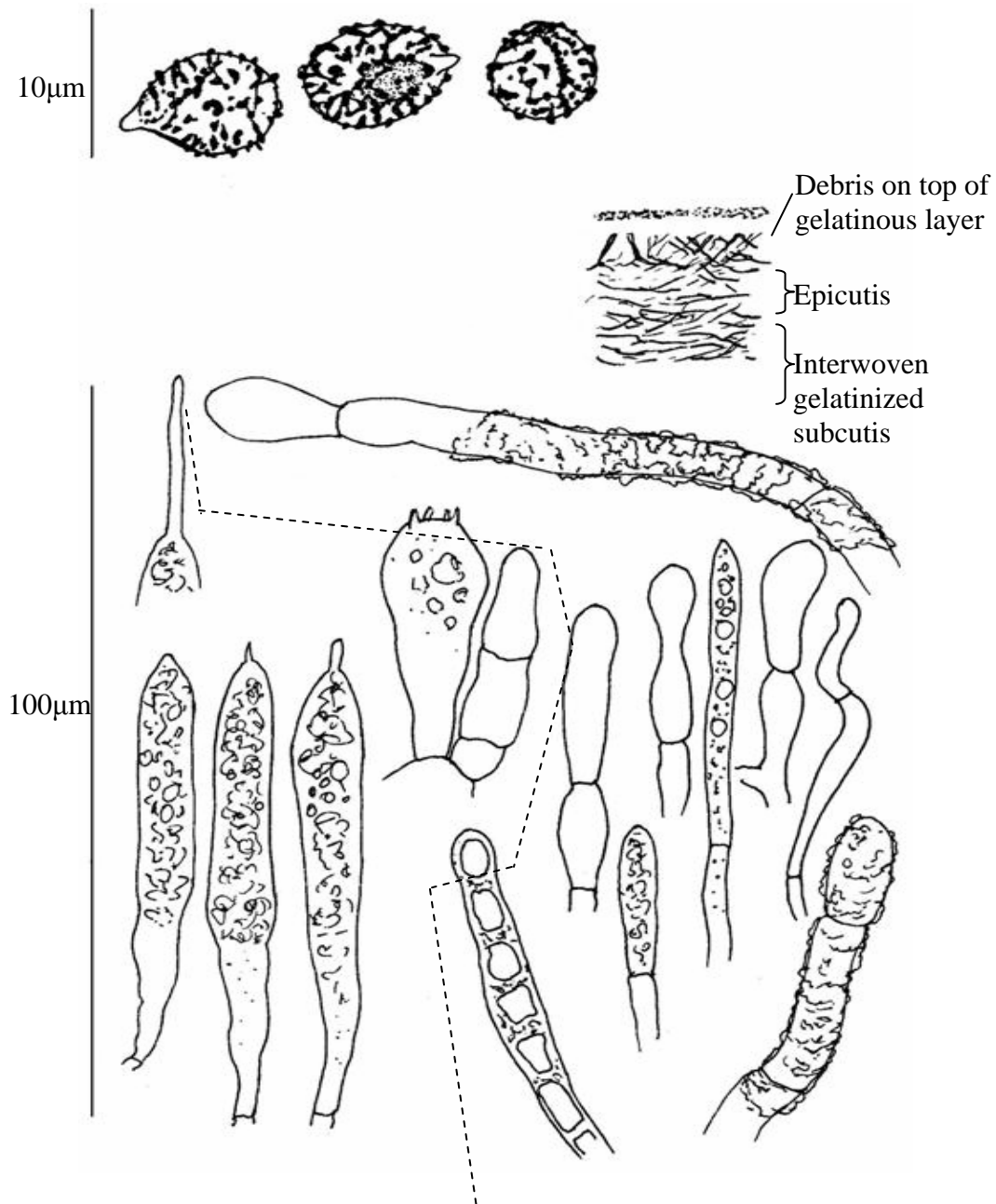


Figure 117. Microscopic characters of *Russula lutea*: Top, spores with 10µm scale bar; middle, diagram of section through cutis; bottom left, hymenial cystidia and basidium with packing cells; bottom, to right of dotted line, hyphal ends, incrustated primordial hyphae and cystidioid cells, lower scale bar is 100µm.



Figure 118 Macroscopic characters of *R. lutea*: a collection from under oaks, squares on the background are 1cm^2 , inset square shows spore colour, the soil at the collection site has stained the stipe at left greyish, this is not a bruising reaction.

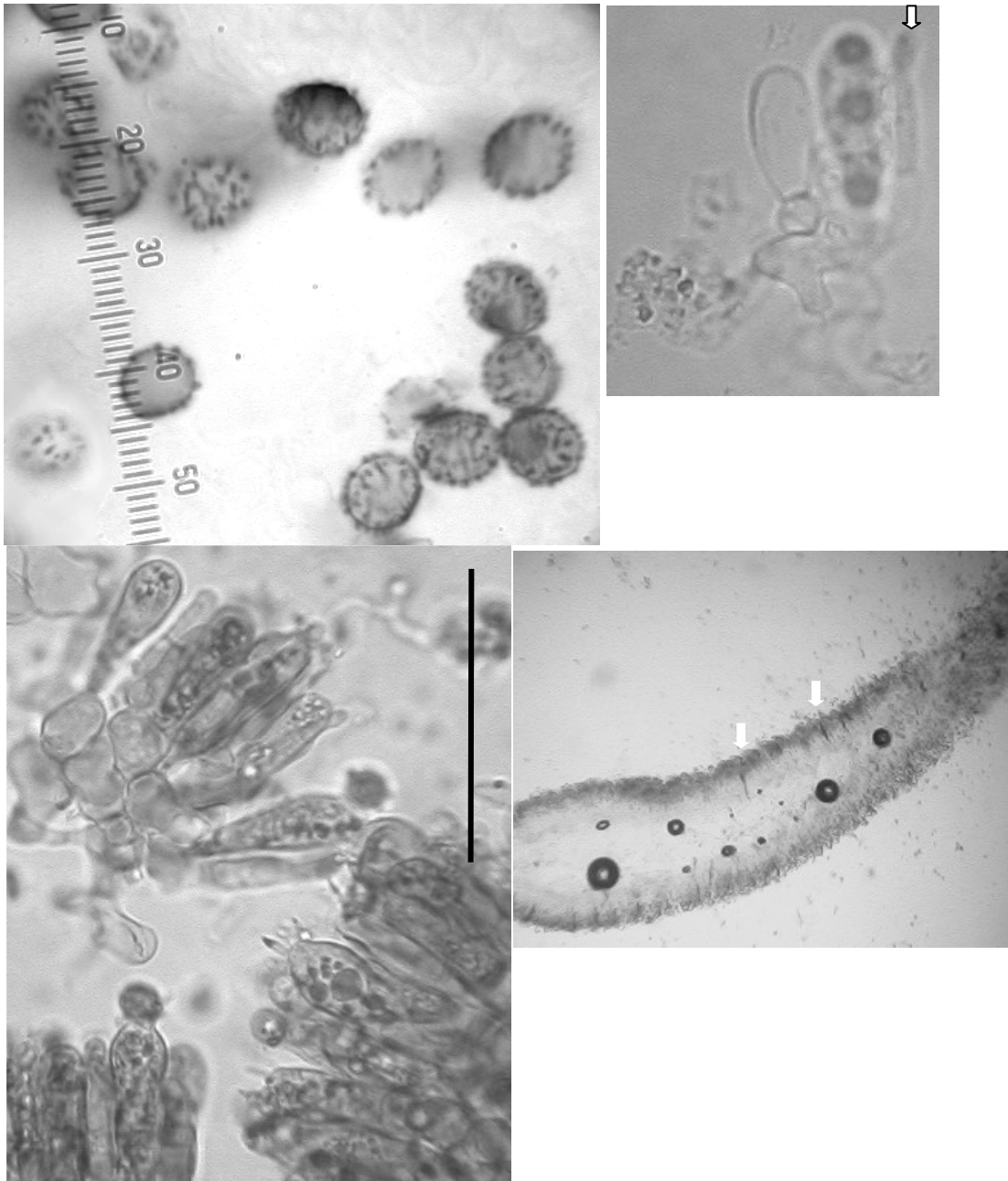


Figure 119. Hymenium of *R. lutea*: Top left, spores with 1µm division scale; top right, basidioles with packing cells to their right (arrowed); bottom left, fragments of the hymenium showing basidioles and a segment of subhymenium at upper left and mature basidia at lower right, scale bar is 50µm; bottom right, section through gill stained in SV illustrating the sparse nature of the hymenial cystidia which are stained dark, arrows point to two of them.

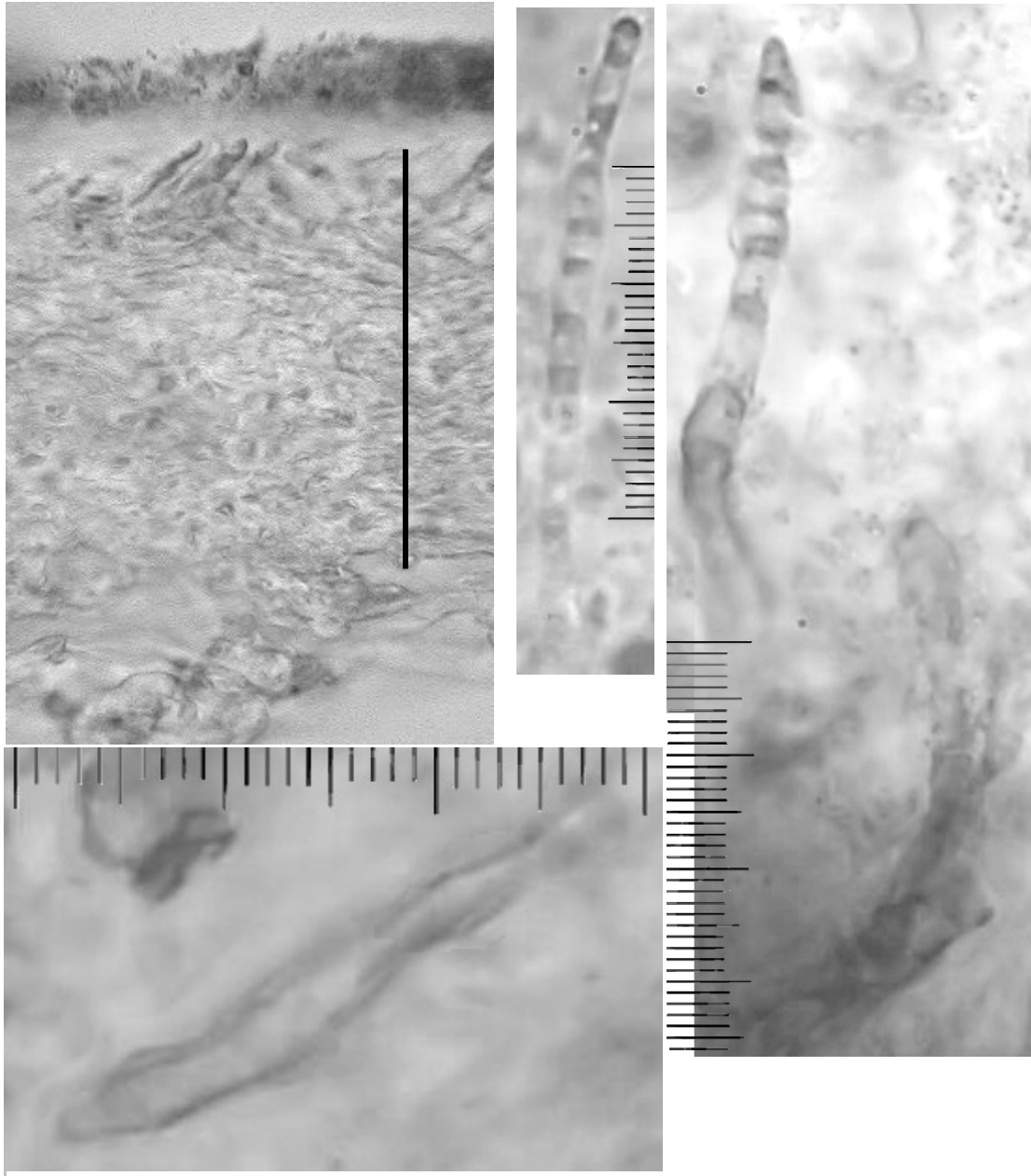


Figure 120. Cutis of *R. lutea*: Top right, section through cutis showing the dark layer of debris lying on the glutinous matrix, primordial and generative hyphae forming the epicutal turf and the subcutis which rests directly on the trama with no defined hypodermis, scale bar is 100 μ m; top middle, a cystidioid hyphae with banded contents: top right, two primordial hyphae stained in acid fuchsin in which the incrustations show as darker areas along the walls, the top part of the left hyphae is naked and has banded refractive contents; bottom, detail of a primordial hyphae in SV in which the incrustation shows as a sheath of varying thickness, the scales for the latter three photographs are in 1 μ m divisions.

Subsection *Amethystinae* (Romagn.) Bon

***Russula murrillii* Burlingham**

Mycologia 5:310, 1913

Description of Vancouver Island collections:

Cap 3.7-10.3cm diameter, pulvinate when young, sometimes with a flattish umbo within the central depression, expanding to shallowly centrally depressed, usually with rounded margins, but those growing in clusters becoming rather irregularly uplifted, margins smooth, slight striations developing in age and dry conditions. Colour a greyish dark pink to a greyish violet, often dull brownish or with olive tints centrally, becoming more brownish-grey in age, the colours opaque and chalky, usually with a ring of minute blackish floccules around the central depression but not always within it, on occasion the blue pigment is much reduced and the colour resembles that of *Russula veternosa*, i.e. dull yellowish on the disc and pinkish towards the margins, buttons may be these colours initially. The appearance of the cap surface is as if coloured with chalk pastels and often lightly rubbed around the depression with charcoal, and is quite distinctive. The cutis is viscid when wet, drying matte with a greyish bloom, and minutely concentrically areolate throughout, this character being more pronounced in the cap centre. Peeling 1/2 to 3/4 or sometimes completely, flesh white, tinged pink under the cutis, unchanging.

Gills cream at first, becoming a deep cream to light orange-yellow, unchanging where damaged, ventricose, narrowly adnexed to free at stipe, acute to subacute or sometimes obtuse at cap margin, up to twice the depth of the cap trama at 1/2-radius, subdistant, subgills occasional, a small degree of forking common, texture average to slightly pliable.

Stipe 5.2-10.1 x 1.1-2.6cm, chalky white, pruinose, particularly near the base, longitudinally slightly rugulose, unchanging where damaged but sometimes browning slightly at the very base, in dried material the stipe retains its white surface. Shape

generally cylindrical to clavate but when growing in clusters may taper downwards or be irregular in shape, stuffed with a soft bread-textured trama that develops 1-3 cavities, becoming hollow in age. Microscopically incrusted primordial hyphae may be found in the surface of the base of the stipe in young basidiomata.

Texture quite firm.

Taste mild and nutty.

Odour not distinctive usually, one collection with a slight fruity-flowery smell, sometimes with an iodoform smell at the stipe base or when deteriorating in an enclosed space.

Spore colour orange-yellow, Romagnesi IVa-c.

Spores 7.3-10.8 x 6-8.5 (-9) μ m, L:W 1.06-1.6 with a mean of 1.24 (n=50).

Ornamentation 0.2-0.8 μ m high, of hemispherical, isolated warts, elongated, blunt, low crest-like warts and warts joined with short to long, branched, generally heavy lines, some spores with a partial reticulum, less commonly with mostly isolated warts. **Woo** **types** B1-2, C1-2, rarely A1-2. **Suprahilar patch** amyloid, roundish, around 3 μ m diameter, warts not generally forming a border. **Hiliferous appendix** up to 2.0 μ m long, 1.6 μ m wide at base. **Basidia** mostly 4-spored but 2-spored ones common, 32-48 x 9.5-13.5 μ m, clavate and bulbous in the upper 1/3, embedded amid many basidioles.

Sterigmata fairly short, 3-5 μ m long and 1.3-1.5 μ m wide at the base. **Pleurocystidia** very sparse, (they are difficult to find on the gill as they are not strongly differentiated from the submature basidia), 47-70 x 5-11 μ m, protruding up to 15 μ m, most embedded except for the tip, originating in the subhymenium, fusoid, cylindrical or with constrictions toward the apex, sometimes appearing thicker walled than in other *Russulas*, tips obtuse, mammillate, or with a short strangulate appendage; with refractive contents in the apex, not reacting in SV. **Cheilocystidia** sparse, only the tips protruding, mostly under 8 μ m wide and usually with more constrictions than pleurocystidia, contents

similar. **Subhymenium** 25-30µm thick, pseudoparenchymatous, gill trama of sphaerocytes, vascular hyphae not seen.

Cutis 50-150µm thick, up to 175µm thick over disc, consisting of a more or less colourless subcutis and a pinkish epicutis embedded in a gelatinous matrix that may extend 20µm or more beyond the epicutis in water mounts. **Subcutis** cellular, of roundish to flattened sphaerocytes that are about 12–20 (–45)µm across in the mid subcutis, becoming smaller near the boundaries between the epicutis and hypodermis, lacking vascular hyphae. **Epicutis** an ixotrichodermis, of erect, branched, somewhat tortuous and nodulose hyphae 2-4µm wide, sometimes incrustated, containing many pink granular pigment bodies up to 2.5µm across, hyphal tips rounded, sometimes capitate, often with a small yellowish refractive body in the tip that slowly turns bluish in SV.

Primordial hyphae 5-8µm wide, project from the epicutal surface and often lie repent on it. They are multi-septate, incrustated, the contents staining pink in acid fuchsin. They may be branched in their lower portions but the terminal 3-4 cells, around 60-110µm total length, are unbranched and narrowly clavate, and often include a small yellowish refractive body, bluing slightly in SV, at the terminus. The incrustations appear as a roughened, closely fitting sleeve with small globular extrusions, greying slightly in SV, not very visible in water mounts, as droplets in aqueous methylene blue mounts, disappearing in KOH, and breaking into horizontal bands or squarish blocks in acid fuchsin mounts. The areoli seen macroscopically are clumps of hyphal ends and primordial hyphae protruding around 10-15µm above the general epicutis level.

Pileocystidia and pseudocystidia not seen, though the primordial hyphae appear somewhat like cystidia. **Hypodermis** a narrow layer of compact tramal tissue and distinctly more parallel interwoven hyphae than in the subcutis.

Trama of large discrete clusters of sphaerocytes bound by a hyphal mesh, vascular hyphae apparently absent, although short sections of some hyphae may have refractive contents.

Chemical reactions: FeSO₄ - unreacting to slightly yellowish or pale brownish; KOH - pinkish to brownish orange on cap surface, no reaction to slightly yellowish on stipe;

NH₄OH - no reaction; guaiac - blue-green; guaiacol - faintly pinkish; phenol - slowly brownish purple (after more than 5 minutes); SV - initially pink on the gills and cuticle, becoming brownish, slowly staining some refractive bodies and incrustations bluish.

Habitat and tree associations: Gregarious, sometimes clustered, rarely singly, under Douglas fir or western hemlock, usually under canopy openings and well lit patches of forest floor, often in patches of broom or huckleberry, October to November.

Collections: CR981029-01 and CR 021015-13, under roadside red alder with old-growth western hemlock with western red cedar and huckleberry, just inside the beginning of the Rainforest trail (east side), P.R.N.P., near Tofino N 49.036°, W 125.667°. CR001104-02 under regeneration Douglas fir and western hemlock with big-leaf maple, Pacific blackberry, salal, ocean spray (*Holodiscus discolor*) and sword fern, Gowen Todd peninsula trail, N 48.5187°, W 123.52935°. CR001115-07 under old-growth western hemlock and Sitka spruce with western red cedar, huckleberry and salal, Clayoquot Island, N 49.1542°, W 125.9191°. CR011111-02, CR011111-03, CR 041114-01 and CR 041011-01, at the forest edge under mature and sapling Douglas fir with broom, Royal Roads N 48.4375°, W 123.4744°. CR 021027-03, at the forest edge by the road, under regeneration Douglas fir, Mesachie Lake Forest Research Station, N 48.826113°, W 124.13635°.

ITS1-F to

| Collection | ITS4-B | RFLP: HinfI | AluI | Sau3A |
|-------------|--------|-------------|------|----------|
| CR001104-02 | 849 | 428, 374 | 337 | 365, 276 |
| CR011111-02 | 864 | 420, 369 | 320 | 363, 280 |

Notes: Burlingham (1913) commented on the beauty of *Russula murrillii* with its "violet cap and pure-white stem", a type she collected from Corvallis, Oregon. It is indeed an attractive and clean-looking mushroom, with its contrast between the violet cap, white stipe and egg-yolk yellow gills. The particular colour and texture of the cap cutis, described above, is quite distinctive and apparent even in old, faded basidiomata. It can be quite common in the coastal Douglas fir forests. Its range and different tree hosts could suggest more than one species but there do not appear to be any macroscopic or

microscopic differences between the coastal Douglas fir populations and those from the coastal western hemlock zone.

Singer (1942) considered *Russula murrillii* to be synonymous with *Russula punctata* Krombholz (= *Russula amethystina* Quelet). However by 1957, after examining more collections, he conceded that *Russula murrillii* was an autonomous Pacific Northwestern species. It is very similar to *R. amethystina* sensu Romagnesi (1967), which grows with *Picea* and *Abies*, more rarely with *Pinus*. The spore print of *R. murrillii* is described in Singer (1947 and 1957) as Crawshay D-E, which is paler than that of most of the Vancouver Island collections which are generally Crawshay E or slightly darker, a shade or two deeper than Romagnesi's description of *R. amethystina* (spore print IIIId-IVa). The spore size of *Russula murrillii* ranges larger than those of *R. amethystina* (7-9 x 5.5-8) but have the same ornamentation. Romagnesi's drawing of the primordial hyphae shows a thicker, rougher layer of incrustations than is normal for *R. murrillii*, but other characters including the occasional iodoform odour, the weak reaction with guaiacol, and the macroscopic appearance are similar.

Russula turci is quite similar but has more consistently reticulate spores, stipe occasionally with pink tints and yellowing at the base, cap colour more vinaceous or dark red, a thicker subcutis (around 150µm), thicker incrustations on the primordial hyphae and softer flesh, but the same spore colour as that of *R. murrillii*. *Russula turci* grows with *Pinus* and *Picea*.

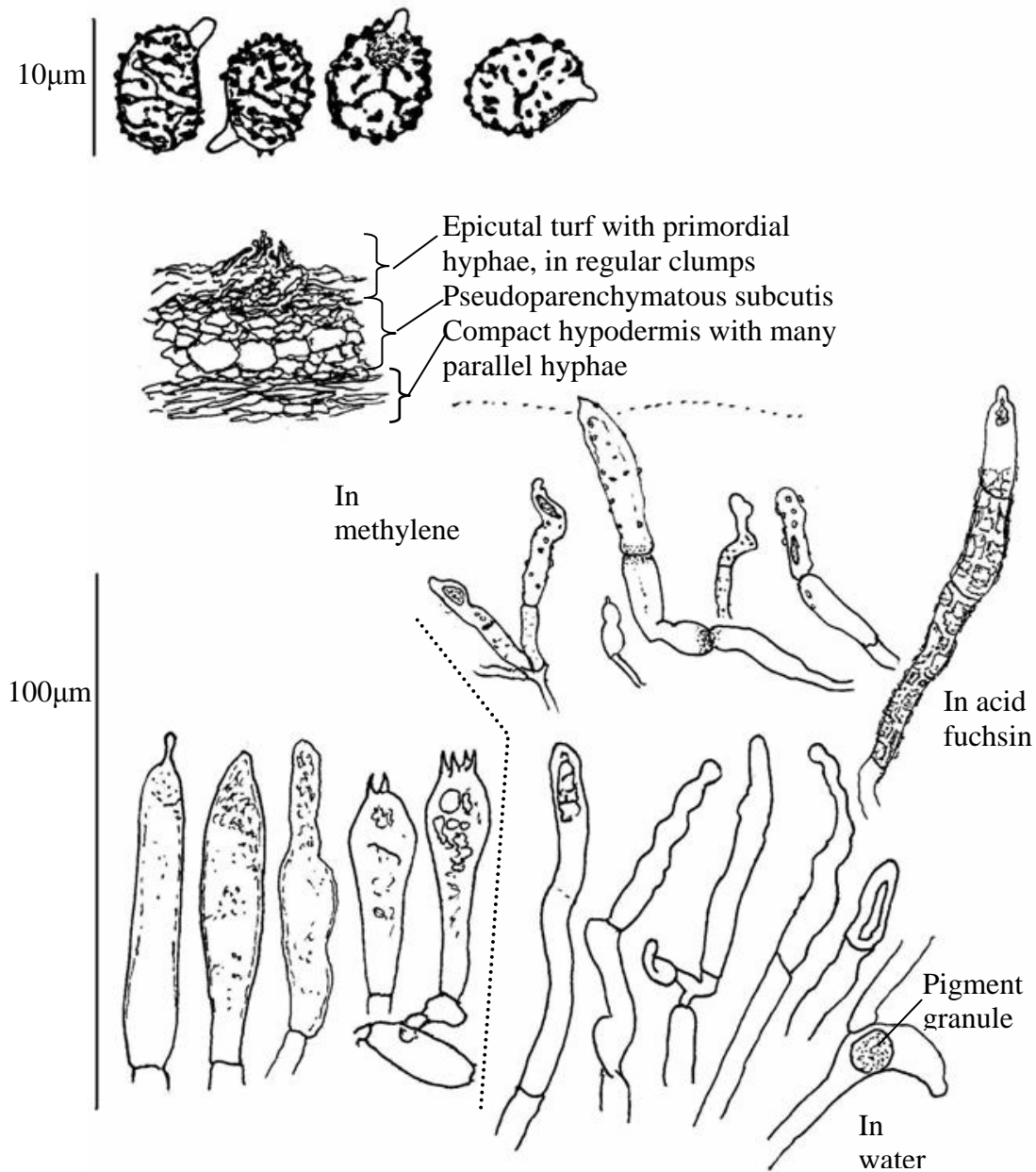


Figure 121. Microscopic characters of *R. murrillii*: Top, spores with 10µm scale bar; middle, diagram of section through cutis; bottom left, hymenial cystidia, a two-spored and a 4-spored basidium; bottom right, hyphal ends and primordial hyphae from epicutis in water, above which are these structures in aqueous methylene blue and to the right of them is a primordial hyphae in acid fuchsin; lower scale bar is 100µm.

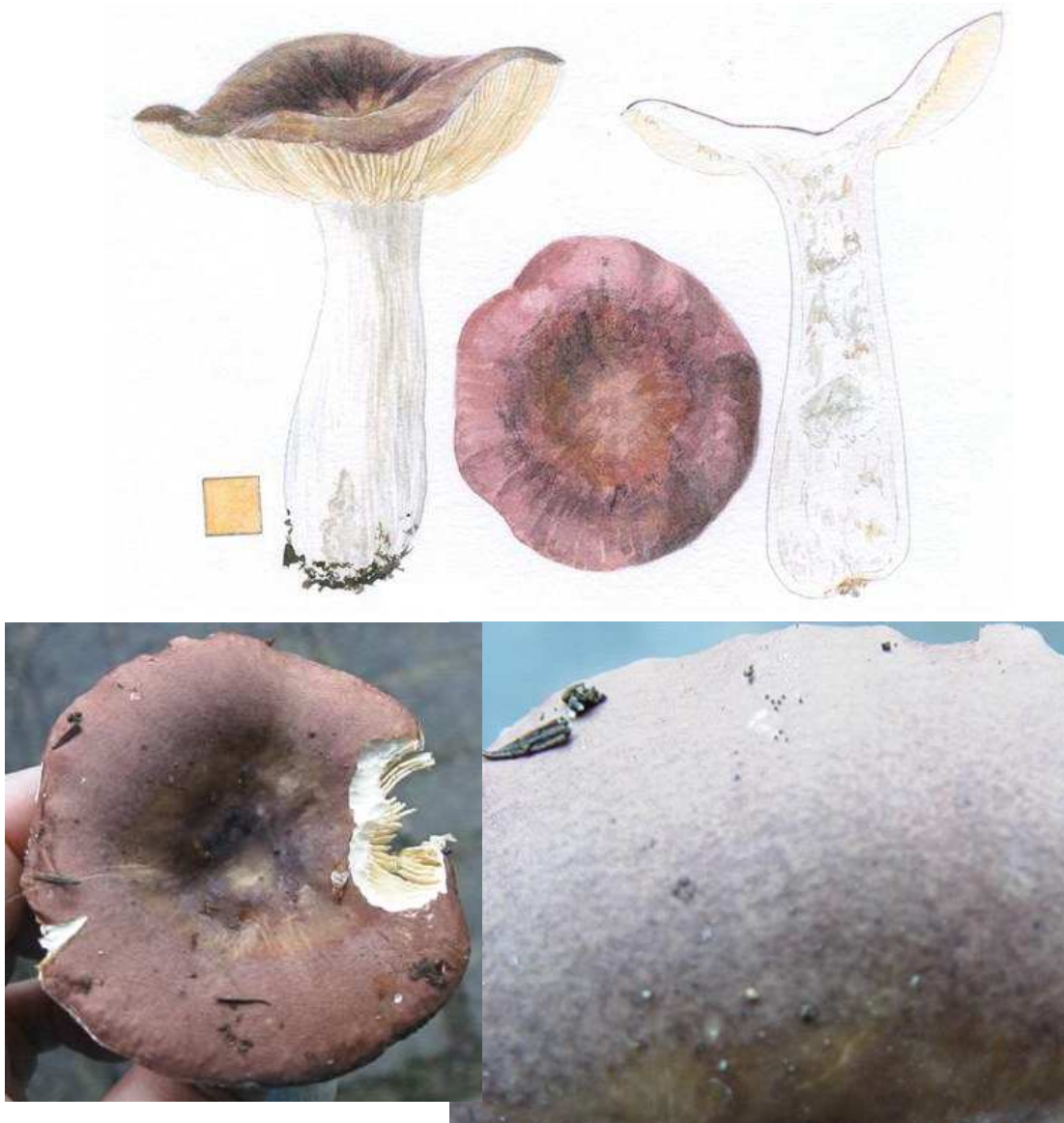


Figure 122. Macroscopic characters of *R. murrillii*; Top, illustration of profile, cap and longitudinal section of mature basidiomata, small square is 1cm² and shows spore colour; bottom left, top of cap showing unchanging white flesh and yellow gills where slug-damaged; bottom right, close-up of same cap cutis showing minute areolae.

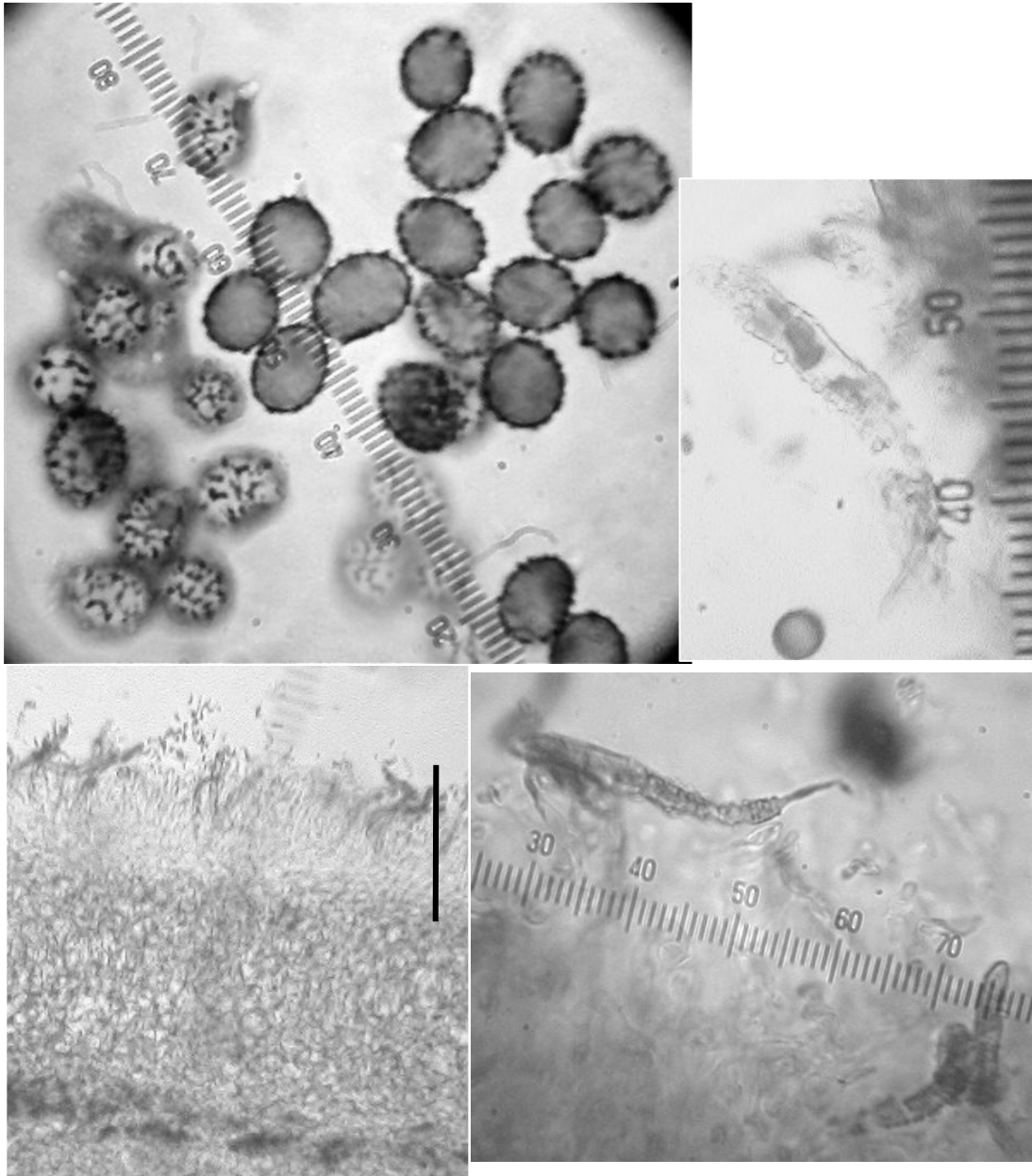


Figure 123. Spores and cuticular characters of *R. murrillii*: Top left, spores with 1μm division scale; bottom left, section through cutis showing an ixotrichodermal epicutis with darker primordial hyphae, above a pseudoparenchymatous subcutis and a darker, denser, hypodermis, stained in acid fuchsin, scale bar is 100μm; top right, a primordial hypha in SV showing a darkened refractive body within and a darkened, cracked sheath-like incrustation with small globular exudates; bottom right, detail of the epicutis stained in acid fuchsin, showing three primordial hyphae with dark-stained incrustations; 10 scale divisions are 25μm for both right-hand photographs.

Clade 7b

Section *Paraincrustatae* Sarnari

Subsection *Lepidinae* (Melzer and Zvara) Singer

Russula albida Peck

Bull. N.Y. St. Mus. 1:10, 1888

Description of Vancouver Island collections:

Cap 3-6cm diameter, plano-convex when young with an incurved margin, becoming shallowly depressed with irregularly uplifted margins that remain smooth, pale cream initially, eventually a pale clear yellow with an ochre yellow centre, yet the impression is of a cream coloured cap rather than a yellow one. Not very viscid when wet, drying matte or with a slight sheen, peeling to 1/2 the radius, flesh white, unchanging.

Gills pale cream when young, deep cream to pale orange-yellow at maturity, not bruising, adnate to adnexed, ventricose, about 1.5 times the depth of the trama at half-radius when mature but very shallow at first, subacute at margin, close to crowded, no forking or subgills seen, brittle.

Stipe 2.2-5.8 x 0.9-1.7cm, white, smooth, slightly pruinose especially near the base when young, cylindrical to slightly clavate, stuffed with a firm bread-textured trama that develops 3 or 4 cavities, unchanging or with slight yellow-brown bruising at the very base.

Texture somewhat firmer and more brittle than an average *Russula* but not as firm as the *Compactae*.

Taste mild and nutty, lacking any bitter taste.

Odour pleasant, nutty and fruity, of brazil nut or floral, depending on one's interpretation.

Spore colour pale orange-yellow. Romagnesi IIIa.

Spores 9-11(12) x 7-9 μ m, L:W 1.13-1.54 with a mean of 1.29, (n=30), subglobose to broadly ellipsoidal, the largest spores more ellipsoidal to obovoid. **Ornamentation** of pointed, narrow conical to peg-like warts 0.2-.0.8 μ m or occasionally to 1 μ m high, generally the full height range on each spore, many warts isolated but short catenations and fine to heavy lines linking several warts occur on most spores, not forming a reticulum. **Woo types** A2-B2. **Suprahilar patch** amyloid, an irregularly shaped area with or without warts at its border. **Hiliferous appendix** relatively short for the spore size, around 1.4-2.2 μ m long, 1.4-1.7 μ m wide at base. **Basidia** 4-spored, occasionally 2-spored, 30-55 x 10-13 μ m, with the older ones having a longer base than the shorter developing ones, clavate, the longer ones sometimes more bulbous in the upper 1/3, the hymenium expands outwards by one to two cells with each generation of basidia. Sterigmata up to 7.5 μ m long and 2.2 μ m wide at the base. **Pleurocystidia** sparse, 60-75 x 5-10 μ m, embedded or protruding up to 20 μ m, originating in the subhymenium, cylindrical, fusoid or occasionally contorted, tips acute, mucronate, or with a short narrow appendage, contents refractive in KOH, pinkish brown and darker than basidia in SV. **Cheilocystidia** occasional, similar to pleurocystidia. **Subhymenium** 25-50 μ m thick, pseudoparenchymatous, sometimes not well defined, separated from the gill trama by a one or two layers of hyphae. **Gill trama** of voluminous sphaerocytes 25-60 μ m across, no vascular hyphae seen.

Cutis 120-250 μ m, an ixodermis composed of a thick subcutis and a barely differentiated epicutis 20-50 μ m thick. **Subcutis** of tightly interwoven semi-upright hyphae 2-4 μ m wide, slightly yellowish towards the subcutis base, more or less hyaline above, embedded in a gelatinous matrix, vascular hyphae rare. **Epicutis** of tangled hyphal ends which are towards the thinner end of the width range in general, ends obtuse, sometimes slightly capitate, accompanied by numerous septate, occasionally branched, incrusting **primordial hyphae**, mostly 4-5 μ m wide but ranging from 2-6 μ m wide, and with up to about 100 μ m

lying on the epicutal surface, contents slightly refractive and sometimes yellowish banded to globular, tips usually subacute. The hyphae and incrustations stain pink in acid fuchsin but are harder to see than in SV, which stains the whole epicutis pink initially, with the primordial hyphae and incrustations a deeper pink, and some of their contents light grey, often but not always in the terminal cells. The incrustations appear as an incomplete and patchy granular or darkly dotted sheath, some hyphae are almost naked and the ends of many are naked. **Pileocystidia** rare and uncertain, some of the primordial hyphae have refractive contents, lightly greying in SV, in the terminal 1-3 cells, which are sometimes narrowly clavate and occasionally arise from a narrower hyphae, are patchily incrustated and otherwise similar to the rest of the primordial hyphae, but which do look somewhat cystidioid. These structures are 25-75µm long and 4-6µm wide in general. **Hypodermis** none.

Trama of discrete well defined clusters of sphaerocytes bound by a hyphal mesh, vascular hyphae not seen.

Chemical reactions: FeSO₄ - very weakly pinkish grey; KOH - no reaction on cap, slightly yellowish on stipe; phenol - pinkish-brown, becoming almost black after 10 minutes; SV - pinkish on the gills, bright pink on the cuticle, both turning brown after 10-15 minutes, pinkish brown on the stipe trama, cystidia and vascular hyphae not reacting to slightly brownish.

Habitat and tree associations: In dry mineral soil under Douglas fir and western hemlock.

Collections: CR010516-01, under mature regeneration Douglas fir with understory western hemlock and ivy ground cover, in May during fairly dry weather, Tillicum Park, N 48.45750°, W 123.385450°. One other collection, 981114-04, from Koksilah river area on a limestone slope with Douglas fir and salal, passed on to me by forayers, has similar spores to the above collection but with a size range extended down to 7µm, and a pink reaction of the cutis with SV, but the poor condition of the cutis, which has been

grazed by slugs, prevented a positive identification. The description above does not include data from this collection.

| ITS1-F to | | | | |
|-------------|--------|-------------|----------|---------------|
| Collection | ITS4-B | RFLP: Hinf1 | Alu1 | Sau3A |
| CR010516-01 | 866 | 390, 330 | 500, 309 | 375, 271, 242 |

Notes: Singer (1947) and Thiers (1997) both placed *Russula albida* in the *Lepidinae*, which has both incrustated primordial hyphae and SV -ve pileocystidia that may also have incrustations. Neither author specifically mentions incrustated hyphae although Singer refers to the presence of primordial hyphae in the cutis; both authors note a lack of pileocystidia. The spore size given by Singer is 8.8-10.8 x 7.8-9.2µm, which is consistent with the size range of most of the spores in the Vancouver Island collection, though large spores occasionally up to 12µm long but of average width are common. This collection lacked the slight bitter taste that is reported for *Russula albida*, although this character is recorded as mild to bitterish, indicating variation. Singer also mentions that the hymenial cystidia are numerous, which was not the case in the V.I. collection, he also notes the pink to red reaction of the flesh with SV, which occurred in the V.I. collection with the cutis and gills but less so with the stipe trama.

Other white to cream or light yellow Russulas include *Russula brevipes* which is sometimes quite mild, but much larger, more robust, with white spores and a non-separable cutis. *Russula raoultii*, *R. crenulata*, *R. cremoricolor* and *R. cascadiensis* are all acrid tasting and have white spores. *Russula basifurcata* is a yellowish or dingy white, mild-tasting, yellow-spored species that may sometimes stain red in SV, but the cap cutis is thinner and barely peels, the gills are frequently forked, and microscopically it lacks incrustated hyphae and has an inamyloid suprahilar patch and much smaller ornamentation on the spores. *Russula lutea* and *R. flaviceps* are more yellow and have darker spores which are also smaller, and the latter species bruises greyish. Pale yellow forms of *Russula chamaeleontina* have a similar spore size and ornamentation, incrustated primordial hyphae and are mild-tasting, they differ only in having a darker spore print.

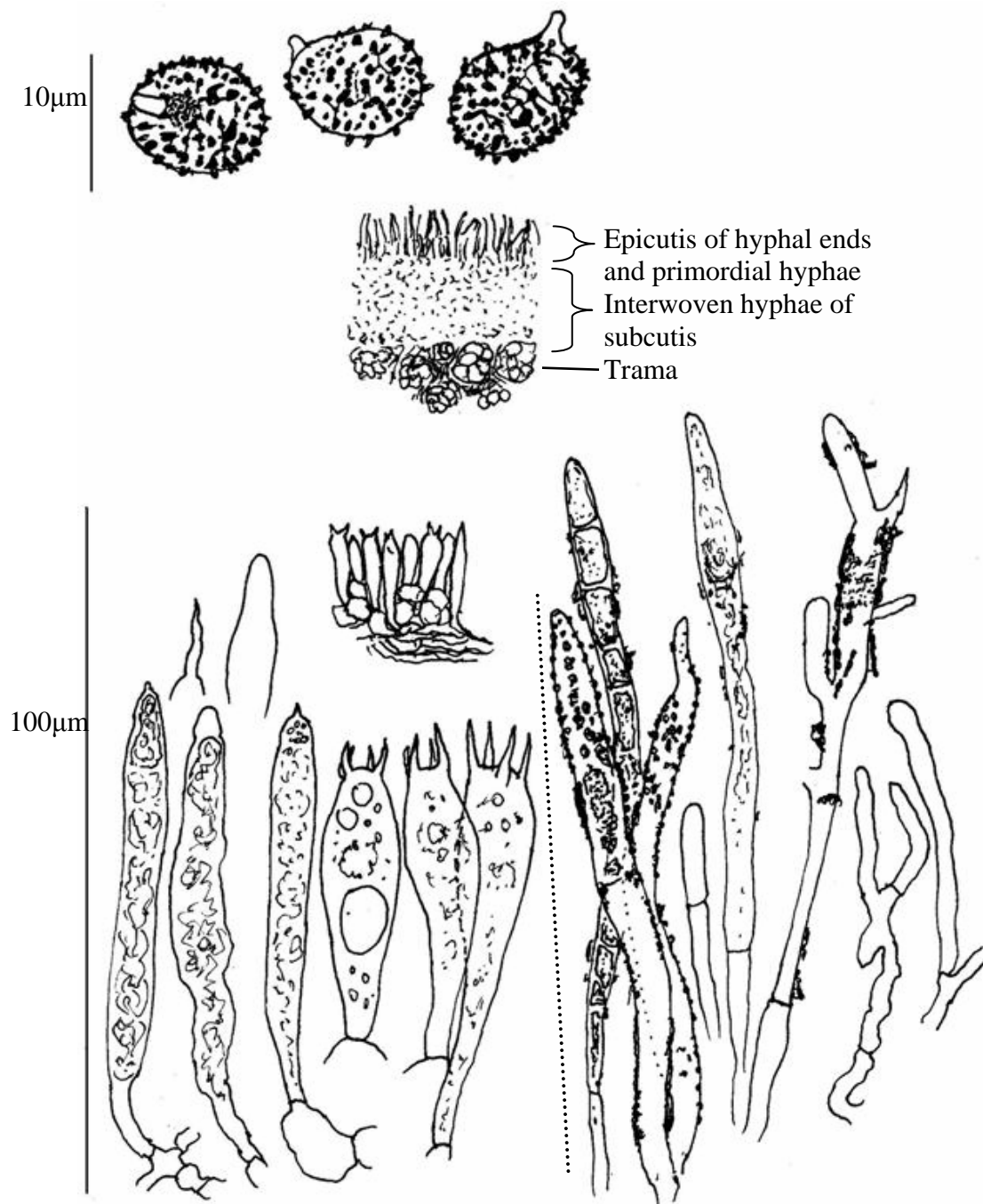


Figure 1. Microscopic characters of *Russula albida*: Top, spores with 10µm scale bar; middle, diagram of cutis in SV, which dissolves the gelatinous matrix allowing the epicutis to expand upwards; bottom left, hymenial cystidia and basidiomata with, above them a diagram of the structure of the hymenium showing the raising of newer basidiomata above the origin of the older ones by means of an inflated basal cell; lower right, incrustated primordial hyphae and epicutal hyphae, lower scale bar is 100µm.

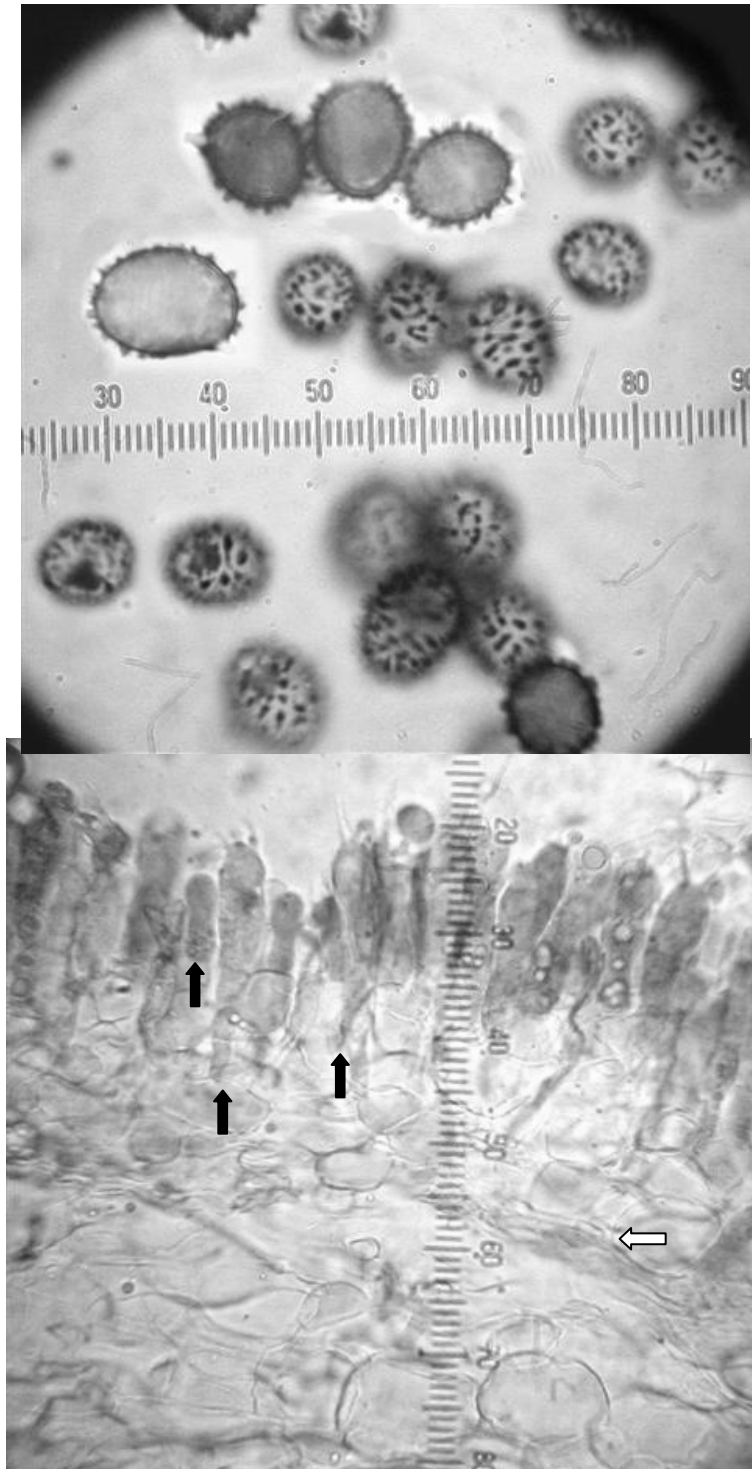


Figure 125. Characters of the hymenium of *R. albida*: Top, spores with 1μm division scale; bottom, section through gill stained in phloxine, the white arrow points to the narrow band of hyphae at the base of the subhymenium, black arrows point to the bases of basidia at different levels, the uppermost one is just starting to develop, note also the large sphaerocytes of the gill trama, 10 scale divisions are 25μm.

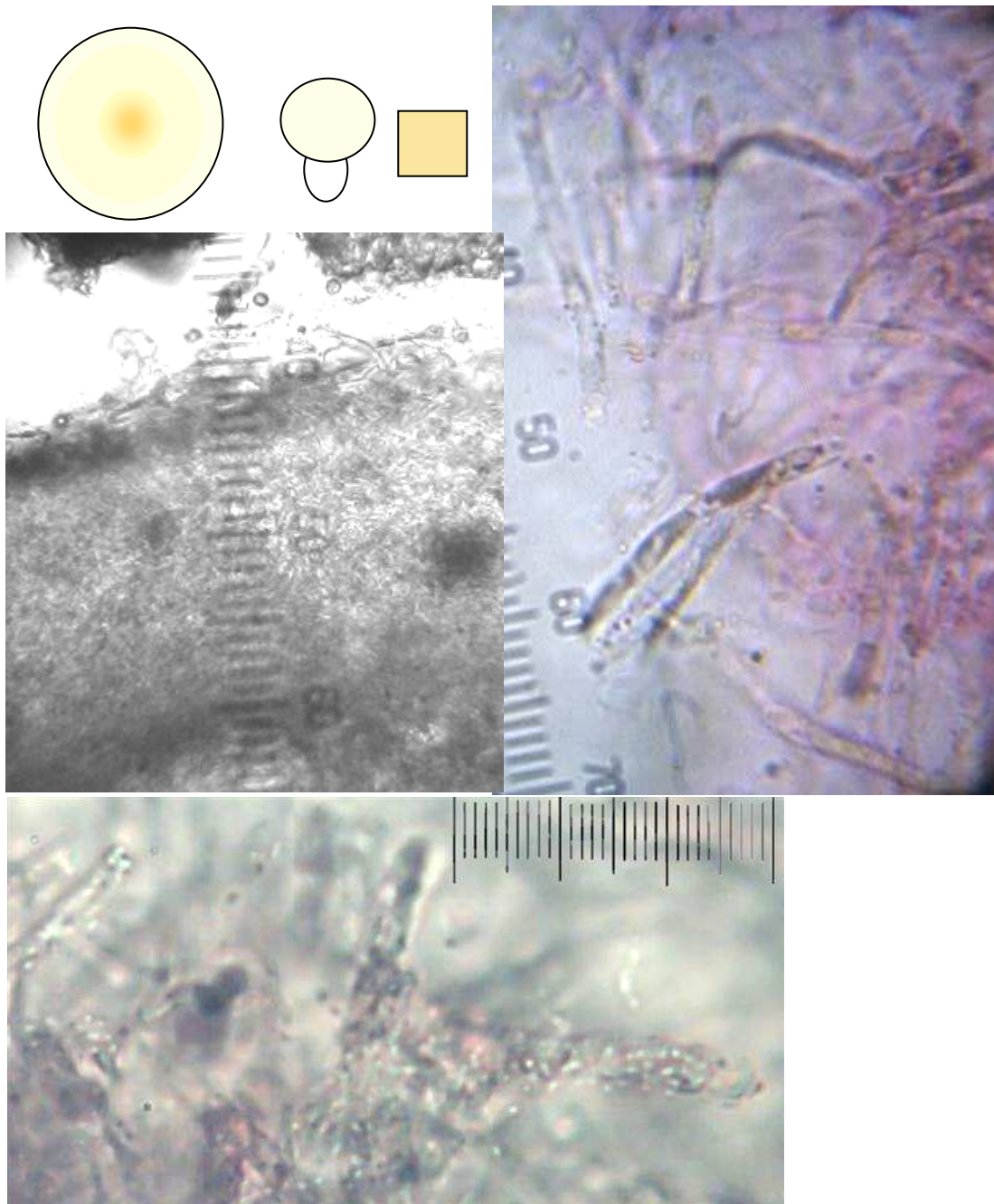


Figure 126. Characters of the cutis of *R. albida*: Top left, field sketch of cap colours; middle left, section through cutis mounted in water, 10 scale divisions are 100µm; top right, cuticular hyphae in SV showing some greying hyphal contents in some cells, 10 scale divisions are 25µm; bottom, close up of incrustated primordial hyphae seen in SV, scale is in 1µm divisions.

***Russula lepidiformis* Murrill**

Mycologia 30:363 1938

Description of Vancouver Island collections:

Cap 5.5-8cm diameter, pulvinate when young, becoming shallowly depressed, margins curved down over gill edges, margins smooth. Colour an intense deep red, more brownish red in the centre, not fading or changing much, young and mature basidiomata about the same colour, not or barely viscid when wet, quickly drying matte and finely velvety. Cutis not peeling, flesh beneath tinted pink, cap trama white, unchanging.

Gills creamy white, close to subdistant, subgills occasional, forking not seen, narrowly adnexed at the stipe, ventricose, broadest at about 3/4 the radius, up to twice the depth of the cap trama at half-radius, at cap margin the gill is rounded up to where it becomes free of the cap cutis, where there is a near 90° angle with the gill margin.

Stipe 4-6 x 1.3-2cm, white, smooth to finely longitudinally rugulose, sometimes pruinose especially near the apex, firm, solid to firmly stuffed, not cavitate, more or less cylindrical, unchanging where cut but browning a little where handled. Microscopically the vascular hyphae in the stipe cortex do not stain in SV.

Texture firm, like a crisp apple, but not particularly brittle.

Taste bitter, but not strongly so, otherwise mild to faintly peppery.

Odour not distinctive.

Spore colour pale cream, Romagnesi Ib-IIa.

Spores 8.0-10.2 x 6.8-8.6µm, L:W 1.15 -1.4 with a mean of 1.25, (n=30), mostly ellipsoidal to ovoid, rarely subglobose. **Ornamentation** of small conical warts 0.4-0.8µm high, very occasionally up to 1µm high, isolated or 2-3-catenate or joined by very

fine lines forming a partial reticulum, with most spores having fairly crowded warts. At a magnification of 400x, the spores appear as if with mostly isolated warts or wart clusters, but the reticulum is apparent at 1000x magnification. **Woo type 2C.**

Suprahilar patch lightly amyloid, irregular in shape and often with a nearly continuous strongly amyloid border containing warts. **Hiliferous appendix** around 1.8-2.2µm long, 1.2-1.5µm wide at base. **Basidia** 4-spored, occasionally 2-spored, 48-60 x 11-15µm, broadly clavate, light grey-brown in 5% KOH, successive basidia developing one cell up from the basal cell of the older basidia. Sterigmata rather fat, up to 7µm long and 1.9-2.5µm wide at the base. **Pleurocystidia** frequent, 70-95 x 7-10µm, most protruding less than 20µm, originating in the subhymenium, more or less fusoid, contents yellowish, refractive in KOH, grey to brownish purple in SV, tips subacute to acute, occasionally with a tiny button. **Cheilocystidia** frequent, 55-70µm protruding up to 20µm, tips acute, obtuse, with a small button or strangulate appendage, barely reacting with SV, occasionally lacking refractive contents, otherwise similar to pleurocystidia. Approximately 200-300µm of the gill margin stains yellow-brown in SV in a clearly delineated band. **Subhymenium** 20-400µm thick, well differentiated, pseudoparenchymatous. **Gill trama** of sphaerocytes with occasional vascular hyphae.

Cutis 150-260µm thick, an ixotrichodermis when young, losing any surface viscid material when mature to become a trichodermis. **Subcutis** about 1/2-2/3 the thickness of the cutis, of hyphae 1.5 –3.5µm wide, pink in water mounts and containing occasional to frequent small globular bodies of dark pink pigment. The lower 30-50µm of the subcutis is a brownish pink and contains frequent vascular hyphae 3-7µm wide, with occasional ones ascending into the epicutis, forming pseudocystidia about 5µm wide. These are often incrustated, terminate below the surface, with tips obtuse, undifferentiated or with a clavate end cell that broadens up to 8µm wide, staining grey in SV and temporarily pink in acid fuchsin. **Epicutis** of erect, tangled, hyaline to pinkish hyphae 2-5 µm wide, many of which are partially incrustated, endings capitate, nodulose, contorted or occasionally with series of short cells occasionally up to 7µm wide, sometimes the terminal few cells with brownish contents. Accompanying the epicutal hyphae are clusters of pileocystidia and primordial hyphae, mostly lying along the surface, all of which are incrustated with a

broken brownish material, often angular as if crystalline, with much of this material loose between the epicutal hyphae and appearing as debris, except that it is within the interweavings of the epicutis. All these elements form a brown crust-like layer that cracks apart into areoli in mature basidiomata. **Pileocystidia** 60–110 x 5–8µm, 0–2 – septate, cylindrical, incrustated, capitate, occasionally with a crown of incrustations, with yellow-brown amorphous to refractive contents that stain temporarily red in acid fuchsin and grey in SV. **Primordial hyphae** 3–4µm wide through the subcutis where they arise, broadening up to 7.5µm wide at the surface, sometimes branched, incrustated more than subcutis hyphae, with colourless to yellowish contents more refractive than epicutal hyphae but less so than pseudocystidia and vascular hyphae, sometimes with a cystidioid terminus, staining pink in acid fuchsin, the incrustations staining brownish grey and the contents unreacting to light grey in SV. **Hypodermis** not strongly differentiated, but separable from the lowermost layers of the subcutis in parts, merely a slightly more compact layer of tramal tissue.

Trama of discrete large clusters, 130–250µm across, of sphaerocytes, bound by a hyphal mesh, with occasional incrustated hyphae and frequent vascular hyphae 4–6µm wide that stain grey-brown in SV.

Chemical reactions: FeSO₄ - light salmon pink; KOH - brownish orange on cap surface, no reaction on stipe; NH₄OH - no reaction; guaiac - blue-green; guaiacol - pinkish; phenol - brownish purple; SV - purple-brown on the gills but unstaining on the gill margins, brownish on the cuticle and trama, cystidia and vascular hyphae non-reacting to greyish.

Habitat and tree associations: not recorded.

Collections: SVIMS 041030, a collection brought in to the October 2004 South Vancouver Island Mycological Society annual show at Swan Lake Nature House. Site of collection and habitat details not known.

Notes: This collection keyed out as *Russula lepida* Fries in Bon (1988) and Romagnesi (1967) with the exception of the positive reaction of the cystidia with SV and larger spores; and its North American equivalent: *R. lepidiformis* Peck in Kibby and Fatto (1990). The cap colour of this collection is more intense and darker than is common for both those species, but not outside of the range. Singer (1957) expressed some doubt as to whether *R. lepida* and *R. lepidiformis* were separate species; the European *R. lepida* has no SV positive elements according to Romagnesi, but Singer queries this based on his own observations of *R. lepida*. The Vancouver Island collection agrees reasonably well with Murrill's original rather brief description and with Singer's more detailed description made from the type and supplementary collections. *Russula lepidiformis* has larger spores than *R. lepida*: 7.5-11.7 x 7-10.2µm. Minor differences between the Vancouver Island collection and Singer's description of *R. lepidiformis* include the slightly shorter basidia, 33-42µm, and lack of reaction of hymenial cystidia with SV. Murrill found the type in Florida under turkey oak, a species not present on Vancouver Island, so it is hoped that more collections of this rather beautiful *Russula* will be found and a habitat ascertained.

The Kibby and Fatto (1990) key also led to *R. subvelutina* Peck, a dark red, mild species which does have SV positive cystidia, albeit scarce. This species has darker, smaller spores, and at the time of writing I have not acquired a full description with which to judge any similarities with the Vancouver Island collection. *Russula rubra* Fries is another red to deep red species with similarly hard flesh and incrustated hyphae in the cap cutis, with cap and hymenial cystidia staining dark grey in SV, but an intensely acrid taste. *Russula rhodopoda* Svara in Melzer and Zvara, is a mild tasting red species reported from the Pacific northwest (Thiers 1997), but has a glossy cap, yellow spores, and a cutis lacking incrustations but with many well differentiated pileocystidia.

If the microscope slide of the cutis is illuminated with a white LED bulb, the yellow-brown pileocystidia show up better and are easier to differentiate from the primordial hyphae than when a tungsten bulb is used.

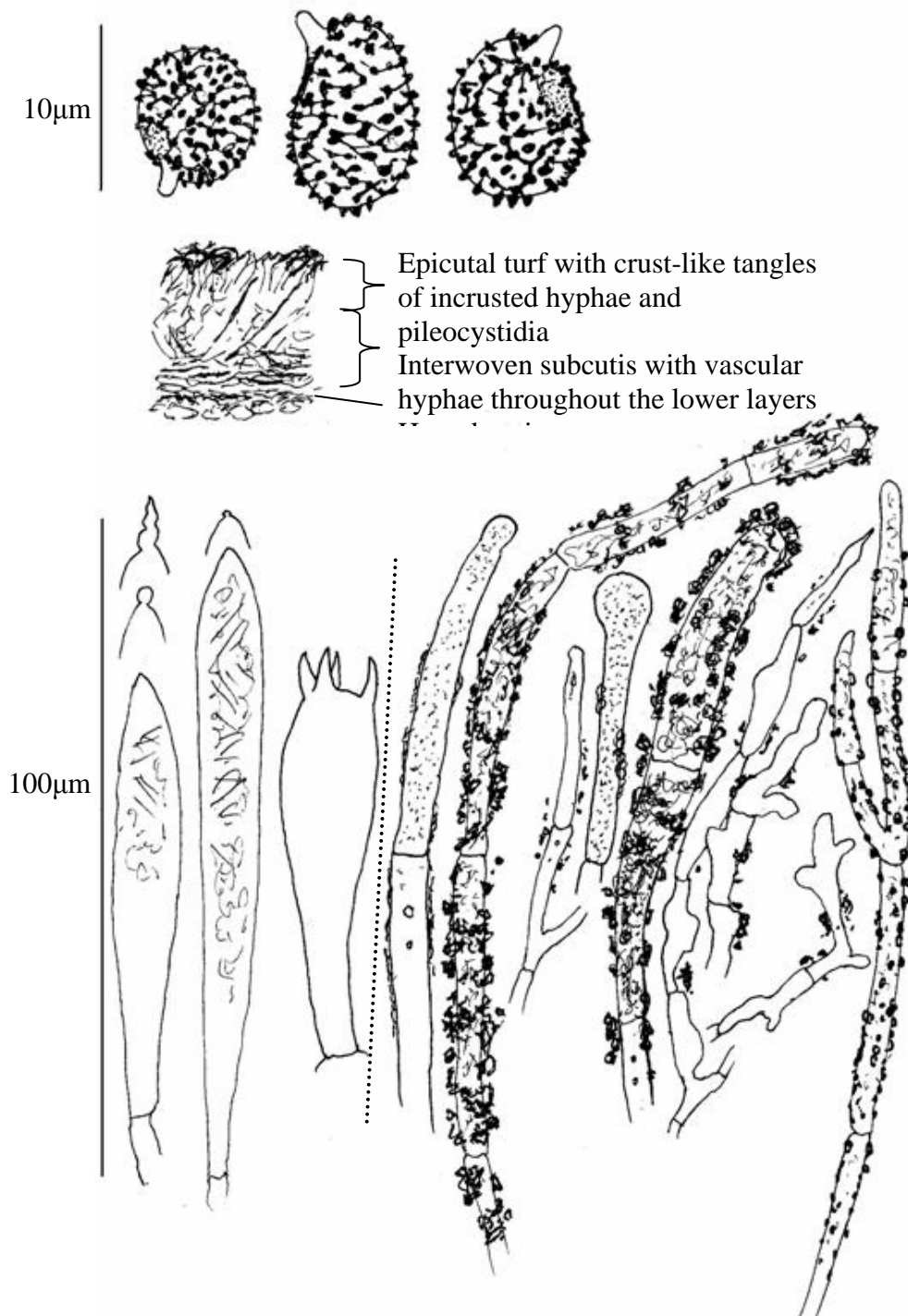


Figure 128 Microscopic characters of *Russula lepidiformis*: Top, spores with 10µm scale bar; middle, diagram of section through cutis; bottom left, cheilocystidia, pleurocystidia and basidium; bottom right, pileocystidia, primordial hyphae and hyphal ends from the epicutis, lower scale bar is 100µm.

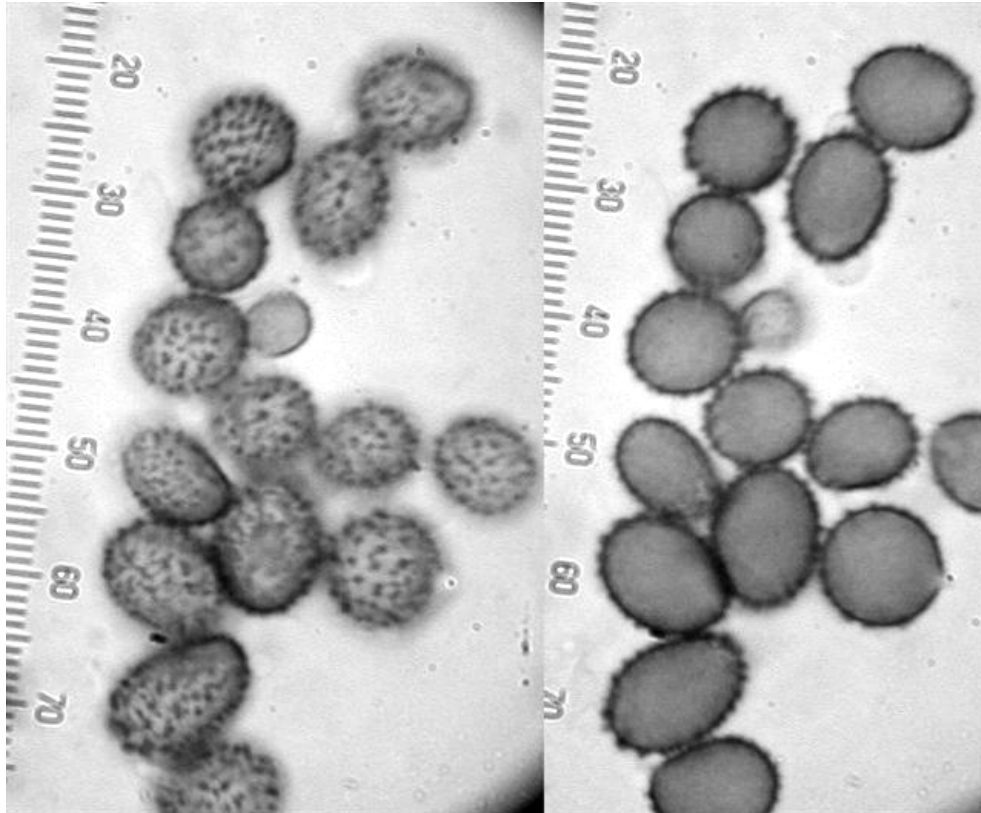


Figure 129. Spores of *R. lepidiformis* in surface view (left) and equatorial view (right), scale is in 1 μ m divisions.

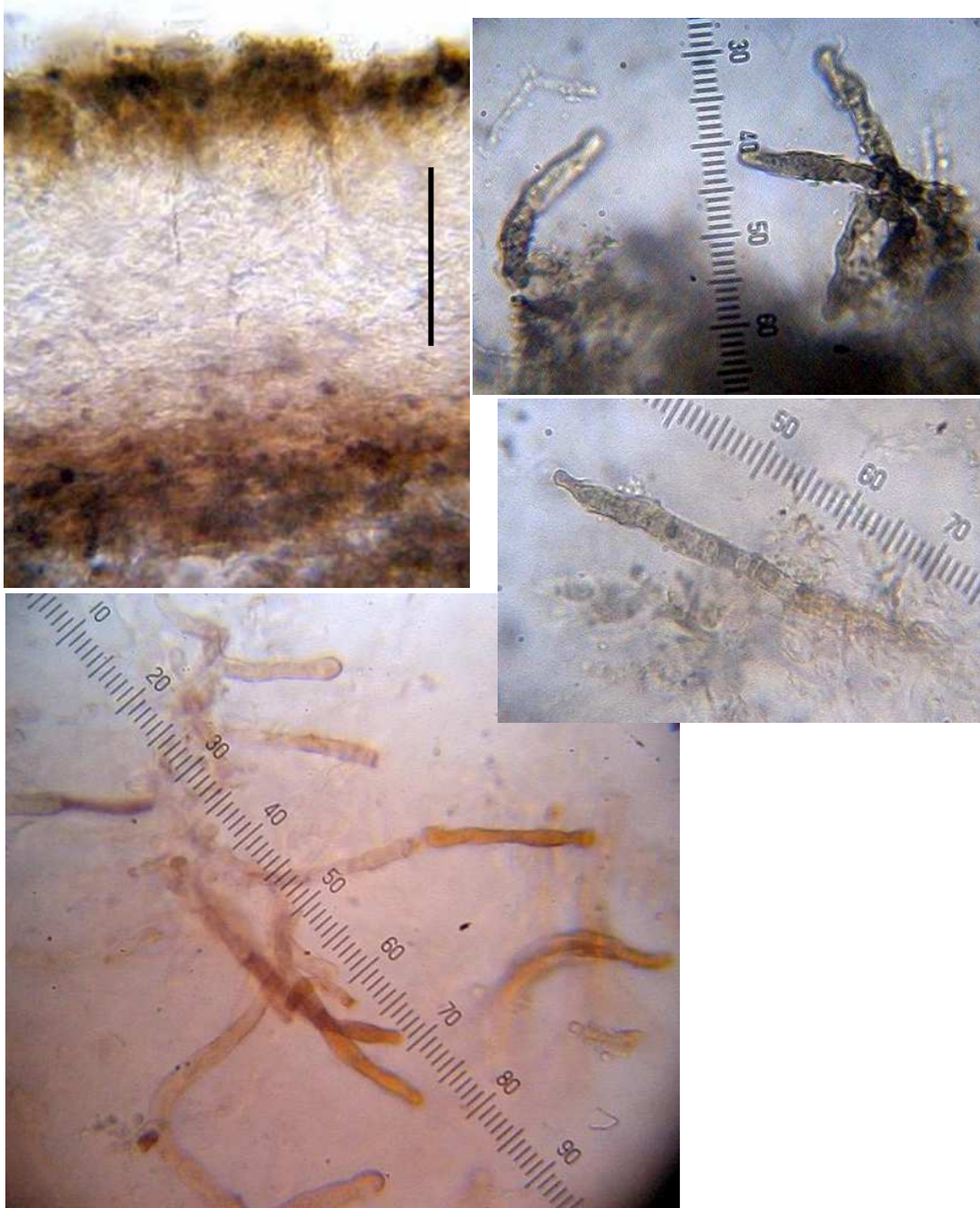


Figure 130. Characters of the cutis of *R. lepidiformis*: Top left, section through cutis mounted in water, scale bar is 100 μ m; top and middle right, two views of pileocystidia in SV; bottom, surface view of cutis mounted in water of a younger basidiomata showing the yellow-brown pileocystidia and the paler and slightly broader primordial hyphae at top and bottom of picture, the incrusting material is less obvious in this mount, 10 scale divisions are 25 μ m for all three pileocystidia photographs.

Clade 8a

Section *Amethystinae* Romagn. emend Sarnari

Subsection *Olivaceinae* Singer

Russula olivacea (Schaeff.) Fries

Epicr. Myc. 1938

Description of Vancouver Island collections:

Cap (4.5 -immature) 8.4-11.4cm diameter, convex or pulvinate when young, expanding to irregularly plane with a central shallow depression or in one collection illustrated below, convex with a flattish centre and rim, the shape of an inverted soup bowl, the cap margins smooth and downcurved over the gill ends but not actually inrolled. The colours are mostly drab, with olive green and purple hues that mix to form a dull brown, dry, not or barely viscid when wet, pruinose when young, later finely felted like kid leather, the surface breaking up into concentric areoli especially towards the margin. Cutis peeling up to 1/2 when young, later barely peeling at all, flesh beneath with a dull green or greyish purple tint, otherwise creamy white, unchanging.

Gills cream at first, becoming deep egg-yolk yellow at maturity, unchanging where damaged, close, little forking, subgills common and often reaching almost to the stipe, relatively thin, slightly decurrent to adnate at the stipe, subacute at cap margin, of even depth at first, becoming ventricose, from around 1/3 to equal the depth of the cap trama at half-radius, the gill edges tinted with the cap colour along the outer 2-5mm.

Stipe 3.2-6.9 x 1.8-2.4cm, slightly more clavate than cylindrical, firm, generally with a partial to complete flush of pink, otherwise creamy white, pruinose, fairly smooth to slightly rugulose, browning at the base, solid to stuffed with a firm trama that does not

form cavities, although it may be hollowed out by insects in age, unchanging to faintly greyish-brown where damaged.

Texture hard, robust, not brittle except in the gills.

Taste mild, nutty, slightly sweet.

Odour not distinctive to fruity or like meat.

Spore colour deep ochre-yellow, Romagnesi IVc.

Spores 8.6-13.6 x 7-11.8 μ m, L:W 1.04-1.39 with a mean of 1.19 (n=30), varying considerably in size within one spore print or piece of gill, subglobose to ellipsoidal to obovoid, large spores may be pyriform, globose or narrowly obovoid instead of the more normal shape. **Ornamentation** of warts 0.5-1.4 μ m high, on most spores below 1 μ m, conical, pointed, or often shortly crestate or arc-shaped, mostly isolated, sometimes in rows, sometimes linked to close neighbours with low, fine lines, not forming a reticulum, often incompletely amyloid. **Spores** may have mostly well-spaced heavy warts, or commonly a mixture of heavy warts with fine warts scattered among them. **Woo types** 2A-3A-2B-3B. **Suprahilar patch** a lightly amyloid irregularly shaped area with warts within and at its borders. Hiliiferous appendix around 1.9-4.8 μ m long, 1.5-3.0 μ m wide near the base. **Basidia** 4- and 2-spored, 45-77 x 11-13 μ m, the older and spent basidia with long narrow bases. Sterigmata 7-12 μ m long and 1.6-3 μ m wide at the base, those of 2-spored basidia generally larger than those of 4-spored ones. **Pleurocystidia** frequent, 90-150 x 8-12 μ m, protruding up to 55 μ m, less so toward the gill margin, originating in the subhymenium or outer trama, cylindrical to narrowly fusoid, contents yellowish and refractive in KOH, often apparently empty except for the tip, tips acute, more often mucronate to tapering with a long filamentous strangulate appendage, red to a slightly more brownish red than the basidia in SV. **Cheilocystidia** none near the cap margin, instead the gill edge has a gelatinous substance and contorted, stunted basidioles, over the remainder of the gill margins are numerous cheilocystidia, the tips protruding only up to 30 μ m, narrow and contorted, sometimes capitate and sometimes tapering 37-57 (-75) x

5-7µm, very occasionally septate, and rarely branched, often lacking refractive contents partially or entirely. **Subhymenium** 40- 70µm thick, sometimes merging gradually into the gill trama, pseudoparenchymatous, expanding outward by one to two cells with successive developing basidia. **Gill trama** of sphaerocytes and occasional vascular hyphae.

Cutis 90-150 µm thick, a weakly gelatinised trichodermis. **Subcutis** a greyish pink zone up to half the cutis depth, consisting of the tangled bases of the epicutal hyphae and hyphae 3-6 µm wide, continuous with those of the trama, with no distinct demarcation line. However, in freshly prepared sections in water the air trapped in the more porous trama distinguishes it from the denser subcutis. The subcutis is thinner and even less differentiated from the trama toward the margins. Vascular hyphae not seen. **Epicutis** of erect, hyaline to pinkish hyphae 5-7µm wide, most with obtuse undifferentiated tips, others with small capitate or tapered tips, and fairly frequent inflated cells up to 10µm wide, one to three of which often form a fusoid base to a narrower tip making an ampulliform structure, sometimes these cells are articulated or shaped like tarsals. On a few of the inflated sections the cell walls appear minutely roughened. Some of the terminal cells have refractive contents or globules, which become slightly browner than the others in SV, but lack any typical greying reaction. Some hyphae lying along the surface have greenish brown contents. **Primordial hyphae** not seen, no one structure stains differentially in acid fuchsin, instead, the whole epidermis, especially the deeper tissues, retains a slight pink hue. **Pileocystidia** - none that are unambiguously obvious. Some of the hyphae have slightly refractive contents and these sometimes terminate in cystidia-shaped cells, but lack any reaction with SV. **Hypodermis** none.

Trama of discrete clusters of sphaerocytes bound by a hyphal mesh, vascular hyphae not seen.

Chemical reactions: FeSO₄ - brown; KOH - reddish on cap surface, no reaction on stipe; NH₄OH - no reaction; phenol - bright blackcurrant-juice purple; SV - bright red on the gills, brown on the cuticle (hyphae pink under the microscope), hymenial cystidia weakly greying or browning.

Habitat and tree associations: In old-growth forest of Douglas fir, western hemlock and western red cedar, the host may be Douglas fir rather than western hemlock as *R. olivacea* has not been found in the coastal western hemlock areas that lack Douglas fir. The species is uncommon locally.

Collections: CR001010-01, beside a trail under old-growth Douglas fir, western hemlock and western red cedar, Cathedral Grove, near Cameron lake, N49.291161°, W124.662468°. CR021019-01, on ground in a mixed-age stand with old-growth western hemlock, Douglas fir and western red cedar, Royal Roads University woodlands, N48.433667°, W123.477333°.

| ITS1-F to | | | | |
|-------------|--------|-------------|---------------|----------|
| Collection | ITS4-B | RFLP: HinfI | AluI | Sau3A |
| CR021019-01 | 1141 | 229, 180 | 451, 379, 269 | 337, 195 |

Notes: The similarities between *Russula olivacea* and others in clade 8 are the generally firm texture, solid stipe, and the epicutal hyphae which are upright, crowded, with the majority of an even width, around 4-5µm, bringing to mind the tentacles of certain tropical sea anemones associated with clown-fish or of a twist-pile carpet.

Russula olivacea is superficially similar to several large, mild, yellow-spored *Russulas* with mixtures of purple and olive in the cap. *Russula xerampelina* and other species in that group have a fishy odour, stain blue-green with FeSO₄, brownish purple with 2% phenol, bruise yellow then brown, and have microscopic differences in the cutis and spores. *Russula integra* has a similar robust texture and colours to *R. olivacea* but differs in its reaction to phenol, the texture of the cap cutis and microscopically to acid fuchsin and SV on the cutis. *Russula occidentalis* has a more viscid cutis, a pink to grey to black bruising reaction, and incrusted hyphae in the cutis. Two other members of the *Olivaceinae*: *Russula alutacea* and *R. vinosobrunnea*, occur on the west coast, Woo (1988), (Thiers 1997), both of which have the blackcurrant colour reaction with phenol, the former has a reddish-purple cap and reticulate spores and the latter, not recorded north of California, is a smaller species generally with slightly smaller spores (up to

10µm long) with more catenate ornamentation. It is not yet known if these species also carry the approximately 250 bp insertion in the ITS region.

The occasionally septate cheilocystidia on these Vancouver Island collections are unusual, they have also been found on the gill margins of *R. smithii*, a green and brown, white-spored species in the subgenus *Amoenula*.

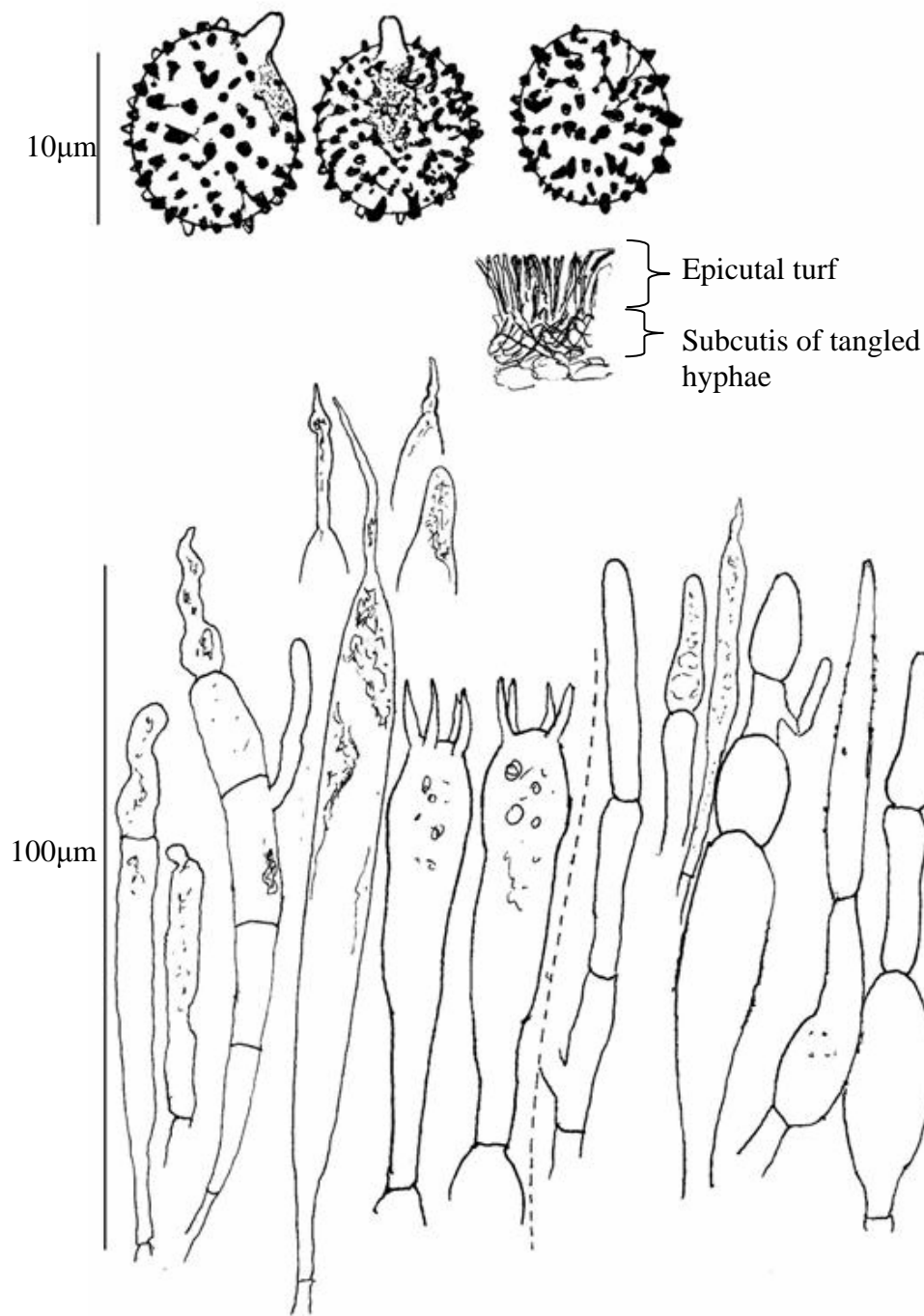


Figure 131 Microscopic characters of *Russula olivacea*: Top, spores with 10 μm scale bar; middle, diagram of section through cutis; bottom left, three cheilocystidia, a pleurocystidia and various tip shapes and two basidia; bottom right, hyphal ends from the epicutis, the most numerous type is the left-hand one adjacent to the dotted line, very occasionally elements with minutely roughened hyphal walls as is shown in two of the inflated hyphae, lower scale bar is 100 μm .



Figure 132. Macroscopic characters of *R. olivacea*: Top, two basidiomata measuring 11.4cm and 8.4cm diameter, the larger is mature, bottom left, the underside of the larger basidioma; bottom right, illustration of immature and young-mature basidiomata in profile and in longitudinal section, square shows spore colour and is 1cm².

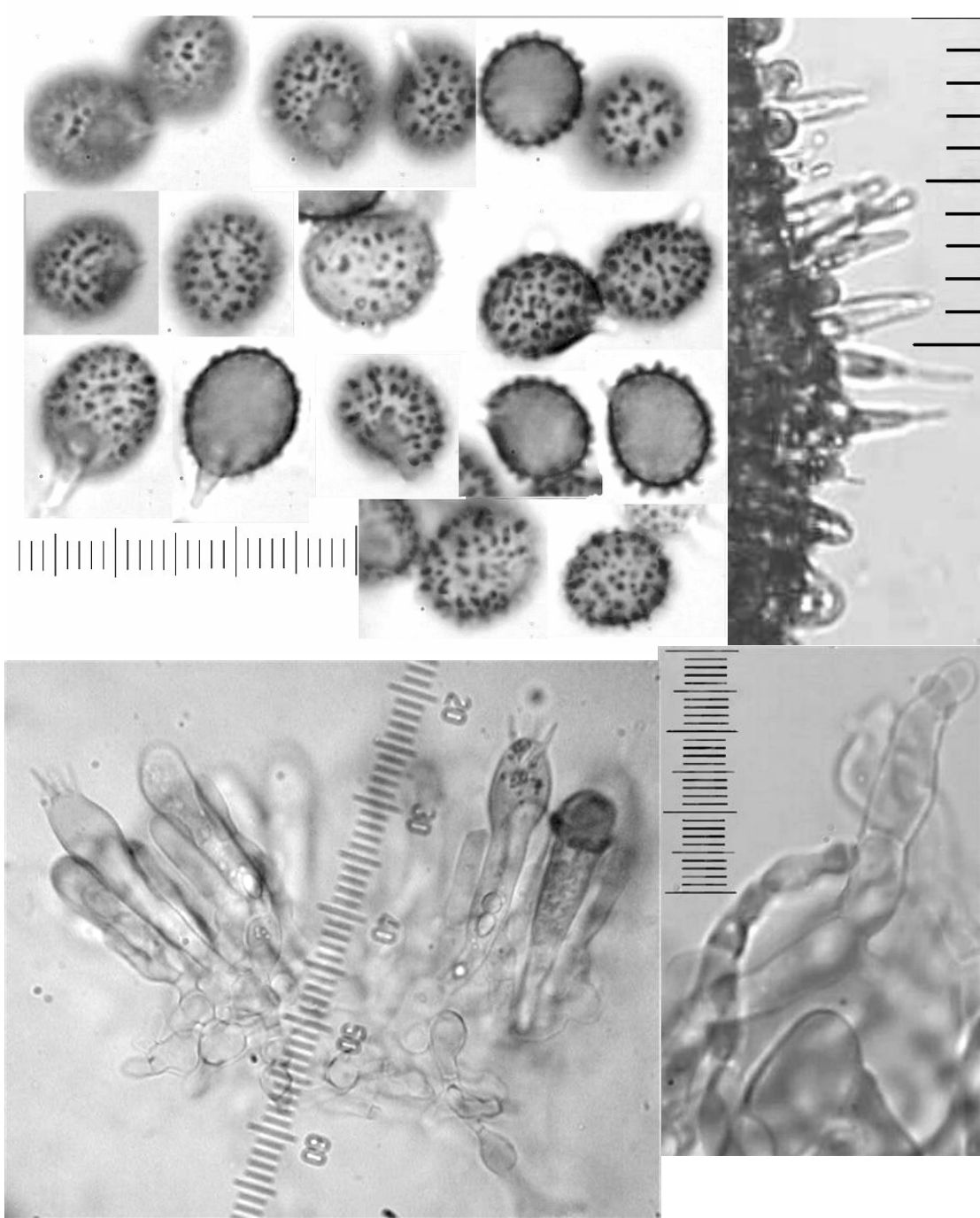


Figure 133. Hymenium of *R. olivacea*: Top left, spores with 1 μ m division scale; top right, pleurocystidia with a variety of tip shapes protruding from hymenium, scale is in 10 μ m divisions; bottom right, septate cheilocystidia with 1 μ m division scale; bottom left, basidia and basidioles with subhymenium, 10 scale divisions are 25 μ m.

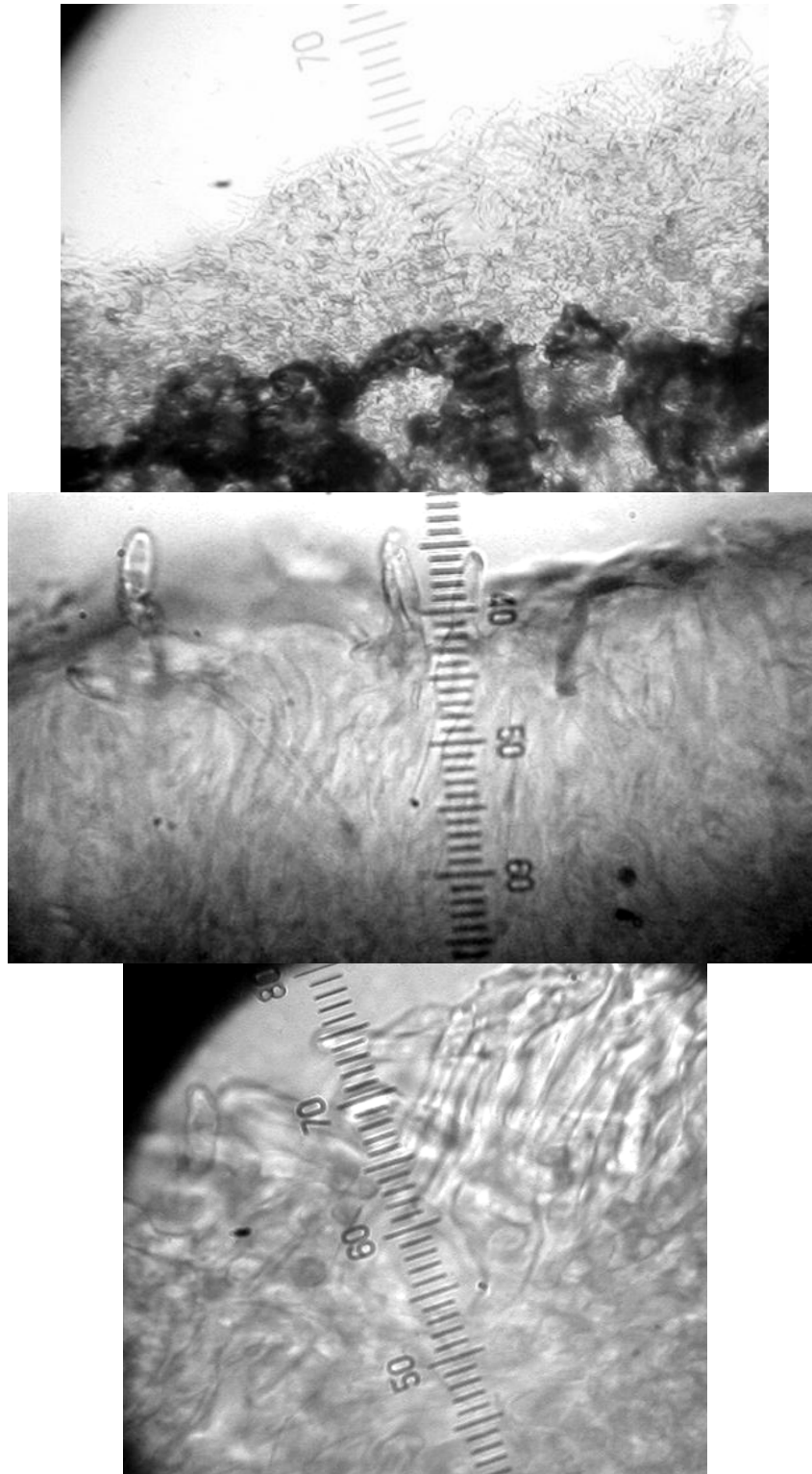


Figure 134. Cutis of *R. olivacea*: Top, section through cutis with tramal tissues below, in which the trapped air appears as dark patches, 10 scale divisions are 100μm; middle and bottom, two views of the epicutal turf in water mounts, from near the cap centre and near the margin respectively, 10 scale divisions are 25μm.

Clade 8c

Subsection *Urentes*

Series *Veternosa*

Russula veternosa Fries

Epicrisis Myc. 357. 1838

Series *Maculata*

(*Russula maculata* Quelet & Roze)

(in Quelet, Bull. Soc. Bot. France. 24: 323. 1878)

Description of Vancouver Island collections:

Cap 3.9-8cm diameter, convex with a small central depression at first, expanding to shallowly and broadly centrally depressed or almost infundibuliform, margin smooth, striate in age, long remaining downcurved over the end of the gills (not inrolled), colour light to mid terracotta colour (brownish-pink), usually with a cream to light brownish-yellow centre, this sometimes with olive tints, occasionally this colour over all but for the slightly pinker margin, colours generally paler when young, moist to slightly viscid, viscid when wet, drying matte, cutis peeling 1/4 to 1/3, cap trama firm, creamy white, pink under the cutis, unchanging where damaged or at most becoming very pale grey-brown.

Gills deep yellowish cream, becoming light orange-yellow at maturity, unchanging where bruised, close to crowded, with occasional lamellulae and forking near stipe, adnexed to ascendant to almost free at stipe, subacute to obtuse at cap margin, of equal depth along most of their length but narrowing towards the stipe, 5-7 mm deep at half-radius, approximately twice the depth of the trama, texture pliable to slightly brittle.

Stipe 2.2-8cm, x 1-2.7cm, length in general roughly equal or slightly longer than cap diameter, more or less cylindrical to slightly clavate, sometimes widening at the apex, surface white, often with a pinkish flush near the base, longitudinally rugulose, solid, stuffed with a bread-textured trama that does not usually develop cavities, unchanging when cut or bruising weakly light grey-brown.

Texture firm, not brittle, but becoming softer in age.

Taste peppery to acrid, sometimes with a slightly bitter component at first.

Odour slightly fruity and faintly of ginger biscuits.

Spore colour ochraceous yellow, Romagnesi IVb.

Spores 6.5-8.8 x 5.7-7.5µm, L:W 1-1.28, mean (n = 60) 1.14, broadly ellipsoidal, ellipsoidal to obovoid. **Ornamentation** of conical to peg-like or occasionally crestate warts 0.4-0.7µm, rarely to 1.0µm, 2-3-catenate or connected by fine to heavy lines often forming horizontal or vertical bands, with occasional isolated warts, sometimes forming a broken reticulum, Woo type B2-C2. **Suprahilar patch** amyloid, a more or less round patch bordered by warts and lines. **Hiliferous appendix** 1.7-1.9µm long, 1.1-1.3µm wide near the base. **Basidia** mostly 4-spored, some 2-spored, 34-52 x 10-12µm, clavate. Sterigmata up to 8µm long, 1-1.5µm wide near the base. **Pleurocystidia** frequent, regularly distributed, 35-80 x 7.5-10µm, rarely to 12µm wide, originating in the subhymenium, embedded or only protruding up to 20µm, fusoid to clavate, tips obtuse, subacute, with a small button or short appendix, or occasionally inflated, contents refractive, yellowish in KOH, dark grey to purple in SV. **Cheilocystidia** numerous, protruding up to 30µm in some cases, or sometimes adhering to the gill margin, contents and shape similar to pleurocystidia but usually more slender, 6-8 µm wide. **Subhymenium** 20-40µm, a dense and interlocked pseudoparenchymatous layer. **Gill trama** of sphaerocytes with occasional vascular hyphae.

Cutis 120-200µm at half-radius, about 2/3 the depth consisting of a pinkish subcutis, and an epicutis with many pileocystidia embedded in a conspicuous glutinous layer. **Subcutis** of compactly interwoven parallel or tangled narrow hyphae mostly under 2µm wide, with rare to occasional vascular hyphae that may ascend and terminate within the epicutis, embedded in a gelatinous matrix. **Epicutis** a trichodermis of erect free hyphal ends mostly under 2µm wide, undifferentiated, with a small capitum, or quite commonly ending in a small cystidium, embedded in a viscid matrix. **Pileocystidia** abundant, 40-

100 x 4-8µm, occasionally up to 180µm in length, cylindro-clavate to clavate, tips obtuse, with a small capitatum or a narrowed but not constricted tip, generally 3-4 septate with septa spaced about 10-35µm apart, somewhat articulated, rarely aseptate and these usually short and small, contents greyish to purple in SV. Rare pileocystidia appear to have an exudate or irregular mucilaginous sheath which may stain grey in SV but not or only fleetingly in acid fuchsin. **Pseudocystidia** none or rare. **Hypodermis** a layer of compacted tramal tissue up to twice the cutis depth.

Trama of discrete clusters of sphaerocytes within a denser hyphal network, with occasional vascular hyphae, purple in SV.

Chemical reactions: FeSO₄ - light greyish pink; KOH - orange to yellowish on cap cutis, faintly yellow on stipe; NaOH₄ - no reaction on cap or stipe; phenol - purple-brown; SV - greyish-purple on gills and cutis, deep purple to black on vascular hyphae and cystidia.

Habitat and tree associations: gregarious under Douglas fir with or without western hemlock or western red cedar and understory huckleberry, commonly in regeneration stands and in well drained mineral soil rather than duff.

Collections: CR010902-03 in a mixed-age stand with veteran trees of Douglas fir with western red cedar, huckleberry and sword fern, near the ridge-top in well-drained soil, near the High Ridge trail, Francis King Park, Victoria, N 48.4833°, W 123.4502°. CR001108-03 in regeneration Douglas fir with western red cedar on south-facing slope, Royal Roads N 48.436°, W 123.474°. CR 010909-01, in young regeneration Douglas fir with western red cedar, Kemp Lake trail N 48.375283°, W 123.78037°. NP981107-01 with young Douglas fir, western hemlock and western red cedar, on private land, Hutchenson road, Mill Bay.

ITS1-F to

| Collection | ITS4-B | RFLP: Hinf1 | Alu1 | Sau3A |
|-------------|--------|-------------|----------|---------------|
| CR001108-03 | 865 | 432, 359 | 526, 271 | 380, 220, 171 |
| CR010909-01 | 860 | 423, 364 | 500, 291 | 323, 220, 155 |

Notes: These collections of *Russula veternosa* could equally have been identified as the closely related *Russula maculata*, as the spore ornamentation is closer to that of the latter species than the former. *Russula veternosa* should have spores with isolated pointed warts up to 1µm rather than with connections as in the Vancouver Island collections. The spore size, however, is consistent with *R. veternosa* sensu Romagnesi (1967), as are the multiseptate pileocystidia, the smaller hymenial cystidia, the faint ginger smell, the more muted cap colours and the slightly grey-brown rather than yellowish bruising reaction. *Russula maculata* tends to have a brighter red and yellowish mottled and spotted cap, spore sizes 8.2-10 x 7-8.7µm, hymenial cystidia from 80 - 115µm long, and many aseptate pileocystidia, otherwise 1-2-septate. The identification of these Vancouver Island collections as *Russula veternosa* called for a judgment as to whether the cuticular and macroscopic characters bore more taxonomic weight than the spore ornamentation: others may disagree, and it may be that this is a species distinct from either of those discussed here.

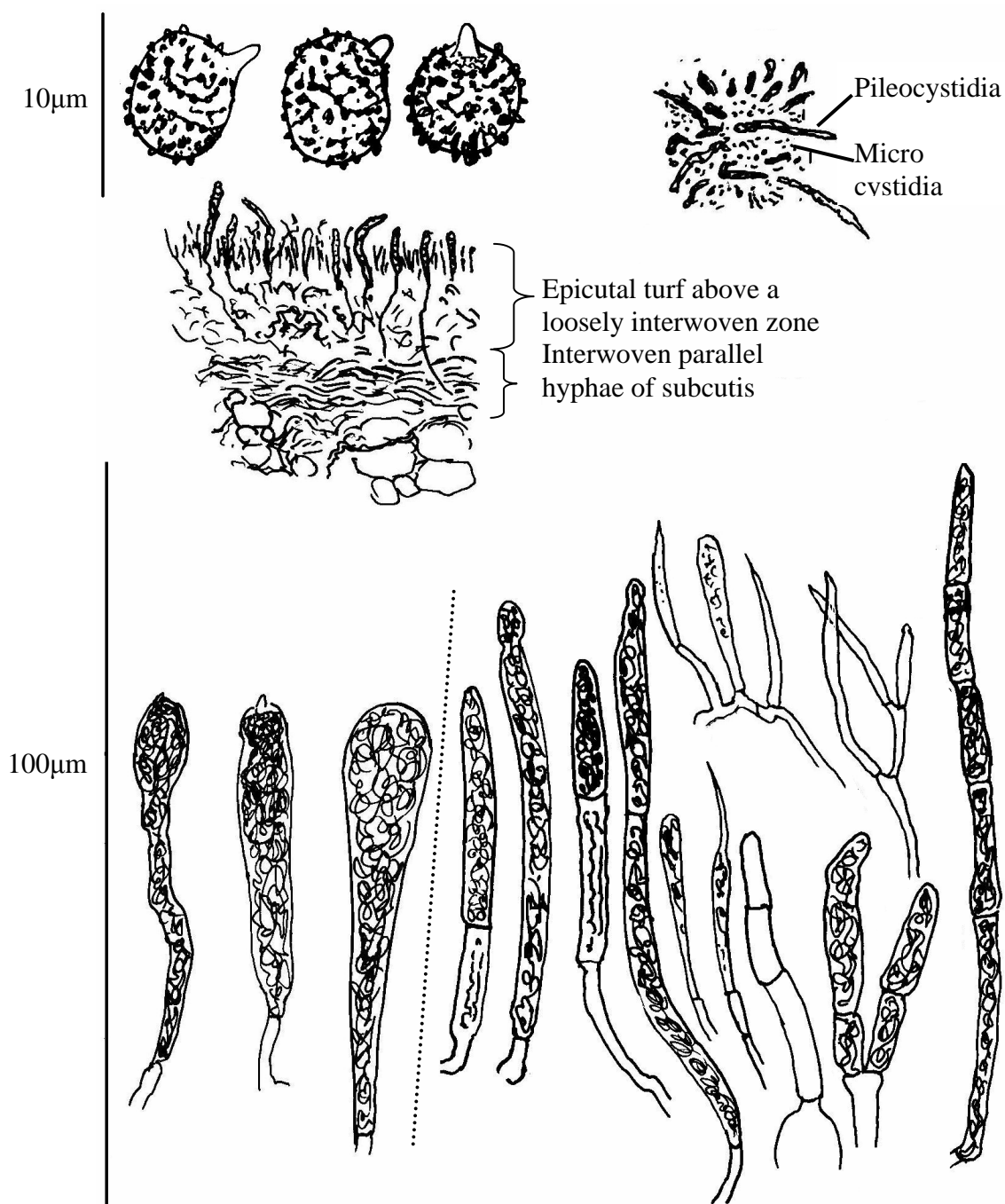


Figure 135. Microscopic characters of *R. veternosa* : Top left, spores with 10µm scale bar; top right, diagram of pileocystidia and micro-cystidia; middle, diagram of section through cutis; bottom left, hymenial cystidia; bottom right, pileocystidia, hyphal ends and micro-cystidia from the epicutis, lower scale bar is 100µm.



Figure 136. Macroscopic characters of *R. veteriosa*: Top. Illustration of immature and mature basidiomata with longitudinal section, the square shows spore print colour and is 1cm²; bottom, collection of *R. veteriosa* in habitat showing the typical terracotta and dull cream-yellow cap colours.

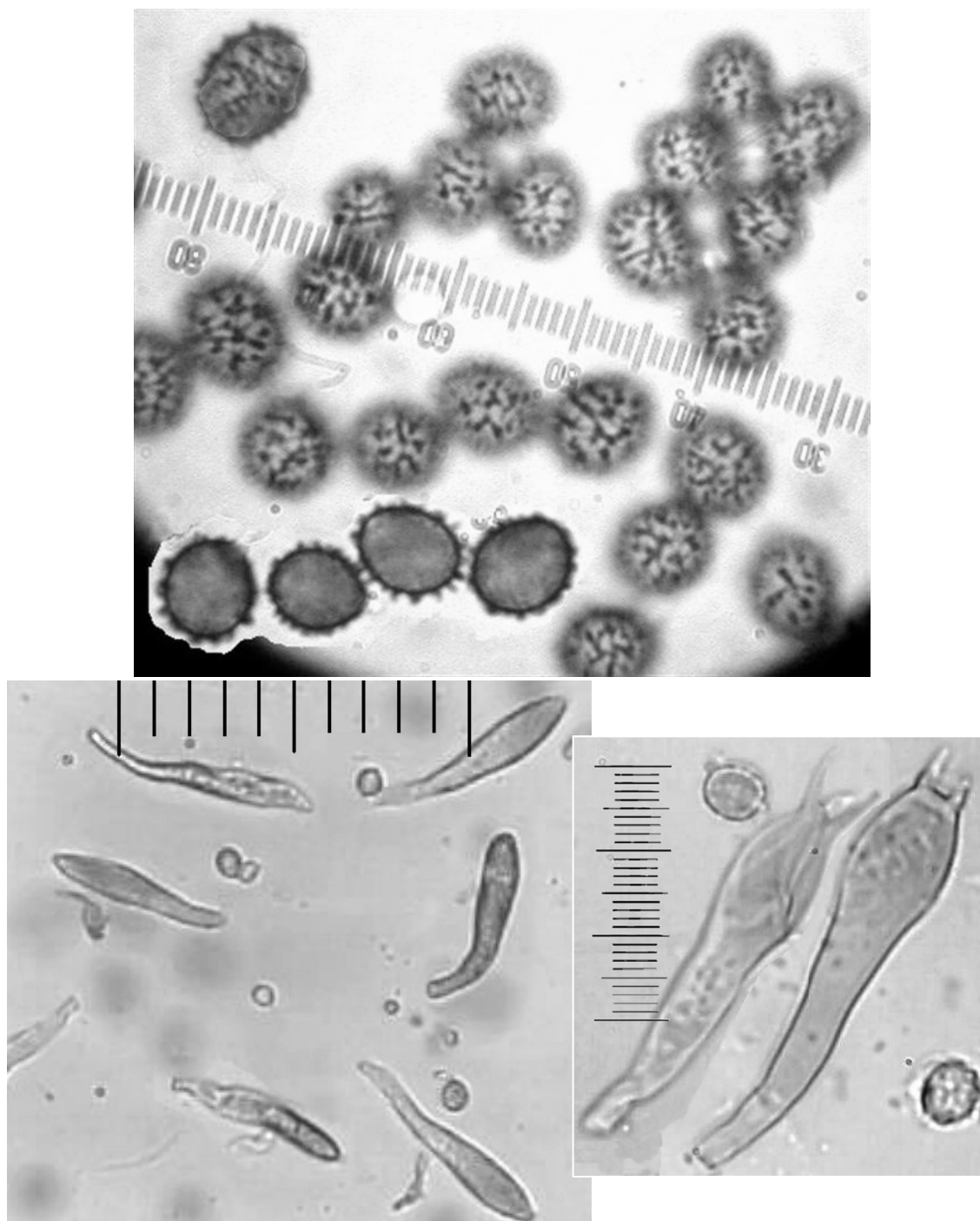


Figure 137. Hymenial characters of *R. veternosa*: Top, surface view of spores with inset equatorial view of four of the spores below the scale, scale is in 1µm divisions; bottom left, hyphal cystidia in a crush mount, scale is in 10µm divisions; bottom right, two basidia, the left a four-spored and the right a two-spored one, scale is in 1µm divisions.

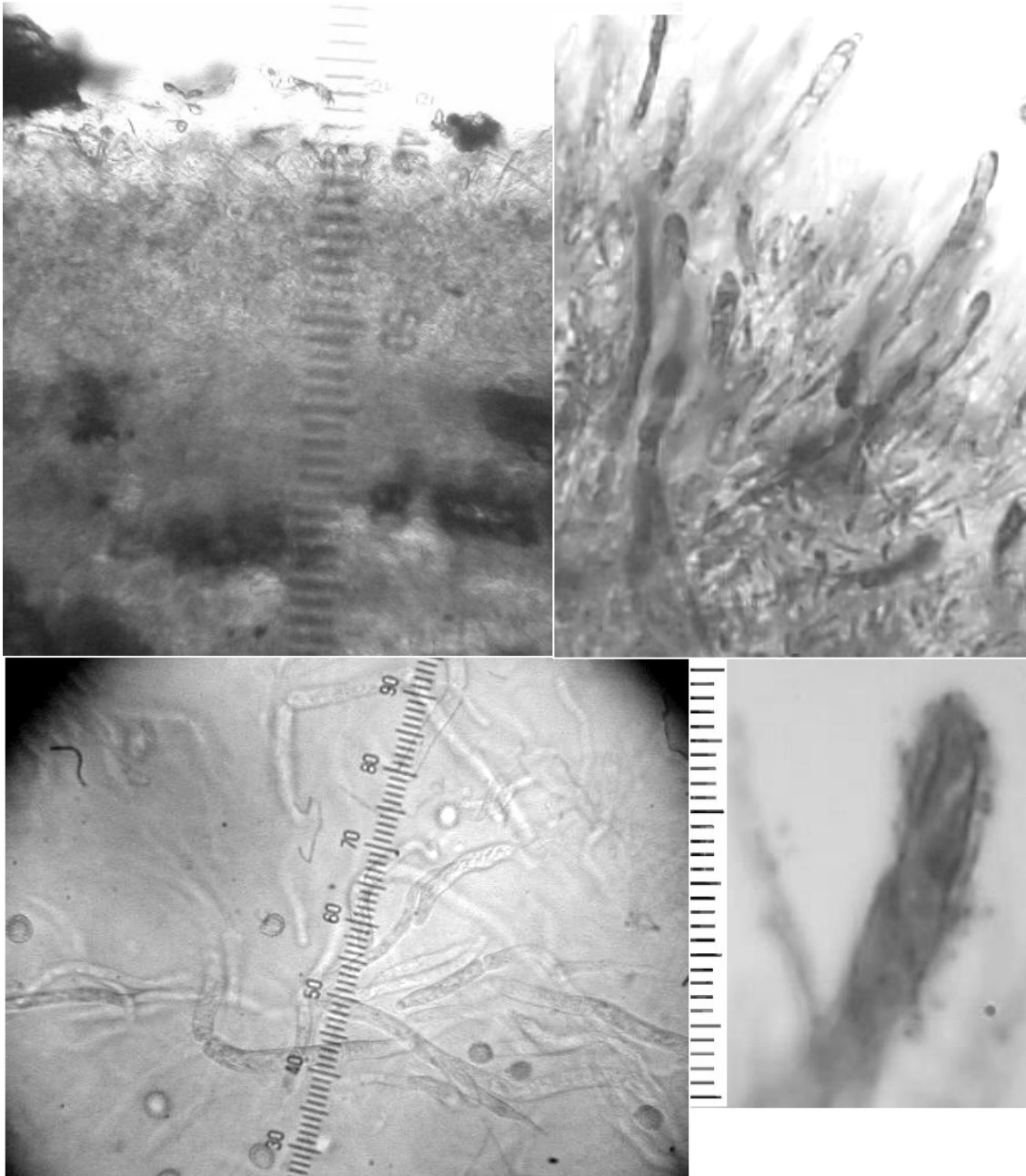


Figure 138 Cuticular characters of *R. vetermosa*: Top left, section through cutis, the epicutis is between the 40 and 43 mark, the subcutis to about the 53 mark and the hypodermis the 50-80 μ m compact layer below this, scale is in 10 μ m divisions; top right, oblique view of epicutis in SV showing pileocystidia amidst erect hyphal ends some of which are also darkened by SV, scale is approximately the same as in the bottom photograph; bottom left, surface view of cutis in NH₄OH showing septate pileocystidia, 10 scale divisions are 25 μ m; bottom right, rare pileocystidia end with exudate stained with SV, scale is in 1 μ m divisions.

Clade 8d

Section *Paraincrustatae* Sarnari

Subsection *Integrae* (Maire) Sarnari

Russula velenovskyi Melzer & Zvára

Archiv pro Přírodovědecký Výzkum Čech. 17: 92. 1927

Description of Vancouver Island collections:

Cap 10cm diameter, this mature collection of one basidioma is more or less shallowly infundibuliform, a bright brownish red, (light terracotta), darker at the margin, dull yellow to dark cream centrally, viscid when wet, drying matte, marginal 5mm striate to tuberculate, peeling to 1/2 the radius, flesh beneath firm and white.

Gills deep cream, brittle, adnate to adnexed, broadening outwards, about 5mm deep - shallower than cap flesh at half-radius, obtuse at cap margin, close, not noticeably forked, with the cutis colour extending 2-3mm along the outer gill edges.

Stipe 9.4 x 2.8cm, flared at the apex and to a lesser extent at the base, stuffed with a firm bread-textured trama, not cavitate, surface white with rose-pink flush on the lower half, unchanging where damaged.

Texture firm, not brittle.

Taste mild with a faint peppery aftertaste.

Odour mild, not distinctive.

Spore colour deep yellowish cream, Romagnesi IIIa.

Spores 6.7-8.8 x 5.7-7.6 μ m, L:W 1.07 -1.25 with a mean of 1.16, (n=32), subglobose to broadly ellipsoidal. **Ornamentation** of peg-shaped to crestate warts up to 0.7 μ m high but most often up to 0.5 μ m high, sometimes incompletely amyloid. Some spores have ornamentation of mostly isolated warts with just a few fine connectives linking 2-3 warts or 2-3 catenate, other spores have zebroid ornamentation in which most of the warts are linked by crests, forming a broken reticulum, the majority of spores are in between these extremes with some crests, some fine-line linkages and some isolated warts. **Woo types** B1-2, C1-2 to E1. **Suprahilar patch** an irregular amyloid area often bordered by warts, hiliferous appendix often relatively long and slender, 1.3-2.1 μ m long, 1.1-1.5 μ m wide near the base. **Basidia** mostly 4 spored, 35-50 x 8-10.1 μ m, clavate. Sterigmata up to 8 μ m long and 1.5 μ m wide at the base. **Pleurocystidia** somewhat sparse, on average 50-80 μ m apart, 50-110 x 7-11 μ m, protruding 10-35 μ m, originating in the subhymenium, more or less fusoid, tips obtuse, acute, capitate or with a wavy to strangulated appendix, contents refractive in KOH, purple to black in SV. **Cheilocystidia** absent towards the cap margins, otherwise patchily distributed, similar to pleurocystidia but reacting less strongly with SV. **Subhymenium** 30-45 μ m thick, pseudoparenchymatous. **Gill trama** of large sphaerocytes 30-60 μ m wide, with rare vascular hyphae.

Cutis 100-170 μ m thick, in cross sections in NH₄OH appearing as a light brownish lower layer, overlain by a thick pale pink layer then a thin slightly greyish layer directly beneath the thin, pink epicutis. Gelatinous matrix not evident. **Subcutis** comprising the aforementioned brownish, hyaline and greyish layers, of tightly interwoven, mostly parallel hyphae, 1.5-4 μ m wide, the greyish layer appears so in water and NH₄OH mounts because of air trapped within interstices of a more openly woven layer, in KOH this is not seen. Vascular hyphae rare. **Epicutis** of more or less repent, compactly interwoven hyphae somewhat more tortuous and more interlocked than those in the subcutis, ends undifferentiated or sometimes with slightly refractive contents, accompanied by pileocystidia that lay along the surface and appear adhered to it. **Pileocystidia** frequent, originating in the upper subcutis or within the epicutis, 25-100 (-130) x 2.5-7 μ m wide, the shorter ones aseptate, longer ones 2-3 septate, cylindrical to narrowly clavate, most often the terminal cell is clavate, ends obtuse or slightly capitate, contents refractive,

banded, staining light grey in SV, pink in acid fuchsin with acid-resistant exudates that appear as small surface granules in patches, often towards the base of the cystidia.

Pseudocystidia not seen. **Hypodermis** a layer of more compact tramal tissue with flattened sphaerocytes.

Trama of discrete clusters of sphaerocytes bound by a hyphal mesh and occasional vascular hyphae.

Chemical reactions: FeSO₄ - salmon pink; KOH - bright red on cap surface, slightly yellowish on stipe; phenol- purple-brown; SV - brownish red on the gills, purplish on the cuticle, cystidia and vascular hyphae grey to black.

Habitat and tree associations: on limestone south-facing slope with madrone, Douglas fir and shore pine with salal understory.

Collections: CR981114-05, from the north valley slope along the Koksilah river on the forest floor in a mixed-age stand of Douglas fir, madrone and a few pines, N 48.6550°, W 123.7303°.

Notes: *Russula velenovskyi* is indistinguishable in macroscopic appearance from *Russula veternosa*, and has a similar spore size and ornamentation. It differs in its mild taste, paler spore print, no odour of gingerbread or honey, the habitat in Douglas fir-madrone-pine forest and the rather easy to overlook incrustations that stain pink in acid fuchsin. It occurs in Northeastern North America (Kibby and Fatto 1990), but has not previously been recorded from the Pacific Northwest. The spores of this collection are slightly larger than is given in Romagnesi (1967) for European material, 6.5-8.5 x 5.5-6.5µm) but close to those for Northeastern North America sensu Kibby and Fatto (1990) (6.5-9 x 5.5-7.5µm), they also have more connectives between the warts than is given in either of those descriptions. *Russula paludosa*, a similarly coloured mild species also recorded from California, has larger spores with larger warts and a cellular subcutis sensu Thiers (1997).

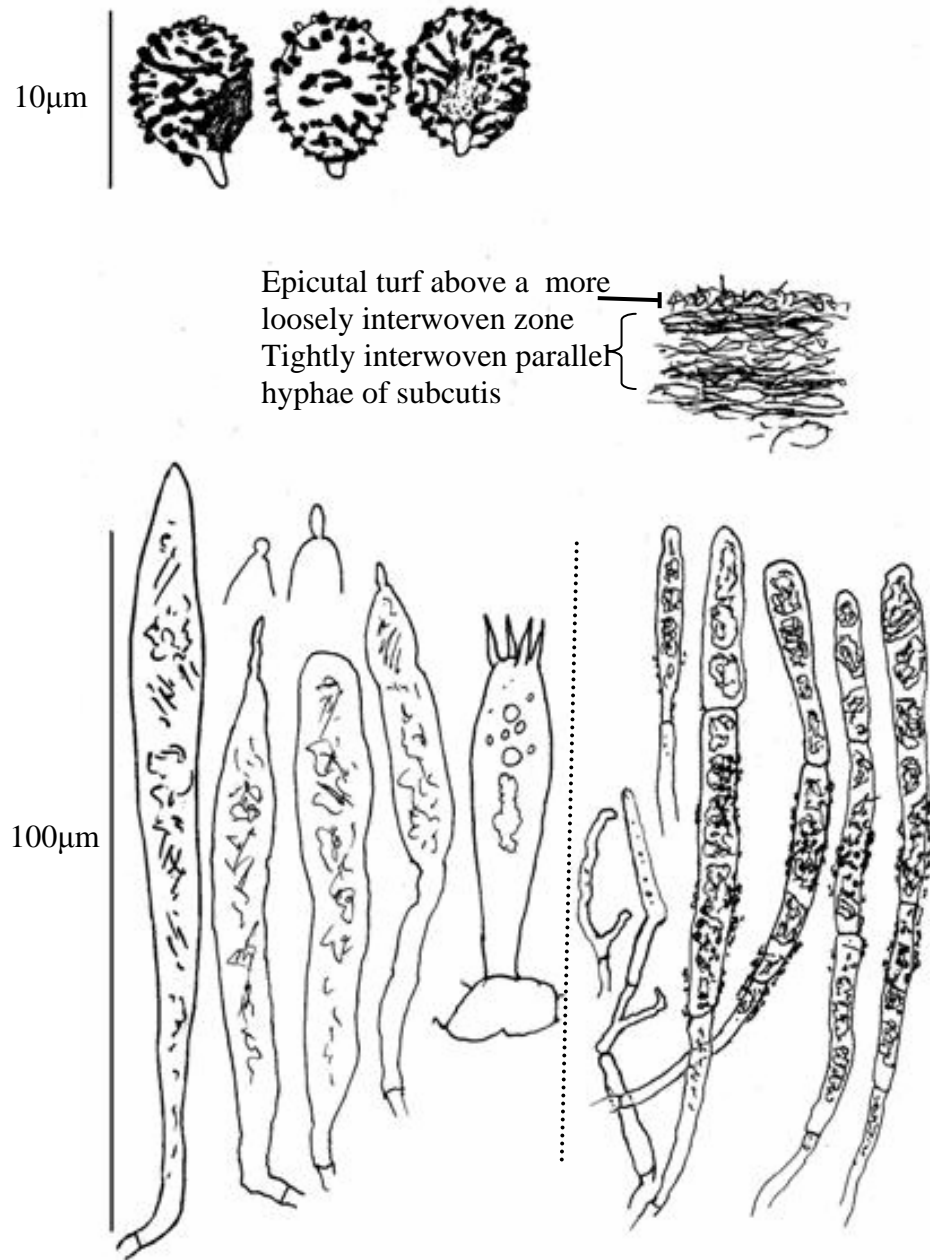


Figure 139. Microscopic characters of *R. velenovskyi* : Top, spores with 10µm scale bar; middle, diagram of section through cutis; bottom left, hymenial cystidia and basidium; bottom right, hyphal ends and pileocystidia from the epicutis, lower scale bar is 100µm.

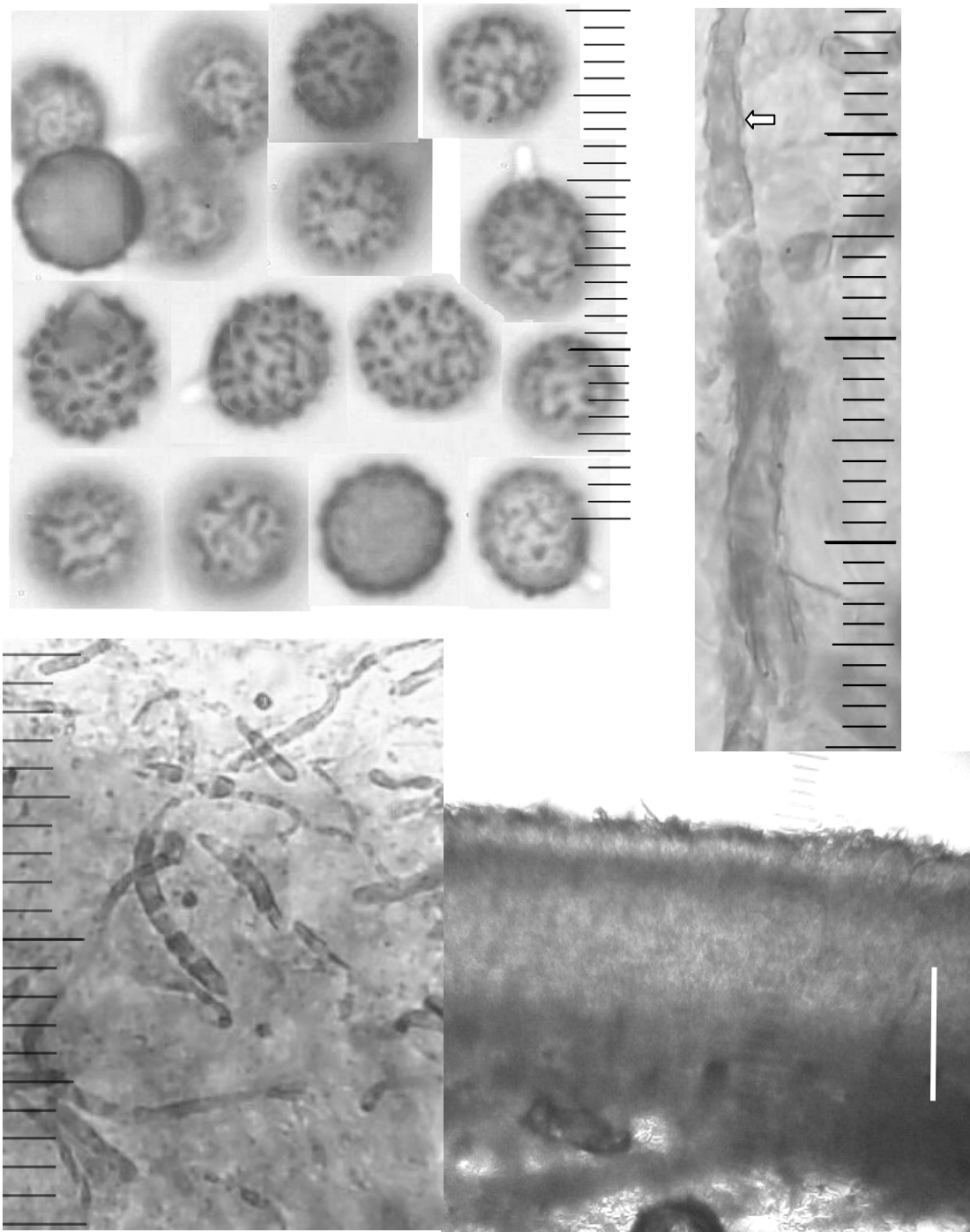


Figure 140 Hymenial and cutis characters of *R. velenovskyi*: Top left, spores with 1µm division scale; top right, a pileocystidium stained with acid fuchsin, both the contents and the exudate are stained, arrow points to an irregular, broken sheath of exuded material, scale is in 2.5µm divisions; bottom left, surface view of pileocystidia stained in SV, 1 scale division is 10µm; bottom right, section through cutis mounted in NH_4OH , note the darker band below the epicutis which is due to trapped air bubbles, scale bar is 100µm.

***Russula cf. integra* Fries (1st variety)**

Epicr. Myc. 360. 1838

Description of Vancouver Island collections:

Cap 5.1cm diameter, one mature basidioma only, shallowly centrally depressed with broadly downcurved smooth margins that extend over the rounded ends of the gills, deep green centrally and dull brown with subtle vinaceous tints at the margins, like bronze, with a darker band at the shoulder where the pigments overlap, viscid when wet, drying subglossy. Cutis peeling up to 2/3 the radius, flesh white, light grey-brown under the cutis.

Gills cream, close, occasional subgills, forking not seen, adnexed and slightly ascendant at the stipe, broadening a little towards the margins, rounded at the cap margin, about equal the depth of the cap trama at half-radius, thinner than in most *Russulas*, not much thicker than paper.

Stipe 3.7 x 1.4cm, more or less cylindrical to clavate, white, longitudinally markedly rugulose, stuffed with a bread-textured trama with no cavities at this stage, rind firm, 2.5-3mm thick, flesh unchanging where damaged.

Texture fairly firm.

Taste mild and nutty.

Odour not distinctive.

Spore colour deep orangish-cream, Romagnesi IIIc but with a pinker cast.

Spores 8.9-11.4 x 7.4-9.9µm, L:W 1.05-1.45 with a mean of 1.15, (n=30), subglobose to broadly ellipsoidal. **Ornamentation** of large, conical, pointed, peg-like or short-crestate warts 0.5-1.5µm high, mostly isolated or clustered in connected groups of 2-4, rather like the markings of a leopard, fairly densely distributed, connecting lines occasional, on

many spores the wall between the warts is also lightly amyloid making the whole spore quite dark compared to other species. **Woo types** 3A-3B. **Suprahilar patch** an irregularly shaped amyloid patch, the borders with warts and darker in general.

Hiliferous appendix 1.9-2.9µm long, 1.3-1.9µm wide near the base. **Basidia** 4 and 2-spored, 37-55 x 10-13µm, clavate, broadest in the upper 1/3 but generally with a gradual taper downwards. Sterigmata 4- 7.3µm long and 1.4-1.9µm wide at the base.

Pleurocystidia 65-110 x 8-12µm, the majority are 10µm wide, protruding up to 50µm, originating in the subhymenium or outer trama, fusoid to narrowly clavate, tips obtuse to subacute, occasionally with a small button, contents yellowish, refractive in KOH, grey in SV. **Cheilocystidia** abundant, taking up most of the gill margin, 9-13µm protruding 20-40µm beyond the gill margin, partially filled with yellowish refractive contents, mostly towards the tip, that barely if at all stain in SV. Tips mostly obtuse to subacute. **Subhymenium** 12-25µm thick, mixed, of hyphae of variable diameter with short inflated irregularly shaped cells frequent. **Gill trama** of sphaerocytes with occasional vascular hyphae.

Cutis 160-µm thick at half-radius, an ixotrichoderm consisting of a thick subcutis and a poorly differentiated epicutis. **Subcutis** of tightly interwoven branched hyphae 1.5-3µm wide, that are repent in the lower layers, gradually becoming more upright towards the epicutis, which is a continuation of the process. In the lower layers are vascular hyphae with yellowish refractive contents, 3-8µm wide, not reacting with SV, which sometimes ascend through the subcutis to give rise to clavate pseudocystidia at the surface, and with contents that stain pink in acid fuchsin. **Epicutis** of more or less erect hyphal ends 2-5µm wide, with undifferentiated obtuse tips or sometimes slightly capitate or clavate at the end. **Pileocystidia** 25-100 x 5-10µm, occasionally longer, numerous, lying along the surface, clavate or cylindrical with yellowish refractive contents, not reacting with SV but with contents staining pink in acid fuchsin, only rarely can one be found with a small amount of incrustation. These structures bear more resemblance to cystidia than to primordial hyphae as they arise from narrower hyphae lacking refractive contents and not staining in acid fuchsin, although they are usually the terminus of such hyphae. The clavate refractive part has 0-3 septa. **Primordial hyphae** 3-6µm wide, with weakly

refractive contents, occasionally with a few specks of incrusting material, infrequently septate, behind the cystidioid terminus there may be a 100µm or more between septa. **Hypodermis** a yellowish band 10-25µm thick of interwoven parallel hyphae, interwoven with the trama.

Trama of discrete clusters of sphaerocytes bound by a dense hyphal mesh, with occasional vascular hyphae around 5µm wide, not reacting with SV.

Chemical reactions: FeSO₄ - pale salmon-pink; KOH - brownish orange on cap surface, no reaction on stipe; phenol - brownish purple; SV - greyish on the gills, pale grey on the cutis, cystidia and vascular hyphae not reacting.

Habitat and tree associations: On the bark of a living old growth Sitka spruce, about 1.5m up from the ground, and with huckleberry also sprouting from crevices in the bark. October.

Collections: CR981013-01, from a Sitka spruce in the St. Joseph River campground at Cape Scott Park, N 50.761075° W 128.363231°.

Notes: The bronze and greenish colours together with the large spores with long pointed warts and the cuticular elements staining with acid fuchsin place this species in the *Russula integra* group, however, the spore print is slightly paler and the degree of incrustation is small, and it does not exactly match any of the several varieties of *Russula integra* in Bon (1988) and Romagnesi (1967). Several of these aforesaid varieties are found with spruce, but although this Vancouver Island collection was found on spruce, it would seem unlikely that the roots of the tree were available to the mycelium were it confined to the crevices in the bark, and more likely that its host is one of the *Vaccinium* species such as huckleberry or salal that grow in soil pockets in the bark.

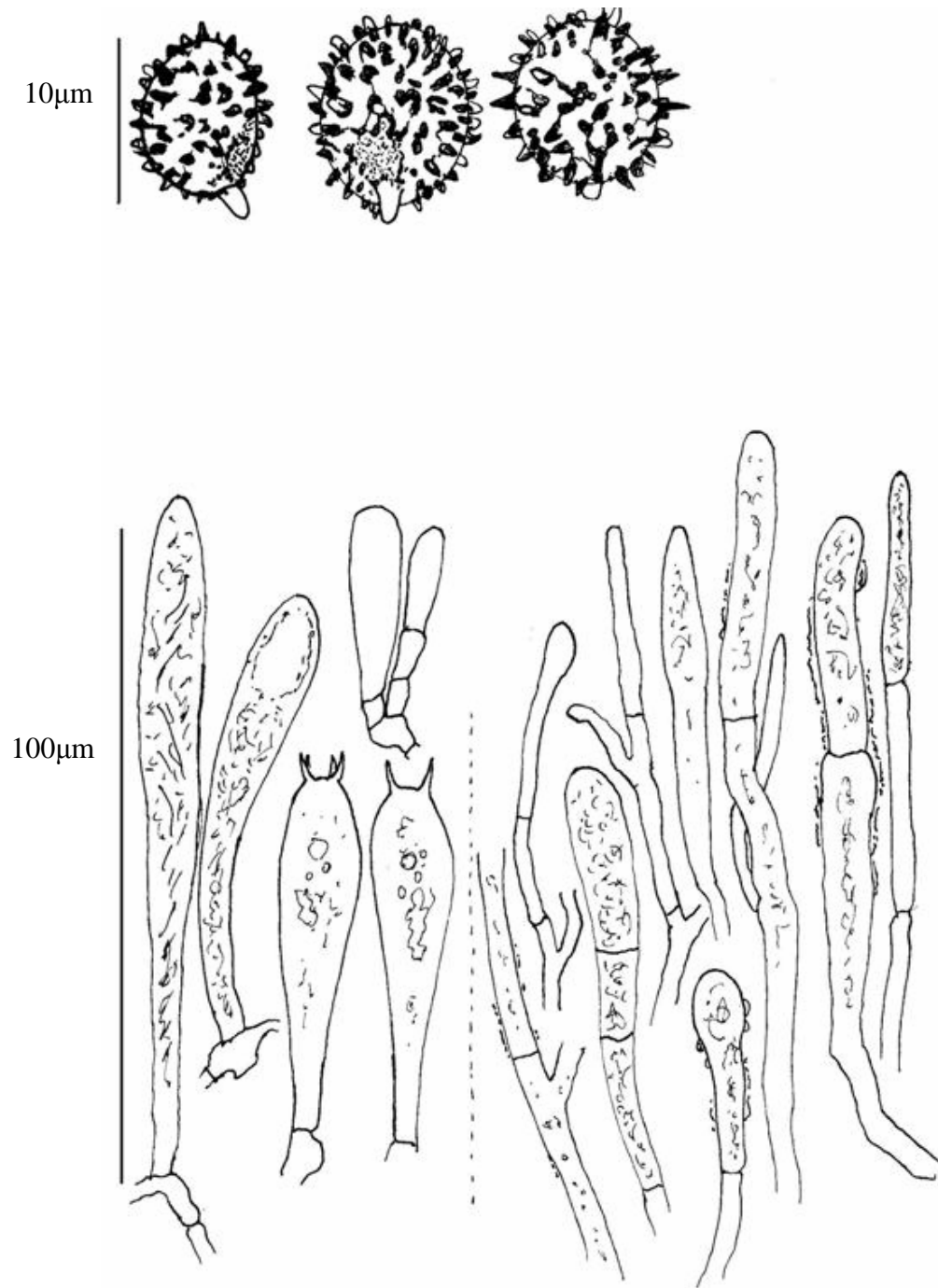


Figure 141 Microscopic characters of *Russula cf. integra* : Top, spores with 10µm scale bar; bottom left, hymenial cystidia, two basidia and basidioles; bottom right, hyphal ends, primordial hyphae and cystidioid terminal cells from the epicutis, lower scale bar is 100µm.

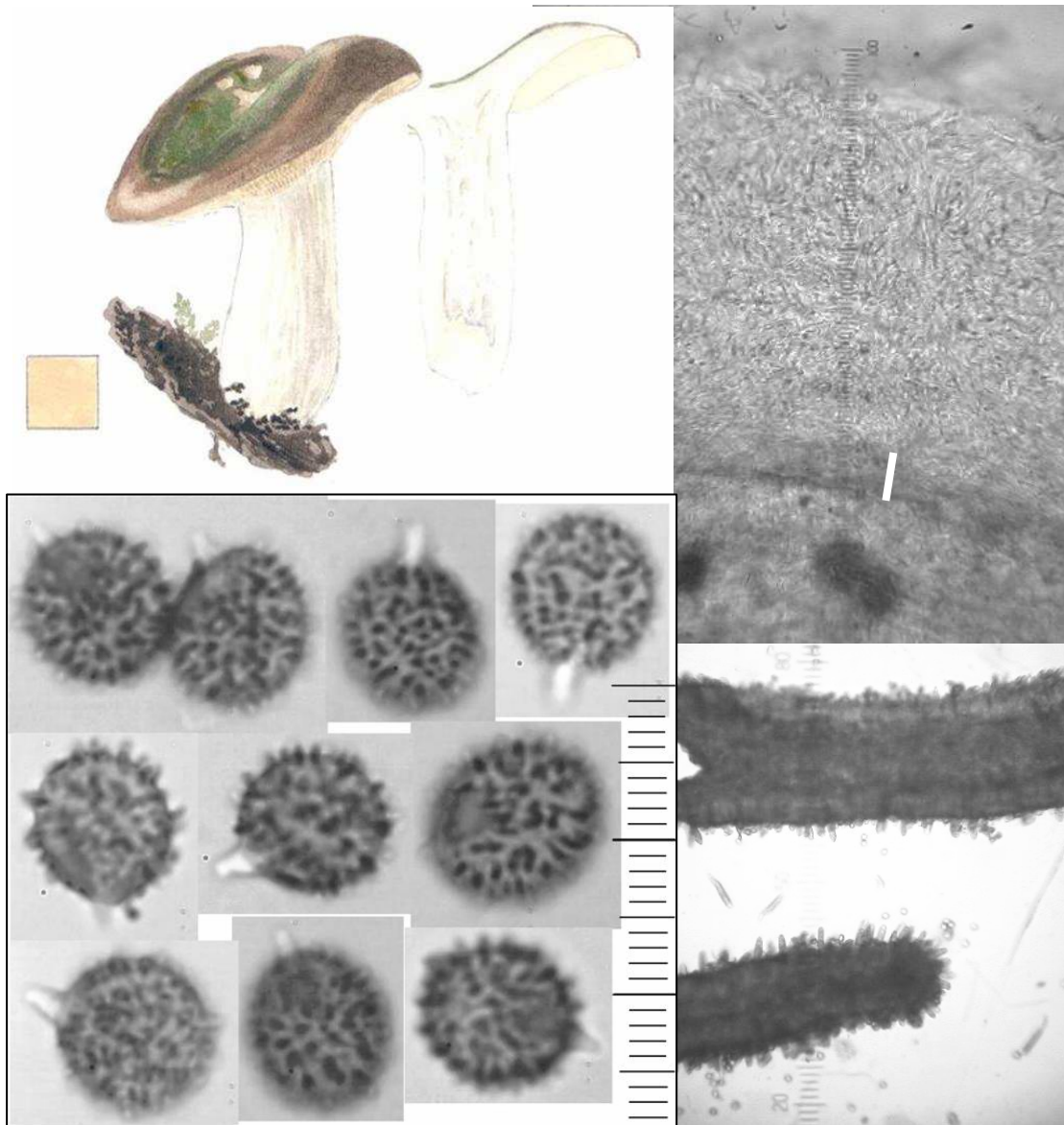


Figure 142 *Russula* cf. *integra*: Top left, illustration of profile and longitudinal section as found on Sitka spruce bark, small square is 1cm² and shows spore colour; bottom left, spores with 1 µm division scale; top right, section through cutis in water, the hypodermis is indicated with the 25µm long white bar, 10 scale divisions are 25µm; bottom right, sections through gill showing the protruding pleurocystidia and cheilocystidia, scale is in 10µm divisions.

***Russula cf. integra* Fries (2nd variety with reticulate spores)**

Epicr. Myc. 360. 1838

Description of Vancouver Island collections:

Cap 4.9-12cm diameter, convex when young, becoming shallowly depressed at maturity with margins remaining curved down over the gill ends, sometimes becoming lobed, smooth, not or barely developing marginal striations in age. Colour overall brownish, sometimes greyish-brown when young, at maturity more yellow-brown centrally and more vinaceous-brown towards the margins, with or without blackish zones between, sometimes dull purple at the margin, sometimes slightly olivaceous tints marbled through, generally bronze-hues. The Saturna Island collection has more of the vinaceous to purple hues mixed with dull brown. Cutis viscid when wet, drying almost matte, peeling up to 1/2 the radius, flesh beneath light purple, cap trama pale cream, unchanging where damaged.

Gills cream when young but quite soon becoming deep yellow, subdistant, with occasional subgills but no forking, narrow and ascending to free at the stipe, broadening outwards, rounded at the cap margin, up to 1.5 times the depth of the cap trama at half-radius, thinner than in most *Russulas*, not much thicker than paper, not bruising.

Stipe 4.2-11 x 1.8-2.1cm, cylindrical or slightly ventricose, shorter or longer than the cap diameter (the longest stipe not belonging to the widest cap), longitudinally finely rugulose. Surface and trama very pale yellow, browning weakly at the base, elsewhere unchanging to slightly buff where damaged, solid to firmly stuffed, not cavitate.

Texture very firm and somewhat elastic, robust and not breaking easily, becoming more fragile in age.

Taste mild and nutty.

Odour mild, slightly of rubber.

Spore colour a deep strong yellow bordering on orange, Romagnesi IVc.

Spores 8-9.2 (-10.3) x 6.5-8µm, L:W 1.09-1.34 with a mean of, 1.20 (n=30), subglobose to broadly ellipsoidal, often slightly pyriform. **Ornamentation** of blunt or occasionally conical or crestate warts 0.3 -0.9µm high with most spores having warts in the mid size range. On some spores the warts are mostly isolated with just a few heavy lines connecting groups of 2-3 warts, other spores are partially zebroid with scattered isolated warts and a well developed partial reticulum, most have a combination of both elements with no strong reticulum. **Woo types** B2-C2, occasionally A2 or E2. **Suprahilar patch** an irregular amyloid patch, often rectangular and up to 4µm long, generally with warts at its borders. **Hiliferous appendix** relatively large, 1.6-2.6 x 1.3-1.6µm. **Basidia** 4-spored, occasionally 2-spored, 35 -57 x 9-13µm, clavate to slightly bulbous in the upper 1/3. As the hymenium grows outwards by a cell or two for each successive basidia developed the older basidia have longer narrower bases than the newer ones. Sterigmata relatively slender, up to 9µm long and 1.2 -1.3 µm wide at the base. **Pleurocystidia** 57-100 x 7.5 -11µm protruding up to 20µm, originating in the subhymenium, fusoid, tips acute or usually with a terminal button, filamentous or allantoid appendage, contents yellowish, refractive in KOH, sometimes only in the upper half, unreacting to greyish to dark in SV, with all reaction types occurring on one small piece of gill. The pleurocystidia are patchily distributed, they appear infrequent because many are embedded in the hymenium and do not react with SV, and so are hard to see, some patches of gill seem to be devoid of them, in others they are spaced about 50-100µm apart. **Cheilocystidia** 48-90 x 7.5-9µm numerous, protruding 20-40µm, cylindrical to fusoid, tips subacute or more often with a filamentous appendage or small button, not or barely reacting with SV. **Subhymenium** 30-50µm thick, pseudoparenchymatous. **Gill trama** of sphaerocytes up to 28µm across, with occasional vascular hyphae.

Cutis 170-200µm thick, of two layers plus a hypodermis. **Subcutis** about 3/4 or more of the depth of the cutis, of tightly interwoven and tangled semi-upright hyphae 2.5-5µm wide, appearing pink in water mounts and containing occasional pinkish globules of pigment, occasional vascular hyphae in the lower layers, staining weakly grey in SV.

Epicutis of upright, septate, branched hyphae, pileocystidia and probably primordial hyphae that lie along the surface. Epicutal hyphae in general very slightly wider than in the subcutis, 4-6µm with rare inflated cells up to 12µm wide, the terminal cells may be short, sometimes contorted, ends obtuse or often with a longer tapering terminal cell.

Pileocystidia numerous, cylindrical to narrowly clavate, 4-7 x 55-120µm or sometimes longer, rarely aseptate, mostly 3-4 septate, the end cell generally the broadest, tips obtuse, contents refractive, weakly greying and often with a granular appearance in SV, rarely with small inconspicuous dots of incrusting material. **Primordial hyphae** not clearly differentiated from pileocystidia which may form as a terminus, contents slightly refractive and fleetingly staining pink in acid fuchsin, weakly greying in SV, mostly without incrusting material but very rarely one may be found with a sheath of incrustation or more often just a few dots over a short section. **Primordial hyphae** differ from pileocystidia in being more regularly septate, about every 25-50µm, branched, and more or less cylindrical except for slightly clavate end cells. **Hypodermis** a layer of repent parallel hyphae about 12-25µm thick, absent in places, interwoven with the trama and the subcutis hyphae.

Trama of scattered and irregular clusters of sphaerocytes bound by a loosely interwoven hyphal mesh that in places forms bundles up to 50µm across. Vascular hyphae occasional, with amorphous contents that stain weakly grey in SV.

Chemical reactions: FeSO₄ - very little reaction, slightly greyish; KOH - orange-brown on cap surface, no reaction on stipe; NH₄OH, - no reaction; guaiac - blue-green; phenol - slowly brownish purple; SV - deep greyish pink on cutis, gills and stipe trama.

Habitat and tree associations: In a moist north-facing slope with mature regeneration Douglas fir and western hemlock, the presence of red alder not noted at the time but likely to be close by, October.

Collections: CR021027-04 from alongside the lakeside trail under mature regeneration Douglas fir and western hemlock with salal, Mesachie Lake Forest Research Centre, approximately N48.815°, W124.1358°. PJ981213-01, under mature regeneration

Douglas fir with understory salal and pacific blackberry, by a driveway,
N48.799110°, W123.181273°.

| ITS1-F to | | | | |
|-------------|--------|-------------|----------|----------|
| Collection | ITS4-B | RFLP: Hinf1 | Alu1 | Sau3A |
| CR021027-04 | 832 | 360, 380 | 489, 254 | 355, 260 |

Notes: These collections are undoubtedly close to *Russula integra*, they have the robust flesh that, when young, will withstand being dropped onto a hard surface from chest height without breaking, although this is not a recommended taxonomic method. They differ however in the spores, which in *R. integra* are larger, up to 11µm long and 9µm broad, with isolated spines up to 1.75µm long. Romagnesi (1967) mentions the variability in the amount of incrustation seen on the pileocystidia and primordial hyphae in the epicutis, which can be absent in some collections, and points out that primordial hyphae are usually rare. In Romagnesi's monograph (1967) he recognises a number of varieties of *R. integra*, some of which, in Bon, (1988) are raised to species status. Among these, *R. integra* var. *oreas*, found with spruce, is macroscopically similar to those of the Vancouver Island collection, and has the same spore size and ornamentation, however it is described as fleshy but not robust. The epicutis of *Russula carpini* Heinemann-Girard is most like that of the Vancouver Island collection, but that species bruises yellow, has spores with isolated spines and is found under *Carpinus* (hornbeam). Arora (1986) treats *R. integra* as found in California as a species complex, Thiers (1997) reports it from two counties in California but his description states that the epicutis lacks pileocystidia. The collection described above is the second of two local varieties or species in the *Integrinae* that almost but not quite matches published descriptions for species in this group.

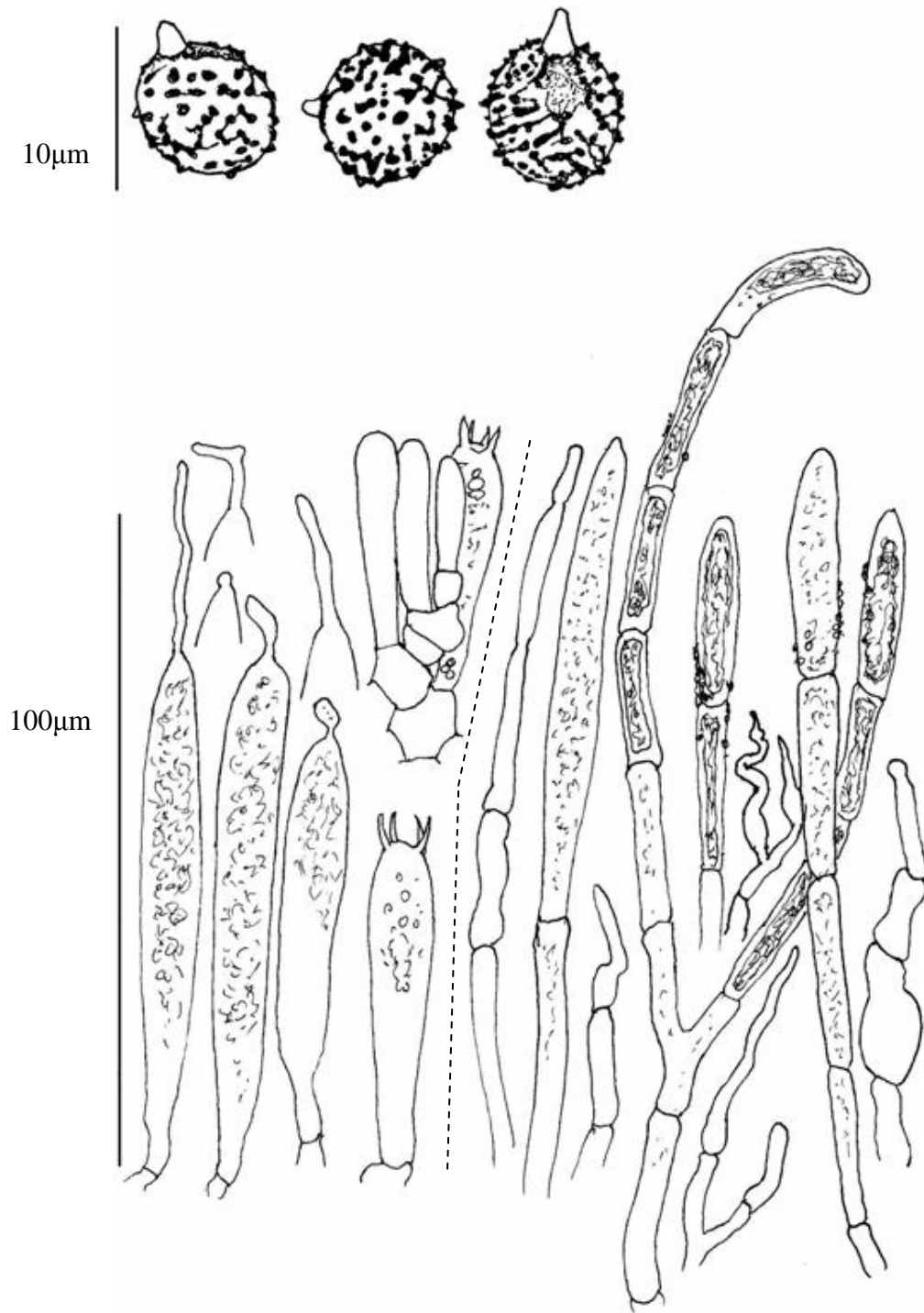


Figure 143. Microscopic characters of *Russula* cf. *integra* 2nd var.: Top, spores with 10µm scale bar; bottom left, hymenial cystidia, a basidium and above it a basidium with basidioles showing the build-up of cellular subymenium; bottom right, hyphal ends, primordial hyphae and pileocystidia from the epicutis, the two marked SV are shown as they appear in SV, lower scale bar is 100µm.



Figure 2. Macroscopic characters of *R. cf. integra* 2nd var. photographed on a scanner, showing basidiomata at various stages of maturity, small square is 1cm² and shows spore colour.

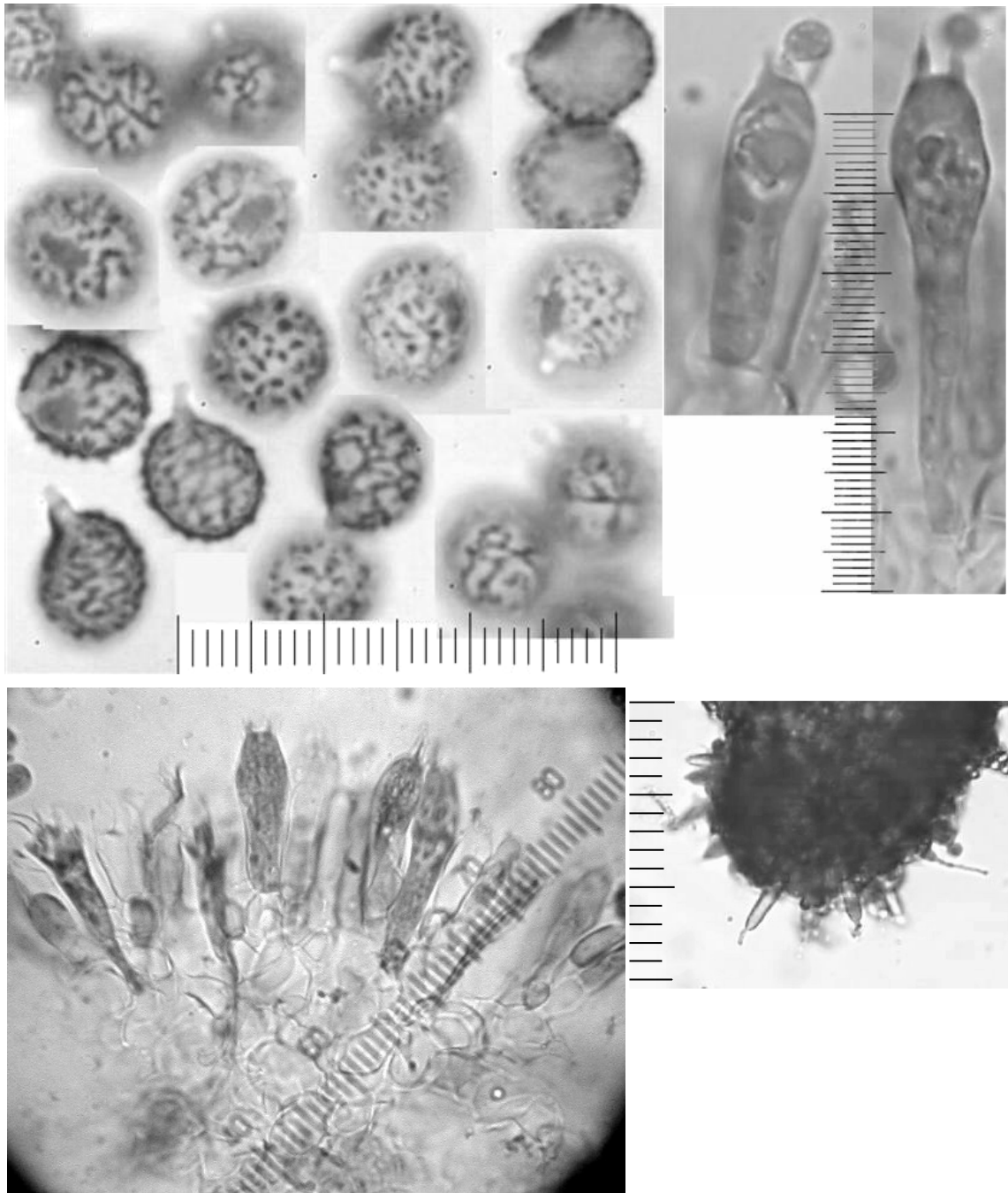


Figure 3. Characters of the hymenium of *R. cf. integra* 2nd var.: Top left, spores with 1 µm division scale; top right, variation in basidia length between new (left) and old (right), shown with 1 µm division scale; bottom left, small section of gill tissue stained in phloxine showing the structure of the subhymenium and hymenium with spent basidia (left) emanating from deeper levels than new basidia (centre), scale is in 2.5 µm divisions; bottom right, cheilocystidia on gill section, scale is in 10 µm divisions..

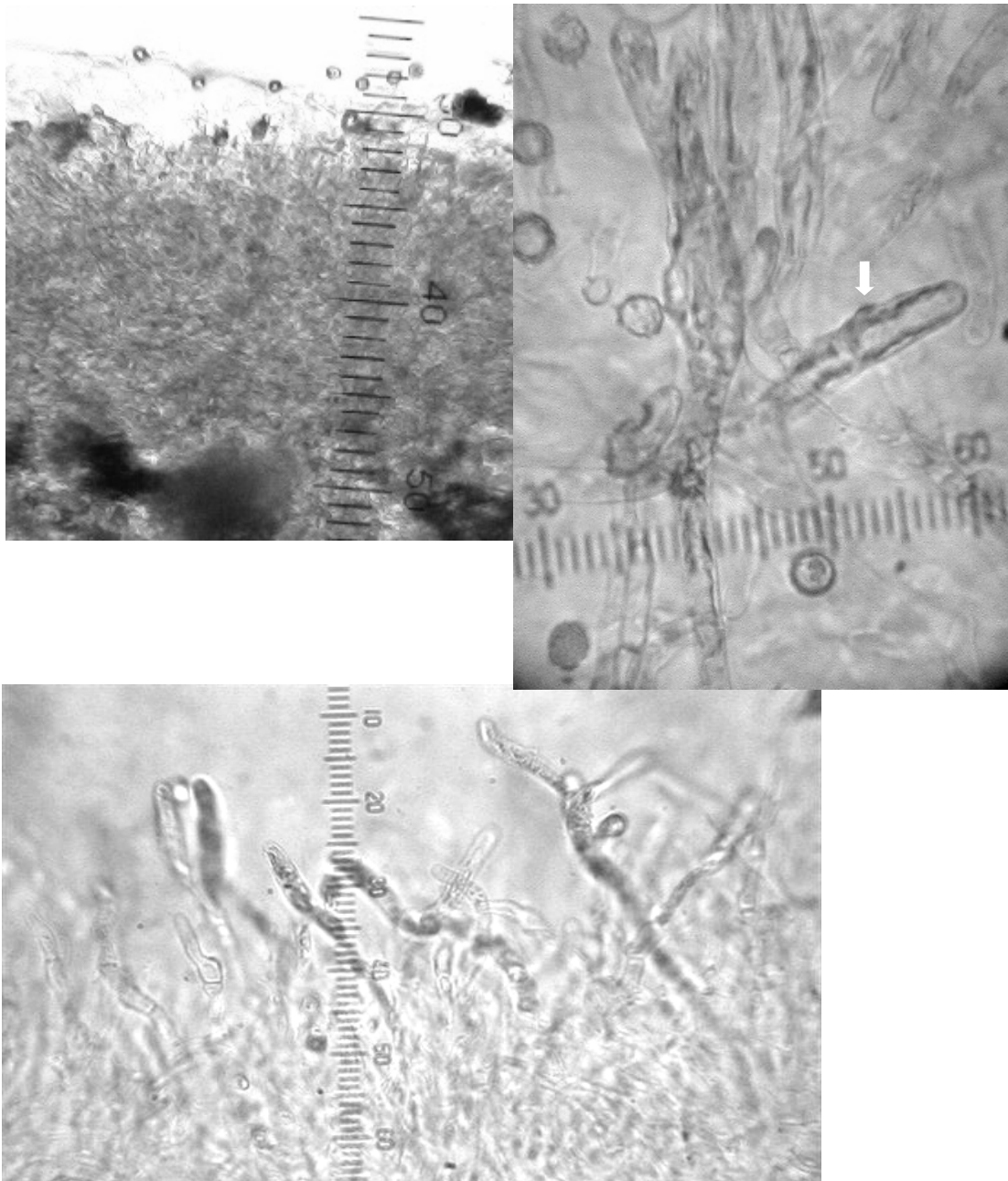


Figure 4. Cuticular characters of *R. cf. integra* 2nd var.: Top left, section through cutis with 10µm division scale, the viscid surface appears 10 – 30µm above the epicutis in this water mount, the hypodermis is around the 48 – 50 scale marks; top right, surface view of epicutis showing pileocystidia and (or) primordial hyphae that are mostly naked, as can be seen from the smooth walls, but occasional small dots of incrusting material such as that arrowed can be seen, scale for this and the bottom photograph is in 2.5µm divisions; bottom, epicutis stained with SV.

Section *Amethystinae* Romag. Sarnari amend.

Subsection *Integroidinae* Romagn. in Bon

***Russula occidentalis* Singer**

Sydowia 11: 155. 1957

Description of Vancouver Island collections:

Cap 5.5 -13cm diameter, convex, closer to hemispherical when young, expanding through more or less plane to shallowly depressed with unevenly uplifted margins, the outer 2-4 mm of which curve down over the edge of the gills giving a slightly inrolled appearance, although not truly inrolled, remaining smooth. The colour is very variable but includes pinkish purple and olive hues, often also yellow-brown, sometimes red-brown, these colours may be marbled throughout or with the olive and brown in the centre and the pinks and purples toward the margin. Some basidiomata are strongly coloured, almost black in the centre, others are quite pale, almost buff, some lack pink and purple hues and are green to brown only. Cutis slightly viscid when wet, drying matte and slightly pruinose or minutely concentrically areolate towards the margin, centre subglossy, peeling 3/4 the radius, flesh beneath greyish pink, cap trama creamy white, discolouring faintly dirty pink, finally dark grey, although this may take many hours in some cases, particularly in dry weather.

Gills light cream to cream, edges bruising grey to black, brittle, close to almost crowded, occasional subgills, generally some forking throughout the radius, adnexed to ascending at the stipe, broadening outwards, acute to obtuse and rounded at cap margin, both may be seen in one basidiomata (fig. 2), around 1.5-1.7 times the depth of the cap trama at half-radius, up to 12mm deep.

Stipe 3 -11.2cm x 1.5-4.2cm, roughly equal in length to cap diameter on average, white to creamy white, developing dingy pink stains where handled or damaged, becoming dark grey to brownish-grey, eventually black, often also with some browning near the base,

longitudinally rugulose, pruinose when young, clavate, cylindrical, or broadest at the apex, solid, not developing cavities. In dry weather the bruising reaction is paler and slower and the flesh may not fully blacken.

Texture firm and robust.

Taste mild, sometimes nutty.

Odour not distinctive, in one collection slightly cheesy.

Spore colour warm cream, Romagnesi IIc-d.

Spores 7.9-11.2 x 6.7-8.9 μ m, L:W 1.11-1.46 with a mean of 1.30, (n=30). The wide range of spore sizes is due to the basidia having sometimes 2 and sometimes 4 spores, which translates to a dichotomy in size within one spore print, although the larger range is more common, there is some variation in relative proportions between basidiomata.

Spores are ellipsoidal to obovate, rarely subglobose. **Ornamentation** is of mostly conical, pointed, isolated warts mostly around 1 μ m high but ranging between 0.4-1.7 μ m high, occasionally a few warts may be linked by fine to heavy lines with catenations rare. Woo type 3A, occasionally 3B. **Suprahilar patch** amyloid, irregularly shaped, with warts at its border. **Hiliferous appendix** around 2.1 μ m long, 1.7-1.8 μ m wide near the base. **Basidia** 4 and 2 -spored, 52-62 x 14 -17.7 μ m, voluminous, often abruptly bulbous in the upper 1/3. Like others in this clade the hymenium grows a cell or two for successively developing basidia, however because the cells are relatively small there is not such a wide range of basidia lengths. Sterigmata relatively stubby, up to 8 μ m long and 2.0-2.8 μ m wide at the base, those of two-spored basidia being broader than those of 4 -spored. **Pleurocystidia** frequent and evenly distributed, 70-125 x 9-13 μ m protruding 15-40 μ m, appearing elliptical in end view (when gill surface is examined), originating in the lower subhymenium, almost cylindrical to fusoid to narrowly clavate, tips subacute, contents partially yellowish and refractive in KOH, sometimes very weakly or rarely appearing empty, unreacting or with brownish-purple upper half in SV. **Cheilocystidia** 60-90 x 9-13, numerous, protruding up to 30 μ m, fusoid or clavate, ends subacute to

obtuse or sometimes with the terminal 25-30µm narrower, around 6-8µm, aseptate, contents partially refractive, usually at the tip, unreacting to brownish in SV.

Subhymenium 20 -30µm thick, of interwoven hyphae and small cells. **Gill trama** of sphaerocytes generally under 25µm, with a central core of more or less parallel hyphae, no vascular hyphae seen.

Cutis 80-160µm thick, an ixotrichodermis of which about 2/3 the thickness is subcutis, with a well differentiated epicutis, lacking pileocystidia. **Subcutis** of tightly interwoven repent to semi-upright hyphae 1.5-3µm wide, tinted pinkish or greenish en masse, and a few hyphae contain greyish or greenish vacuolar pigment globules, vascular hyphae not seen. **Epicutis** of erect hyphal ends 2-4µm wide, undifferentiated or frequently with a tapering terminal cell up to 50µm long, and numerous incrustated, septate primordial hyphae 4 -6µm wide, rarely with inflated cells up to 8µm wide, the incrustations varying from a thin broken sheath to fine or heavy droplets up to 2µm diameter, visible in water mounts and bright pink in SV, but neither the hyphal contents nor the incrustations staining much in acid fuchsin, although the latter remain visible. **Pileocystidia** absent. **Hypodermis** a band around 25µm thick of repent, parallel light yellowish brown hyphae interwoven with the subcutis and trama.

Trama of discrete well separated clusters of sphaerocytes interspersed between bundles of hyphae, vascular hyphae rare, not staining in SV.

Chemical reactions: FeSO₄ - weakly salmon pink or greyish green on young material; KOH - yellow-brown to orange on cap surface, no reaction to brownish on stipe; phenol, -dull reddish purple; SV - deep pink initially, then browning on the gills, trama and cuticle, hymenial cystidia brown or grey, vascular hyphae not reacting, primordial hyphae and incrustations bright strong pink; PDAB (paradimethylaminobenzaldehyde) - vivid magenta on stipe (Woo, 1989), not tested on Vancouver Island collections.

Habitat and tree associations: under western hemlock in natural and regeneration stands with or without either Douglas fir or Sitka Spruce.

Collections: CR980821-03, from old growth Douglas fir with understory western hemlock at about 300m elevation on Phillips Ridge trail, Strathcona Park, N 49.5900°, W 125.583°. PJ990731, from a mixed-age stand of western hemlock with veteran Douglas fir and western red cedar, Saturna Island crown land section 4, N 48.776474°, W 123.295362°. OC011013-01, from a stand of young (< 50 years) western hemlock, near Mesachie Lake Forest Research station, approximately N 48.8257°, W 124.1348°. JJ021020-03, from regeneration western hemlock and Sitka spruce, China Beach area, approximately N 48.4362°, W 124.0888°.

| ITS1-F to | | | | |
|-------------|--------|-------------|----------|----------|
| Collection | ITS4-B | RFLP: HinfI | AluI | Sau3A |
| JJ021020-03 | 900 | 430, 334 | 385, 298 | 340, 251 |

Notes: *Russula occidentalis* is superficially similar to *R. olivacea*, *R. xerampelina*, *R. isabelliniceps* and *R. integra* none of which have the pink to grey to black colour changes of the flesh. *Russula decolorans*, *R. claroflava*, and *R. pacifica* also bruise grey, these have, respectively, a red cap, a yellow cap and a purple cap, the latter also is the only *Russula* species that shows no reaction to phenol, it also has SV positive pileocystidia and a thicker cutis. Other greying and blackening *Russulas* are of subgenus *Compactae* and lack any of the red, yellow and blue pigments in the cutis, and have spores with an inamyloid suprahilar patch, these species include *R. adusta*, *R. albonigra*, *R. anthracina*, *R. dissimulans* and *R. nigricans*.

The incrustations on the primordial hyphae have apparently been overlooked by other authors in their descriptions of *Russula occidentalis*. Singer (1957) in his original description states "epicutis of pileus formed by hyphae which are equal, smooth, "empty", clampless, 1-3.5µm thick, filamentous, and making up a trichoderm which becomes depressed at an early age. Thiers (1997) notes that the California material has poorly differentiated pileocystidia, which may or may not be the same as the primordial hyphae in Vancouver Island collections. Singer had published *R. occidentalis* as a subspecies of *R. vinosa* in 1940, which species does possess heavily incrustated primordial hyphae and is very similar to the Vancouver Island collections described above. The

incrustations dissolve in 3% ammonia and 5% KOH and if the cutis had previously always been examined in these reagents as is a common practice, this would explain the omission in other descriptions, however it is also common practice to examine the cutis in SV to determine the presence of pileocystidia, in which case the bright pink incrustations would be hard to miss were they present. This would indicate a great amount of variation in the presence or absence of primordial hyphae and pileocystidia in the cutis. In *Russula* phylogenetic analyses *R. occidentalis* and *R. vinosa* fall in the same terminal clade as *R. integra* and *R. claroflava*, both of which have incrustations that redden in SV.

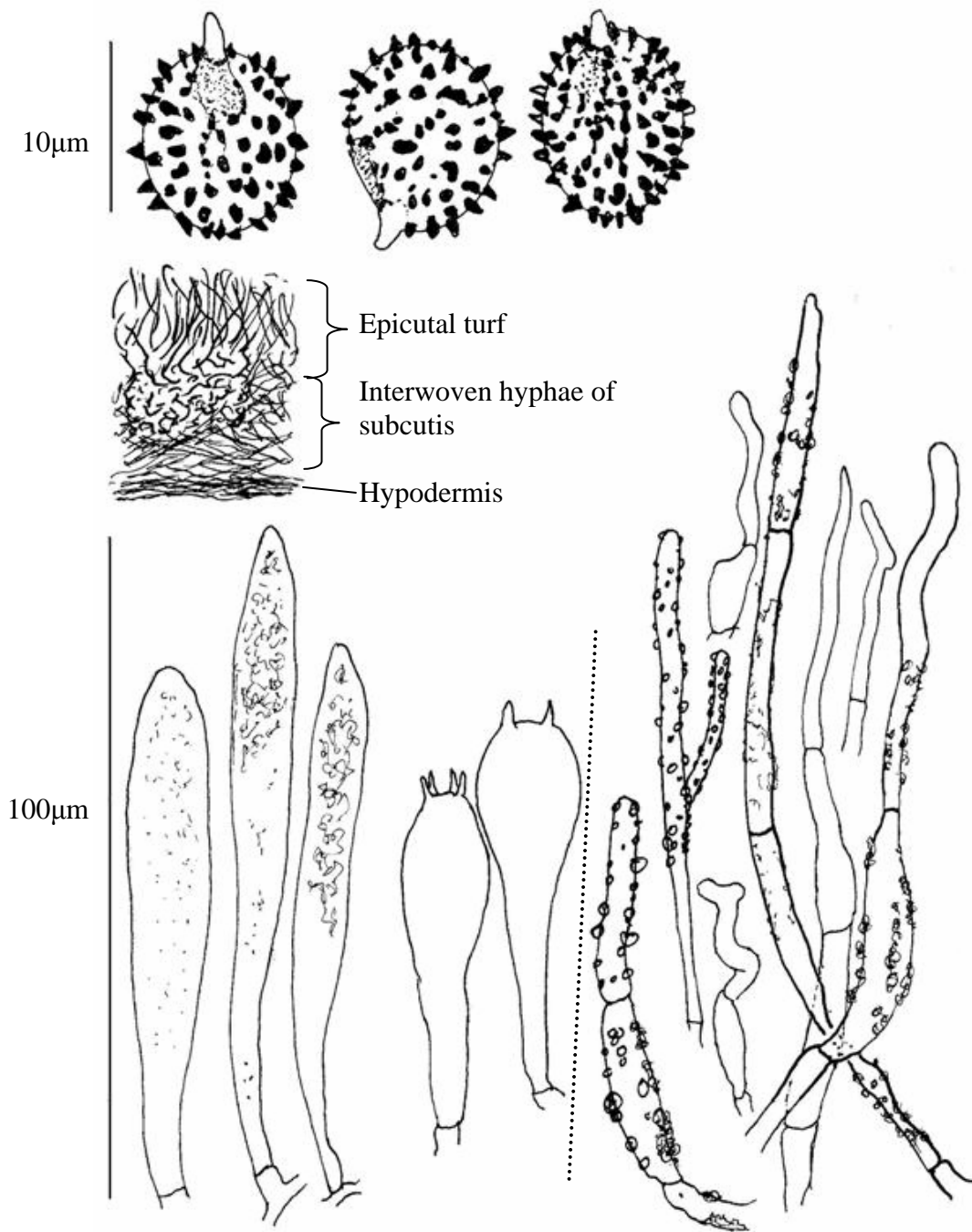


Figure 144 Microscopic characters of *Russula occidentalis*: Top, spores with 10µm scale bar; middle, diagram of section through cutis; bottom left, cheilocystidia, two pleurocystidia, a four and a two-spored basidium; bottom right, primordial hyphae and hyphal ends from the epicutis, lower scale bar is 100µm.



Figure 145 Macroscopic characters of *R. occidentalis*: Top, illustration of profile and longitudinal section showing progressive bruising reaction, small square is 1cm² and shows spore colour; middle, collection with 1cm division scale, note the bruising on the stipe; bottom, view of the cap surface of the larger basidioma.

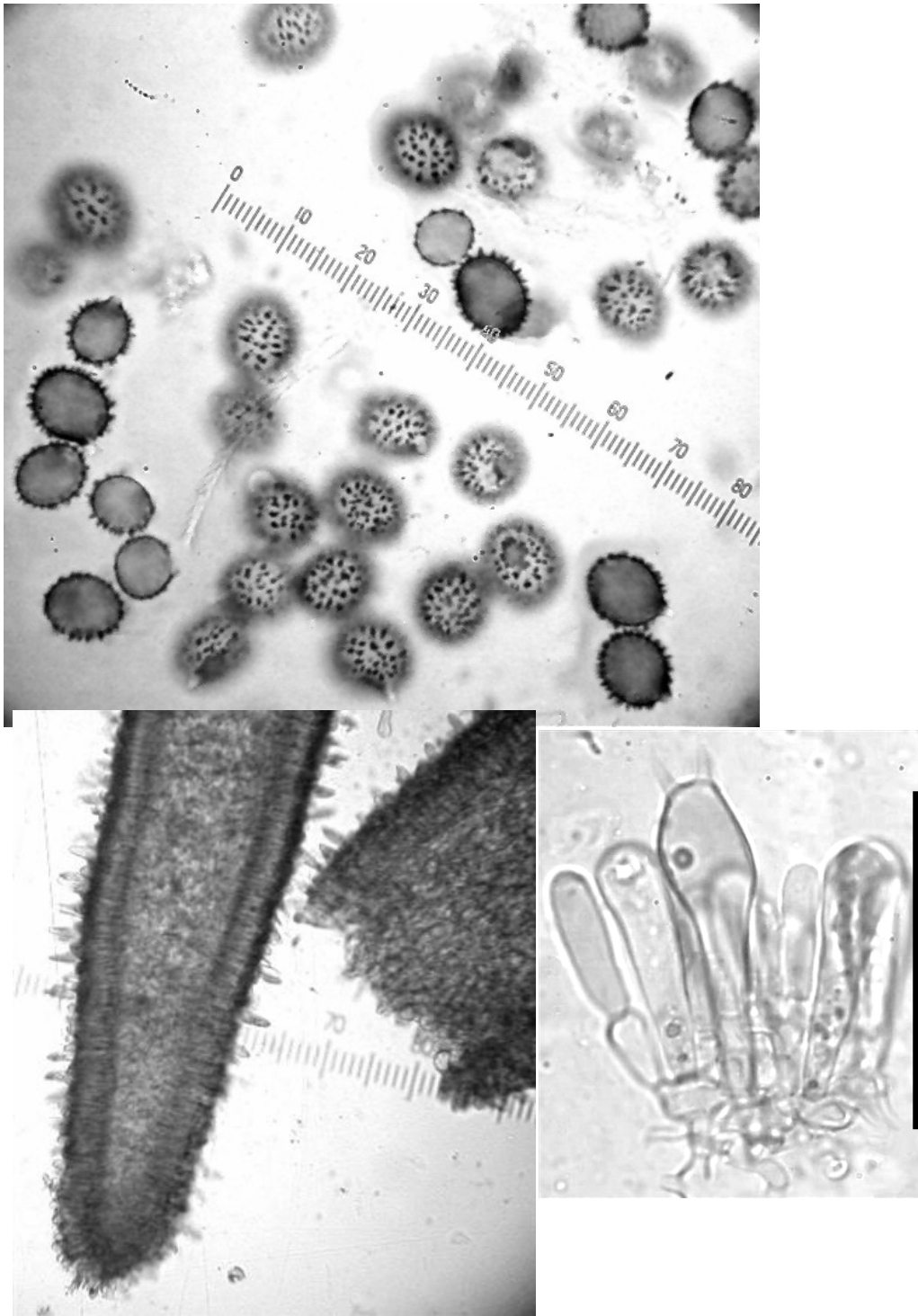


Figure 146 Characters of the hymenium of *R. occidentalis*: Top, spores with 1 μ m division scale; bottom left, section through gill showing the protruding pleurocystidia and compact gill trama, 10 scale divisions are 100 μ m; bottom right, fragment of hymenium showing basidium and basidioles supported on stepped basal cells, scale bar is 50 μ m.

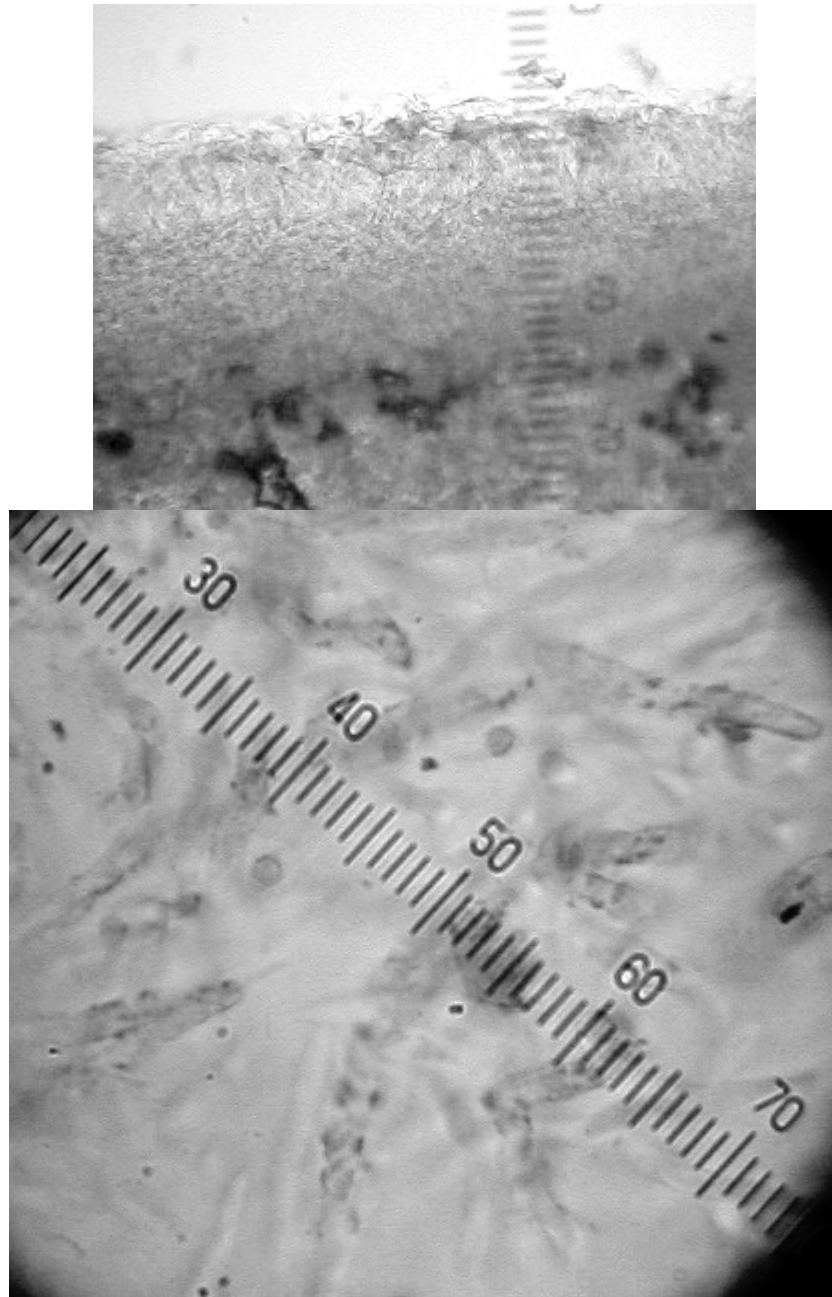


Figure 147 Cutis of *R. occidentalis*: top, section through cutis in which the epicutis shows a clear differentiation from the subcutis at about the 55 mark on the scale, of which, 10 divisions are 100µm; bottom, surface view of epicutis in SV showing naked epicutal hyphae in the background and incrustated primordial hyphae in the foreground, 10 scale divisions are 25µm.

Clade 9a

Section *Tenellae* Quélet

Subsection *Sphagnophilae* Singer

Russula sphagnophila Kauffman

Mich. Acad. Sci. Rpt. 11: 86. 1909

Description of Vancouver Island collections:

Cap 1.7-6.5cm diameter, convex when young, becoming plano-convex with a shallow central depression, margins remaining curved over the gill ends, sometimes almost inrolled in places, smooth when young, soon becoming striate, finally tuberculate. Colour very dark vinaceous purple to brownish purple to brownish violet centrally, lighter purple towards the margin, fading to brownish pink to greyish olive on the margin and olive to yellow-brown or grey-brown over the disc, with a duller brown or grey zone between. Cutis slightly viscid when wet, drying matte, peeling 1/2-3/4, flesh beneath tinted pink, otherwise creamy white, not or barely yellowing, fairly thin, barely 2mm thick at half-radius on a 6cm diameter cap.

Gills white at first, becoming pale cream, subdistant, subgills and forking uncommon, rounded to sinuate at stipe, ventricose or broadest close to the margin, 2-4 times the depth of the trama at half-radius, up to 3mm deep, rounded at the cap margin up to an acute junction with the cutis, pliable, not bruising.

Stipe (1.6-) 4.3-5.0 x (0.4-)1-1.3cm, longer than cap diameter, cylindrical but usually broadening slightly at the base, longitudinally rugulose, soft and compressible, stuffed, becoming cavitate and finally hollow, white, staining dull yellow especially near the base.

Texture fairly soft, but not exceptionally fragile.

Taste mild or with a slightly peppery aftertaste.

Odour slight, bread- or yeast-like in one collection, slightly fruity in the other.

Spore colour deep cream to pale orange-yellow, Romagnesi IId -IIIa.

Spores 8.2-10.2 x 6.3-8.2µm, L:W 1.11-1.36 with a mean of 1.23 (n=50), narrowly to broadly ellipsoidal. **Ornamentation** of bluntly conical warts 0.5-1.1µm high, often a mixture of heavy warts with finer ones interspersed, mostly isolated or 2-4-catenate, or warts joined by a heavy lines, on some spores catenations will run almost the length of the spore, fine lines occasional, these plus catenations forming a partial reticulum. **Woo types** B2-3 to C2-3. **Suprahilar patch** a roundish amyloid area bordered by warts, occasionally including them. **Hiliferous appendix** 1.3-1.6 µm long, 0.8-1.2µm wide near the base. **Basidia** 4-spored, uncommonly 2-spored, 37-50 x 12-14.5µm, strongly clavate to bulbous in the upper half. Sterigmata up to 8µm long and 2.1µm wide near the base. **Pleurocystidia** frequent, 43-68 x 7-12.5µm, elliptical in end view, protruding less than 20µm, originating in the subhymenium, fusoid to cylindrical or slightly clavate, tips obtuse or sometimes with a small button, contents refractive, pale yellow in KOH, weakly greying in SV. **Cheilocystidia** frequent, 35-40 x 8-10µm, protruding around 20µm, otherwise similar to pleurocystidia. **Subhymenium** 20-35µm thick, pseudoparenchymatous, of relatively large cells up to 13µm wide, with younger basidia raised one to two cells above the mature ones, **gill trama** of sphaerocytes with occasional vascular hyphae.

Cutis 100-110µm thick, an ixotrichodermis of two distinct layers. **Subcutis** around 1/2 the depth of the cutis, compactly interwoven, hyphae 1.5-2.5µm wide, repent and more or less parallel, occasional vascular hyphae weakly greying in SV. **Epicutis** of erect hyaline to pinkish hyphae 1.5-4µm wide, and abundant pileocystidia. Hyphal ends undifferentiated, occasionally obtuse, or most often with a tapering terminal cell that sometimes ends in a small button. **Pileocystidia** abundant, 28-80 x 6-10 (-13)µm the majority around 40-60µm long, clavate to cylindroclavate, 0-5-septate, only the shorter ones aseptate, most 2-3-septate, sometimes constricted at the septa, contents pale yellow,

refractive, often only partially filled, greying in SV, sometimes only weakly.

Hypodermis a narrow layer of compacted tramal tissues.

Trama of loosely defined clusters of sphaerocytes bound by a hyphal mesh and occasional vascular hyphae.

Chemical reactions: FeSO₄ - pale grey to pinkish grey; KOH - salmon pink to orange on cap surface, no reaction on stipe; acid fuchsin - no reaction on cuticular hyphae and cystidia; phenol - pale pink to pale brown; SV - pink initially on the gills and cutis, then brown, cystidia and vascular hyphae weakly greying, sometimes not reacting.

Habitat and tree associations: In very wet maritime forests, with Sitka spruce, not necessarily with sphagnum.

Collections: CR001011-38 and -39 on and beside the root pad of a fallen old-growth Sitka spruce, Meares Island boardwalk, N49.1560°, W125.8695°. CR001011-42, in grass and moss (not sphagnum) under mixed age with old-growth Sitka spruce and red alder, alongside the south part of the boardwalk from Wickanninish bay parking lot, PRNP, N49.012617°, W125.674650°. CR011030-03, in grass under young Sitka spruce, Long beach picnic area, PRNP, N49.070061°, W125.7545°. CR020927-01, on duff near base of western hemlock in a valley bottom with old-growth Sitka spruce and western red cedar, Carmanah grove, N48.6585°, W124.6895°.

ITS1-F to

| Collection | ITS4-B | RFLP: HinfI | AluI | Sau3A |
|-------------|--------|-------------|----------|----------|
| CR011030-03 | 816 | 374 | 511, 267 | 305, 191 |

Notes: The spores of *R. sphagnophila* should have more reticulations than is apparent in the above collections, whose spores are intermediate in size and ornamentation between those of *R. brunneoviolacea* and *R. nauseosa*. The collections differ from the latter in having paler spores and from the former in being softer-fleshed with a stronger and earlier development of striations on the cap margin. *Russula brunneoviolacea* prefers a drier forest habitat wherein Douglas fir is found, and *R. sphagnophila* a moister habitat

with Sitka spruce, but where these habitats overlap the difference between the two species becomes difficult to discern. *Russula puellaris* is very similar to *R. sphagnophila* in colour and stature, but the entire basidioma yellows, and some of the pileocystidia are filled with a deep yellow refractive material.

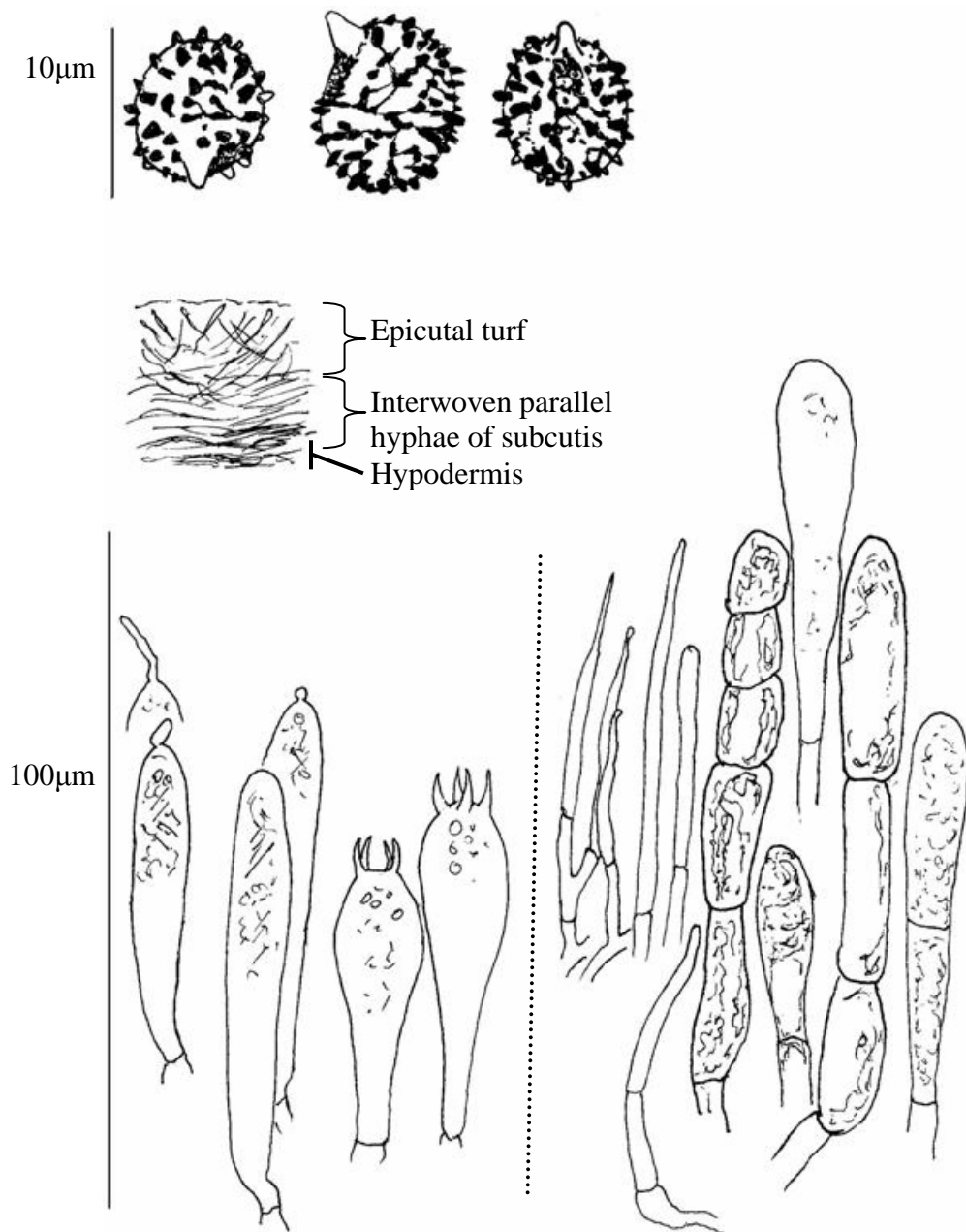


Figure 148 Microscopic characters of *Russula sphagnophila*: Top, spores with 10 µm scale bar; middle, diagram of section through cutis; bottom left, cheilocystidia and two pleurocystidia, two basidia; bottom right, hyphal ends and pileocystidia from the epicutis, lower scale bar is 100 µm.



Figure 149 Macroscopic characters of *R. sphagnophila*: Top (left) and underside (right) of a rather small but fully mature basidioma from Carmanah Grove, the cap is 1.7cm across on the longer dimension.

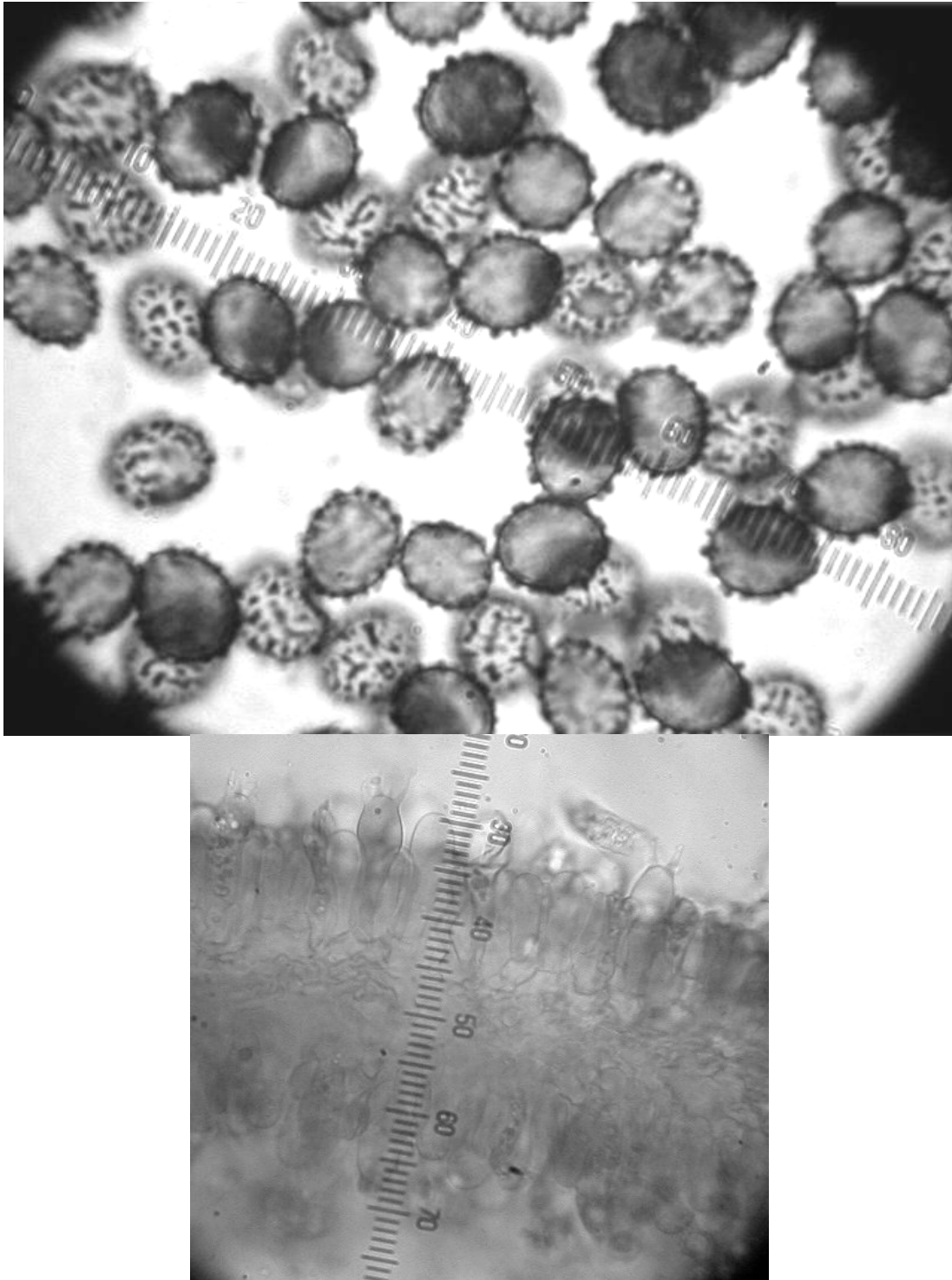


Figure 150 Hymenial characters of *R. sphagnophila*: Top, spores with 1µm division scale; bottom, section through gill near the margin showing several basidia and basidioles, 10 scale divisions are 25µm.

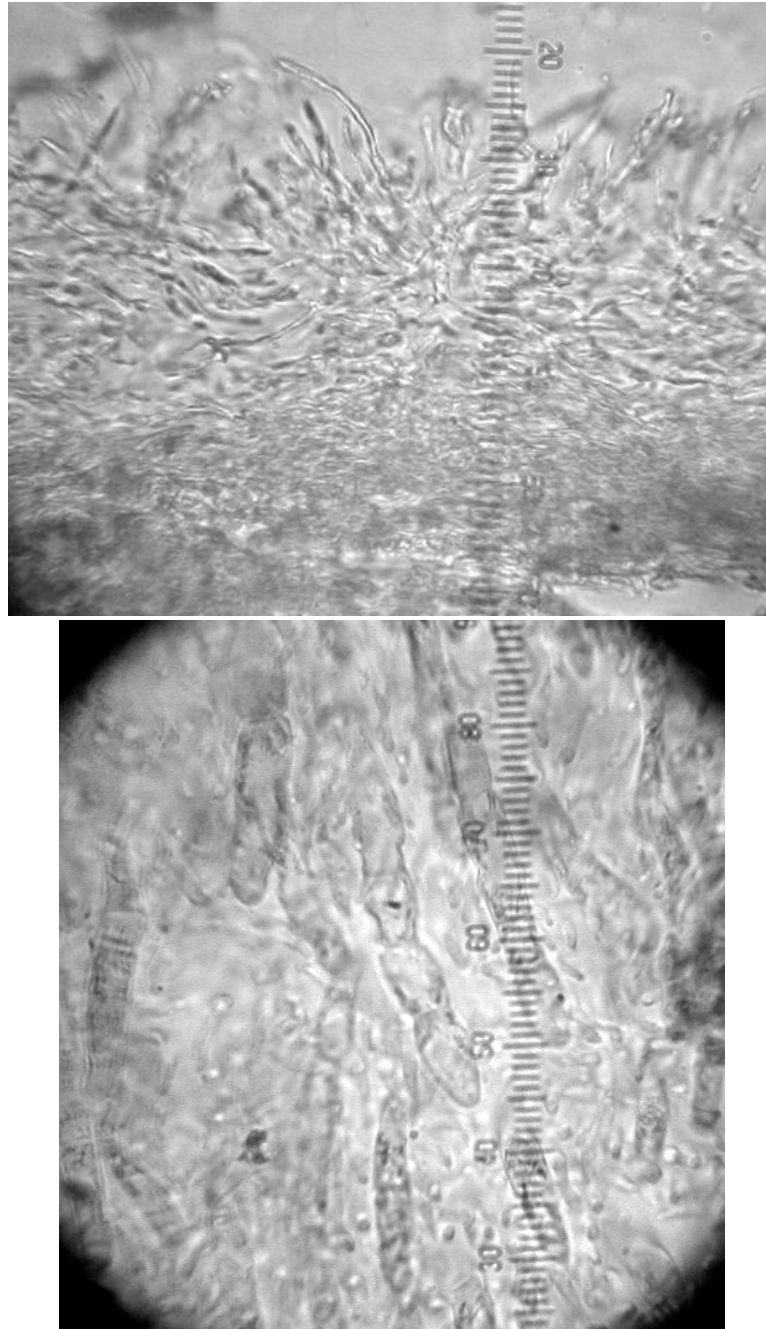


Figure 151 Cutis of *R. sphagnophila*: Top, section through cutis in NH_4OH , with hyphal ends but no pileocystidia in view, 10 scale divisions are $25\mu\text{m}$ for this and the bottom photograph; bottom, surface view of cutis with several septate pileocystidia.

***Russula brunneoviolacea* Crawshay**

Spore Ornamentation of the Russulas. p90. 1930

Description of Vancouver Island collections:

Cap 3.3-3.9cm diameter, almost spherical with a flattened disc area when young, becoming plane with a shallow central depression and downcurved, margins smooth when young, becoming striate in age. Colour a more or less even dark vinaceous purple when young, becoming brownish violet to brownish purple, usually more brown to almost black centrally with clearer hues towards the margin. Viscid when wet, soon drying subglossy with a matte centre. Cutis peeling 2/3-3/4 the radius, trama beneath tinted pink, otherwise white, unchanging.

Gills deep cream to pale orange at maturity, subdistant, subgills and forking uncommon, adnexed at the stipe, broadening outwards, obtuse to rounded at cap margin, 2-4 times the depth of the cap trama at half-radius.

Stipe 3.5-6.0 x 0.9-1.4cm, usually longer than the cap diameter, cylindrical to narrowly clavate, flexuous, white, glabrous, longitudinally slightly rugulose, stuffed with a soft bread-textured trama which may develop three or more small cavities that merge to form a hollow stipe, unchanging or with a faintly buff to yellowish bruising especially at the base.

Texture fairly soft and fragile.

Taste mild, nutty or sweet.

Odour not distinctive to slightly nutty or fruity, sometimes with a faint phenolic, iodine or disinfectant smell at the very base of the stipe on young basidiomata.

Spore colour Romagnesi IIb-c.

Spores 7.4-8.8 (-9.8) x 6.1-7.1 (-8.6) μ m, L:W 1.14-1.31, with a mean of 1.22 (n=30), subglobose to broadly ellipsoidal. **Ornamentation** of warts 0.5-0.9 μ m high, mostly hemispherical, sometimes conical, occasionally crestate, often heavy, mostly joined in rows by thin to thick lines which often run more or less vertically but can be in any direction, generally forming a very broken reticulum, occasionally an almost complete one, or sometimes with a lot of isolated warts or clusters of warts with little reticulum development. **Woo types** B2-C2, rarely D2. **Suprahilar patch** strongly amyloid, irregularly shaped, often with warts within and on its borders. **Hiliferous appendix** around 1.3 μ m long and 0.8 μ m wide near the base. **Basidia** 4-spored, occasionally 2-spored, 37-52 x 10-14.2 μ m, short and broad, clavate and bulbous in the upper 1/3, often abruptly so. Sterigmata relatively short, 5.6-6.2 x 1.6-2.2 μ m. **Pleurocystidia** common, normally distributed (i.e., neither numerous nor sparse), 55-75 x 7.5-14.6 μ m, protruding up to 30 μ m, sometimes embedded, originating in the subhymenium or outer trama, cylindrical to fusoid, tips acute to subacute or sometimes rather blunt and rounded, contents refractive, weakly greying in SV. **Cheilocystidia** variable in frequency and distribution, 37-55 x 8-13 μ m, embedded or protruding 10-15 μ m, fusoid to clavate, often crumpled, sometimes with one septum, tips acute, rounded and somewhat irregular, or often with a tiny button, contents refractive, although often only at the tip, brown or grey in SV. **Subhymenium** 10-25 μ m thick, pseudoparenchymatous, sometimes with longer, narrower cells but not interwoven hyphae, **gill trama** of sphaerocytes, vascular hyphae uncommon.

Cutis 110-130 μ m thick, an ixotrichodermis. **Subcutis** about 2/3 the cutis depth, of tightly interwoven semi-upright hyaline hyphae 2-6 μ m wide, the lower layers repent and parallel, with a few vascular hyphae weakly staining grey in SV, occasionally giving rise to pseudocystidia that terminate at the surface alongside the pileocystidia. Occasionally a small area has a few sphaerocytes and inflated hyphae in the interwoven zone. **Epicutis** of upright hyphae 2-5 μ m wide, generally septate every 10-25 μ m, tips undifferentiated, clavate or sometimes capitate and generally at or near the upper width range (4-5 μ m). **Pileocystidia** abundant, 19-70 x 5-10 (-13) μ m, the majority under 50 μ m long, clavate, 1-5-septate, most with 2 septa, tips obtuse, very occasionally capitate, contents refractive,

yellowish in KOH, light to dark grey in SV, sometimes only partially staining.

Pseudocystidia similar in width and septation to pileocystidia but emanating from the lower subcutis and hence, longer. **Hypodermis** a layer of parallel hyphae interwoven with the subcutis and less so with the upper trama. In places, below the interwoven subcutis and above the normal trama, there is a layer up to 150µm thick of loosely interwoven more or less parallel hyphae with inflated segments, air spaces and sphaerocytes up to about 20µm across.

Trama mostly of sphaerocytes in loosely defined clusters and as a layer above the hymenium, bound by a hyphal mesh and occasional vascular hyphae.

Chemical reactions: FeSO₄ - pale salmon pink; KOH - deep red, turning orange- brown on cap surface, slightly pale green on stipe; NH₄OH - no reaction; guaiac - blue-green; guaiacol - a strong deep pink; phenol -brownish purple; SV - pink at first, then brownish on the gills and cutis, cystidia and vascular hyphae grey.

Habitat and tree associations: Gregarious on the forest floor in mature regeneration western hemlock stand or Douglas fir-madrone-garry oak woodland.

Collections: OC011013-04, Mesachie Lake Forest Research Centre, amongst western hemlocks, exact location not recorded but in the vicinity of N48.8257°, W124.1348°. Collection CR981114-01, from a limestone outcrop under young Douglas fir with madrone, occasional small oaks and salal, differs from the above description in the following characters: the spores are slightly smaller, 6.5-8.9 x 5.8-6.9µm, and although the mean L:W is similar at 1.21, the range is larger at 1.06-1.41, the spore colour could not be accurately ascertained but appears slightly darker at IId or IIIa, and there was no reaction with FeSO₄. Other characters including the spore ornamentation are comparable with the Mesachie Lake collection. The location of the latter collection site is in the Koksilah river valley, north side, near N48.6559°, W123.7294°.

ITS1-F to

| Collection | ITS4-B | RFLP: Hinf1 | Alu1 | Sau3A |
|-------------|--------|-------------|----------|----------|
| CR981114-01 | 832 | 369, 263 | 500, 305 | 343, 271 |

Notes: The North American collections of *Russula brunneoviolaceae* differ in spore ornamentation from those in Europe as described by Romagnesi (1967), that have long, mostly isolated spines, but drawings by Crawshaw (1930) show spores with ornamentation much like the North American and Vancouver Island collections. The basidia of the Vancouver Island material are larger than the dimensions (31-42 x 7.9-10.2µm) given by Shaffer (1970) for Michigan material, but the spores are very close to his variant 1. The subcutis of Vancouver Island collections varied in the amount and position of inflated cells, sometimes within the subcutis, sometimes within the hypodermis, and sometimes lacking. Romagnesi (1967) described such a layer beneath the cuticle and distinguished it from the interwoven layer beneath the epicutis. Shaffer also observed this character in some but not all of the basidiomata in his collections, noting that he did not think this significant due to the inherent variability of this character. *Russula nauseosa*, described and illustrated below, is similar in many microscopic characters and, with the exception of spore colour, virtually indistinguishable macroscopically from *Russula brunneoviolacea*, the larger spore size differentiates it microscopically. *Russula puellaris* is also quite similar, but bruises yellow all over, and usually is red-brown to purple rather than violet, becoming quite brown in age. Two collections with macroscopic characters virtually identical to *R. brunneoviolacea* and with spores of comparable size and ornamentation but darker (Romagnesi IIIa and IVa), and with slightly longer pileocystidia, were made from the coastal Douglas fir zone. These are close to *R. laricina*. *Russula sphagnophila* differs from *R. brunneoviolacea* in its more striate to tuberculate cap margin, its association with wetter forests that sometimes include sphagnum, larger spores and softer flesh. *Russula brunneoviolacea* is normally associated with deciduous trees, especially oaks, of which there are a few in the vicinity of the Mesachie Lake Forest Research Centre, as well as red alder and some willows, so the association with western hemlock may or may not be correct.

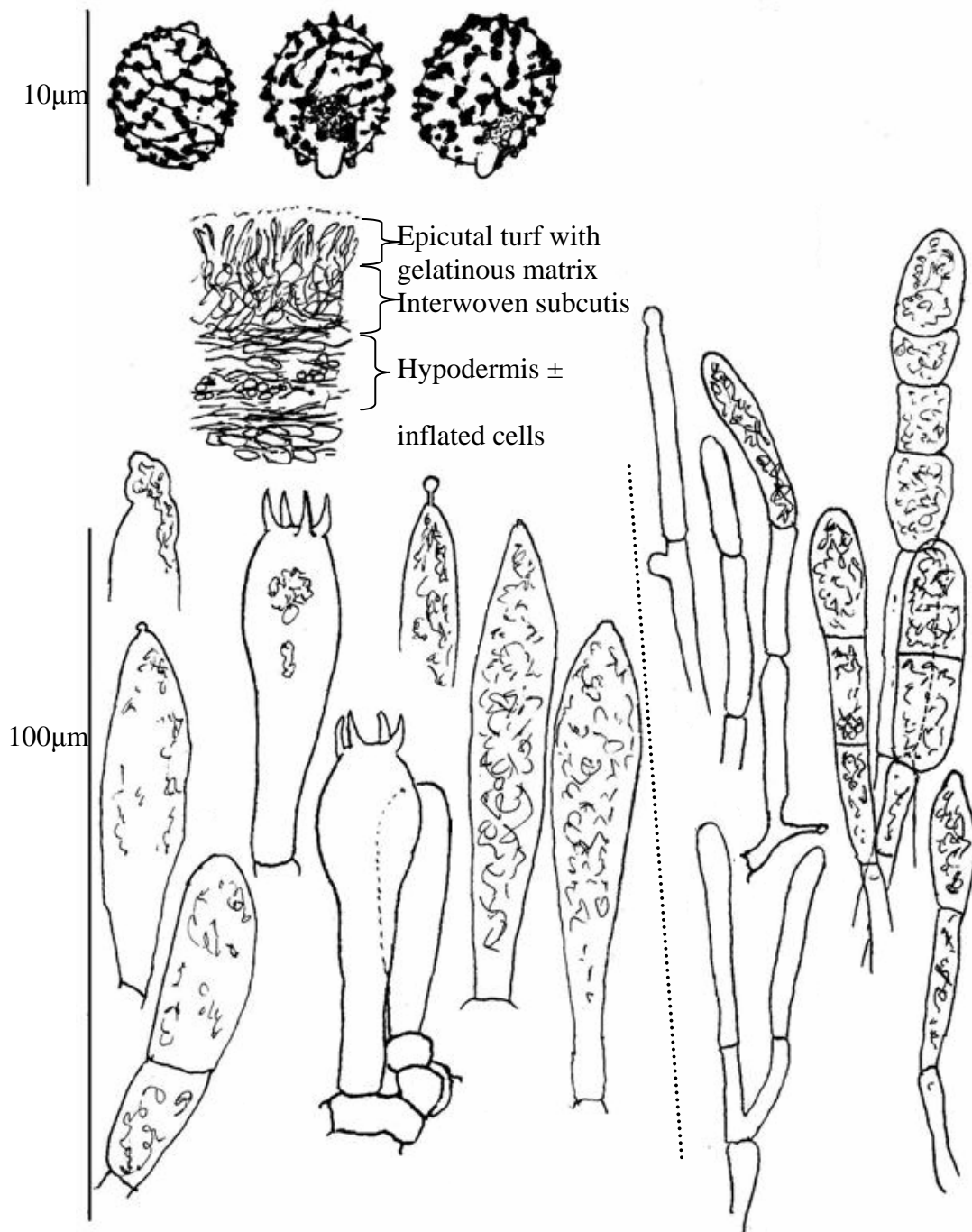


Figure 152 Microscopic characters of *Russula brunneoviolaea*: Top, spores with 10µm scale bar; middle, diagram of section through cutis; bottom left, cheilocystidia, basidia and pleurocystidia; bottom right, hyphal ends and pileocystidia from the epicutis, lower scale bar is 100µm.

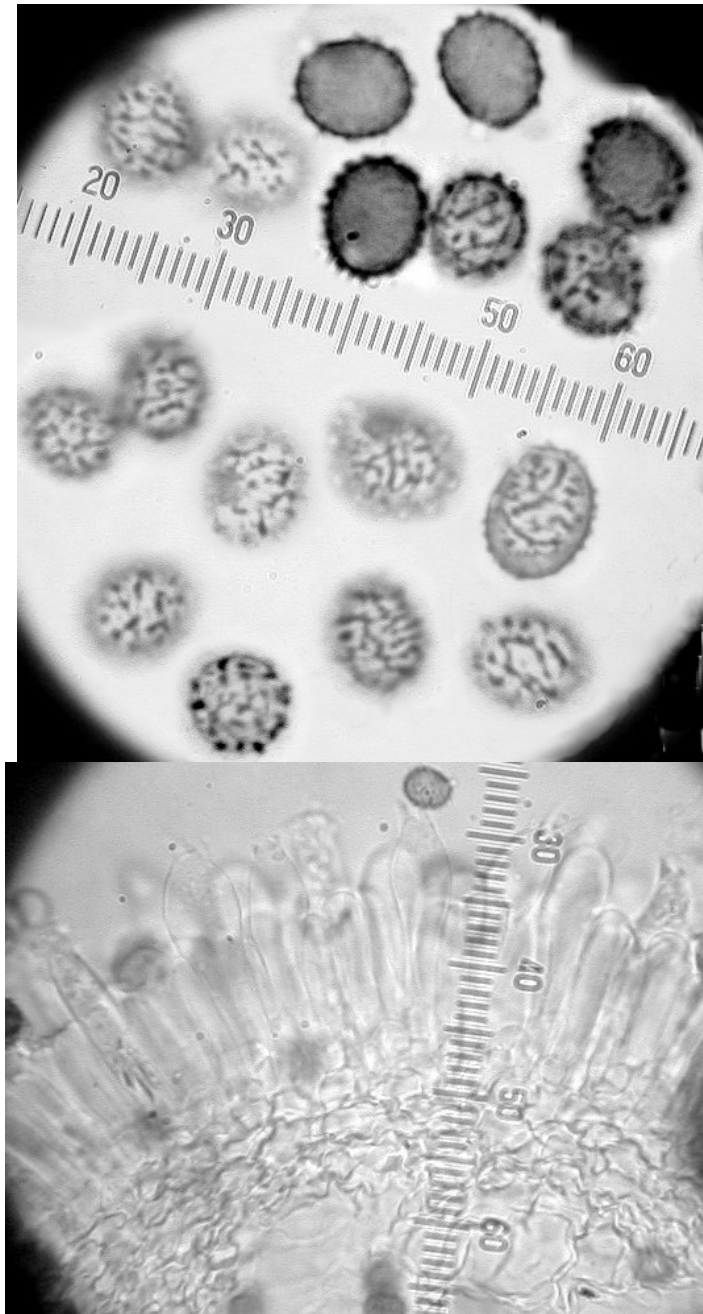


Figure 153 Hymenium of *R. brunneoviolacea*: Top, spores with 1µm division scale; bottom, section through hymenium including subhymenium, mounted in Melzer's reagent, 10 scale divisions are 25µm.

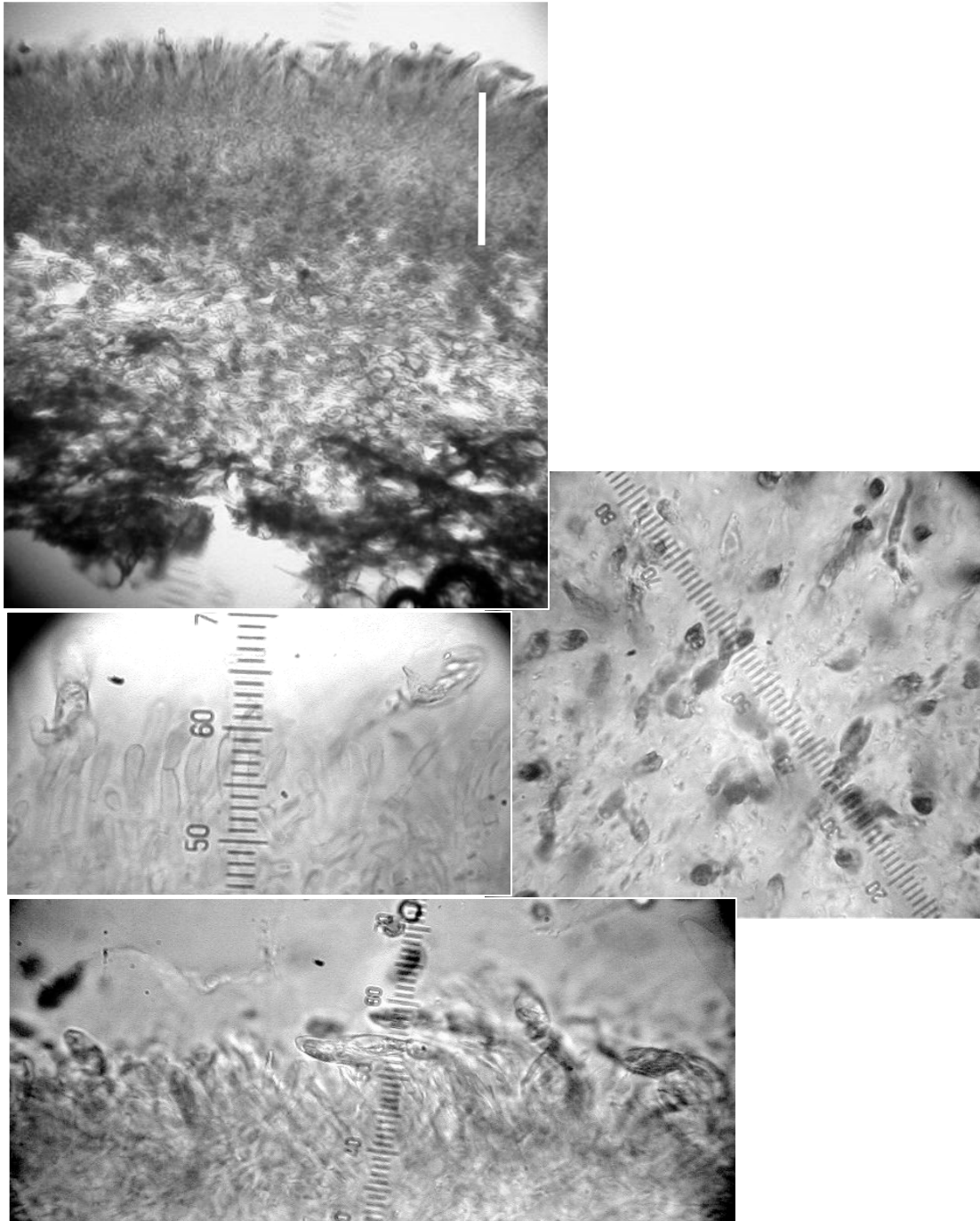


Figure 154 Cutis of *R. brunneoviolacea*: Top: section through cutis and underlying tissues, the tramal tissue is darkly stained at the bottom of the photograph, the area between this and the denser subcutis is the hypodermis filled with inflated hyphae, air spaces and sphaerocytes, in this patch of cutis it is wide, in other areas it lacks inflated elements and consists only of parallel hyphae, scale bar is 100 μ m; middle left, epicutal hyphae and pileocystidia stained in Congo red; middle right, surface view of cutis stained in SV showing darker pileocystidia; bottom, sectional view of pileocystidia stained in SV at epicutal surface, 10 scale divisions are 25 μ m for the last three scales.

***Russula abietina* Peck**

Annual Report N.Y. St. Mus. 54:180. 1901

Description of Vancouver Island collection:

Cap 3.3-9cm diameter, almost spherical when young, becoming convex with a small central depression, eventually almost plane but shallowly depressed, the margin curved over the gill ends, eventually uplifted, smooth, the outer 5mm or so striate in age. Colour, generally a mixture of olive green and brownish-yellow centrally and pinkish purple towards the margins, but with a wide range in colour balance and tone. Young caps may be deep brownish purple, almost black, yellowish pink, yellow-brown or olive, mature caps may be zoned or mottled with brownish red, bronze, grey-brown, or pink and green, fading to pale dull green with traces of pink at the margin, generally, dull green is rarely absent. Cutis viscid when wet, drying glossy to subglossy, peeling 1/4 to 1/2, flesh white, pinkish just under the cutis, unchanging, up to 5mm thick at half-radius.

Gills cream at first, becoming a light orange-yellow at maturity, adnexed to ascending, sometimes with a tiny decurrent tooth, to free, close to subdistant, sometimes distant, usually with subgills and forking throughout the radius, ventricose, around twice the depth of the cap trama at half-radius when mature, obtuse to rounded at the cap margin, unchanging when bruised.

Stipe 2.6-7.5 x 1.4-2.5cm, generally longer than the cap diameter, cylindrical to slightly clavate, white, longitudinally slightly rugulose, stuffed with a fairly firm bread-textured trama that becomes cavitate and finally hollow in age, unchanging to slightly greying beneath the rind when cut. Sometimes a wad of soil-encrusted mycelium remains attached to the stipe base on collection.

Texture about average, firmer when young, quite soft and fragile in age.

Taste mild, sometimes nutty, with a faint peppery aftertaste.

Odour not distinctive to slightly nutty.

Spore colour a deep warm cream to pale orange, Romagnesi IIIa-c.

Spores 7.5-9.5 x 6-8µm, L:W 1.1-1.38 with a mean of 1.24 (n=66), subglobose to broadly ellipsoidal for the majority of spores (from 4-spored basidia), also large spores ranging from around 10.3 x 8µm up to 12.1 x 9µm sometimes as narrow as 6.9µm, obovoid to narrowly ellipsoidal, from 2-spored basidia, these are more common in some basidiomata than others. **Ornamentation** of conical, peg-like to short-crestate warts 0.6-1.2µm (-1.5) µm high, that are mostly isolated, sometimes 2-4 clustered or occasionally catenate, with few to no fine lines and no reticulum. **Woo types** A2-3, B2-3, rarely C2-3. **Suprahilar patch** an irregular roughly elliptical to rectangular amyloid patch with warts on its borders. **Hiliferous appendix** around 1.5-1.9 µm long, 1-1.2µm wide near the base. **Basidia** the majority 4-spored, occasionally 2- and rarely 1-spored, 34-53 x 9-12.5µm, clavate to slightly bulbous in the upper 1/3, generally rather smoothly tapering downward. Sterigmata 5-7µm long and 1.4-1.9µm wide at the base. **Pleurocystidia** common to sometimes sparse, irregularly distributed, 52-85 x 8-12µm, occasionally up to 110µm long, protruding 10-30µm, originating at all levels within the subhymenium, narrowly clavate or fusoid, tips acute, rostrate, or sometimes with a narrow meandering appendage up to 20µm long, contents pale yellowish and refractive in KOH, unreacting or purple in SV, whole patches of gill may have only unstaining ones. **Cheilocystidia** abundant to rare, protruding to 20µm, 50-55 x 5-10µm wide, fusoid, tips blunt and irregularly shaped, mucronate, tapered or capitate, partially filled with refractive material, not reacting in SV. **Subhymenium** 20-30µm thick, pseudoparenchymatous, expanding by one cell for each successive basidium formed. **Gill trama** of sphaerocytes with occasional vascular hyphae 5-6µm wide.

Cutis from 70µm thick near the cap margin, to 200µm thick over the disc, an ixotrichodermis of three layers, an epicutal turf, a interwoven layer of subcutis and a repent layer of subcutis. **Subcutis** of tightly interwoven and tangled pinkish hyphae around 2µm wide, toward the base of the subcutis are bundles of repent hyphae which are interwoven with the upper trama, vascular hyphae rare. **Epicutis** around 40-50µm thick,

of erect hyphae and abundant pileocystidia, upright erect hyaline hyphae 1.6–2.6 wide, tips undifferentiated or more often with a long tapered end cell up to 50µm long, sometimes tortuous and/or knobbly, accompanied by pileocystidia and pseudocystidia in variable densities. **Pileocystidia** 25-90 x 3-6µm, cylindrical, sometimes with a clavate or broader cylindrical terminal cell 6-7µm wide and then with a spatulate outline, tips obtuse, some pileocystidia short-clavate 25-55 x 5-8µm, those under 50µm are 0-1-septate, longer ones are 2-3-septate, or with a septum approximately every 20-30µm, contents partially refractive, pale yellow, unstaining to weakly greying in SV. There is usually a mixture of long-cylindrical, short-clavate and cylindrical cystidia with clavate ends, but the predominance of one or the other type varies between basidiomata and between the cap centre and margin. **Pseudocystidia** common toward the cap margins, infrequent over the disc, it is possible that some of these structures are actually primordial hyphae, since the contents are only weakly refractive, partially greying in SV.

Primordial hyphae probably present, in young basidiomata especially, some of the cystidioid surface hyphae stain temporarily in acid fuchsin, although this is mostly the cell contents, in some SV mounts and in aqueous methylene blue, patches of cystidioid hyphae have minutely roughened walls, usually adjacent to a septum, but fuchsin does not differentially stain these areas. **Hypodermis** not differentiated from trama.

Trama of discrete clusters of sphaerocytes bound by a hyphal mesh with very occasional vascular hyphae around 4µm wide, not reacting in SV.

Chemical reactions: FeSO₄ - greyish pink to salmon pink; KOH - brownish orange to reddish on cap surface, unreacting to yellowish on stipe; NH₄OH - no reaction; guaiac - blue-green; phenol - slowly brownish purple, taking up to 10 minutes to react; SV - deep brownish pink on gills and cutis, cystidia and vascular hyphae weakly to strongly grey or purple.

Habitat and tree associations: On well drained soils on east or west-facing slopes under a broad age range of Douglas fir and western hemlock, with understorey of sword fern and huckleberry. Grand fir may be present in the vicinity as it is common in these forest stands, but it was not looked for at the time of collection.

Collections: CR001104-01 along a trail downslope from the parking lot, on duff under young regeneration western hemlock and Douglas fir, Gowland Tod Provincial Park N48.527°, W123.529°. DG010902-01, amidst sword fern and huckleberry under mixed age Douglas fir, western hemlock and western red cedar, just off the High Ridge trail, Francis King Park, N48.4813°, W123.449317°. CR021009-02, on duff with understory and old-growth western hemlock and Douglas fir with western red cedar, Royal Roads N48.434100°, W123. 478350°.

| ITS1-F to | | | | |
|-------------|--------|-------------|---------------|----------|
| Collection | ITS4-B | RFLP: HinfI | AluI | Sau3A |
| CR001104-01 | 848 | 363 | 500, 358, 285 | 322, 205 |
| DG010902-01 | 874 | 419, 390 | 491, 290 | 357, 255 |

Notes: Although the type of *Russula abietina* Peck is considered by Singer (1947) to be a mixture of two other species: *R. sphagnophila* and *R. blackfordae*. The above collections differ from these latter species macroscopically in stature, cap colour and spore colour. The Vancouver Island collections match the concept of *R. abietina* sensu Grund (1965) and Thiers (1997), except for ranging slightly larger than the upper cap diameter of 7.5cm given by Thiers. Whether or not Peck's type of *R. abietina* is invalid, collections answering the general description and concept of this species turn up regularly in the Pacific Northwest, so clarification of the taxonomy of this species would be welcome. This species shows the same pigment pattern as members of the *Xerampelinae* and is therefore placed in the closely related *Sphagnophilae*, with which it shares most other characters.

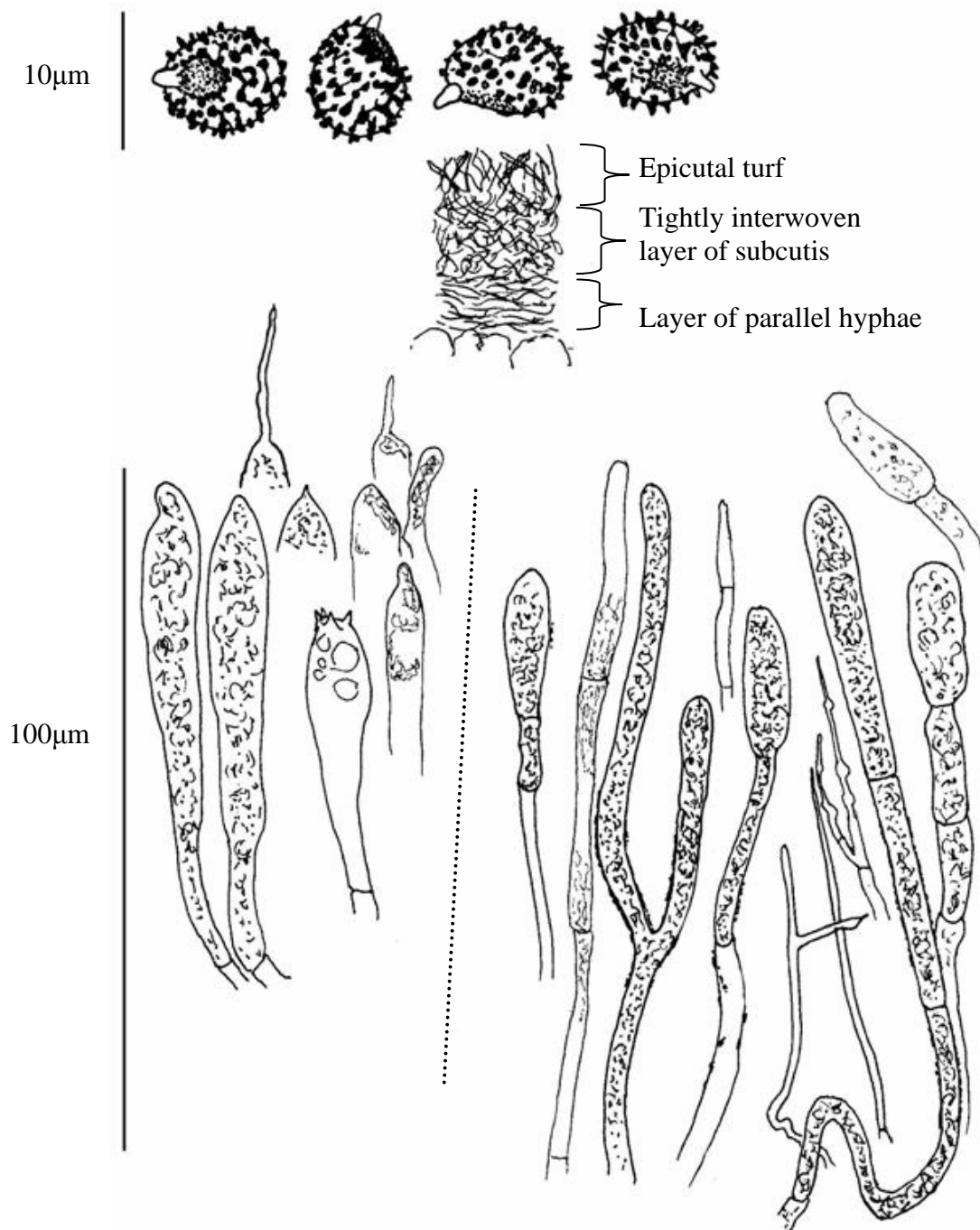


Figure 155. Microscopic characters of *Russula abietina*: Top, spores with 10µm scale bar; middle, diagram of section through cutis; bottom left, pleurocystidia, a basidium and to its right, cheilocystidia; bottom right, pileocystidia, pseudocystidia and hyphal ends from the epicutis, lower scale bar is 100µm.



Figure 156 Macroscopic characters of *R. abietina*: Top, illustration of profiles, top views and a longitudinal section of immature to mature basidiomata showing the colour range, the square is 1cm² and shows spore colour; bottom, mature basidiomata in habitat.

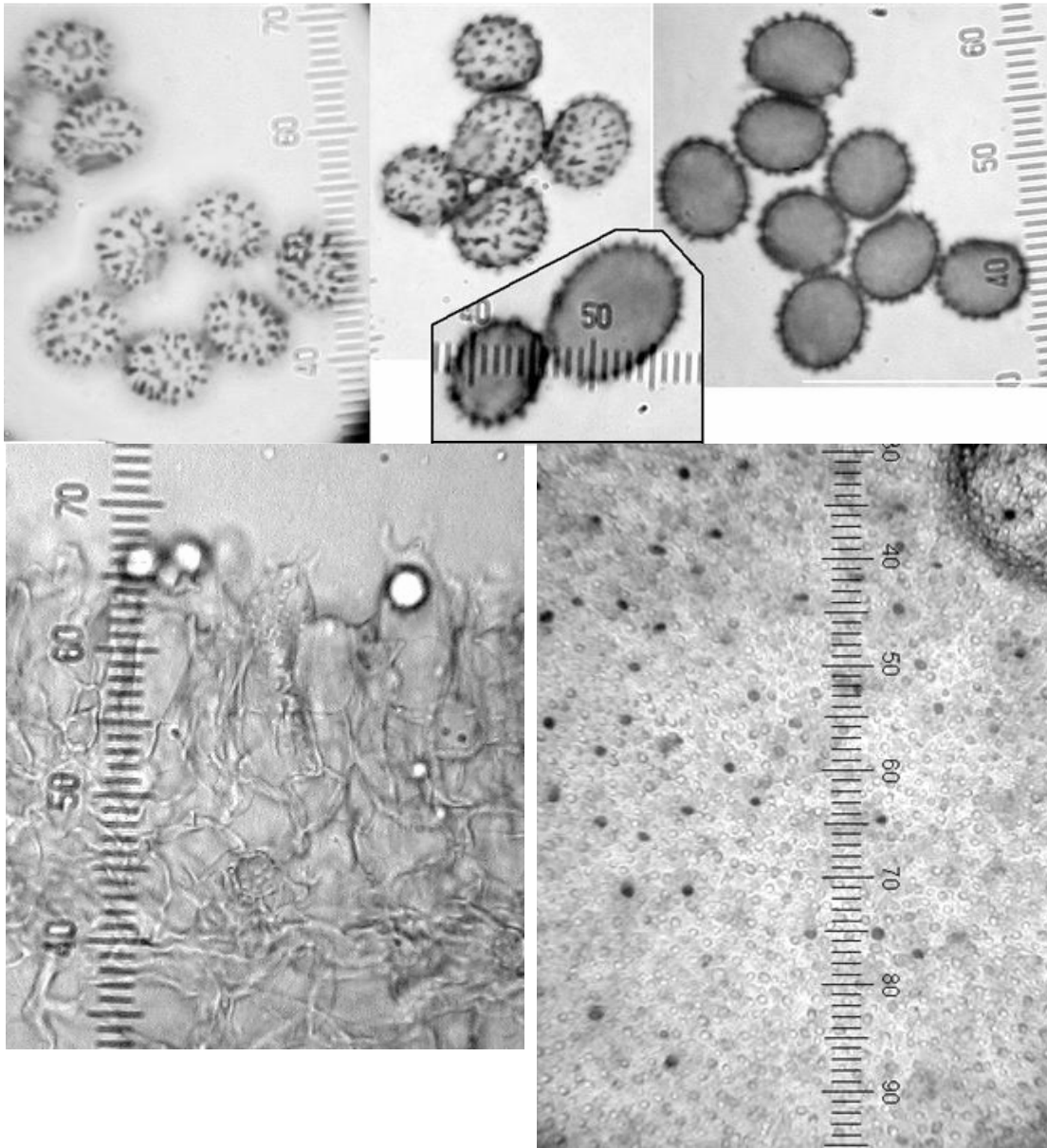


Figure 157. Hymenium of *R. abietina*: Top, spores in surface and equatorial view with (centre) a composite of two focal depths and inset, a spore from a 4-spored basidia and a larger one from a 2-spored basidia, scales are all in 1 μ m divisions; bottom left, section of hymenium showing immature, mature and spent basidia upon a pseudoparenchymatous subhymenium and part of the gill trama below the 40 mark, 10 scale divisions are 25 μ m; bottom right, surface view of gill stained in SV showing the patchy distribution and reactivity to SV of pleurocystidia (dark spots), scale is in 10 μ m divisions.

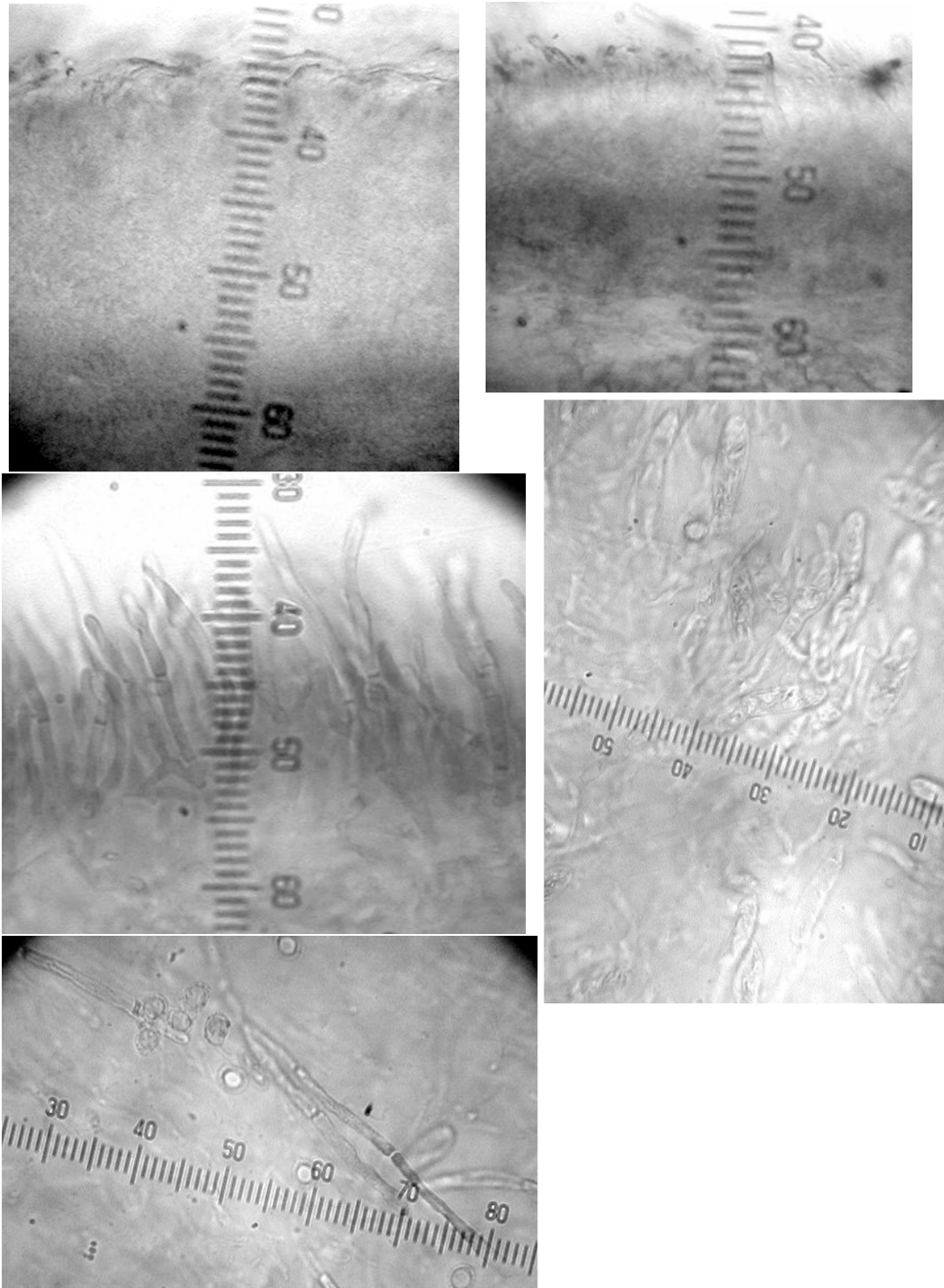


Figure 158. Cutis of *R. abietina*: Top, section through cutis near the cap centre (left) and the margin (right), 10 scale divisions are 100 μ m; middle left, hyphal ends from the epicutis, stained in Congo red, 10 scale divisions are 25 μ m; middle right, surface view of cutis in NH₄OH, showing a cluster of pileocystidia, scale as left; bottom, pseudocystidia (or primordial hyphae) in SV, scale as above.

***Russula aeruginoides* nom. prov.**

Description of Vancouver Island collection:

Cap 10cm diameter, almost plane but with a broad, shallow central depression. Colour a clear light olive green, with a darker green concentric band around the central depression, margin striate on this mature specimen. Cutis viscid, drying subglossy, peeling 1/4 the radius, cap trama white, dull yellow under cuticle, unchanging, around 5-6mm deep at half-radius.

Gills deep yellowish cream with rusty spotting on the eroded margins, subdistant to close, some forking towards cap margin, narrowly adnexed and ascending to almost free at stipe, broadening outwards, approximately twice the depth of the cap trama at mid-radius, rounded at cap margin, brittle.

Stipe 5.5 x 2.4cm, slightly more clavate than cylindrical, creamy white, bruising a red-brown at the base, stipe rind and cap trama immediately above the gills slightly greyish, stipe stuffed with a bread-textured trama.

Texture of average *Russula* texture.

Taste mild and nutty.

Odour not distinctive.

Spore colour light orange-yellow, Romagnesi IIIc but slightly more pink.

Spores 7.1-10 x 6.1-8.3µm, L:W 1.03-1.36 with a mean of 1.16, (n=30), subglobose to broadly ellipsoidal. **Ornamentation** of pointed, peg-like or occasionally short-crestate, heavy, incompletely amyloid warts 1-1.5µm high, occasionally up to 2µm high, mostly isolated, sometimes with fine lines joining 2-3 warts or short catenations, not forming a reticulum. Fine, low dots are sometimes interspersed between the larger warts, especially towards the suprahilar patch. **Woo types** A3-B3. **Suprahilar patch** strongly amyloid,

with small to medium sized warts on its border. **Hiliferous appendix** relatively small, 1.4-1.8µm long, 1-1.2µm wide near the base. **Basidia** most 4-spored, some 2-spored, 35-52 x 10-14µm, the majority of mature basidia are close to 37-40µm long, clavate to slightly bulbous in the upper 1/2. Sterigmata about 6-10µm long and 2-2.6µm wide near the base. **Pleurocystidia** frequent, 60-95 x 9-13 (-15) µm, protruding 10-30µm, arising from the subhymenium, fusoid, tips obtuse, acute, mucronate or most commonly with a small terminal button or allantoid appendage, contents refractive, colourless to pale yellow in KOH, red-brown or grey in SV. **Cheilocystidia** locally abundant but irregularly distributed, similar to pleurocystidia but fewer react to SV, occasional ones lack refractive contents. **Subhymenium** 12-25 µm thick, pseudoparenchymatous, **gill trama** of sphaerocytes of irregular outline, with occasional vascular hyphae.

Cutis 80-150µm thick, an ixotrichodermis, the turf layer becoming repent towards the margin, pigment granular, and darker in the epicutis and lower subcutis. **Subcutis** of tangled hyphae 2-4µm wide, becoming more loosely interwoven toward the top and more repent and yellowish-green toward the base, embedded in a gelatinous matrix, vascular hyphae uncommon. **Epicutis** consisting of upright hyphae, 2.5-3.5µm wide, containing a vacuolar and granular green pigment, hyphal ends obtuse, not differentiated, with frequent pileocystidia, embedded in a sometimes conspicuous gelatinous matrix. No incrusted hyphae and nothing staining in acid fuchsin. **Pileocystidia** 40-87 x 4-10µm, 1-3-septate, the majority being 2-septate, rarely aseptate, often constricted at the septa, clavate or with a clavate to broadly cylindrical terminal cell on a narrower base, tips obtuse, contents yellow-green refractive, staining pink in SV. **Pseudocystidia** occasional, arising from the subcutis, slightly refractive. **Hypodermis** a narrow layer up to 20µm thick, of parallel hyphae interwoven with the tramal and subcutis hyphae.

Trama of discrete clusters of sphaerocytes bound by a hyphal mesh, vascular hyphae uncommon.

Chemical reactions: FeSO₄ - faint salmon pink; KOH - tan to orange on the cap surface, no reaction on stipe; phenol - slowly brown; SV - red-brown on cap cutis, red on gills,

pileocystidia pink, hymenial cystidia mostly stain brownish red, some grey, some non-staining.

Habitat and tree associations: On rotten log, amongst western hemlock, huckleberry and salal, in moist, level, mixed-age stand with some old growth close to an estuary.

Collections: CR981013-08 near estuary along San Joseph trail, Cape Scott, approximately N50.768°, W128.342°.

Notes: The spores are heavily ornamented and have an amyloid suprahilar patch, indicating that this species is not *R. aeruginea*, nor does it have other characteristics of the *Heterophyllidia*. This collection has the microscopic characters and outward appearance of *R. urens*, but it is not peppery and the cystidia are rarely positive in SV (pepperiness and SV positive staining are often correlated). *Russula olivacea*, which can be greenish, tends to also have purple hues in the cap, pink on the stipe, and a dry, concentrically areolate cutis with a smooth cap margin, and lacks pileocystidia. The granular pigment is similar to that found in *Russula murrillii* and *R. puellaris*, save that it is green rather than pink. This collection fits best in the *Sphagnophilae* and is closest to *Russula nitida*, a slightly smaller species (up to 7cm cap diameter), which occasionally fades to a greenish colour from brownish purple, and grows in moist, acidic soils, though rarely with spruce or other conifers. Unfortunately, only one collection of one mature basidiomata has been found, so it would seem to be very rare.

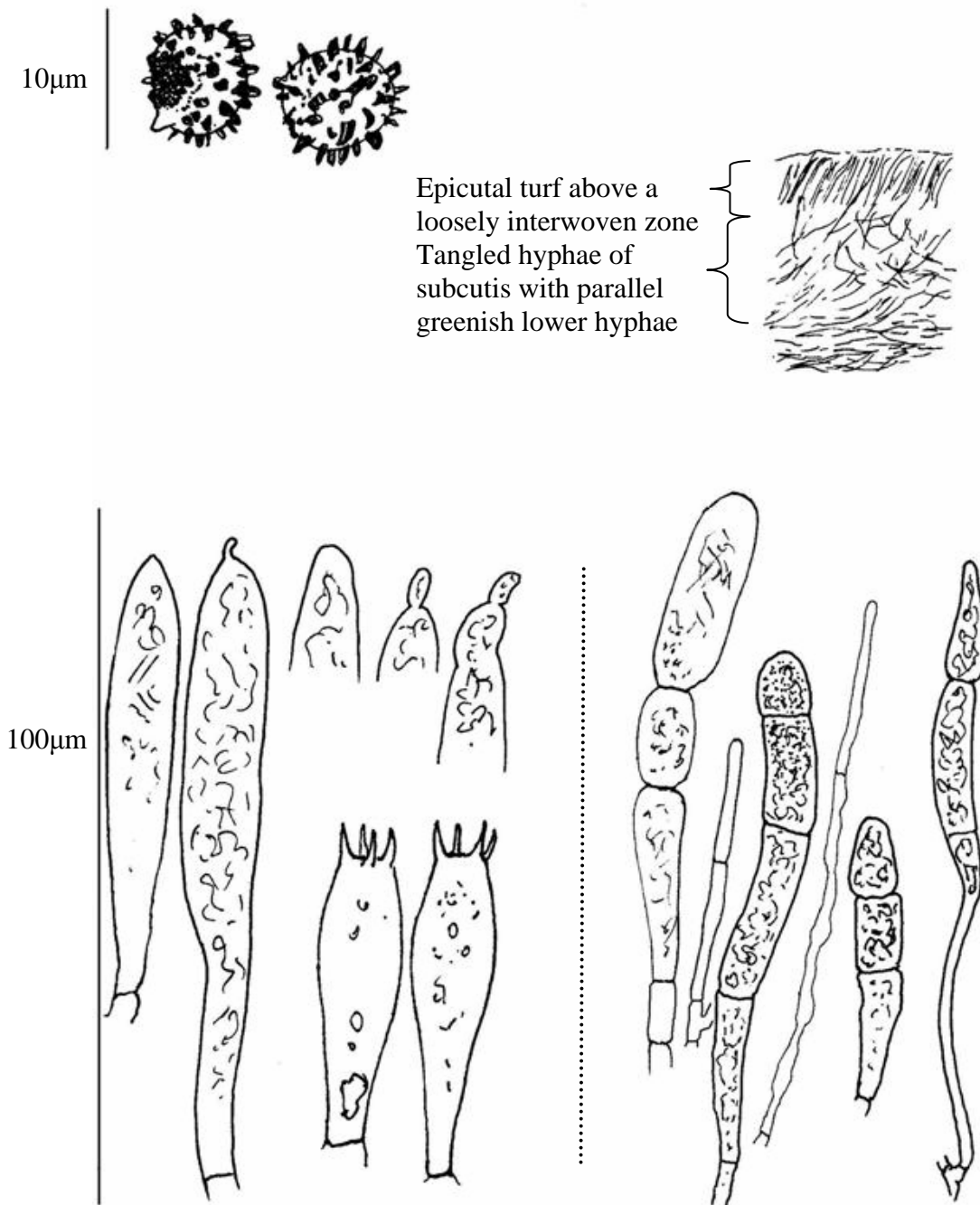


Figure 159 Microscopic characters of *Russula aeruginoides*: Top, spores with 10µm scale bar; middle, diagram of section through cutis; bottom left, hymenial cystidia and basidia; bottom right, pileocystidia, hyphal ends, lower scale bar is 100µm.



Figure 160 Macroscopic and pigmentation characters of *R. aeruginoides*: Top, profile and longitudinal section of a mature basidioma, square is 1cm² and shows spore colour; bottom, two colour photomicrographs of the surface of the epicutis showing the green vacuolar pigment which is more apparent in the left picture, and the granular inclusions, more apparent at a lower focal point in the right picture, 10 scale divisions are 25μm for both photographs.

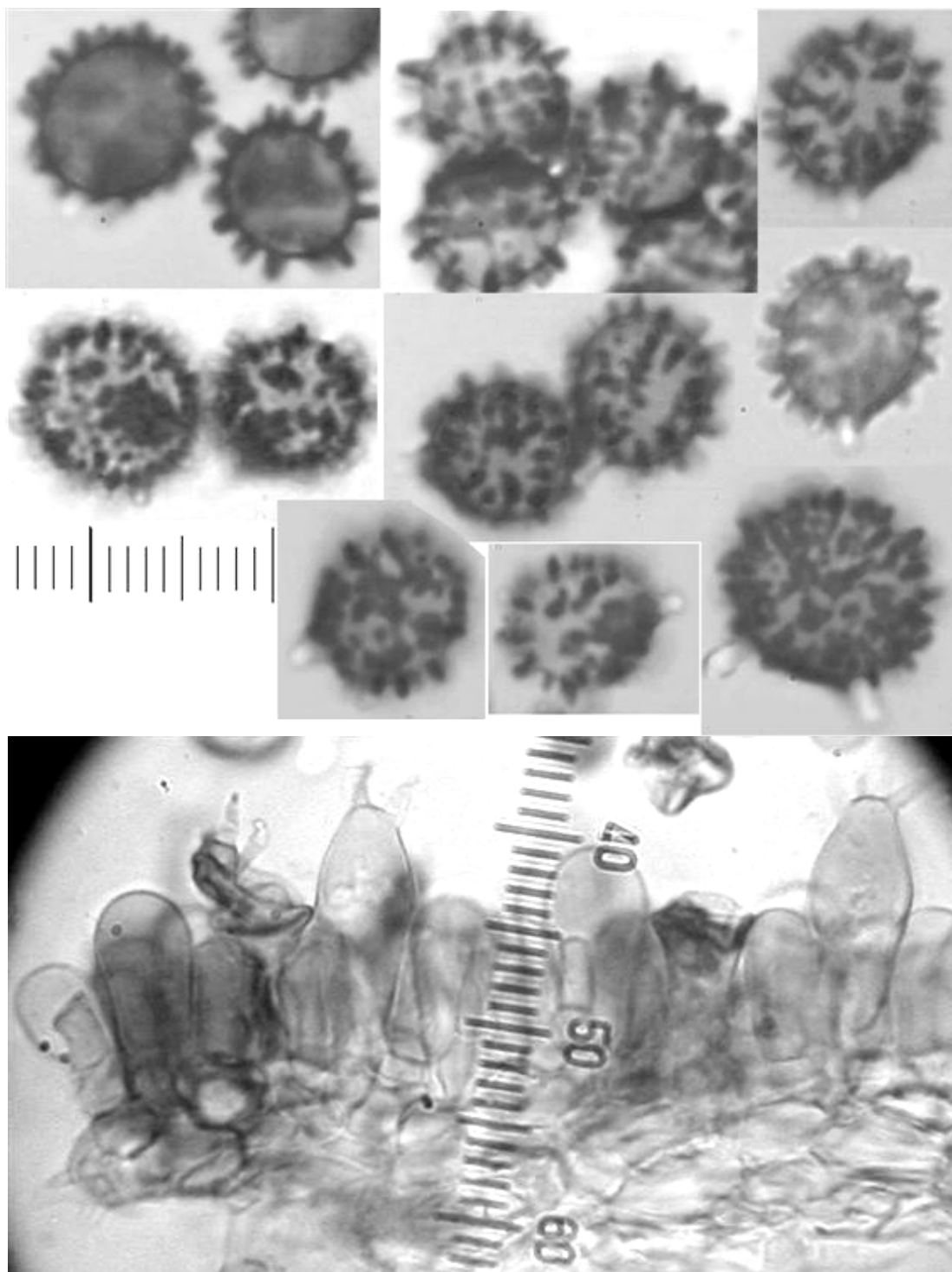


Figure 161 Characters of the hymenium of *R. aeruginoides*: Top, spores with 1µm division scale; bottom, section of hymenium showing basidia, basidioles and subhymenium, 10 scale divisions are 25µm.

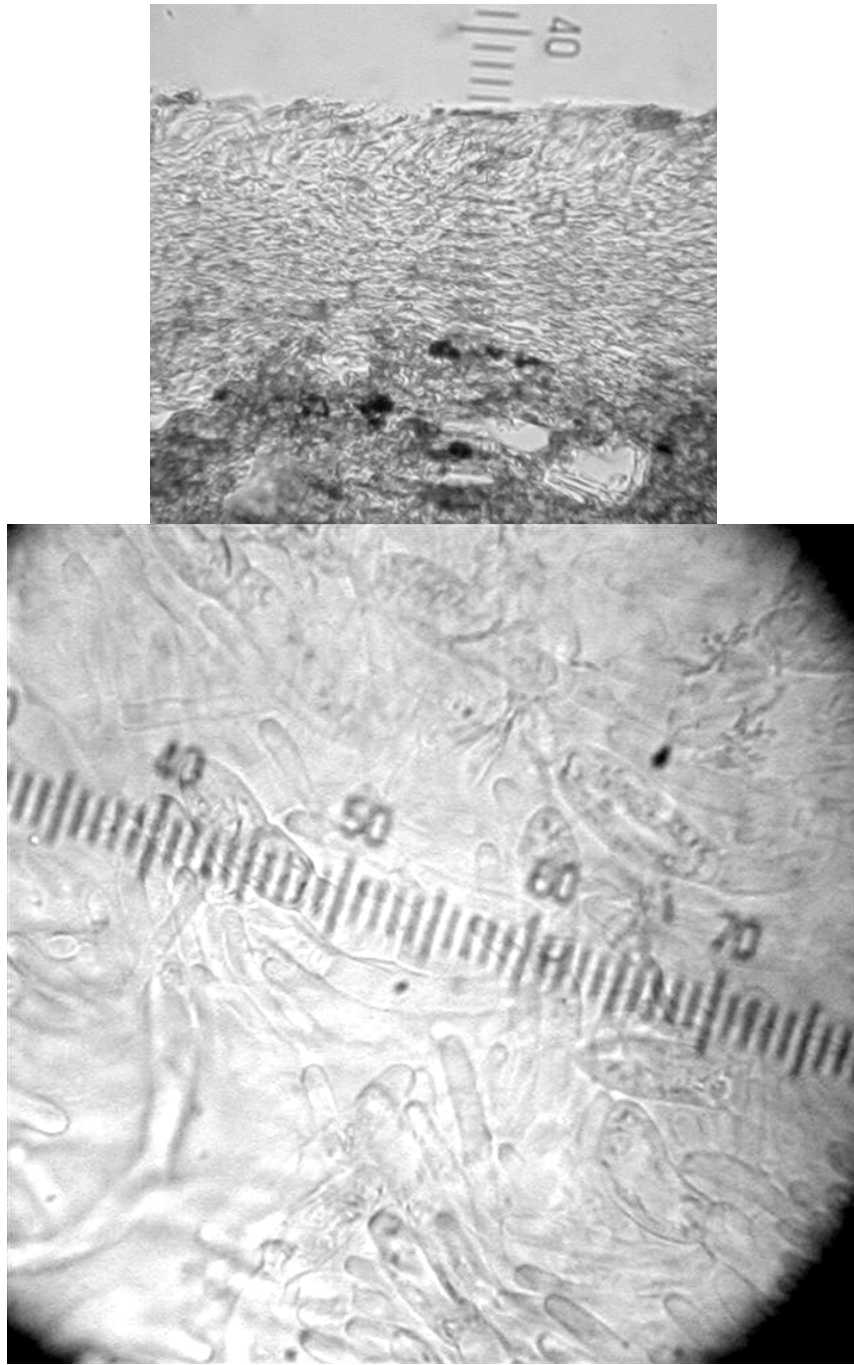


Figure 162 Cutis of *R. aeruginoides*: Top, section through cutis, 10 scale divisions are 100µm; bottom, surface view of cutis in 3% NH₄OH showing epicutal hyphal ends and broad, septate pileocystidia with refractive contents, 10 scale divisions are 25µm.

Clade 9b

Subsection *Xerampelinae* Singer

Beih. Bot. Centralbl. 49(2): 240. 1932

Subsection *Xerampelinae* Singer is in section *Polychromae* R. Maire subgenus *Russula*, in the classification system of Sarnari (1998), and replaces the name *Viridantinae* Melzer-Zvára which has been in use since 1927 for this group. Taxonomically this is a well defined group whose member species are relatively easy to recognize macroscopically from the combination of mild taste, odour of trimethylamine (shellfish), deep cream to yellow spores, flesh which turns ochre yellow and eventually brownish where damaged, and a grey-green to blue-green reaction with FeSO₄. Most stain red in aniline (Grund, 1965, Romagnesi 1967). Microscopically, they have few pileocystidia, which, together with the hymenial cystidia, stain weakly if at all in SV, and spores with an ornamentation of conical or bluntly conical warts, mostly 0.8 to 1.2µm high, isolated or catenate with very little reticulum development.

There are several varieties of this species, named according to the colour and texture of the cap cuticle. A few of these varieties such as *Russula elaeodes* (Bresad.: Romagn.) Bon, *R. grundii* Thiers and *R. semirubra* have been raised to the status of species. One variety, *R. xerampelina* var *isabelliniceps* published as nom prov. by Grund (1965) in his Ph.D. thesis, has consistent morphological differences from the sister species and does not appear to intergrade with any of them, and warrants being raised to species level. The restriction fragment lengths of the ITS region of the rDNA gene of *R. elaeodes*, *R. isabelliniceps*, *R. semirubra* and *R. xerampelina* var. *xerampelina* all show very similar patterns, and these in turn closely match the RFLP patterns of the sequenced ITS regions of four isolates of *R. xerampelina* whose sequences were downloaded from Genbank.

Russula erythropoda and *R. xerampelina* var. *erythropoda* are considered synonyms of *R. xerampelina* by many authors including Romagnesi (1967), Bon (1987), Buczacki

(1992), Courtecuisse and Duhem (1995) and Adamčík, who designated a neotype of the species (2002).

One of the collections, *R. cf. pruinosa* was initially thought to be a member of subgenus *Amoenula* Sarnari, because of the lack of pileocystidia and cheilocystidia in several of the mounts, and because of the elongated terminal cells of the epicutal hyphae. However, the RFLP pattern of the ITS region matched that of other *Xerampelinae* and did not match that derived from a DNA sequence of *R. amoenicolor* from GenBank. Also, the chromatograph of cuticle pigments showed a red which did not fluoresce in blue LED light, in common with that found in other *Xerampelinae*.

***Russula xerampelina* (Schaeff.) Fries**

Epicr. Myc.: 356. 1838

Description of Vancouver Island collection:

Cap 5.2-12.5cm diameter, convex at first becoming centrally depressed at maturity, margin smooth, rounded with the cutis often extending down and under the edge of the cap trama so that it looks somewhat inrolled, and the pigment extends along the outer gill margin a short distance to up to half way. Colour ochraceous-olive when very young, becoming deep purple with a darker purple to black centre, occasionally with mottled areas of yellow ochre or brownish-olive, sometimes this colour in the cap centre. Surface viscid and usually with a slight bloom, drying matte. Cutis peels 1/2 to 2/3 of the radius. Cap trama cream, purplish-pink under the cutis.

Gills close to subdistant, sometimes quite coarse, adnexed to sinuate at stipe, acute at margin, arched, narrowest at stipe and broadening outwards, approximately equal in depth to that of the cap trama at half-radius, the margins parallel to the cap surface, margins entire. Colour cream when young, becoming warm yellow to light orange-yellow at maturity and developing brown stains where damaged and on the gill margins. Anastomoses frequent, especially near the stipe but often distributed throughout the radius, (fig. 163) free sub-gills rare.

Stipe 5.0-8.2 x 1.1-3.1cm, cylindrical to clavate, with a firm rind 2-5mm thick, stuffed with a bread-textured trama that develops irregular cavities and turns pinkish-brown on cutting and around insect damage. Surface longitudinally finely rugulose, pruinose, cream to light yellow, flushed partly or entirely with pink, bruising ochre-yellow when scratched, eventually browning.

Texture quite firm and somewhat brittle, gills brittle.

Taste mild, sweetish or nutty, sometimes slightly peppery, especially when young.

Odour not distinctive or mushroomy when young, sometimes with a rubbery component, gradually developing a crab or shrimp smell as it ages, eventually smelling strongly fishy. In dry weather, the mushroom may become too dry to detect much odour.

Spore colour light orange-yellow, Romagnesi IIIb-c.

Spores 6.2-8.5 x 5-7.5µm for the Strathcona collection, 6.8-10 (-12) x 6-8µm (-10µm) for the other lowland collections, overall mean 7.56 x 6.34µm; L:W ratio 0.94-1.45, mean 1.2 (n=30), ellipsoidal, many a curved teardrop shape with the suprahilar patch area flattened or slightly concave in side view. **Ornamentation** of sharply or bluntly conical warts, 0.8-1.2µm (-1.5µm) high, isolated or catenate, a few joined by lines but not forming a reticulum, or occasionally a partial reticulum seen. **Woo types** B3 to C2 to C3. **Suprahilar patch** amyloid, a distinct grey area in Melzer's reagent, with uneven edges and with occasional low warts at the margin. **Basidia** 40-55 x 10-15µm, clavate, mostly 4-spored but 2-spored ones common, giving rise to the larger end of the size range of spores. Sterigmata 5-8µm long. **Cheilocystidia** rare, not staining in SV or staining pinkish to red, as does the gill margin. **Pleurocystidia**, scattered to evenly distributed, staining reddish or weakly grey in SV, protruding only 10-25µm beyond basidioles, 67-120 x 9-15µm, but most 10-11µm wide, many elliptical in end view, clavate sometimes pinched or crumpled, ends narrowing, blunt, developing one to a series of 2 to 3 capita in diminishing sizes (ampullaceous) in aging sporocarps, (fig,??.) **Subhymenium** about 50-70µm thick, parenchymatous, gill trama of sphaerocytes without laticifers.

Cutis 60-140µm thick at half radius, up to 250µm thick on disc, of tightly interwoven and felted hyphae within a gelatinous matrix. **Subcutis** about half the depth of the cutis but not well differentiated, the **epicutis** merely of slightly more upright felted hyphae with few free hyphal ends visible. In water mounts of cutis sections, the red-purple colour is stronger in a layer just above the trama and in the epicutis, with a paler band between, the colour visibly leaching out into the mount. **Pileocystidia**, unevenly distributed with some areas of the cutis apparently devoid of them, other parts with small clusters of them, 30-70µm x 5-7.5µm, 0-1-septate, cylindrical to narrowly clavate with rounded ends, many with a pinched or narrowed end, contents refractive but not as strongly so as on most

other *Russulas*. **Pseudocystidia**, none seen. Cuticular hyphae 2.5-4µm wide, with hyphal ends at the cap surface with blunt cylindrical, tapering or lance-shaped end cells up to 5µm wide, occasionally forming low clusters protruding about 20µm beyond the surrounding surface.

Trama of bundles of hyphae enclosing clusters of sphaerocytes, lacking SV-positive laticiferous hyphae.

Chemical reactions: FeSO₄ - blue-green; KOH - red to orange red on cap surface (slightly browner on young, still yellowish caps), yellowish on stipe; NH₄OH - no reaction; phenol - brownish purple; SV - on gills brownish-purple to purple-grey, on cutis pink-grey.

Habitat and tree associations: Found from low-lying coastal regions to at least 300m, in well drained and often dry soils from August to December among Douglas fir and hemlocks and mixed coniferous forest containing one or both of these trees. *Russula xerampelina* generally occurs singly or in small groups of 2 or 3, but may be more abundant in good years such as 2004.

Collections: CR980807-03 Rocky Point N48.3162°, W123.5818° amongst old growth Douglas fir. CR001202-02 Rocky Point N48.3313°, W123.5551°, amongst second growth Douglas fir, with some western hemlock and madrone. CR001127-01 Royal Roads N48.4369°, W123.4793° in a mixed-age stand of Douglas fir. CR001001-02 Koksilah Ridge N48.6558°, W123.7357° on a rocky knoll with a small Douglas fir, Oregon grape and huckleberry. CR980821-05 Strathcona Park, Phillips Ridge trail at about 300m, N49.59°, W125.583° amongst Douglas fir, hemlock sp. and *Abies* sp. CR010814-03, Fairy Lake near Port Renfrew, N48.5840°, W124.0035°, two immature sporocarps with yellow ochre to olive colours and a finely areolate cuticle texture, found with mature western hemlock and Sitka spruce. This latter collection has the texture and habitat associated with *R. isabelliniceps* and may be that species, but the DNA analysis, in particular the RFLP pattern for the enzyme AluI showed a closer relationship to *R. xerampelina*.

Collections from Saturna Island: PJ981122 from under Douglas fir on a roughly south facing slope on a lawn, N48.799114°, W123.178658°. PJ981018-ER17 from Saturna Island Ecological Reserve, amongst mature Douglas fir with understory western hemlock, N48.774588°, W123.155597°.

Two collections were made from the forests around the Breitenbush area in the Oregon Cascade mountains for comparison with the Vancouver Island material. These showed very slight differences in morphology in that the terminal hyphae in the cutis are more upright, patches of cutis have broader hyphae at 4.5 to 8µm (within a couple of millimetres from areas of the narrower type), and the cutis generally 200 to 250µm thick. Other characters are no different, and the DNA is very similar to the Rocky Point collection in particular.

| Collections | ITS1-F to ITS4-B | RFLPs: | | |
|-----------------------|------------------|----------|----------|---------------|
| | | HinfI | AluI | Sau3A |
| CR001001-02 | 885 | 427, 343 | 531, 295 | 341, 266, 205 |
| CR001127-01 | 900 | 427, 336 | 530, 282 | 341, 266, 205 |
| CR001202-02 | 852 | 416, 340 | 506, 295 | 367, 270, 218 |
| CR010814-03 | 880 | 419, 353 | 511, 278 | 326, 261, 200 |
| <i>R. xerampelina</i> | | | | |
| (Breitenbush, OR) | 874 | 416, 340 | 506, 295 | 367, 252, 205 |

Notes: These collections agree very well with the descriptions of Northern California *Russula xerampelina* sensu Thiers (1997), Washington collections (Grund, 1964), and the European description sensu Romagnesi (1967), and with the description and illustrations for var. *xerampelina* in particular of Adamčík (2002). The spores of the Vancouver Island collections span a greater range than those of the neotype of Adamčík (2002) which range from 8.2-10.6µm x 6.3-8.2µm. Romagnesi (1967) gives the spore size range from 7.7-11.5µm x 7-8.5µm. The ITS rDNA region shows some variation between individuals but

the general pattern of all the RFLP's is remarkably consistent within the species, other members of the *Xerampelinae* group and to those derived from sequences of *R. xerampelina* from GenBank.

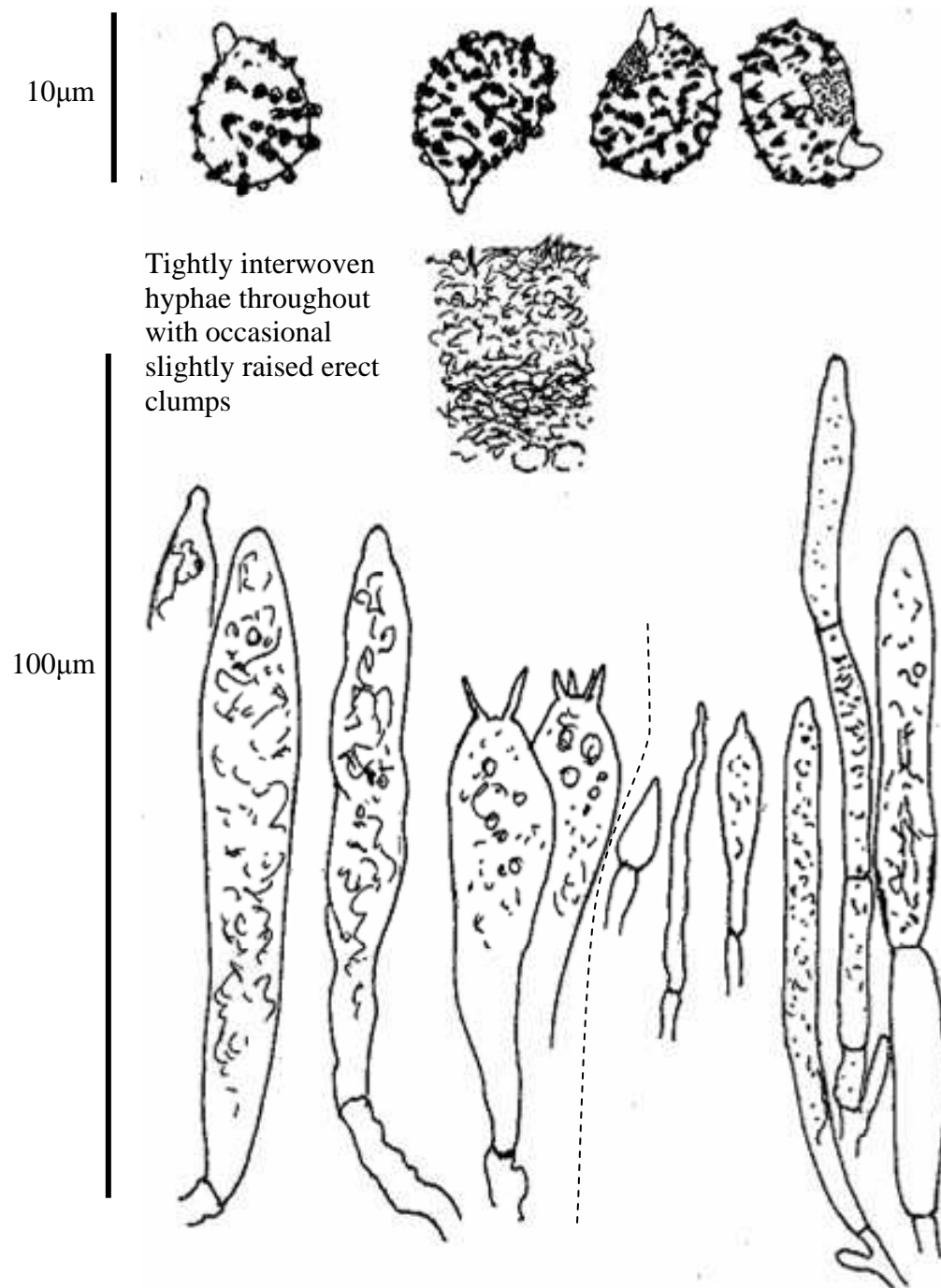


Figure 164 Microscopic characters of *R. xerampelina*: Top, spores with 10µm scale bar; middle, plan of cutis in section in 5% KOH; lower left, basidia and hymenial cystidia; lower right, pileocystidia and hyphal ends in cutis, lower scale bar is 100µm.



Figure 165 Macroscopic characters of *R. xerampelina*: Top, illustration of three phases in development from yellowish when young to purple in maturity, profiles, longitudinal sections and gills, square is 1cm² and shows spore deposit colour; bottom, *R. xerampelina* gills showing anastomoses common in this species, note also the almost completely pink stipe.

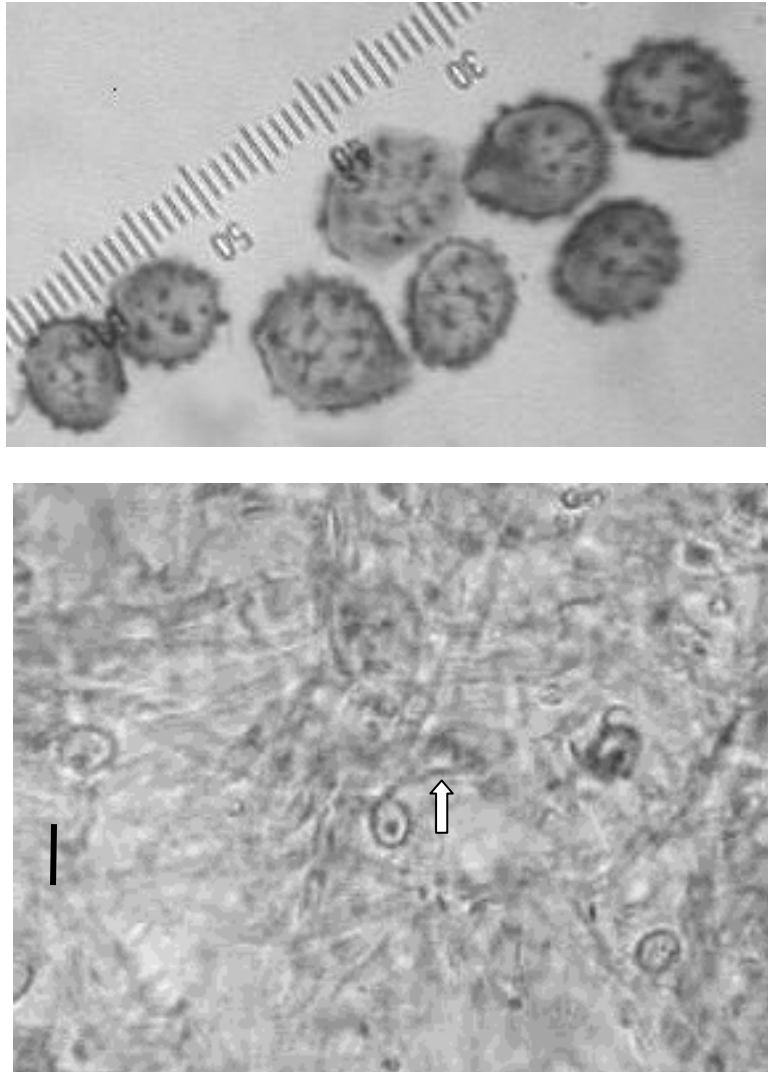


Figure 166 Hymenium and cutis of *R. xerampelina*: Top, spores with 1 μ m division scale (composite photograph of two depths of focus); bottom, surface view of cap cutis, arrow points out a pileocystidia, scale bar is 10 μ m (rounded objects are spores.)

***Russula semirubra* Singer**

Sydowia 11:218. 1957

Description of Vancouver Island collection:

Cap 3.7-16cm diameter, convex at first becoming plane to shallowly centrally depressed at maturity, margin smooth, rounded with cutis colour extending 1-2mm along the outer gill margin. Colour a strong primary red to deep carmine tending to black or darker red at the centre, in older caps the red fading to a pinkish-red with a deep pinkish-red to red-brick colour in the centre, and with a whitish bloom. Surface viscid, drying matte. Cutis peels 1/3 to 1/2 of the radius. Cap flesh cream, deep rose-pink under the cutis.

Gills Subdistant to moderately close, sometimes quite coarse, adnexed to sinuate to free at stipe, rounded at margin, ventricose, slightly broader than the depth of the cap trama at half-radius, up to 2cm on larger caps, gill margins entire, staining brown in age and where damaged. Colour cream when young, becoming deep cream to pale orange-yellow at maturity. Some anastomoses near the stipe, free sub-gills rare.

Stipe 1.3-12.4 x 1.0-2.8cm, cylindrical to clavate, with a firm pale yellow rind 2 to 5mm thick, and an interior stuffed with a bread-textured trama that develops irregular cavities and turns an orange-brown to pink-brown on cutting and around insect damage. Surface longitudinally finely rugulose, pruinose, cream to light yellow, flushed partly or entirely with pink, bruising ochre-yellow when scratched, eventually browning.

Texture quite firm, not brittle when young, becoming so in age, gills brittle.

Taste mild, sweetish or nutty, sometimes slightly peppery.

Odour fishy, or of crab or shrimp, becoming stronger in age.

Spore colour deep cream or pale orange-yellow, Romagnesi IIIa

Spores 8-12µm x 6.5-9µm, L:W ratio 1.14-1.43, mean (N=30) 1.27, broadly ellipsoidal to subglobose. **Ornamentation** of sharply or bluntly conical warts, 0.5-1.5 (-2.0µm) high, isolated or catenate, a few joined by lines but not forming a reticulum, or occasionally a partial reticulum seen. **Woo types** B2, B3, C2 or C3. In two collections the ornamentation is similar to that of *R. xerampelina* with warts mostly 0.8-1µm high but ranging from 0.5-1.5µm. The Combers Beach trail collection has spores with more pointed, narrow warts up to 2µm high, with fewer connectives between them, of Woo type 3A or 3B. **Suprahilar patch** amyloid, a distinct grey area in Melzer's with uneven edges with a few low warts at the margin, on some spores this grey-stained area encloses the lower part of the hyliiferous appendix like a collar. **Basidia** 40-70µm x 10-15µm, most in the 50-60µm x 12-14µm range, clavate, 4-spored or occasionally 2-spored, many with a sterile companion cell arising from the same basal cell. Sterigmata 5-8µm long. **Cheilocystidia** rare, not staining in SV or staining pinkish to red, as does the gill margin. **Pleurocystidia**, scattered to evenly distributed, staining dark red to purple in SV, sometimes banded or incompletely staining, not protruding or only protruding 10 to 20µm beyond basidioles, originating in the subhymenium, 55-120µm x 8-15µm, but most are 10-12µm wide, many elliptical in end view, cylindrical to narrowly clavate or fusoid, ends blunt, with an obtuse point, a short tapering terminus which may be constricted at intervals, or with a small capitum. **Subhymenium** 25-50µm thick, parenchymatous, **gill trama** of sphaerocytes without laticifers.

Cutis 160-250µm thick. **Subcutis** approximately 1/2 to 2/3 of the cutis thickness and consisting of tightly interwoven hyphae within a gelatinous matrix. **Epicutis** of more or less erect hyphae forming a turf in which hyphae are clumped into fascicles, only slightly gelatinised. In water mounts of cutis sections, the subcutis is pinkish and the epicutis more brownish-pink. Cuticular hyphae are 1.7-5µm wide, most at the narrower end of the range, except in the epicutis, hyphal ends septate and sometimes broadening around the septum, end cells cylindrical, tapering or ampulliform. On the outer 1/4 of the cap diameter, the cutis thins to 100µm and the epicutis becomes interwoven and indistinct from the subcutis. **Pileocystidia**, rare and gathered into small patches on the cutis, absent elsewhere, cylindrical to narrowly clavate with obtuse ends, 0-1 septate, 30-100µm long x

5-10µm wide, contents refractive but not as strongly so as on most other *Russulas*, light grey in SV. **Pseudocystidia** not seen.

Trama of bundles of hyphae enclosing clusters of sphaerocytes, sometimes appearing layered, laticiferous hyphae rare or none.

Chemical reactions: FeSO₄ - blue-green; KOH - clear red on cap surface, yellow-brown on stipe; phenol - brownish purple; SV - on gills deep red, on the cutis pink-grey.

Habitat and tree associations: Found in coastal forests, generally in moister sites than *R. xerampelina*, and with mature Douglas fir, western hemlock, madrone, red alder or Sitka spruce as potential hosts. Red alder may have been present in the mixed forest at Koksilah but was not noted at the time. *R. semirubra* was found singly in the following collections.

Collections: CR001007-02 from the forest floor in a mixed age stand with mature trees including Douglas fir, western hemlock, red alder, western red cedar, cottonwood and big-leaf maple, Cowichan River trail N48.7563°, W123.8254°. CR001001-04 on south facing slope under madrone and Douglas fir, Koksilah Ridge, N48.656°, W123.736°. CR010920-35 in old growth rain forest in more open area under red alder and Sitka spruce, Combers Beach trail, Pacific Rim National Park N49.045°, W125.70633°.

| Collections | ITS1-F to ITS4-B | RFLPs: Hinf1 | Alu1 | Sau3A |
|--------------------|------------------|--------------|----------|---------------|
| CR001007-02 | 852 | 416, 340 | 482, 291 | 332, 226, 207 |

Notes: This mushroom differs from *R. xerampelina* in its strongly magenta-red colouration, larger cap size, up to 16cm wide in these collections, paler spore print that is deep cream to pale yellow-orange, Romagnesi IIIa as opposed to IIIb-c for *R. xerampelina*, larger spores with fewer connectives between the warts, and turf-like epicutis distinct from the subcutis rather than the more homogeneous cutis of *R. xerampelina*. The RFLPs of the ITS region of rDNA gene of *R. semirubra* show a similar pattern to that of *R. xerampelina* except for the fragments from the Sau3A

digestion, of which one at 226 is 37bp smaller than the average size of that fragment in *R. xerampelina*.

Thiers' (1997) description of the Californian material has the cutis at only 65-70µm thick. However, the cuticle thicknesses of many species described by Thiers is consistently thinner than those of the same species on Vancouver Island. This discrepancy is either due to climatic differences affecting the cuticle, or to a difference in the method of measuring. The Californian material is also described as having hymenial cystidia of 36-70µm x 9-16µm, shorter and perhaps a little broader than in the Vancouver Island collections, but otherwise similar in shape. Variation in length of cystidia can be due to the age of the collection, since the terminus of hymenial cystidia frequently elongates in age. Grund (1965) was most likely describing *R. semirubra* in his thesis when he described briefly the variety of *R. xerampelina* var. *rubromarginata* nom. prov.

The collections from Cowichan and Koksilah differ slightly in spore ornamentation and habitat from the Pacific Rim N. P. collection, which consisted of one large sporocarp. It may be a different species or merely a local variation, a question that was not settled by the DNA analysis since the Pacific Rim N. P. collection failed to amplify.

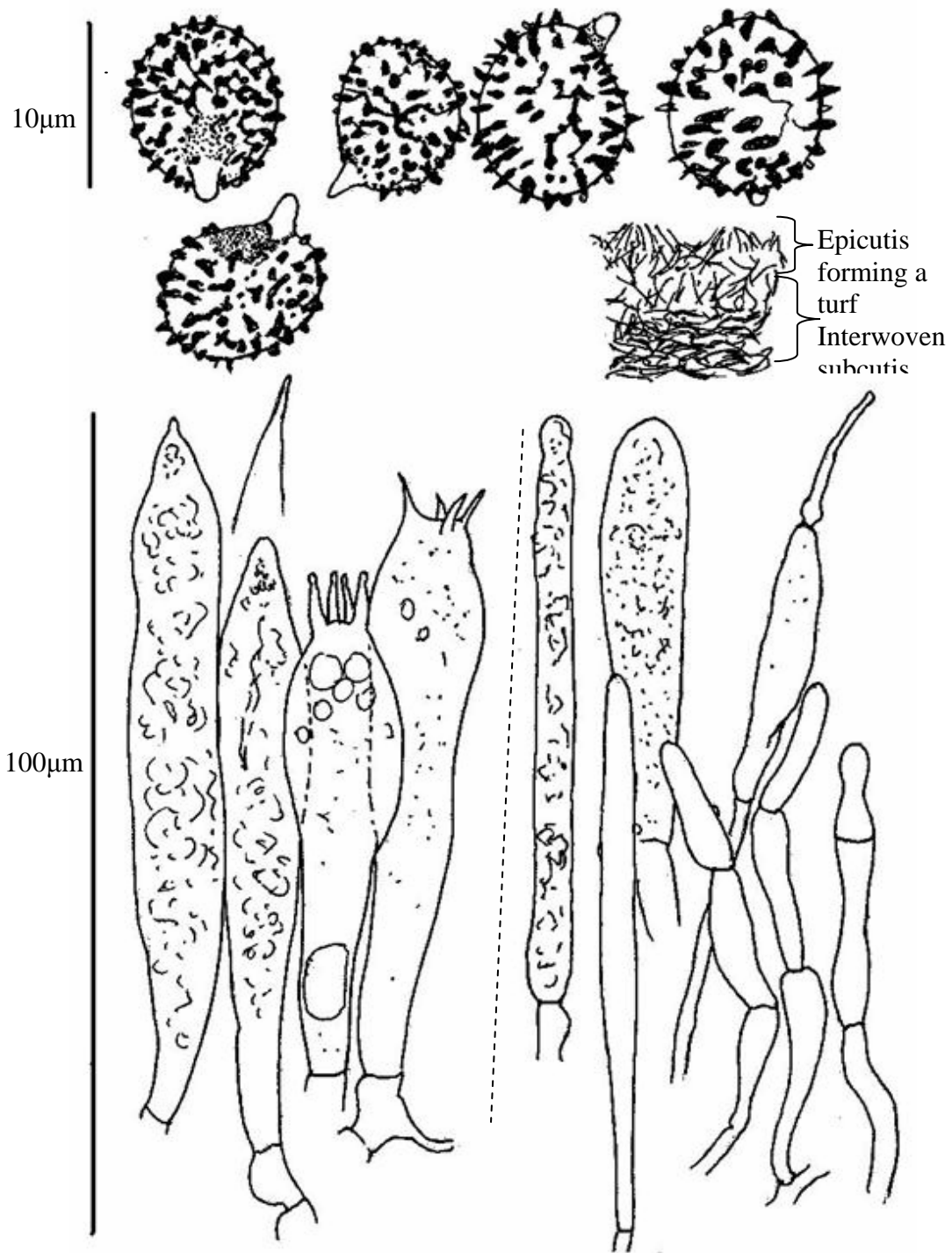


Figure 167 Microscopic characters of *R. semirubra*: Top, spores, the three on the right from Cowichan and Koksilah collections, the two on the left from Combers Beach trail, P.R.N.P., scale bar is 10µm; middle right, plan of cutis in section in 5% KOH; bottom left, basidia and hymenial cystidia; lower right, pileocystidia and hyphal ends in cutis, lower scale bar is 100µm.



Figure 168 *Russula semirubra*, top, (Koksilah collection) in side view, top view and longitudinal section, square is 1cm^2 and shows spore colour en masse. Beneath is the Combers Beach Trail, P.R.N.P. collection of *R. semirubra* with a 16cm wide cap and less pink on the stipe.

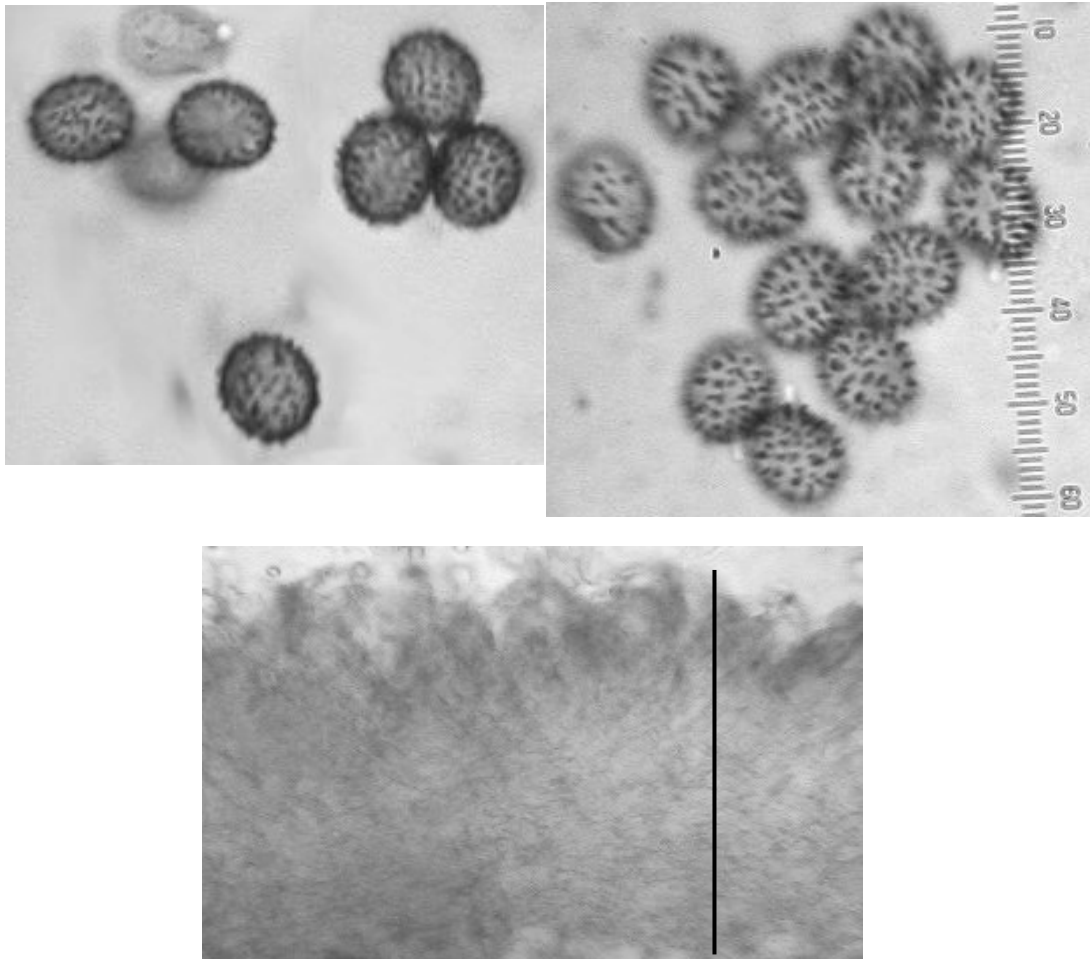


Figure 169 Spores and cutis of *R. semirubra*: Top left, spores of Koksilah collection; top right, spores of the P.R.N.P. collection, both with 1 μ m division scale; bottom, section through cutis showing upright turf of hyphal ends clustered into loose fascicles above an interwoven subcutis, scale bar is 250 μ m.

***Russula isabelliniceps* Grund**

1965, PhD Thesis, Washington State University (as *R. xerampelina* var. *isabelliniceps*)

Description of Vancouver Island collection:

Cap 7.4-16.8cm diameter, pulvinate at first, soon developing the distinctive deep, broad central depression with the broadly rounded margin, central depression often cyathiform, margin smooth but may develop striations in age or in dry conditions. The margin usually does not become uplifted in age. Often the caps are remarkably even and round. Colour ranges from a mid to light brownish olive or ochraceous olive, light brown, tending towards a brownish pink at the margin or sometimes completely this colour, the colour and texture often reminiscent of suntanned Caucasian skin. Commonly the olive and ochre hues are in the centre and the pinker hues towards the margin. Surface viscid and with a brown bloom which is more easily seen in tangential view, drying matte. The cutis breaks into more or less concentric bands of minute areolae formed by the clumping of the epicutal hyphal ends. Cutis peels 1/4 to 3/4 of the radius. Cap trama cream, purplish-pink under the cutis, browning where damaged.

Gills moderately close to subdistant, sometimes distant, ventricose, adnate to adnexed at stipe, rounded at margin, with the cap margin curving downwards over the ends, approximately equal in depth to that of the cap trama at half-radius, margins entire. Colour cream when young, becoming deep cream to ochre-cream to light orange-yellow at maturity, developing reddish-brown stains where damaged. Anastomoses occasional, mainly near the stipe, free sub-gills rare.

Stipe 5.0-8.3 x 1.6-3.5cm, clavate, often strongly so, stocky, with a firm rind around 5mm thick, stuffed with a firm bread-textured trama which turns pinkish-brown on cutting and around insect damage, but which remains solid and without cavities well into maturity. Surface longitudinally finely rugulose, pruinose, white, occasionally lightly flushed with pink, bruising ochre-yellow where damaged, eventually browning.

Texture quite firm and somewhat brittle, gills brittle.

Taste mild, sweetish or nutty.

Odour mild and slightly fishy, eventually smelling strongly fishy, of trimethylamine.

Spore colour warm deep cream to light orange-yellow, Romagnesi IIc-d or IIIc.

Spores 8.2-12 μ m (-15) μ m x (6.5-) 7-10 μ m (-11) μ m, mean 10.3 x 8.6 μ m, L:W ratio 1.04-1.38, mean 1.2 (n=30), ellipsoidal. **Ornamentation** of sharply or bluntly conical warts, 0.8-1.8 μ m high, occasionally to 2 μ m high, isolated or 2-3 catenate, a few joined by lines but not forming a reticulum, or occasionally a partial reticulum. Spores vary between individual basidioma in that some have isolated pointed warts and others have blunter warts with more catenations and connections (very similar to those of *R. xerampelina*).

Woo types A3 or B2-3, occasionally C2 to C3. **Suprahilar patch** amyloid, a distinct grey area in Melzer's reagent with uneven edges and low warts at the margin, hiliferous appendix up to 3 μ m long. **Basidia** 38-62 x 11-15 μ m, clavate, sometimes broadly clavate, 4-spored occasionally 2-spored. Sterigmata 7-10 μ m long. **Cheilocystidia** sparse, not staining in SV or staining pinkish, otherwise similar to pleurocystidia.

Pleurocystidia, unevenly or evenly distributed, sometimes sparse, arising in the subhymenium, staining red or weakly grey in SV, protruding only 10-25 μ m beyond basidioles, 55-103 x 9-13 μ m, but most 10-11 μ m wide, ellipsoidal in end view, cylindrical to narrowly clavate to fusoid, ends mostly acute, elongating in older caps to a tapering or lanceolate rather than mucronate extension, this sometimes with a series of constrictions. **Subhymenium** parenchymatous, about 30-100 μ m thick, gill trama of sphaerocytes with rare vascular hyphae staining light grey in SV.

Cutis 150-300 μ m thick at half radius, up to 500 μ m on disc, an ixotrichoderm. As a result of the irregular surface described below the cutis thickness can vary between 300 and 500 μ m in a horizontal distance of 200 μ m. **Subcutis** of mostly repent hyphae in the basal layers becoming gradually more upright and less tightly packed toward the epicutis.

Epicutis about 1/5 to 1/4 the depth of the cutis and consists of the hyphal ends bunched into broad fascicles which form the areolae in macroscopic view. The cutis is gelatinised and in some sections continues above the epicutis as a clear pellicle-like layer. In water

mounts of cutis sections, the subcutis is pale and the epicutis brownish.

Pileocystidia, very rare, several 2-3mm² pieces of cutis may be examined without finding any, then only 2 or 3 together, embedded and interwoven with cuticular hyphae rather than freely emergent, contents refractive but not as much as in most *Russulas*, not staining in SV. Mostly cylindrical, none septate, occasionally 1-septate, ends more or less capitate, rounded or tapered, 35-76 x 4-10µm, most 4-7µm wide. **Pseudocystidia**, none seen. Cuticular hyphae 3-5µm wide, with the terminal cells frequently shortest, 20-25µm long, curved-cylindrical or contorted or papillate at the end, often the last 2 or 3 cells forming an ampullate shape with the basal cell inflated up to 12µm. Also common are long narrow hair-like extensions 150µm long and 2 to 2.5µm wide, consisting of about 3 cells. Some hyphae, including sections of these hair-like extensions, have a more or less spiral internal thickening of the cell wall which appears at first sight as small internal incrustations which can be seen to be linked on focussing up and down at high power (1000x). Laticiferous hyphae very rare, bright pink in SV, (two seen out of multiple sections of cutis and underlying trama from 4 collections).

Trama of bundles of hyphae enclosing lenticular clusters of sphaerocytes.

Chemical reactions: FeSO₄ - blue-green; guaiac - rapidly blue-green; KOH - no change to yellow-brown on cap surface, yellowish on stipe; NH₄OH - no reaction; phenol - slowly brownish purple; SV - gills, pinkish-brown to purple-grey, cutis magenta to pink-grey, cap trama magenta.

Habitat and tree associations: These collections were made in coastal forests, often in association with rotted coarse woody debris penetrated by tree roots, always with western hemlock and usually with Sitka spruce.

Collections: CR981013-11 on a rotten stump with western hemlock and salal, San Joseph trail near the estuary, Cape Scott, N50.768°, W128.342°. JD 021027-02 in coarse woody debris with western hemlock, Cowichan Lake area towards Bamfield, precise location not recorded. CR021015 in old growth forest beneath fallen logs and in a stump hollow, with western hemlock, amabilis fir and Sitka spruce along the rainforest trail A, Longbeach

area, Pacific Rim National Park, N49.0490°, W125.6975°. PK 021112-01, from regeneration western hemlock and Sitka spruce Goldbeach campground, Pacific Rim National Park, N49.0565°, W125.7220°. CR030924-05 and CR030924-08 from Port Renfrew area in mature Sitka spruce and western hemlock, N48.5660°, W124.3990°.

| Collections | ITS1-F to ITS4- B | RFLPs: Hinf1 | Alu1 | Sau3A |
|-------------------------------|----------------------|-----------------|----------|---------------|
| CR021015 (P.R.N.P.) | 849 | 416, 340 | 476, 286 | 337, 280, 207 |
| JD 021027-02 (Cowichan) | 845 | 416, 340 | 481, 296 | 327, 271, 196 |
| CR030924-05 (Port Renfrew) | 879 | 419, 353 | 500, 300 | 352, 285, 214 |
| CR030924-08 (Port Renfrew) | 876 | 431, 350 | 482, 285 | 349, 284, 211 |

Notes: *Russula isabelliniceps* is a large, fleshy mushroom that often looks as if it has been turned on a lathe because of its broad vase-like shape, even diameter and concentric markings. The cutis is quite skin-like or sometimes chamois-like, the gills and spore print are a little paler than in *R. xerampelina* and the stipe is white or with only a small amount of pink colouration. The mushroom most likely to be confused with *R. isabelliniceps* is *R. olivacea*, which is also a large, fleshy, mild tasting, yellow spored mushroom with similar colours and with a cutis devoid of pileocystidia and which breaks into concentrically arranged areolae. In Phillips (1991) the reaction of *R. olivacea* with FeSO₄ is given as green but in the Vancouver Island collection of this species an orange-pink reaction occurred in agreement with Romagnesi (1967), Blum (1962), Bataille (1948) and Buczacki (1992). It is possible that Phillips' collection labelled *R. olivacea* is actually *R. isabelliniceps*. The green reaction with FeSO₄ of *R. isabelliniceps* effectively distinguishes it from *R. olivacea*. Other differences include the length of the ITS region which is around 270bp longer in *R. olivacea*, its complete lack of pileocystidia, the more complete pink colouration of the stipe, the drier and more strongly areolate cap surface and darker colouration, which can become deep vinaceous, the non-separable cuticle, the

harder flesh, more lobed and uneven shape, darker spore print and bright blackcurrent purple reaction of the flesh to phenol in *R. olivacea*. *Russula isabelliniceps*, at least in the above collections, always remains a light to mid tone, never becoming dark, and its reaction with phenol is the more usual purple-brown.

The characters distinguishing *R. isabelliniceps* from *R. xerampelina* are the lighter pigmentation of the cap and the lack of strong purples or dark reds, the brownish bloom, larger spores and the habitat.

One of the interesting characters photographed above and noticed in some other members of the *Xerampelinae* but not previously mentioned in the texts consulted is the presence in the cutis of hyphae with spiral internal wall thickenings, not seen in other *Russula* groups.

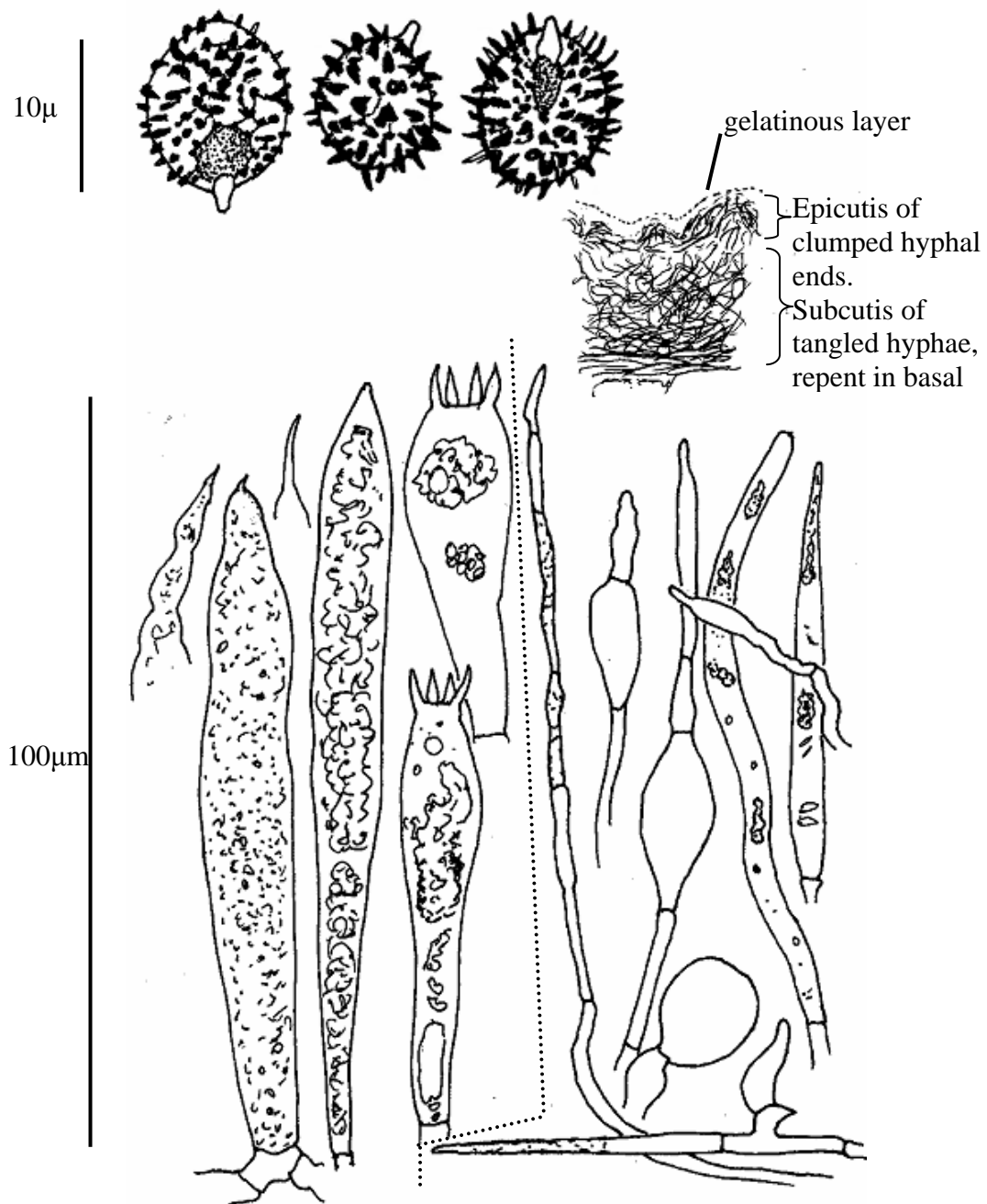


Figure 170 Microscopic characters of *Russula isabelliniceps*: Top, spores with 10 μ m scale bar; middle, diagram of cutis in section in 5% KOH; bottom left, hymenial cystidia and basidia; bottom right, pileocystidia and hyphal ends in cutis, lower scale bar is 100 μ m.



Figure 171 Macroscopic characters of *R. isabelliniceps*: Top left, the olive form showing the browning of damaged flesh typical of the *Xerampelinae*; top right the brownish pink form showing the typical even shape with the cyathiform depression and broad margin; lower right, the brownish form showing the concentric floccules and brown bloom on the surface, and the ventricose gills, (the splitting at the margin is an artifact of weather conditions); bottom left, gills showing some forking near stipe. The basidiocarps in this figure are between 12 to 16cm in diameter.

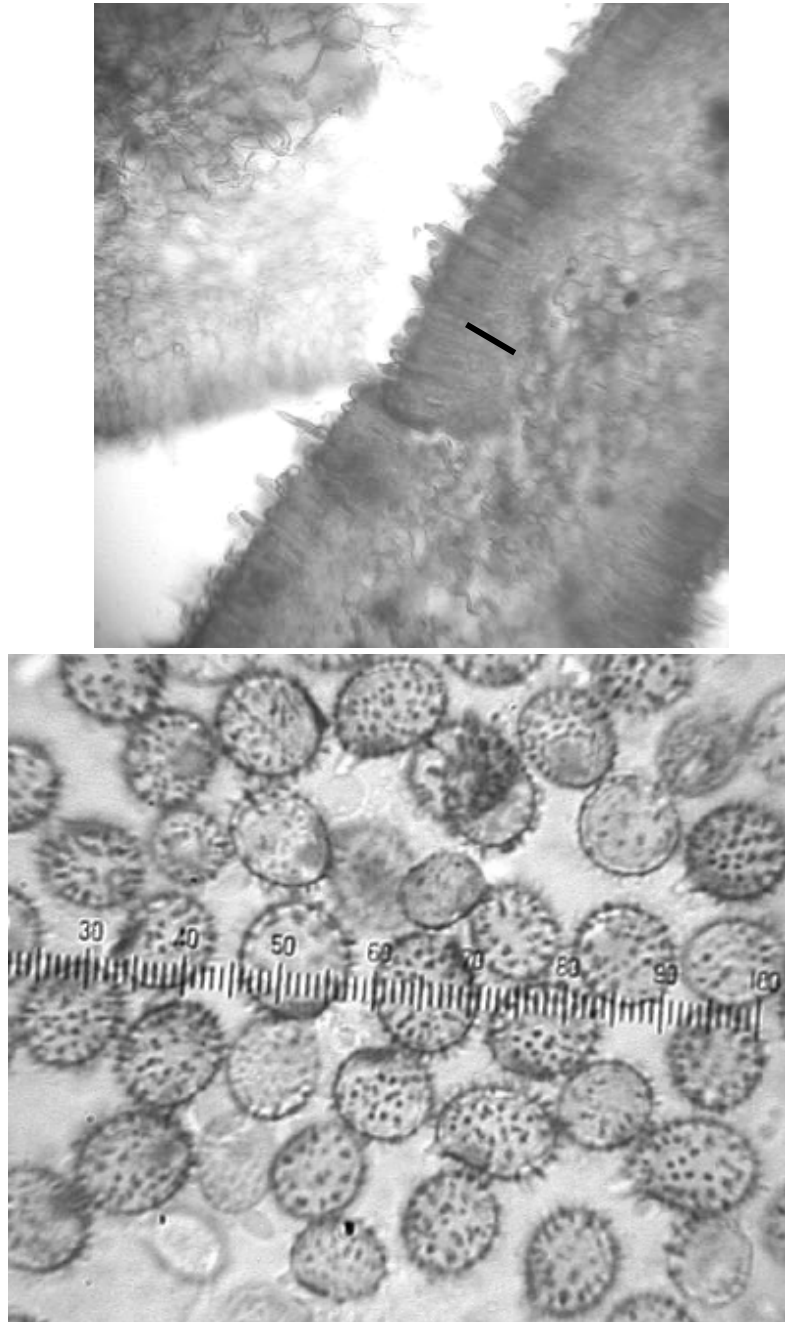


Figure 172 Hymenium of *R. isabelliniceps*: Top, gill sections of an older (left) and young but sporulating basidioma (right), note the increase in thickness of the subhymenium from approximately 50 μ m in the young gill to 100 μ m in the older gill, and the pleurocystidia which protrude more in the young gill of this specimen, (scale bar positioned over the subhymenium is 50 μ m); Bottom, spores with 1 μ m division scale.

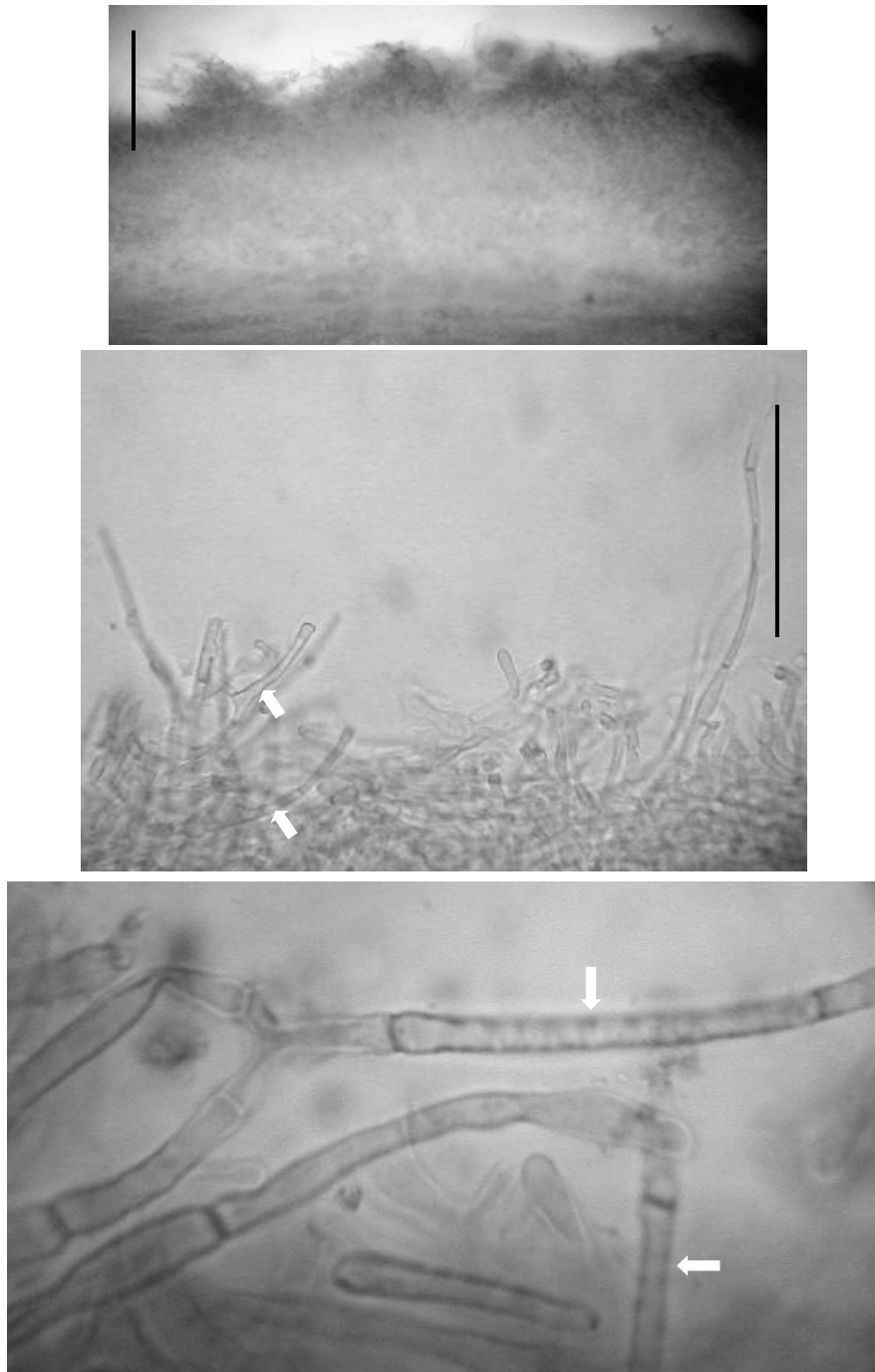


Figure 173 Cutis of *R. isabelliniceps*: Top, section through cutis showing the clumped hyphal ends of the epicutis which form the floccules on the cap surface, scale bar is 100μm; middle, epicutal hyphal ends showing the long hair-like form on the right, and the ampullate forms left, arrowed, scale bar is 50μm; bottom, epicutal hyphal cells of 2-3μm in diameter, which have internal spirally arranged wall thickenings (arrowed).

***Russula cf. pruinosa* Velenovski.**

Description of Vancouver Island collection:

Cap 11-12cm diameter, strongly lobed and deeply rounded at the margin, but not inrolled. The colour is a mixture of greyish violet and purple in the centre, tending to a deep grey-brown olive towards the margin, and marked with yellow-brown to greenish brown spots like watermarks, particularly at the margin. The whole surface is matte and dry with a dense pruina which gives it the look of having mould growth on the surface. The pruina is a mixture of greyish violet, yellowish brown and pale grey, with small more or less discrete patches of individual colours. The cutis peels about 1/3, and the flesh directly beneath is greenish grey. Cap trama cream, turning pinkish brown on cutting.

Gills Deep cream to light yellow ochre, browning where larvae have damaged them, otherwise not browning much, moderate to close, free at stipe, broadening outward in wedge-shape, equal to or more than the depth of the cap trama at half-radius, around 12mm at broadest point. At the cap margin the gills are rounded and enclosed almost to the lower margin by the cap cutis. Gill margins entire.

Stipe 5.4-5.7 x 2.2cm, cylindrical, creamy white with or without a partial delicate pink flush, surface smooth, with a normal degree of pruina. Rind firm, 2-3mm thick, pale yellow on cutting, stuffed with a bread-textured trama which turns pinkish-brown in age and on cutting.

Texture very firm, not brittle except in the gills.

Taste mild

Odour mild, mushroomy.

Spore colour an orange-yellow, Romagnesi. IVa-b

Spores 8.8-10 x 6.8-8.2µm, mean 9.38 x 7.61µm (n=30), L:W 1.13-1.29, mean 1.2, ellipsoidal, warts 0.5-1.0µm high, catenate sometimes forming chains, occasionally

isolated, most joined with a partial reticulum of fine lines. Woo type 2B to 2C.

Suprahilar patch an amyloid area appearing greyish, of uneven shape and with small warts and thickenings around the edge. **Basidia** 45-55 x 12-15µm at the widest part, clavate, but with a relatively long narrow base. Sterigmata 7-10µm long. **Cheilocystidia** and pleurocystidia sparse, breaking more easily than in other *Russulas* so that in a crush mount it is hard to find whole ones. **Cheilocystidia** around 75-80 x 8-12µm, with acute or elongated tips, lightly refractive contents which do not stain in SV. **Pleurocystidia** 60-108 x 8-10µm, laterally flattened or elliptical in end view, more or less cylindrical but of uneven diameter, with rounded or capitate tips, filled with refractive contents, staining red in SV. **Subhymenium** distinct, parenchymatous, 40-50µm thick gill trama of sphaerocytes with no vascular hyphae seen.

Cutis 120-150µm thick. **Subcutis** has a basal layer of interwoven hyphae lying parallel to the cap surface, above which is a tangled somewhat gelatinised mass of hyphae 2.5-3.5µm wide in general, with enlarged elements up to 8µm wide common. **Epicutis** of upright, non-interwoven hyphae up to 120µm in length. Small patches are devoid of this turf, especially near the cap margin. The aerial epicutal hyphae are rarely septate beyond the surface, are 40-120µm long x 1.5-2µm wide, cylindrical or tapering, sometimes stuck together into narrow fascicles of 2-6 hyphal ends of varying length, not gelatinised. Very few hyphae seen with the internal spiral wall thickenings noted in other members of the *Xerampelinae*, and those with more randomly arranged thickenings. **Pileocystidia**, very rare, contents barely refractive, not free of the surface, 17-25 x 4-7.5µm, ends tapered or papillate, difficult to determine whether they are true cystidia or not, not staining in SV. **Pseudocystidia** not seen.

Trama of sphaerocytes in small globular clusters, sometimes not well defined, bounded by bundles of hyphae or sometimes a loose hyphal network.

Chemical reactions: FeSO₄ - strongly blue-green; KOH - red-brown on cap, yellow-brown on stipe; NH₄OH - vinaceous on cap; phenol - brownish purple; SV - brownish-dull violet on cutis and brownish on gills.

Habitat and tree associations: In remnant old growth forest close to the highway, in mineral soil with Douglas fir and western hemlock, at about 1000ft altitude.

Collections: CR010922-02, in mineral soil under old growth Douglas fir and western hemlock, within 12m of the highway, Cathedral Grove (MacMillan Provincial Park) N49.2885°, W124.6705°.

| Collection | ITS1-F to ITS4-B | RFLPs: HinfI | AluI | Sau3A |
|-------------|---------------------|-----------------|----------|---------------|
| CR010922-02 | 859 | 423, 358 | 494, 295 | 338, 271, 191 |

Notes: The heavily pruinose or velvety surface together with the colour mixture of olive and purple and the large, lobed cap which brings to mind *R. amoena* (or *R. amoenicolor*). It matches the rather brief description of *R. pruinosa* in Blum (1962) apart from the spore ornamentation which is up to 3µm in height and of isolated spines. Romagnesi (1967) also briefly describes *R. pruinosa* as being a robust species, very firm, with a large cap which is matte and pruinose, violet, seldom partly olive, with a white stipe, broad gills 10-12mm deep, under firs in mountainous regions of the Central Pyrenees. Without a more complete description of the holotype it is difficult to ascertain if this species from Vancouver Island is the presumably rare *R. pruinosa*. Neither Blum nor Romagnesi actually saw the fresh mushroom. In Sarnari (1998) the photograph of *R. amoenicolor* matches this Vancouver Island species remarkably well, and some of the microscopic characters of the cutis are similar. However, it is not *R. amoenicolor* because unlike this species the spores have a strongly amyloid suprahilar patch, refractive contents in the pleurocystidia, a strong green reaction with FeSO₄, and a darker spore print than *R. amoenicolor* or *R. amoena*, and the RFLP's of the ITS region are like those of the other *Xerampelinae* and unlike that of *R. amoenolens* derived from sequence data from GenBank.

Other similar velutinous species in the *Xerampelinae* include *Russula duportii* Phil. that is generally smaller, to 6cm, mostly green to olivaceous and with isolated warts on the spores, a paler spore print and growth under deciduous trees. *Russula cretata* Romagn. *ad*

int. olivaceous on the centre with violaceous margin, with paler spores (IIc-IIIa) but similar ornamentation and size to the above collection, under deciduous trees on limestone-clay soils. *Russula amoenoides* Romagn. with colours similar to the above collection or paler, spores paler, IId - IIIb and with isolated warts and long, cylindrical pileocystidia, under deciduous trees in clay or sandy soils. These species all vary from the above collection on small details which may or may not be taxonomically relevant. The descriptions are all based on one or two collections that would indicate they are all quite rare.

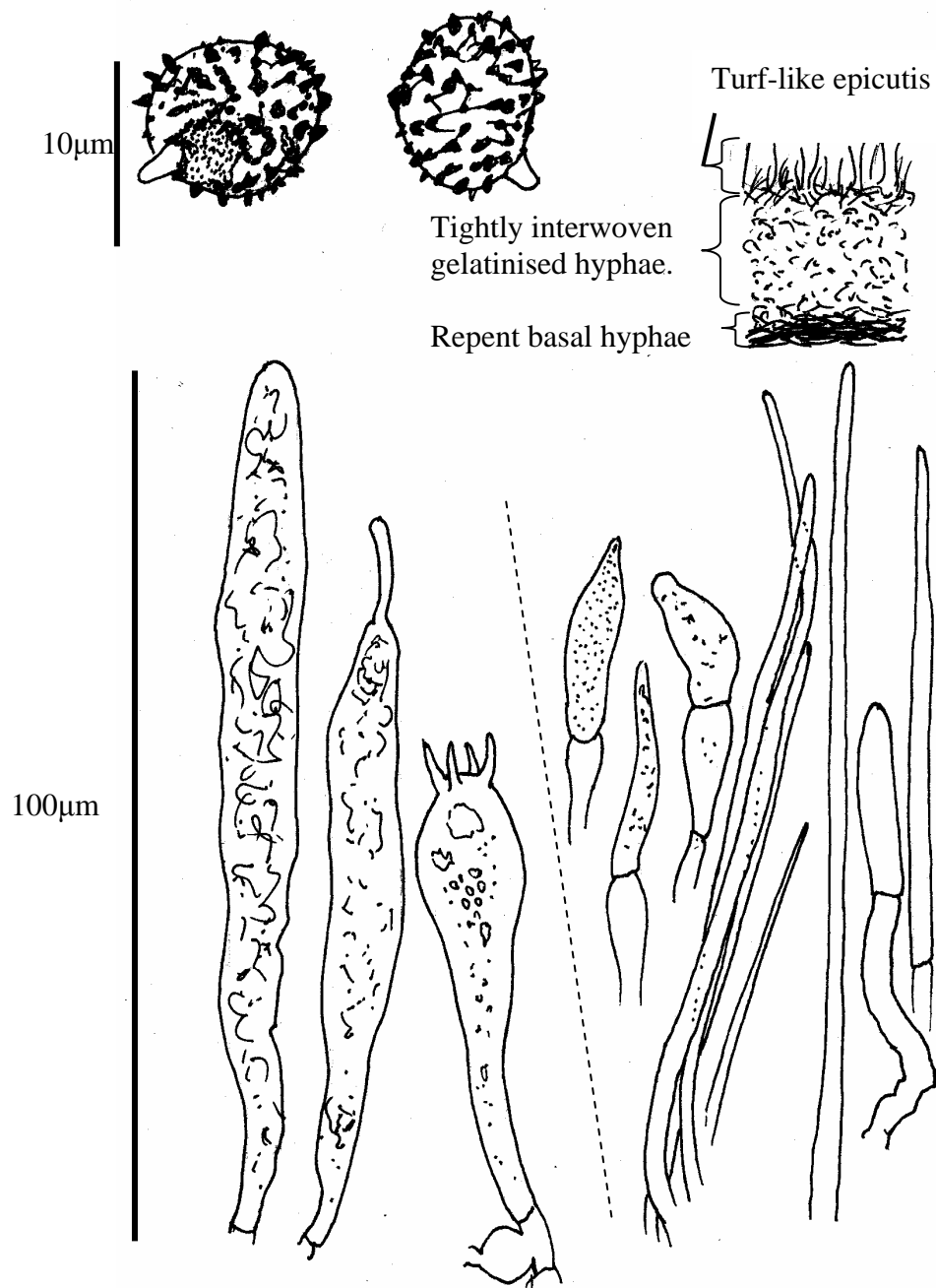


Figure 174 Microscopic characters of *R. cf. pruinosa*: Top, spores with 10µm scale bar; upper right, plan of cutis in section in 5% KOH; bottom left, from left, pleurocystidia, cheilocystidia and basidia; bottom right pileocystidia and hyphal ends in cutis, scale bar is 100µm.



Figure 175 Macroscopic characters of *R.cf. pruinosa*: Top, profile of mature basidioma and a longitudinal section, coloured square is 1cm² and represents spore deposit colour; bottom, gills and cap surface. (Photograph by Bryce Kendrick.)

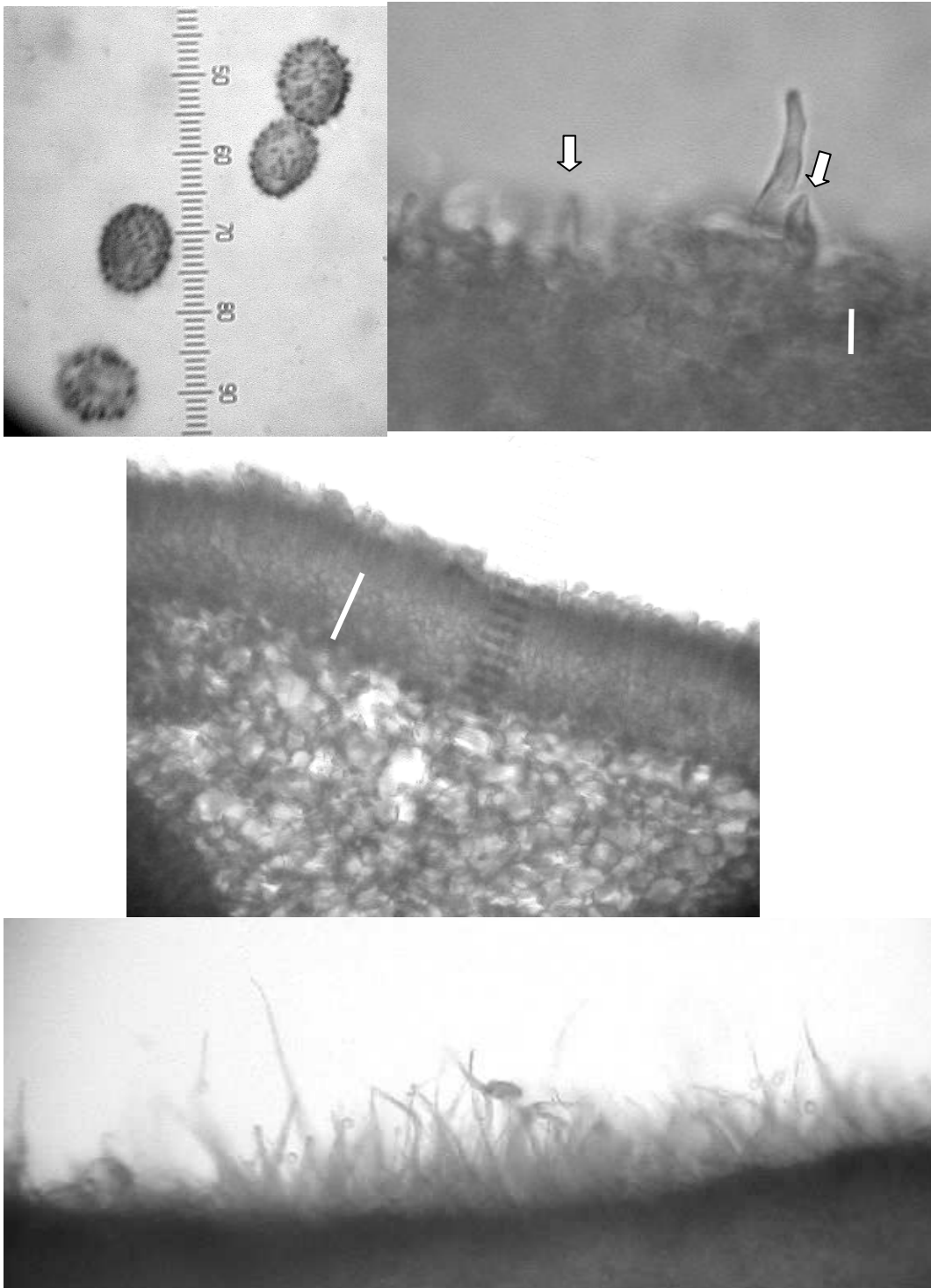


Figure 176 Hymenium and epicutis of *R. cf. pruinosa*: Top left, spores with 1 μ m division scale; top right, gill margin showing cheilocystidia, two protrude about 10 μ m (arrowed), the longer one is less common, scale bar is 10 μ m; middle, gill section showing the pseudoparenchymatous subhymenium marked by the 50 μ m scale bar, and the gill trama of sphaerocytes beneath; bottom, hyphal ends of the epicutis, the longest of which extends 120 μ m above the general surface.

***Russula elaeodes* (Bres.:Romagn.) Bon**

Iconogr. Mycol. 9:470 1929

Description of Vancouver Island collection:

Cap 6.0-12cm diameter, squarish in side view when young, becoming plane to centrally depressed, trama deeper than gills at half radius, fleshy and stocky, colour dark brown to almost black in the centre becoming a yellow-brown outwards and greyer or more olive towards the margin, sometimes with very dark vinaceous tints, may be mottled with mixtures of these colours or with minute concentric areolations. Edge of the cap even or lobed, margin smooth, and maintaining curvature round gill ends as in other *Xerampelinae*, cutis peeling 1/4 to 3/4 of the radius. Flesh dull pink to grey-purple beneath the cutis. Texture dry or only slightly viscid, finely velvety with a whitish bloom. Cap trama light cream becoming dark pinkish cream on cutting.

Gills pale cream becoming pale yellow to a very light orange at maturity, unchanging or slightly bruising reddish brown, close to subdistant, subgills infrequent, occasional forking near the stipe, brittle, adnexed to almost free, broadly rounded at cap margin.

Stipe 2.5-8.3 x 1.3-3.6cm, clavate or fusiform, white with or without a pink flush, bruising ochre yellow, eventually brown, finely rugulose, stuffed with a fairly firm solid stuffing, occasionally with one or two cavities, bruising pinkish-brown.

Texture fairly firm, not particularly brittle but becoming so in age.

Taste mild.

Odour mild, nutty, or with a slight to strong fishy odour.

Spore colour deep-cream to pale yellow, Romagnesi IIc

Spores 9-11.3 (-12.2) x 7.5-10.9, L:W from 1.01 to 1.41, mean 1.22 (n=30), subglose. **Ornamentation** of warts 0.8 -1.2µm (-1.5)µm, conical to peg-like, sometimes wing-like, mostly isolated, some short chains of two or three, occasional fine lines between warts, not forming a reticulum or occasionally forming a partial reticulum, **Woo types** 3A, 3B, occasionally to 3C. **Suprahilar patch** a distinct amyloid patch with irregular edges and small warts bordering it, hiliferous appendix 2-3µm. **Basidia** 40-70 x 12-15µm, the upper 1/3 bulbous, below which the cell is more or less cylindrical or very gradually tapering downwards, 4 or sometimes 2-spored, and some apparently with a single enlarged sterigmata, presumably one-spored though none with a developing spore seen, these could be rather short, broad cystidia but the contents are similar to that of normal basidia. Sterigmata 5-10µm long. **Cheilocystidia** and pleurocystidia regularly distributed and of average density compared to most Russulas but much denser than other *Xerampelinae*, elliptical to flattened in end view, fusiform to clavate, sometimes broad only in the upper half, the lower tapering sometimes quite abruptly to a narrow base. Originating in the subhymenium, measuring 55-90 x 9-14µm. protruding 15-30µm beyond basidioles, most with an obtuse point, but many also with a small, sometimes constricted extension, or a capitum, and some mucronate. Contents of pleurocystidia staining reddish in SV, cheilocystidia stain weakly red if at all. **Subhymenium** about 20µm thick, of jigsaw-puzzle-shaped pseudoparenchymatous cells, very convoluted, **gill trama** of sphaerocytes, often of irregular shape, with occasional vascular hyphae.

Cutis 120-250µm thick, an ixotrichodermis, pink in water mounts with cystidia with yellowish refractive contents. **Subcutis** of tightly interwoven hyphae with very occasional vascular hyphae terminating in pseudocystidia in the epicutis. **Epicutis** around 40µm deep, a layer of more or less erect, tangled hyphae with pileocystidia and free hyphal ends that are occasionally clumped into fascicles over small areas. Hyphal ends are a mixture of shapes, cylindrical, ampullate or tapering, mostly formed of 2-3 cells with occasional inflated cells up to 13µm wide, septate, with individual cells in the order of 12-30µm long, occasionally shorter giving the hypha a jointed appearance. **Pileocystidia**, frequent, not staining in SV, more or less cylindrical to narrowly clavate or fusiform, ends rounded or with a small capitum,

28 to 70µm by 5 to 8µm, 0 to 3 septate. **Pseudocystidia**, occasional, cylindrical, about 5 to 7µm wide, with septae about every 20 to 50µm in the terminal portion, with refractive contents not staining in SV. Cuticular hyphae 2-4µm wide, most being 3µm wide.

Trama of large clusters of sphaerocytes bound by hyphae.

Chemical reactions: FeSO₄ - blue-green to greenish grey; KOH - bright red to reddish orange on the cap, light yellow-brown on the stipe; NH₃OH - no reaction; phenol - light brownish purple; SV - reddish brown on gills and cutis.

Habitat and tree associations: Coastal Sitka spruce zone, often in krummholz where there is little light and undergrowth, on sandy soils, also in old-growth coastal Douglas fir with western hemlock, again with little undergrowth. Sitka spruce and western hemlock are both possible hosts.

Collections: CR001011-55, Wickanninish south beach trail along krummholz, in a stand of Sitka spruce with no undergrowth inland of the beach N49.015733° W125.67335°. CR021016-06, location and habitat as for previous collection. CR000831-04, near Juan de Fuca trail at China Beach park, N48.4370°, W124.0924°, on and near very decomposed coarse woody debris by a small boggy patch under regeneration Sitka spruce and western hemlocks up to 20cm diameter. CR010922-01, Cathedral Grove, N49.2885°, W124.6705°, under old-growth Douglas fir and western hemlock with very little undergrowth. PJ010919 Wickanninish, in a forested part of the rear dunes, with Sitka spruce, western hemlock, shore pine and a salal understory N49.02167°, W125.67467°.

ITS1-F to ITS4- RFLP:

| Collection | B length: | Hinf1: | Alu1: | Sau3A: |
|-------------|-----------|----------|----------|---------------|
| PJ 010919 | 859 | 423, 346 | 494, 291 | 336, 276, 209 |
| CR001011-55 | 859 | 423, 358 | | |

Notes: *Russula elaeodes* differs from the other members of the *Xerampelinae* described earlier in this paper in the increased frequency of cuticular and hymenial

cystidia. The epicutis in these collections also lacks the long narrow hyphal ends with internal spiral thickenings as seen in *R. isabelliniceps* and *R. semirubra*.

Russula elaeodes has characters typical of the *Xerampelinae* such as the trimethylamine odour in age, the spore ornamentation, the green reaction with FeSO_4 and the negative reaction of the cystidia with SV.

The Vancouver Island collections differ from those described from California by Thiers (1997) in the spore size, which is 9-11.3 x 7.5-10.9 μm , larger than the 7-9 μm x 6-7.5 μm in Thiers' description, which matches that of Romagnesi (1967). Thiers also notes the cutis as being only up to 100 μm thick, the warts on the spores as up to 1 μm high, and the pileocystidia as being poorly differentiated, although the remainder of his description matches the above collections very closely.

Russula viridofusca Grund is similar in cap and spore colour with spores measuring (9)10-13 x 8-10 μm , slightly larger than the above collections. Grund (1979) states that the cap margin is striate to tuberculate and lacks the typical fishy odour typical of this subsection, and notes that it differs from *R. eleodes* on this latter character and on the spore size. Grund found *R. viridofusca* only twice in a 3-year period, and rated it rare.

The species most likely to be initially confused with *R. eleodes* is *R. brunneola*, which occurs in the same habitats and has a similarly coloured and textured cap, but lacks the green reaction with FeSO_4 and has a white spore print.

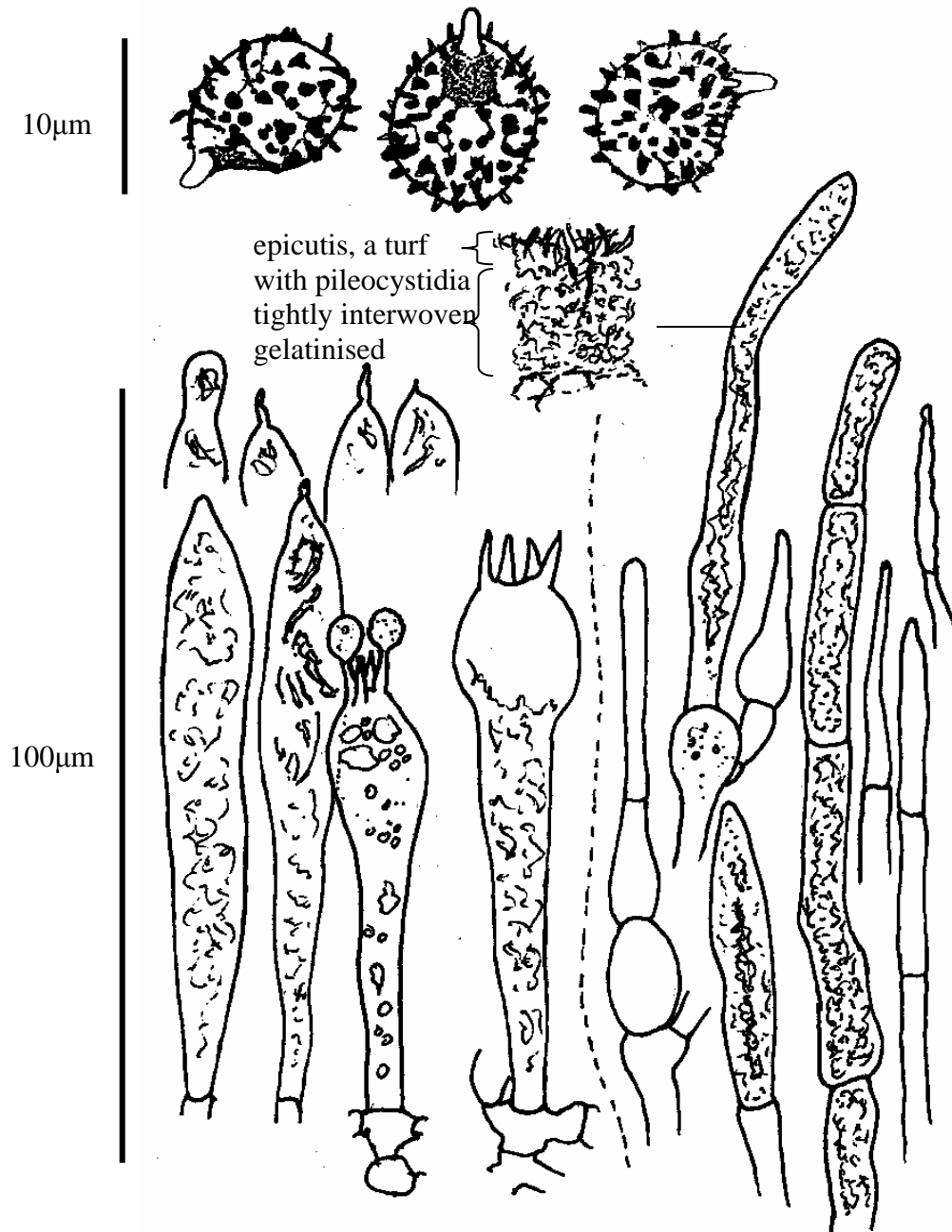


Figure 177 Microscopic characters of *R. elaeodes*: Top, spores with 10µm scale bar; middle, plan of cutis in section in 5% KOH; bottom left, hymenial cystidia and basidia; bottom right, pileocystidia and hyphal ends in cutis, lower scale bar is 100µm.

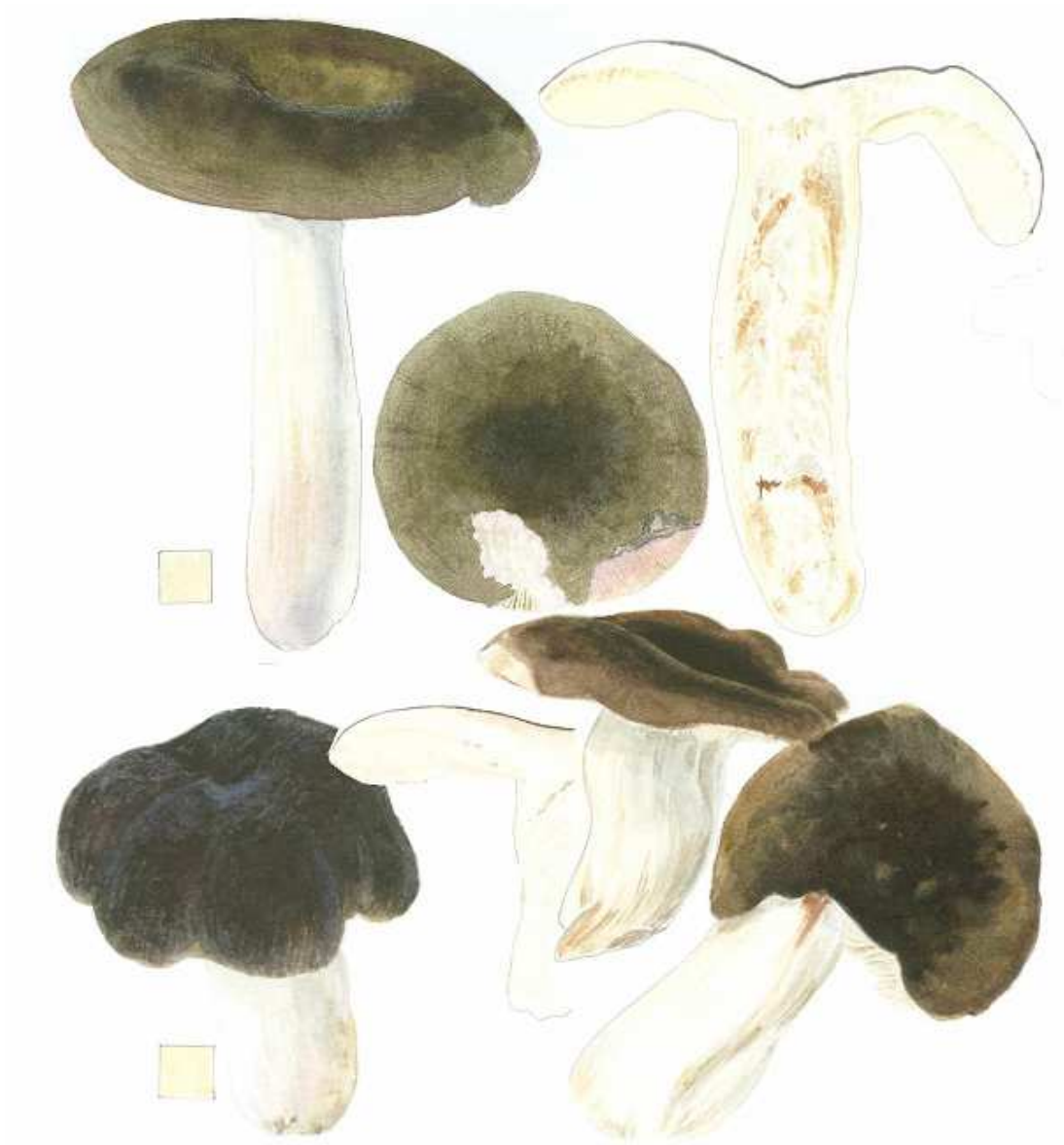


Figure 178 Macroscopic characters of *R. elaeodes*: Illustrations of immature and mature basidiomata and longitudinal sections of two collections, at top centre, the cap surface shows white flesh where nibbled by slugs and pinkish where the cutis has been peeled off. The squares are 1cm² and show the spore colour.

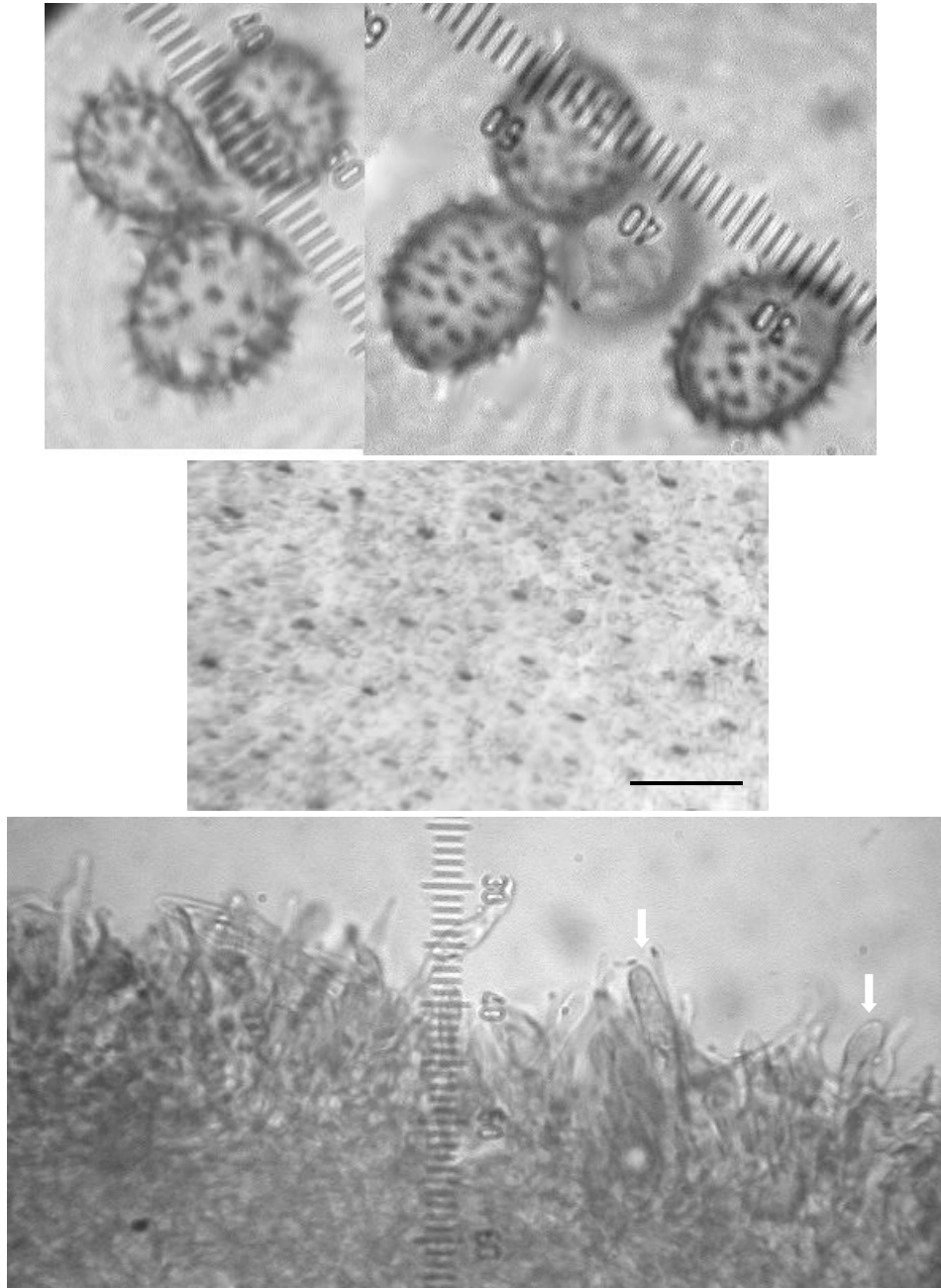


Figure 179 Hymenium and cutis *R. elaeodes*: Top, spores with 1 μ m division scale; middle, face view of gill stained with SV showing the pleurocystidia as elliptical in end view (dark spots), and their fairly even distribution compared with other *Xerampelinae*, scale bar is 100 μ m; bottom, section through epicutis stained in Congo red showing the turf-like hyphal ends and pileocystidia (arrowed), 10 scale divisions are 25 μ m.

Clade 10a

Subsection *Laricinae* (Romagn.) Bon, amend.

Russula aureofulva nom prov.

Cap 3.5-6.8cm diameter convex with a slightly flattened umbo when young, becoming plane with a depressed centre when fully expanded, cap margin rounded, smooth, becoming striate in age, bright golden brown, more orange-brown to red-brown in the centre, slightly to strongly olivaceous towards the margin and when immature, viscid when wet, drying subshining, glabrous. Young caps are more olivaceous but with red-brown disc (fig.4 and 6). At all stages there is a definite underlying dark yellow component to the cap colours. Cutis peeling to half the radius.

Gills subdistant to moderately close, with rare to occasional anastomoses and subgills, broad and rounded at pileus margin, adnexed to sinuate and almost free at the stipe, about twice the depth of the cap trama at half radius, pale cream at first, becoming deep cream at maturity, pliable at first, becoming brittle in age.

Stipe 3.7-8.6cm x 1.2-2.3cm, cylindrical or widening near the base, white, some with a pink flush at the base or apex, unchanging when bruised, stuffed with a breadly textured trama, becoming unevenly cavitate to hollow in age, surface longitudinally finely rugulose.

Texture average for *Russula*, neither very firm nor particularly fragile at maturity.

Taste mild, nutty.

Odour not distinctive.

Spore colour orange-yellow to ochre, Romagnesi IVd.

Spores subglobose, 9.5-14 x 8-11.5µm, mean 12.2 x 10.2µm (n = 45 inclusive of both collections), L:W = 0.97-1.34, mean 1.2. **Ornamentation** of warts mostly 0.5-1.5µm, but

some up to 2.2µm high, isolated, incompletely amyloid, no reticulations or chains of warts. Woo type A3. **Suprahilar patch** amyloid, irregular in outline with small warts at the margin. **Basidia** mostly two-spored, approximately 50-70 µm long by 14-16µm wide, clavate or more often with the distal 1/4-1/3 bulbous, occasional basidia are 3 spored, 4-spored basidia are rare, sterigmata number can be best seen by focussing up and down at 400x on the face of a piece of gill which has been rinsed clear of most of the spores. Sterigmata relatively wide, around 7µm long and around 2µm near the base.

Cheilocystidia occasional, not numerous, like pleurocystidia. **Pleurocystidia** patchily distributed, 70-100 x 8-9µm at widest point, protruding around 25µm beyond the basidia and basidioles, fusoid to clavate with elongated tips, many with the tips cylindrical or tapering, some forming one or two progressively smaller bulb shaped swellings between constrictions, contents refractive in 5% KOH and in SV. **Subhymenium** of small sphaerocytes and **gill trama** of sphaerocytes, laticiferous hyphae not seen.

Cutis 140-200µm thick at half radius, (in SV or water,) an ixodermis not differentiated into layers, of tightly interwoven hyphae approximately 2-3µm wide, not incrustated, embedded in a gelatinous matrix, with very few free hyphal ends above the surface. In 5% KOH, the gelatinous matrix is dissolved, and the epicutis shows more free hyphal ends around 3µm wide which form an interwoven somewhat repent turf. Some hyphal ends have refractive contents. **Pileocystidia** cylindrical to narrowly clavate, occasionally with tiny diverticulae, tips mostly obtuse, a few with a narrower extension, none to several septate, with septa spaced about 25-35µm apart, most are 45-80µm long but range from 25-125µm long and up to 7µm wide, occasional ones to 10µm wide, contents refractive in KOH. Caulocystidia few, similar to hymenial cystidia.

Trama mostly of sphaerocytes, evenly distributed throughout the trama, with generative hyphae interspersed, occasional vascular hyphae under the cutis, barely staining with SV.

Chemical reactions: 2% phenol - brownish purple; FeSO₄ - no change to slightly darker cream to faint pinkish; 5% N₃OH - no reaction; 5% KOH - turns cuticle more orange, stipe no reaction; guaiac - strongly blue-green; SV - macroscopically, gills stain deep pink, cuticle none staining, microscopically, pileocystidia none staining or with

occasional ones grey or with small aggregations of grey stained ones, pleurocystidia pink, occasional ones grey-purple, cheilocystidia not staining.

Habitat and tree associations: Trooping under mixed age stands of western hemlocks with red alder, Douglas fir or western red cedars nearby. All collections were found amongst small understory hemlocks underneath large mature (around 0.8 to 1m diameter) hemlocks. Western hemlock is the most likely mycorrhizal partner since it is the tree consistently present.

Collections: DAVFP 28769 –holotype, (11 specimens), DAVFP 28771 (9 specimens), at GPS reference N48° 26.090' W 123° 28.705' and DAVFP 28768 (1 specimen), DAVFP 28770 (6 specimens) at N 48° 26.045' W 123° 28.700', all from Royal Roads University woodlands, Victoria. This species has not to date been found elsewhere. **Collections** are deposited in the herbarium of the Pacific Forestry Centre, Burnside Road, Victoria, B.C. Canada.

| Collection | ITS1-F to | | | |
|-------------|-----------|-------------|----------|----------|
| | ITS4-B | RFLP: Hinf1 | Alu1 | Sau3A |
| CR031101-01 | 879 | 402, 354 | 477, 285 | 300, 197 |
| CR001108-06 | 868 | 400, 349 | 477, 259 | 295, 208 |
| CR021009-01 | 884 | 400, 354 | 479, 298 | 295, 199 |

Notes: The brown colour of *Russula aureofulva* is suggestive of the *Ingratae* but the pigments are blue-green, yellow and magenta as in subsection *Russula*, there is no strong odour, the margin is not tuberculate, the cuticle is not so heavily gelatinised as is usual in the *Ingratae* and the stipe does not have the regular lenticular cavities that are found in subgenus *Ingratula*. The spores with their incomplete amyloid staining are reminiscent of *R. laurocerasci* and *R. fragrantissima*, but the warts do not form chains or ridges as in those species and the suprahilar patch is amyloid. The weak FeSO₄ and SV reactions, deep yellow, large spores and long, multiseptate pileocystidia of *Russula aereofulva* are typical for the *Tenellae*.

All collections of *Russula aureofulva* were growing in deep shade, in which the magenta pigment fails to develop in some other *Russula* species. Nearby in sunlight were two light brick-red and olive Russulas, collection number CR021009-02, which were initially thought to be the same as the shade-grown *R. aureofulva* collections, however, on closer examination, they were found to be *R. cf. abietina*. The possibility that purple hues might be within the normal colour range of this species were it exposed to more light has been taken into account in the search for its identity. *Russula aureofulva* shares most morphological similarities with the *Tenellae* sensu Romagnesi (1967).

Similar species include *R. aurata* (Blum) which has more red in the cap, flesh bruising yellowish, and smaller spores with some reticulations. *R. aurantiaca* (J, Schaef) Romagn. in subsection *Laetinae* (Romagnesi 1967), has a brick orange cap, pink flush on the stipe, a mild taste, a similar spore colour and ornamentation to *R. aureofulva* and similar cuticle elements, but the spores of *R. aurantiaca* are smaller, and some of the basal cuticular hyphae are incrustated with small acid-resistant granules. *Russula globispora* (Blum) has similar large spores with large isolated warts and deep yellow spore print to *R. aureofulva*, but differs in its lighter, more red-brown cap and acrid taste. *Russula adulterina* Fries has large dark yellow spores with large isolated warts and yellow to olive brown to purple brown cap colours, but it is peppery and has a fruity, pelargonium odour. The most similar species is *Russula straminea* Malençon, as described in Romagnesi (1967), which has similar colouring, odour, taste, spore colour, size and ornamentation, pileocystidia and lamellae. This species differs slightly from *R. aureofulva* in its larger size, grey reaction with FeSO_4 , browning of the flesh and habitat with oaks. Sarnari (1998) The above species are European.

Russula mustelina Fries is a brown to olive capped species reported from the west coast of North America (Burlingham 1915, Grund 1965, Thiers 1997). It differs from *R. aureofulva* in its harder flesh with a solid rather than stuffed stipe, smaller warts on the spores with some reticulations, a paler spore print, a usual association with *Abies*, and a stronger orange reaction with FeSO_4 . *Russula olivacea* (Schaeff.) Fr. has many similarities including the spore colour and ornamentation, but it is much more robust, has no pileocystidia and the stipe flesh has a distinctive blackcurrent colour with 2% phenol.

Grund (1965) reported from Washington State four brownish-capped, mild tasting species with yellow spores having large ornamentation, all with 2 and 4-spored basidia: *Russula disparilis* Burl., which differs from *R. aureofulva* in having a paler spore print and smaller spores, larger basidiomata and no pileocystidia; *Russula sphagnophila* Kauffm. also has paler spores and is described as very fragile in Romagnesi (1967), and *R. alachuana* Murr. is larger, with paler spores but otherwise similar microscopically apart from the cuticle which is thicker and composed of two distinct layers, with constricted terminal hyphal cells in the epicutis (Hesler 1960). The latter two species have more purple in the cap. *Russula viridofusca* Grund is superficially very similar to *R. aureofulva* and occurs under western hemlock, but is in the subsection *Viridantinae* Meltzer-Zvara and has the greenish reaction with FeSO_4 and browning of bruised flesh typical of that subsection, and the spores have smaller warts up to $1.1\mu\text{m}$ high.

The combination of a brassy to golden cap, mild taste, deep orange-yellow spores which are almost twice the dimensions of those of most other *Russulas*, spores with isolated warts, non-incrusted cuticular hyphae and habitat with large western hemlock with understory hemlocks are the distinctive characteristics of *Russula aureofulva*.

All collections were damaged by slugs and millipedes. When collection CR001108-06 was made, approximately 30 stipes were scattered around bearing small rodent toothmarks, consistent with squirrel damage, indicating that these animals had harvested the caps. When collection CR021009-01 was made there were many remnants of stipes in the ground, the remainder having apparently been eaten by slugs.

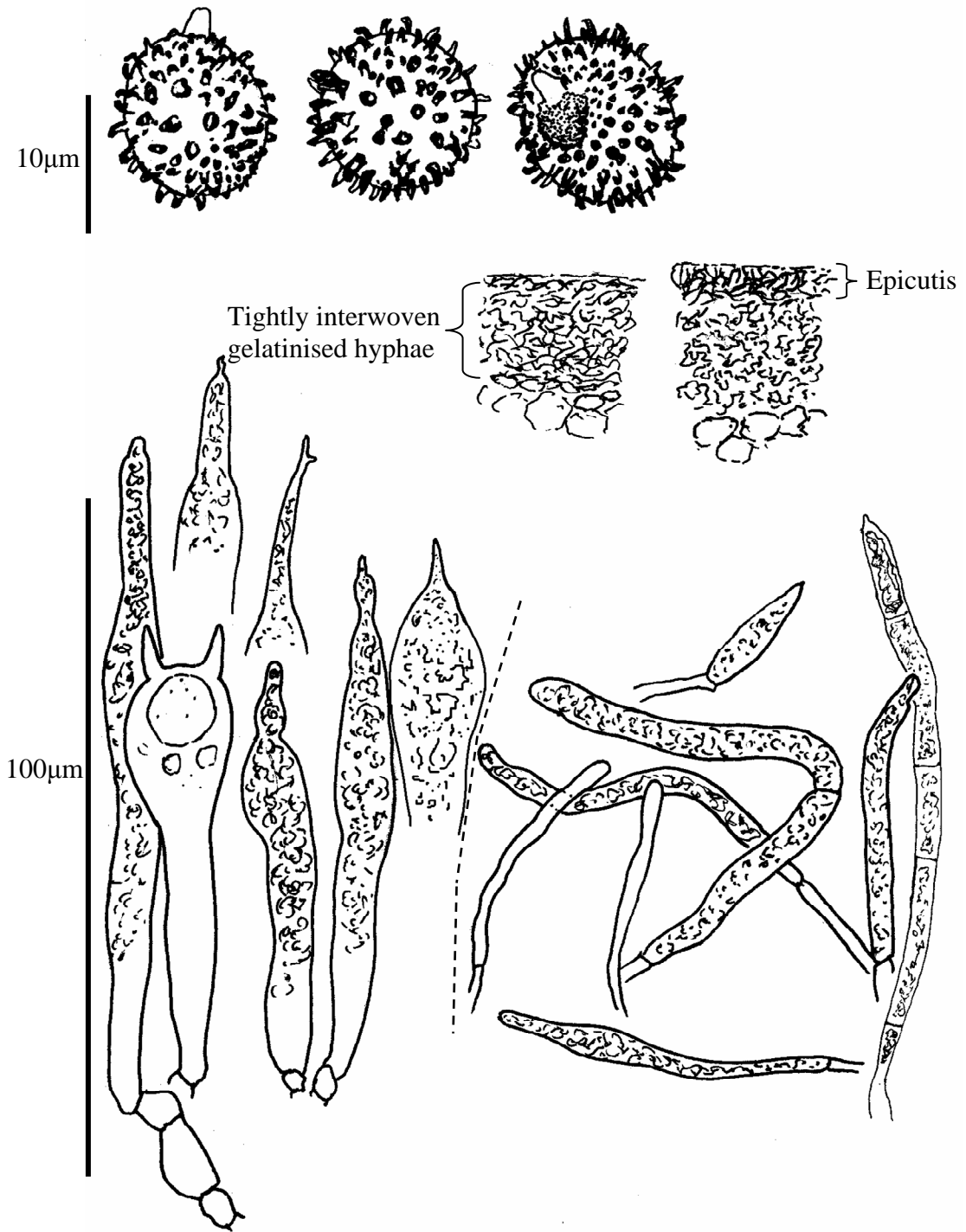


Figure 180 Microscopic characters of *R. aureofulva*: Top, spores, with 10µm scale bar; middle, plan of cutis in section in SV (left) and in 5% KOH (right); bottom left, basidia and hymenial cystidia; bottom right, pileocystidia and hyphal ends in cutis, lower scale bar is 100µm.



Figure 181 Macroscopic characters of *R. aureofulva*: Top, lectotype of immature, mature and in longitudinal section, coloured square is 1cm² and represents spore deposit colour; bottom, mature basidiomata of *R. aureofulva*. Note the broadly rounded gills at the cap margin.



Figure 182 Immature basidiomata of *Russula aureofulva* with 1cm scale (background) and colour scale. The larger two stipes show a pink flush over the parts of surface.

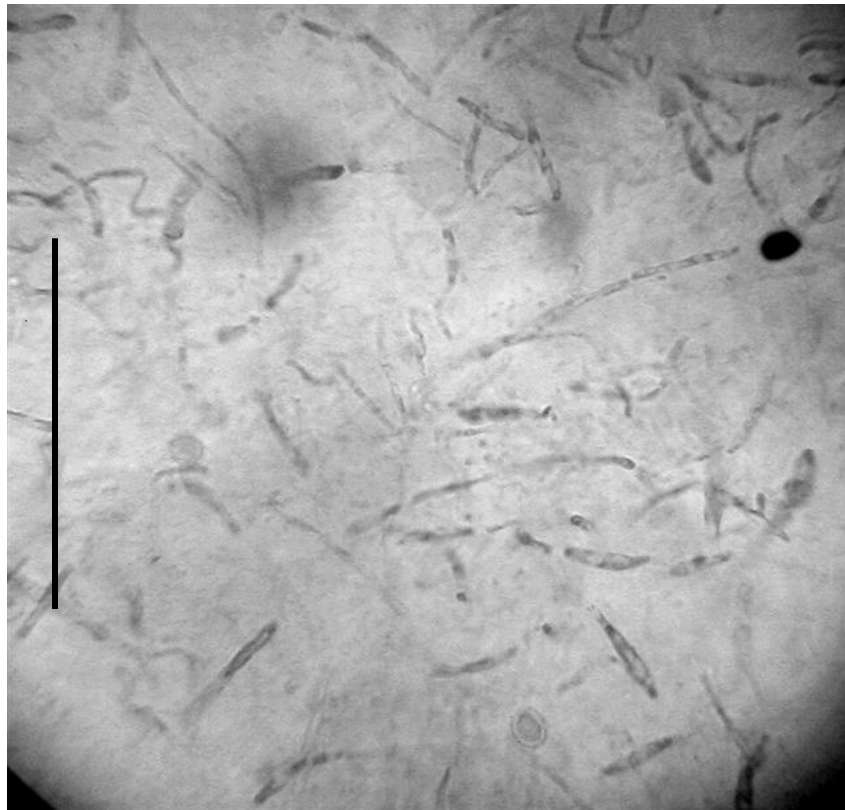


Figure 183 Cutis of *R. aureofulva* with pileocystidia of varying shapes partially stained grey with SV, scale bar is 100 μ m.

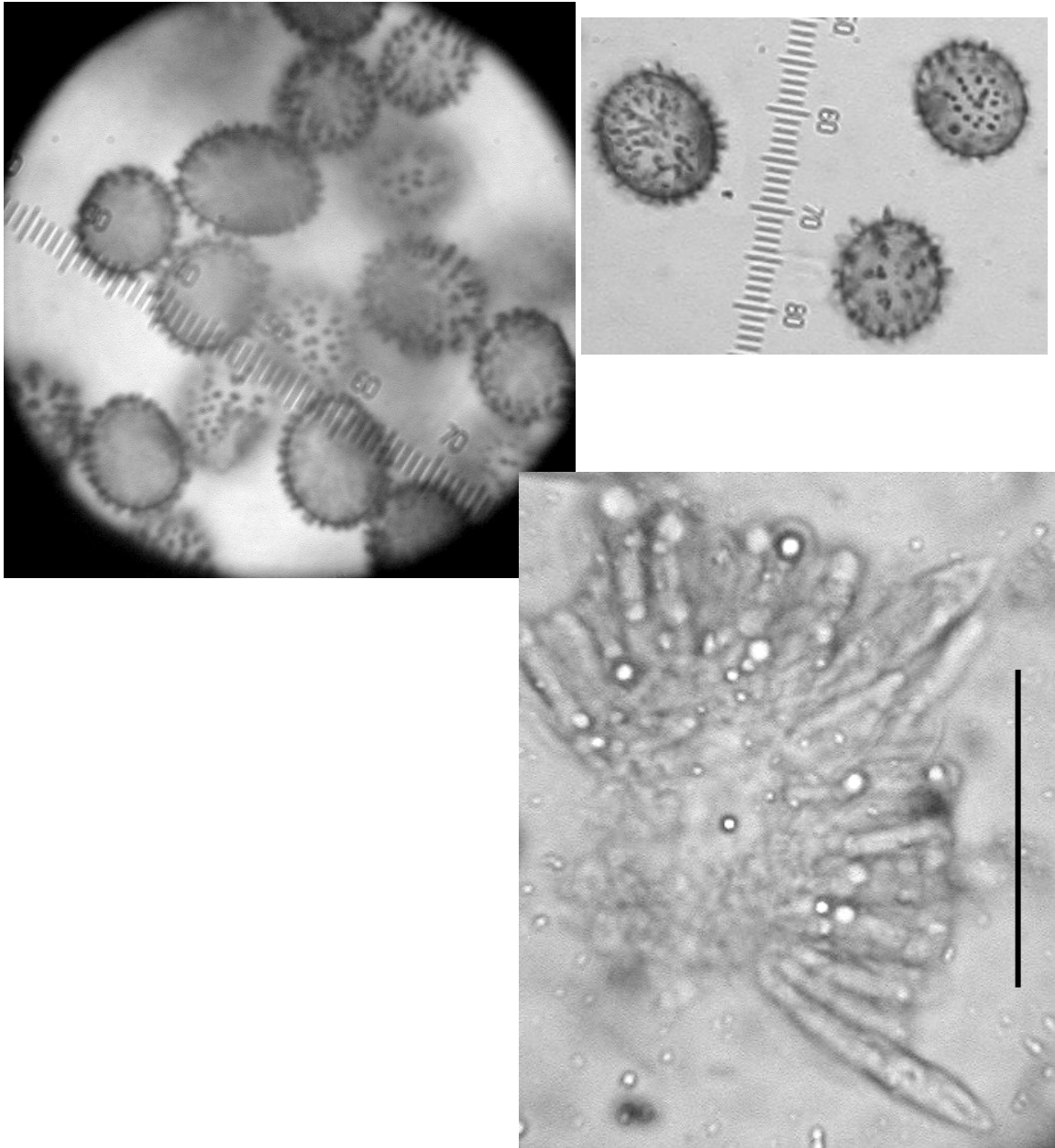


Figure 184 Characters of the hymenium of *R. aureofulva*: Top left, spores with 1μm division scale; top right, composite photograph of spores at surface and equatorial depths of field, scale as before; bottom, squash mount of hymenium showing basidioles and pleurocystidia, scale bar is 100μm.

***Russula cessans* Pearson**

The Naturalist: 101. 1950

Description of Vancouver Island collections:

Cap 3.3-8.5cm diameter, convex when young, becoming plane or with a barely depressed centre, often with a central low umbo, margin smooth, becoming striate in age, peeling 1/3 to 1/2. Colour a clear purplish red, usually darker in the centre, sometimes almost black, sometimes with light brownish to olive areas towards the centre especially in older basidiomata, the darker central colours usually in radiating streaks, viscid drying subglossy. The cuticle appears as a thin translucent rather than opaque coloured layer over the white flesh. Flesh white, unchanging, white to pink under the cuticle, thinning quite steeply off the disc.

Gills white when young, turning cream then finally orange-yellow, narrowly adnexed, acute at the cap margin, broadest about mid-radius, usually deeper than cap trama at mid-radius by 1.5 to 2 times, close to moderately close, with few to no subgills and anastomoses.

Stipe 3.2-10.2 x 1.1-2.4cm, pure white, with no flushes of colour, more or less cylindrical but often somewhat flexuous, longitudinally rugulose, smooth, unchanging. Solid and firm at first, becoming stuffed with a firm bread-textured trama, gradually unevenly cavitate and faintly greying in age. The stipe is generally longer than the diameter of the cap in these collections, giving the mushroom a tall, slender stature.

Texture about that of average Russulas or slightly firmer, but becoming softer and more brittle in age.

Taste Mild, sometimes a slightly soapy aftertaste.

Odour not distinctive.

Spore colour deep ochre yellow, Romagnesi IVd to IVe.

Spores 6.5-8.8 (-9.5) x 6-8 μ m, globose to subglobose to broadly ellipsoidal, L:W from 0.93 to 1.23 with a mean of 1.12 (n=30). **Ornamentation** of rounded warts 0.2-0.8 μ m high, in chains or with heavy connectives forming a partial to complete reticulum, more mesh-like than zebroid. Woo type C2 to D2. **Suprahilar patch** amyloid, irregular in outline and with the border heavily amyloid and warted. **Hiliferous appendix** 1.1-2 μ m long, 0.9 μ m wide near the base. **Basidia** mostly 4-spored, 33-50 x 10-14 μ m, of two basic shapes: The shorter ones arise from the upper cells of the subhymenium and are cylindrical-clavate, the base being relatively wide and the taper very gradual, the longer ones arise from cells lower down and have a bulbous upper part with a steep or abrupt taper to a narrow base. The hymenium expands by one or two cells for successively developing basidia, but the older ones do not collapse until after the next level reaches maturity, apparently elongating to compensate for the growth of the hymenium. Sterigmata 5-8 μ m long. **Cheilocystidia** and pleurocystidia, grey in SV, cheilocystidia few, protruding only around 10 μ m, pleurocystidia regularly distributed, dark grey to black in SV, with refractive contents in KOH, 55-87 x 7.5-10 μ m, clavate to fusiform, acute, rounded or mucronate, arising within the subhymenium. **Subhymenium** 20-50 μ m thick, of small sphaerocytes, gill trama of sphaerocytes with occasional vascular hyphae.

Cutis 200 μ m thick on disc, thinning to 20 μ m near margin, an ixotrichoderm with a turf of hyphal ends and numerous pileocystidia and pseudocystidia with refractive and often banded contents, unstaining to strongly staining dark grey in SV. **Subcutis** of interwoven hyphae with pink contents around 2.5 μ m wide, quite loosely interwoven in the upper half, laticiferous hyphae frequent, staining red or grey in SV. **Epicutis** of semi-upright to repent hyphal ends 2-4 μ m wide, with undifferentiated, obtuse tips embedded in a conspicuous gelatinous matrix. Often the epicutis is not well differentiated from the subcutis. **Pileocystidia** 25-200 x 4-8 μ m, (up to 277 μ m long in Singer's 1957 description) occasional ones inflated to 10 μ m wide. Both cystidia types are septate about every 15 to 35 μ m although some pileocystidia are aseptate, ends rounded, occasionally capitate or clavate, greying in SV. Small diverticulae are sometimes present, not much more than a small bump in the hyphal wall. **Hypodermis** not differentiated from the cap trama.

Trama of sphaerocytes in clusters bound by a hyphal mesh.

Chemical reactions: FeSO₄ - pale pinkish; KOH - brownish orange on cap surface, no reaction on stipe; NH₄OH - no reaction; guaiac - brownish-green; guaiacol - light purple; phenol - very slowly brownish purple; SV - grey on the gills, purple on the cuticle, cystidia and vascular hyphae grey to black. Singer (1957) determined that formalin gave a negative reaction on the stipe.

Habitat and tree associations: Under Douglas fir in grass, September to November.

Collections: CR981120-01 at N 48.4603, W123.3128 from University of Victoria campus by the side of the ring-road just north of the Cunningham parking lot entrance, under Douglas firs. CR040918-01 at N 48.43915, W 123. 478183, Royal Roads University campus, in the stand of mature Douglas fir between Sooke Road and the sports field.

| | ITS1-F to | RFLP: | | |
|-------------------------------------------------------|-----------|---------------|----------|---------------|
| Collection | ITS4-B | HinfI | AluI | Sau3A |
| CR981120-01 | 832 | 364, 249 | 497, 289 | 600 |
| <i>R. cessans</i> GenBank AY061730 1-301IS55 | 902 | 343, 153, 157 | 489, 255 | 288, 272, 183 |

Notes: The Vancouver Island collections match very closely the descriptions of *R. cessans* in Romagnesi (1967) for Europe, and those of Singer (1957) and Thiers (1997) for North America in all morphological characters. Singer examined collections of *R. cessans* from Austria, Sweden, Germany, England and Michigan, North America. The habitat in these descriptions is given as conifers, especially pine. In the Royal Roads collection they were growing in a stand of mature Douglas fir, and under Douglas fir and madrone on the University of Victoria campus. The ITS rDNA region differs in length from that of a *R. cessans* sequence deposited in GenBank, as noted above. The Vancouver Island collection tested also had a restriction site for HinfI and at least one for Sau3A missing compared to the GenBank sequence. These missing sites may be due to single base-pair substitutions within the recognition sequence, which occurs occasionally,

or the ITS rDNA is exceptionally variable in this species. Another explanation is that the GenBank collection and the Vancouver Island collection are not the same species.

Russula cessans grows in proximity to, and in similar habitats to *R. murrillii*, which is also purple with a white stipe, dark yellow spore print and mild taste. The latter is usually shorter in stature, and has an opaque, matte, chalky appearance to the cuticle that has abundant incrustated primordial hyphae. *R. cessans* may also fruit near *R.*

xerampelina, also of similar colours and taste, however, this latter species is usually larger, often has pink on the stipe, has a paler spore print, usually a shellfish odour, and bruises dull yellow then brown. *Russula abietina*, in the *Sphagnophylae* has overlapping habitat, but more green in the cap, a paler spore print, and non-reticulate spores.

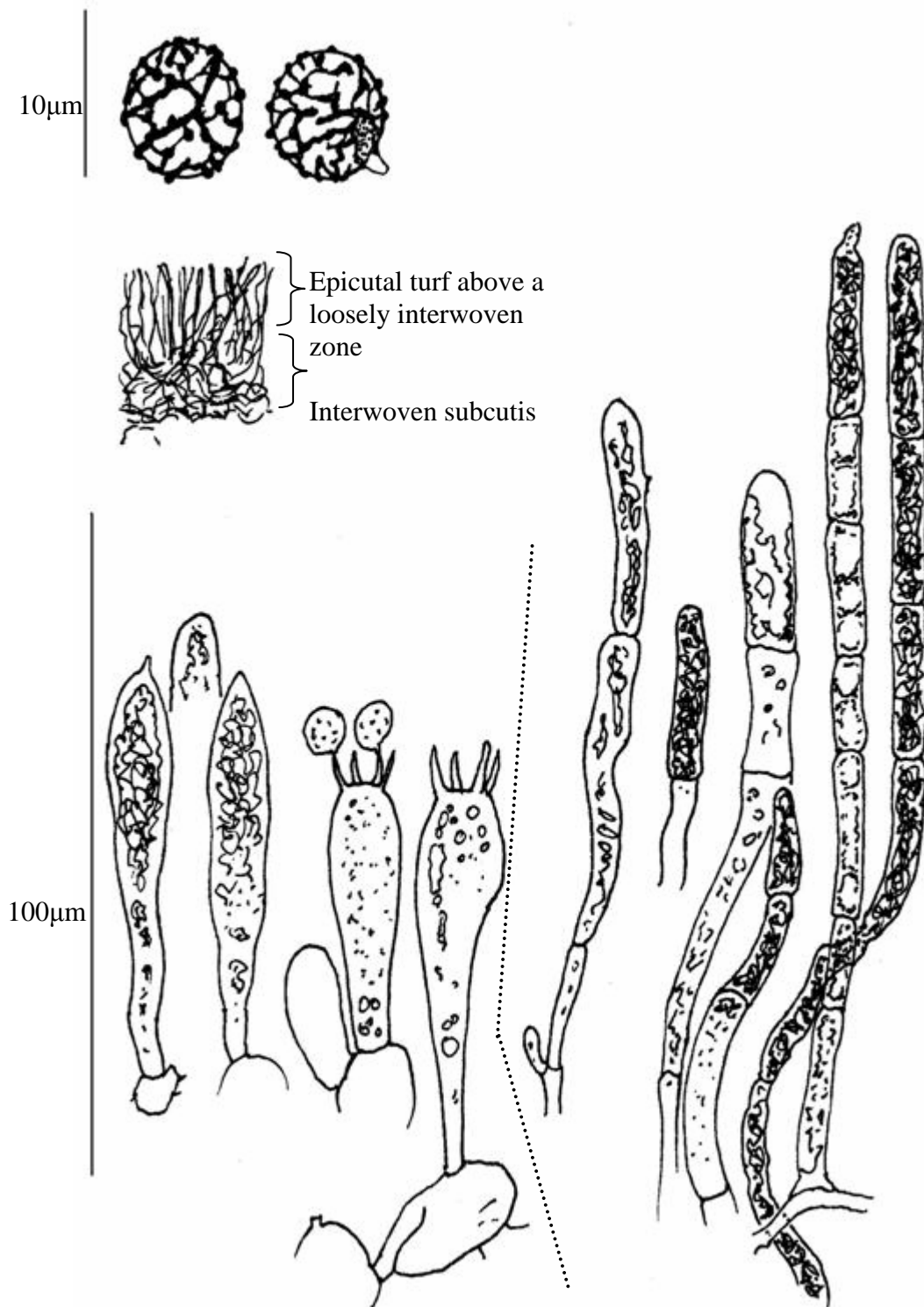


Figure 185 Microscopic characters of *Russula cessans*: Top left, spores with 10 µm scale bar; top right, plan of cutis in section in 5% KOH; bottom left, hymenial cystidia and basidia; bottom right, pileocystidia and pseudocystidia in cutis, lower scale bar is 100µm.

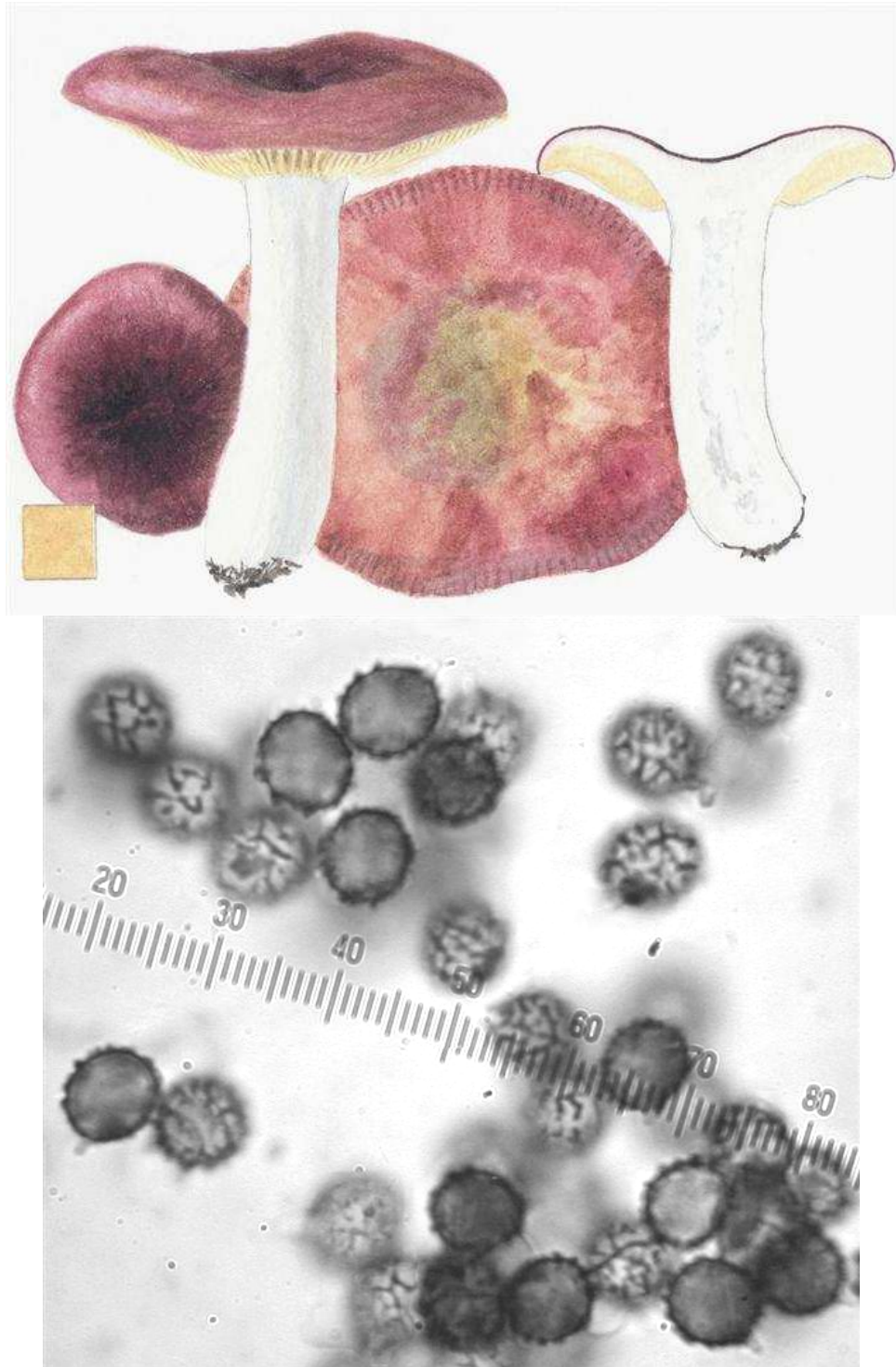


Figure 186 Top: macroscopic characters of *R. cessans* in profile, immature and mature top view and a longitudinal section, square is 1cm² and shows spore print colour; bottom, spores of *R. cessans* with 1µm division scale.

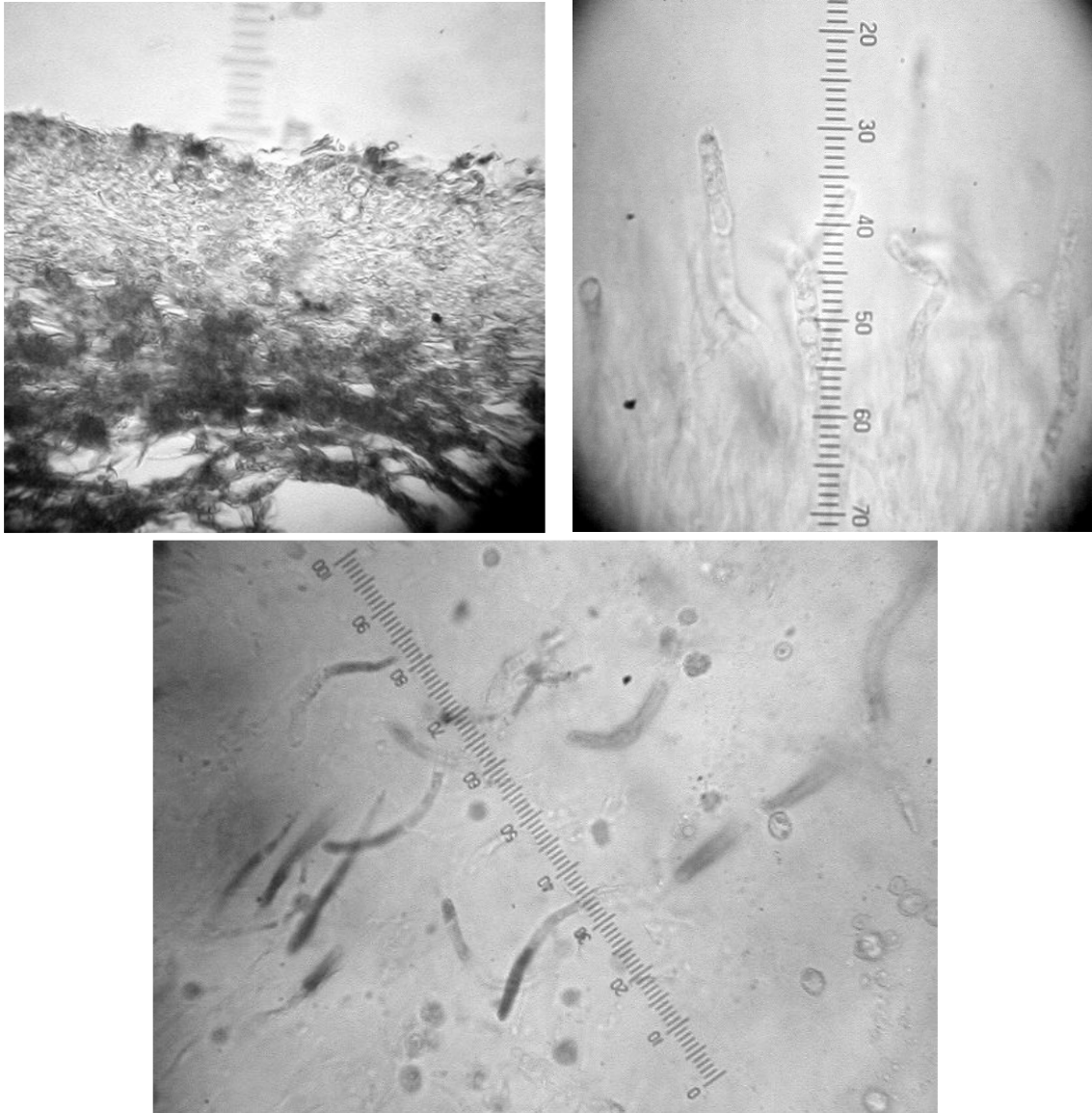


Figure 187 Cutis of *R. cessans*: Top left, section of cutis mounted in 3% NH_4OH , 10 scale divisions are 100µm; top right, detail of the epicutis showing pileocystidia with refractive and banded contents, 10 scale divisions are 25µm; bottom, surface view of cutis stained in SV showing pileocystidia and pseudocystidia, 10 scale divisions are 25µm.

Clade 10b**Subsection *Puellarinae* Singer*****Russula puellaris* Fries**

Epicr. Myc. 383. 1838

Description of Vancouver Island collections:

Cap 3.7-6.5cm diameter, convex when young, becoming plane with a shallow central depression, margins soon striate, becoming tuberculate, to about 1/3 the cap radius.

Colour a dark vinaceous purple, almost black centrally, lighter purple to vinaceous to brownish pink towards the margin, becoming browner as the flesh beneath yellows and shows through the translucent cutis, which also fades in age. Cutis slightly viscid when wet, soon drying matte or with a slight sheen and minutely punctate, peeling 1/2-3/4 the radius, trama beneath tinted pink at first, otherwise creamy white, bruising dull yellow, quite thin, around 2mm at half-radius on a 6.5cm wide cap.

Gills pale to deep cream, bruising dull yellow sometimes also with slightly brown edges, subdistant, occasionally close, subgills and forking uncommon, adnate or sometimes with a tiny decurrent tooth at the stipe, strongly ventricose, up to 10mm or about 5 times the thickness of the trama at half-radius, broadly acute at the cap margin, usually more pliable than brittle.

Stipe 3.0-6.7 x 0.9-1.8 cm, usually longer than the cap diameter, cylindrical to narrowly clavate, longitudinally slightly rugulose, stuffed with a soft bread-textured trama which may develop 3-4 small cavities that merge to form a hollow stipe, white, entirely discolouring dull yellow in age or after handling, and also having a waterlogged look, although this may take several hours to develop.

Texture slightly softer than the average *Russula*.

Taste mild.

Odour slightly fruity, sometimes none.

Spore colour light buff-cream, Romagnesi IIa-c.

Spores 8.3-10.9 x 6.7-9.2 μ m, L:W 1.02-1.21, with a mean of 1.09 (n=20) in the collection from the Rainforest trail, PRNP, and 1.06-1.31, with a mean of 1.18 (n=50) for the remaining collections; globose to subglobose to broadly ellipsoidal. **Ornamentation** of warts 0.5-1.2 μ m high, mostly in the 0.7-1.0 μ m range, conical to bluntly conical or occasionally peg-like, 2-several-catenate, or joined by thin to moderate lines forming a partial reticulum on some spores, or a very broken one on others, occasional spores with mostly isolated warts. Both the spore shape and degree of reticulation vary among collections, although none are completely reticulate. **Woo types** B3 to C3, often with partial E2 type ornamentation, sometimes A3. **Suprahilar patch** strongly amyloid, irregularly shaped, often with warts within and on its borders, sometimes relatively small, 2 μ m or less across. **Hiliferous appendix** 1.4-2.4 μ m long, 0.9-1.5 μ m wide near the base. **Basidia** 4-spored, occasionally 2-spored, 32-45 x 10-13 μ m, short and broad, often almost columnar pre-maturity, becoming clavate and slightly bulbous in the upper half. A few of the basidia are filled with a deep yellow material, most commonly older and spent ones. Sterigmata 5-7.5 x 1.6-2.4 μ m. **Pleurocystidia** frequent to sparse, up to 80 μ m apart near the gill origin to around 30 μ m apart near the gill edge, 50-80 x 7-12 μ m, protruding up to 25 μ m, sometimes embedded, originating in the subhymenium, often quite shallowly, cylindrical to clavate, most tips capitate, otherwise acute to subacute or sometimes rather blunt and rounded, contents refractive, yellow-brown, unreacting to purple in SV, the strongest staining occurs towards the gill origin. **Cheilocystidia** common, 28-45 x 5.5-8 μ m, embedded or protruding 10-15 μ m, fusoid to roughly cylindrical but occasionally with slight constrictions, often crumpled, rarely with 1-2 septa and then "empty" (figure 3), tips capitate, mucronate or with a short irregularly shaped extension, contents refractive, pink in SV. The gill edges sometimes have a thin gelatinous coating in parts which adheres the protruding portion of cystidia to the gill edge, and forms a lumpy coating on the cells, this may be in response to some environmental damage since the affected gill edges are also strongly yellowed. **Subhymenium** 20-40 μ m thick, pseudoparenchymatous, expanding by one cell for each subsequently developing

basidium, of relatively large, roughly ellipsoidal cells up to 20 x 10µm, **gill trama** of sphaerocytes up to 40µm across, vascular hyphae occasional.

Cutis 70-160µm thick, an ixotrichodermis but with a sometimes inconspicuous gelatinous matrix. **Subcutis** about 2/3 the cutis depth but merging gradually into the epicutis without a clear demarcation, of tightly interwoven semi-upright hyphae 2-6µm wide, containing a water soluble pink vacuolar pigment that gives them a granular appearance en masse, the lower layers repent and parallel, merging into the hypodermis. Vascular hyphae uncommon, with yellow refractive contents, barely staining in SV.

Epicutis of upright hyphae 3-5µm wide, generally septate every 10-25µm, tips undifferentiated or most often with a short tapered cell, occasionally bearing a tiny terminal button. Clumps of hyphal tips can be found in which the contents are deep yellow, accompanied by yellow pileocystidia. **Pileocystidia** abundant, of two types: small, clavate ones 25-38 x 4-7µm, 1-2-septate, mostly at the surface, with deep yellow contents (a necropigment) in NH₄OH, sometimes banded, becoming brownish yellow in SV, and longer, broader, 1-4-septate, cylindro-clavate ones with grey to black granular contents in SV, emanating from the subcutis. These latter measure 50-130 x 6-11µm with the terminal 1-3 cells forming a clavate end to a cylindrical base. Occasionally the two types are found within one pileocystidium with the greyish ones forming the terminal cells or vice-versa. The yellow hyphal ends and pileocystidia are variable in their occurrence, increasing in older and more discoloured basidiomata. Very rarely, small particles of a loose incrustation may be found over short sections of the cystidia or their supporting hyphae. **Hypodermis** a layer of parallel hyphae with frequent septa appearing in places as a compressed pseudoparenchymatous layer with normally septate hyphae permeating it.

Trama mostly of sphaerocytes in loosely defined clusters and scattered within a hyphal network, vascular hyphae common, up to 9µm wide, contents either weakly greying and granular or strongly yellow in SV.

Chemical reactions: FeSO₄ - usually weak, pinkish to brownish-grey to grey; KOH - yellowish to orange-brown on cap surface, unreacting to yellowish on stipe; NH₄OH - no

reaction to dull yellow on stipe; phenol -brownish purple, sometimes weak or slow; SV - purplish-pink on the gills, brownish-purple on the cutis, cystidia and vascular hyphae brownish pink to dark grey.

Habitat and tree associations: Singly or in small groups on sandy soils under Sitka spruce, in warm weather May through October.

Collections: PK000527-SchRp on the forest floor towards the lower (seaward) part of the trail, under old-growth Sitka spruce, western hemlock and salal, approximately N49.0665°, W125.7885°. CR010613-27, on duff along the trail inland of the house and campground under regeneration Sitka spruce, western hemlock, western red cedar, salal and grasses, N49.172822°, W125.968405°. BK/OC011030-rfa on duff beneath old-growth Sitka spruce, western hemlock and western red cedar, along the Rainforest trail east of the highway, PRNP around N49.4468°, W125.5317°. CR021016-11, on duff under Sitka spruce krummholz at the beach edge of Wickaninnish bay, PRNP, N49.01262°, W125.67470°. CR020927-03, in old growth valley bottom forest, on very decayed wood and soil mixture at the base of a western hemlock, with Sitka spruce, western red cedar and huckleberry, Carmanah grove, N48.6660°, W124.6840°.

| | ITS1-F to | RFLP: | | |
|-----------------|-----------|----------|----------|---------------|
| Collection | ITS4-B | Hinf1 | Alu1 | Sau3A |
| CR021016-11 | 869 | 386, 330 | 473 | 300, 250, 190 |
| BK/OC011030-rfa | 866 | 380, 241 | 511, 291 | 300, 245, 193 |

Notes: *Russula puellaris* is distinctive in the tendency of the flesh of all tissues to age and bruise ochre yellow. Other macroscopically similar species such as *R. brunneoviolacea*, *R. blackfordae* and *R. sphagnophila* may show some yellowing at the base of the stipe, but this does not extend to the cutis, cap trama or gills. Some of the collections described here were not strongly yellowed but still showed occasional intensely yellowed cells in the cap trama and cutis when viewed under the microscope in several mounting media. This seems to be the main difference between *R. puellaris* and *R. sphagnophila*, which have very similar spore colour, size and ornamentation and similar habitat.

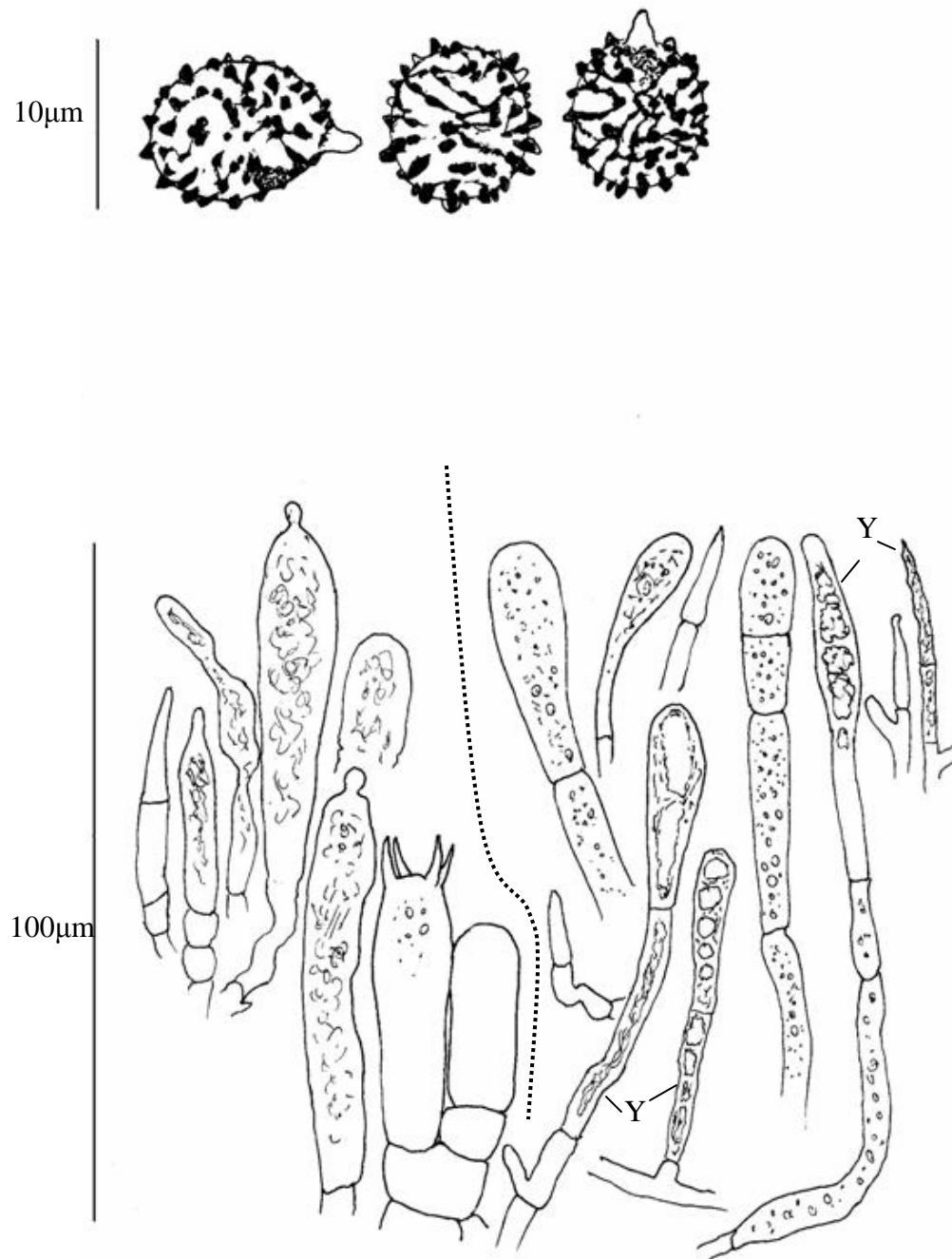


Figure 188 Microscopic characters of *Russula puellaris*: Top, spores with 10 µm scale bar; bottom left, three cheilocystidia, pleurocystidia and basidium with basidiole; bottom right, hyphal ends and pileocystidia from the epicutis, those filled with deep yellow contents are marked Y, lower scale bar is 100 µm.



Figure 189 Macroscopic characters of *R. puellaris*: Top, fresh basidiomata that have not yet yellowed (photograph on left by A. Ceska, that on right showing 1cm scale); below, top and underside of a similarly sized and coloured basidioma several hours after collection, in which the yellowing reaction is well advanced and has changed the purple colour of the cap to brown (photographs by B. Kendrick); small square is 1cm² and shows spore colour.

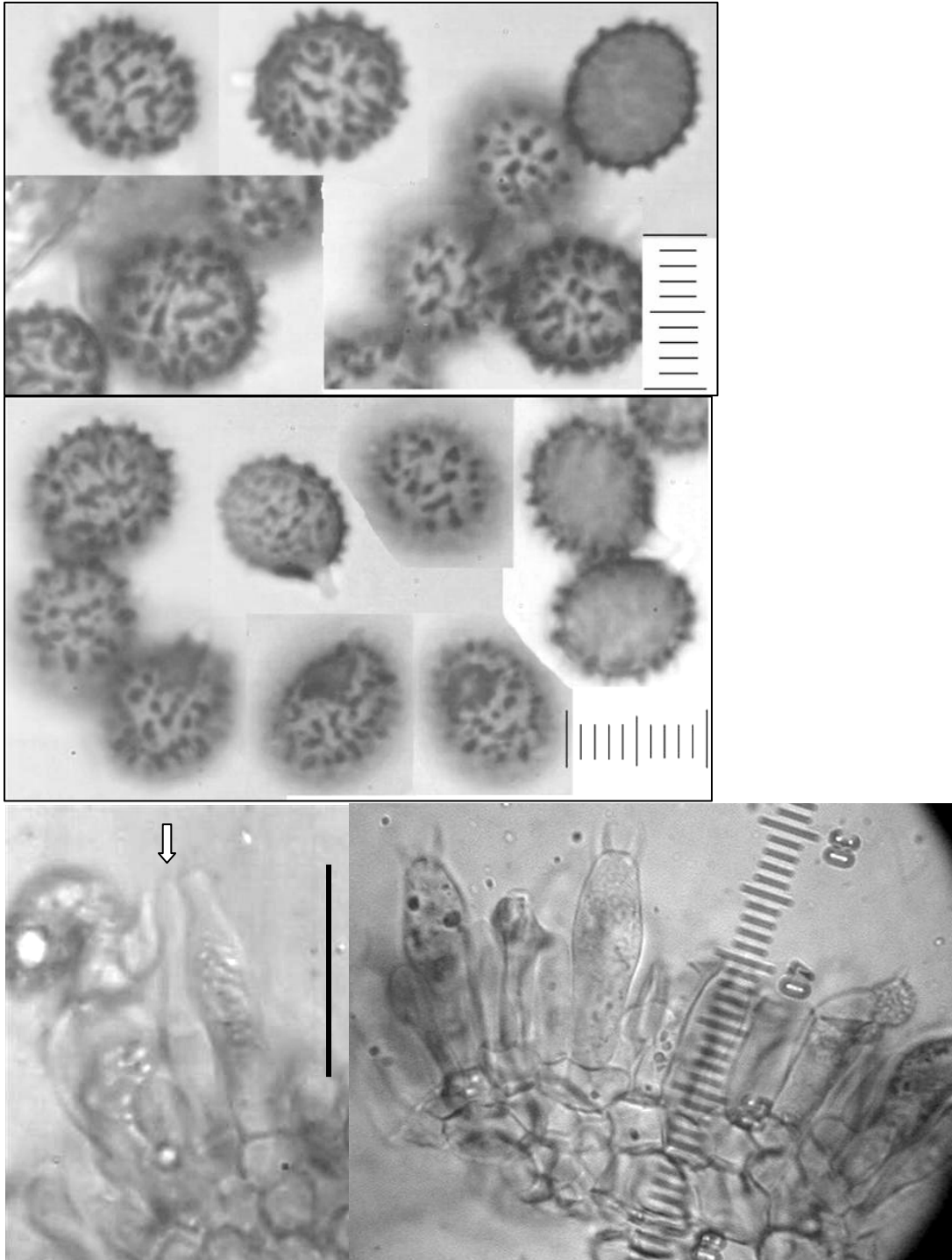


Figure 190 Hymenium of *R. puellaris*: Top, spores of the Wickaninnish collection; middle, spores of the Schooner beach collection, both with 1µm division scale; bottom left, 2-septate "empty" cheilocystidia (arrowed) with a non-septate one to its right, developing directly from the subhymenium, scale bar is 2µm; bottom right, fragment of hymenium showing mature and developing basidia upon the pseudoparenchymatous subhymenium.

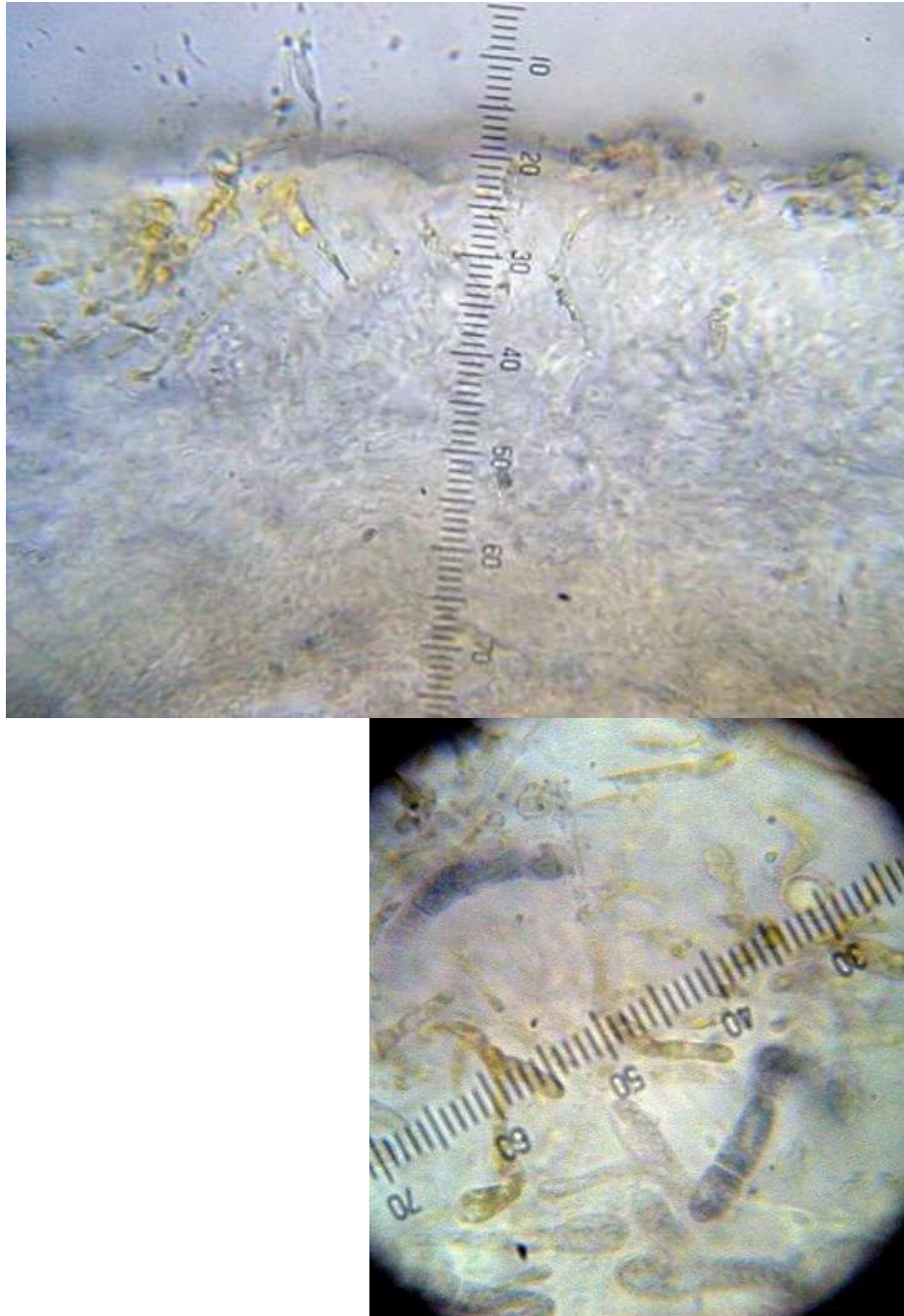


Figure 191 Cutis of *R. puellaris*: Top, section through cutis in which a cluster of hyphal tips and pileocystidia with yellow contents can be seen to the left of the scale, and normal pileocystidia to the right, the section is mounted in 3% NH_4OH , 10 scale divisions are $25\mu\text{m}$; bottom, surface view of epicutis stained in SV showing normal pileocystidia, stained grey, and smaller yellow ones which often have banded contents, scale as above.

Subsection *Laricinae* (Romagnesi) Bon

***Russula nauseosa* (Pers.) Fr.**

Epicr. Syst. Mycol.: 363. 1838.

Description of Vancouver Island collections:

Cap 2- 5.4cm diameter, hemispherical when young, sometimes with a slight umbo, becoming convex or plano-convex usually with a small central depression, margins striate even from quite young, in age almost tuberculate. Colour when young almost black with a purple margin, becoming vinaceous to violet, generally darker and browner centrally, sometimes with an olive tint over the disc, sometimes deep grey-brown, fading in age to greyish. Viscid when wet, drying matte or with a dull sheen and minutely punctate. Cutis peeling 3/4, flesh beneath white to cream, unchanging to discolouring a very pale yellowish brown, trama steeply reducing in thickness to 1mm or less by half-radius.

Gills white becoming cream and eventually pale orange cream, slightly bruising light yellow brown, subdistant to close, sub gills not seen, occasional forking toward the cap margin, adnexed at stipe broadening outwards, obtuse to rounded at the cap margin, 2-4 times the depth of the trama (3 to 6 mm) at half radius, brittle.

Stipe 2.7-5.7 x 0.6-1.3cm, longer than or often twice the cap diameter, white, usually narrowly clavate, stuffed with a soft, bread-textured trama that develops three or more cavities, eventually becoming hollow, discolouring very pale tan to light ochre where bruised and damaged.

Texture firm but quite fragile, later soft and fragile.

Taste mild, at first the gills very slightly peppery.

Odour not distinctive to fruity, one basidioma from the Long Beach picnic site had an apricot, chanterelle-like odour.

Spore colour light dull orange to ochre, Romagnesi IIIb-c.

Spores 8.3-11.4 (-13) x 6.7-9.2 μ m, L:W 1.13 to 1.4 with a mean of 1.26 [n = 48], ellipsoidal to broadly ellipsoidal, occasionally obovoid. **Ornamentation** of fine to heavy, blunt to pointed conical warts 0.5 to 1.3 μ m high, mostly isolated, or 3-5-catenate, occasionally more, sometimes connected in small clusters of 2-4, occasionally linked by fine lines, not forming a reticulum, on some spores the warts are quite crowded. Woo type B3. **Suprahilar patch** amyloid, irregularly shaped, warts at its borders and sometimes within. **Hiliferous appendix** 1.5-2.2 μ m long by 1.2-1.5 μ m wide near the base. **Basidia** 2- and 4-spored, both types equally common, 35-50 x 11-13 μ m, short and broad, clavate. Sterigmata relatively short, up to 7x 2 μ m. **Pleurocystidia** numerous, regularly distributed, 48-80 x 8-12 μ m, protruding 10-25 microns, sometimes embedded, narrowly clavate to fusoid, tips acute, occasionally obtuse or more commonly with a tiny capitulum, contents refractive, blue-black in SV. **Cheilocystidia** frequent to none or sometimes hard to see, 45-55 x 7-10 μ m, embedded or protruding 15-20 μ m, broadly fusoid to clavate, tips capitate, mucronate, occasionally obtuse, not or only weakly staining in SV. **Subhymenium** 20-30 μ m thick, pseudoparenchymatous, merging gradually into trama near the origin of the gill. **Gill trama** of sphaerocytes, generally up to 30 μ m diam., vascular hyphae uncommon.

Cutis 80-160 μ m thick, an ixotrichodermis in two distinctive layers embedded in a gelatinous matrix. **Subcutis** 1/3 to 1/2 the depth of the cutis, tightly interwoven of repent, parallel hyphae containing globular or amorphous pink pigment that rapidly leaches into the mounting fluid, 2.5-5 μ m wide, occasionally with inflated sections, vascular hyphae common, some of which ascend to the epicutal surface and terminate in pseudocystidia, grey in SV. **Epicutis** of upright to semi-upright hyphae with pinkish contents, hyphal ends 2.5-4 μ m wide, undifferentiated, accompanied by multiple pileocystidia. **Pileocystidia** abundant, 30-110 x 5-10 μ m, occasionally up to 12 μ m wide, most in the middle of this range, clavate to narrowly clavate, occasionally almost

cylindrical, arising in the lower epicutis, 1-3-septate, rarely aseptate, quite often constricted at the septa, frequently with a shorter terminal cell about 25-30µm long, tips obtuse to rounded, contents yellowish and refractive in KOH, turning gray to black in SV and pink in acid fuchsin. Sometimes darker pink patches occur with the latter reagent but they do not appear to be outside of the hyphal wall. Very rarely one can find a cystidium with small patches of incrustation below the terminal cell, apparent in fuchsin but not SV mounts. **Pseudocystidia** common, similar in shape and septation to pileocystidia, staining pink in acid fuchsin, generally not incrustated although occasional segments of wall stain more strongly, possibly a very tightly adhering material. **Primordial hyphae**: occasionally long, regularly septate broad hyphae around 7-8µm wide and partially filled with refractive contents may be found that are more like primordial hyphae in appearance than cystidia, but they are not noticeably incrustated, stain weakly grey in SV and patchily pink in acid fuchsin. **Hypodermis** not differentiated from the subcutis or trama.

Trama mostly of sphaerocytes in well defined clusters bound by a hyphal mesh that is more substantial than is generally found in other small Russulas, vascular hyphae occasional.

Chemical reactions: FeSO₄ - no change to a light pinkish brown; KOH - red or orange on cap no reaction on stipe; NH₄OH - no reaction; phenol - brownish purple; SV - initially violet on the gills and cap trama, cystidia and vascular hyphae grey to black.

Habitat and tree associations: On the forest floor beneath western hemlock and Sitka spruce, with understory salmonberry and mosses. Sitka spruce is the most likely tree symbiont.

Collections CR010814-01, in a mature regeneration stand of Sitka spruce and western hemlock along the Fairy Lakes trail near Port Renfrew, N48.583150°, W124.355217°. CR011030-01, in grass under young Sitka spruce with mature Sitka spruce and western hemlock nearby, Long Beach picnic area, PRNP, N49.070061°, W125.754495°.

ITS1-F to

| | | | | |
|------------|--------|-------------|------|-------|
| Collection | ITS4-B | RFLP: HinfI | AluI | Sau3A |
|------------|--------|-------------|------|-------|

CR010814-01 832 400, 364 495, 274 440, 257

Notes: The spore print colour is paler than is given for *Russula nauseosa* in Romagnesi (1967), more like that of *R. nitida*, which also has spores similar in size and ornamentation to the above collection. However, this latter species is associated with birch, of which there is none in the vicinity of the collection area, in fact this tree symbiont is very rare on Vancouver Island. The flesh of *R. nauseosa* does not bruise yellow like that of *R. puellaris*, although it may become weakly yellow-brown especially at the stipe base, and does not have the conspicuously incrustated primordial hyphae of *R. turci* and *R. murrillii*, two other violet to purple, mild, yellow-spored species. *Russula brunneoviolacea* is also macroscopically similar, but that species has paler, smaller spores and flesh that yellows more than that of *R. nauseosa*, and it is found in a different habitat. It is not clear why the epithet *nauseosa* was given to this species, since neither the taste nor the odour is suggestive of vomit.

Russula nauseosa has been placed in the *Laricinae* by Bon (1988) and Romagnesi (1967, 1985), yet in the DNA analysis in Chapter 2 it groups with the *Puellarinae* and, if one follows Bon (1988), with the *Odoratinae*, a group he segregated by its odour. In Europe it fruits in late spring to early summer, on Vancouver Island along the coast, spring-like weather may persist in some years for much of the year, so fruiting seasons for some species are extended, the above collections were made in mid-August and late October.

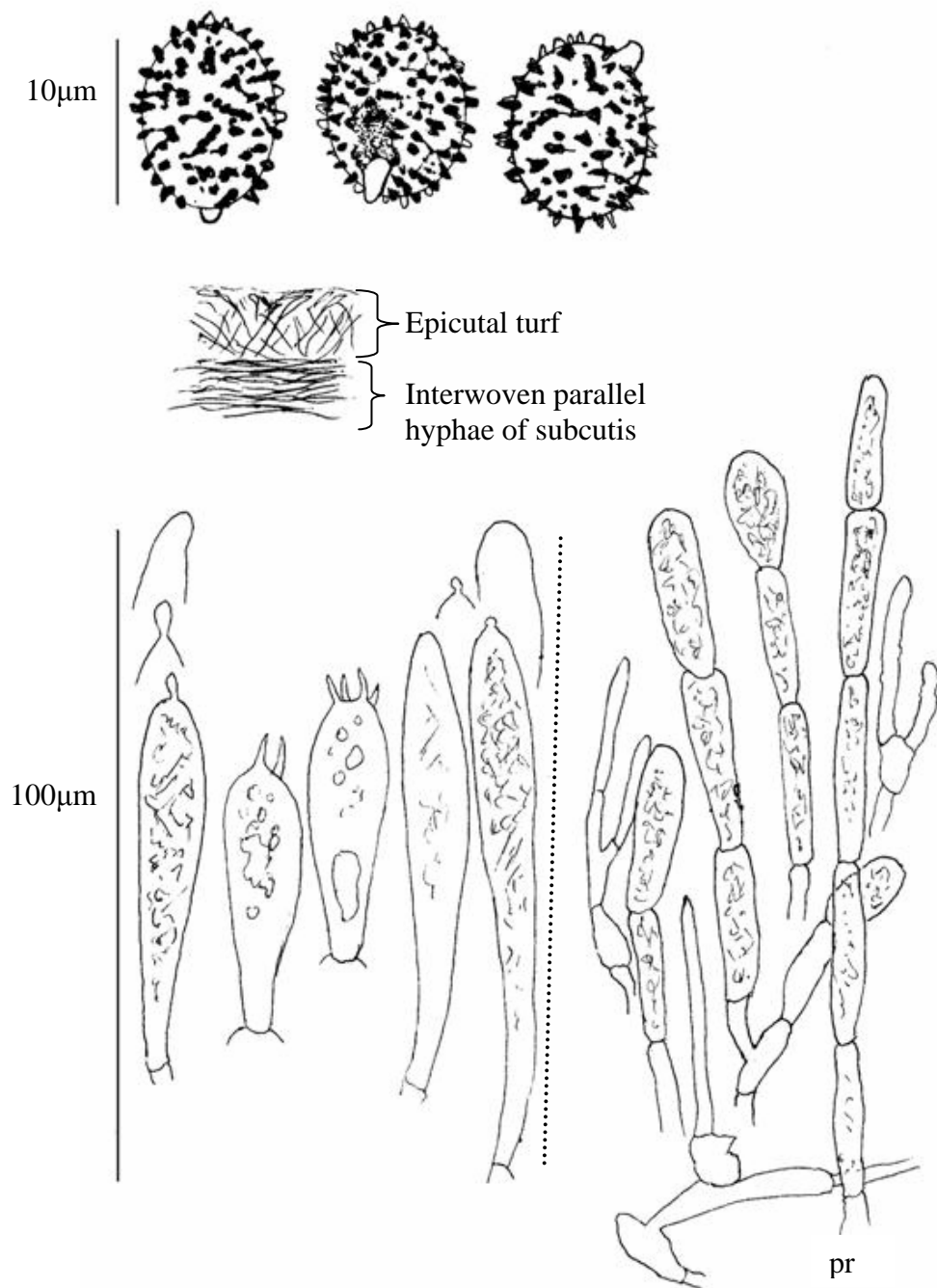


Figure 192. Microscopic characters of *Russula nauseosa* : Top, spores with 10µm scale bar; middle, diagram of section through cutis; bottom left, cheilocystidia, basidia and pleurocystidia; bottom right, pileocystidia, hyphal ends and possible primordial hyphae (marked pr) from the epicutis, lower scale bar is 100µm.

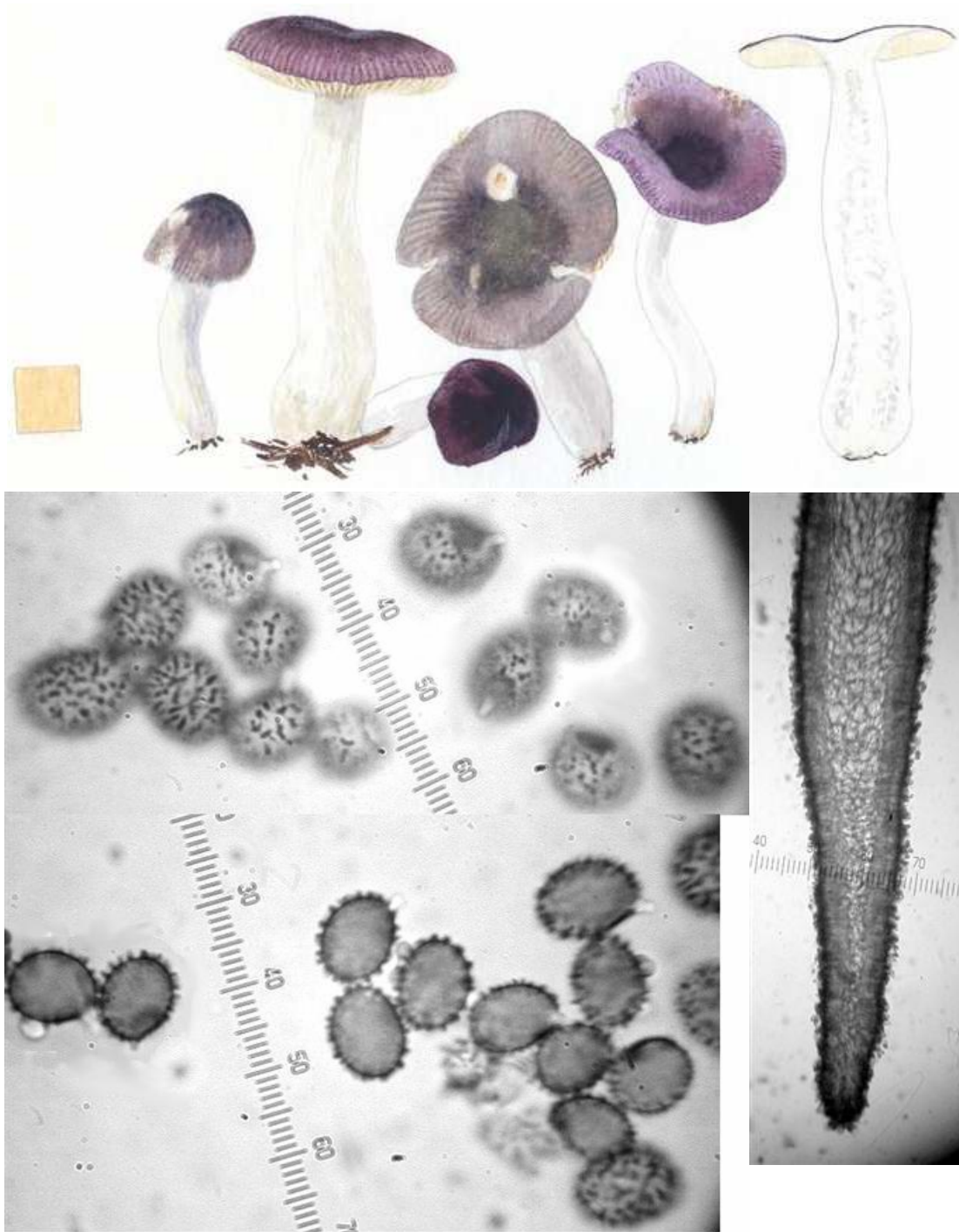


Figure 193. Macroscopic and hymenial characters of *R. nauseosa*: Top, illustration showing profiles and top of several basidiomata of varying maturity, with a longitudinal section and spore colour in the 1cm² square; bottom left, spores in surface and equatorial view with 1µm division scales; bottom right, section through gill showing gill trama of spherocytes and differentiated subhymenium which becomes less strongly differentiated towards the origin, 10 scale divisions are 100µm.

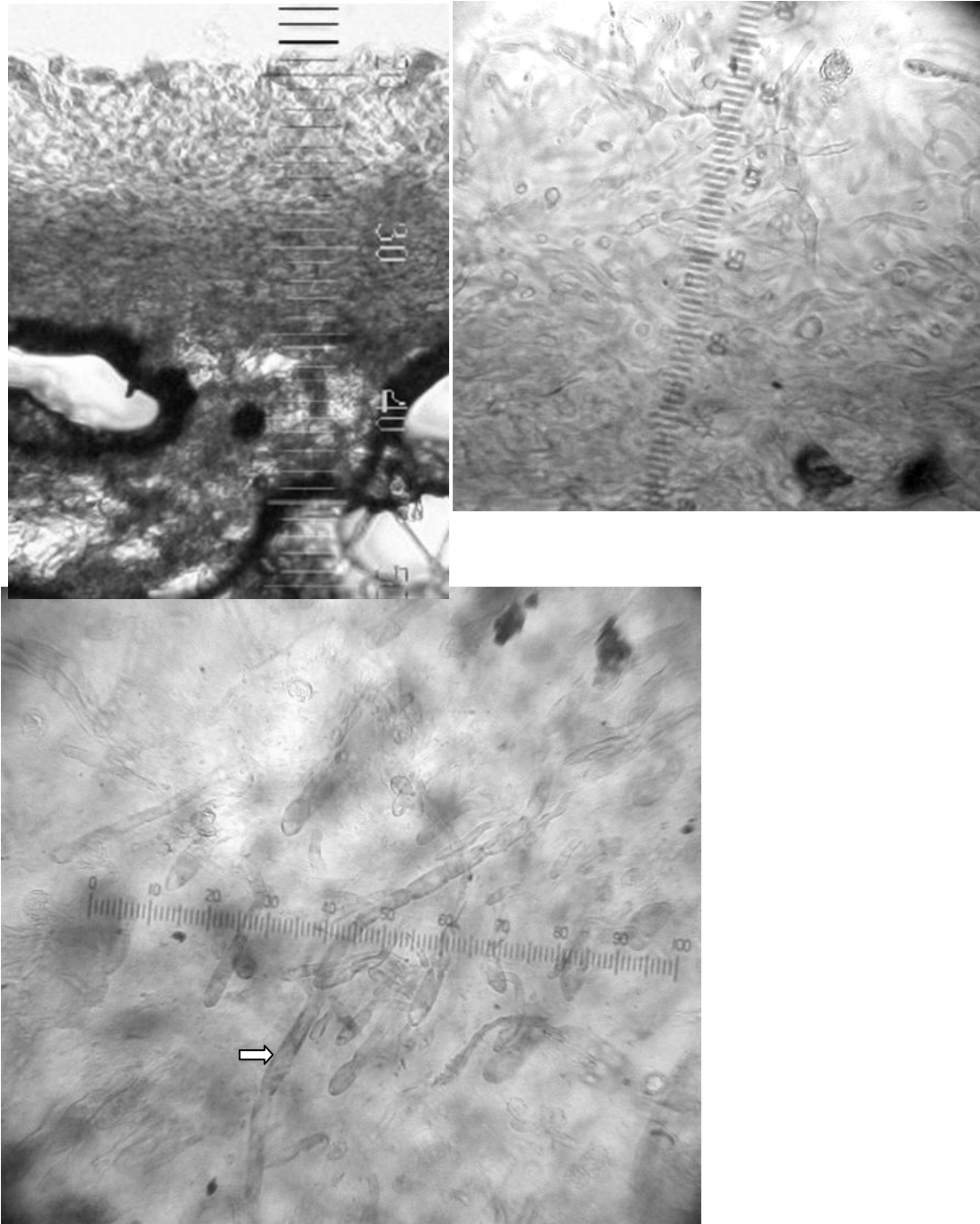


Figure 194 Cutis of *R. nauseosa*: Top left, section through cutis and part of trama stained in Congo red, the cutis-trama boundary is about the 35 mark on the scale, 10 scale divisions are 100µm; top right, closer view of the epicutal hyphae in which a few slightly inflated sections can be seen, as can the tip of a pileocystidia, upper right, 10 scale divisions are 25µm; bottom, surface view of cutis stained in acid fuchsin, several clavate pileocystidia can be seen and also a primordial hyphae (arrowed), 10 scale divisions are 25µm.

Table 4. Comparison of key characters of small, mild-tasting, purple to violet, cream and yellow-spored *Russulas*. All but *R. murrillii* are in section *Tenellae* Quélet. Information from local collections.

| Species | Spore size μm | Spore colour | Spore ornamentation | Yellowing | Habitat |
|--------------------------------------------------------------|--------------------------|-------------------------|-----------------------|--------------------|------------------------------------|
| <i>R. brunneoviolacea</i> | 7.4-8.8 x 6.1-7.1 | Cream IIa-d | Partial reticulum | Base of stipe only | Oaks, Douglas fir, western hemlock |
| <i>R. sphagnophila</i> | 8.2-10.2 x 6.3-8.2 | | | | Sitka spruce, western hemlock |
| <i>R. puellaris</i> | 6.5-10 x 5.5-8 | | Mostly isolated warts | Completely | |
| <i>R. nauseosa</i> | 8.3-11.4 x 6.7-9.2 | Deep yellow IIIc-IVc | | Base of stipe only | Douglas fir and western hemlock |
| <i>R. cessans</i> (larger basidiomata -up to 9cm) | 6.5-8.8 x 6-8 | | Partial reticulum | None | |
| <i>R. murrillii</i> (appears chalky, has incrustated hyphae) | 7.3-10.8 x 6-8.5 | | | | |

There are a number of small, purple to violet, mild, non-yellowing, gregarious *Russulas* in Vancouver Island coastal forests within the *Tenellae* that can be extremely frustrating to identify. Since they are closely related there is scant difference between cuticular characters, so obtaining a good spore print with which the colour can be accurately assessed is crucial. Unfortunately, one may come across collections that differ only in one character such as spore colour, ornamentation or size, or that differ in habitat or slight macroscopic characters, but have virtually identical microscopic characteristics. In the European literature there are many more species described in this general group than in North America, and it is quite likely that some local species are undescribed and that others have more variation in certain characters than has been so far recorded.