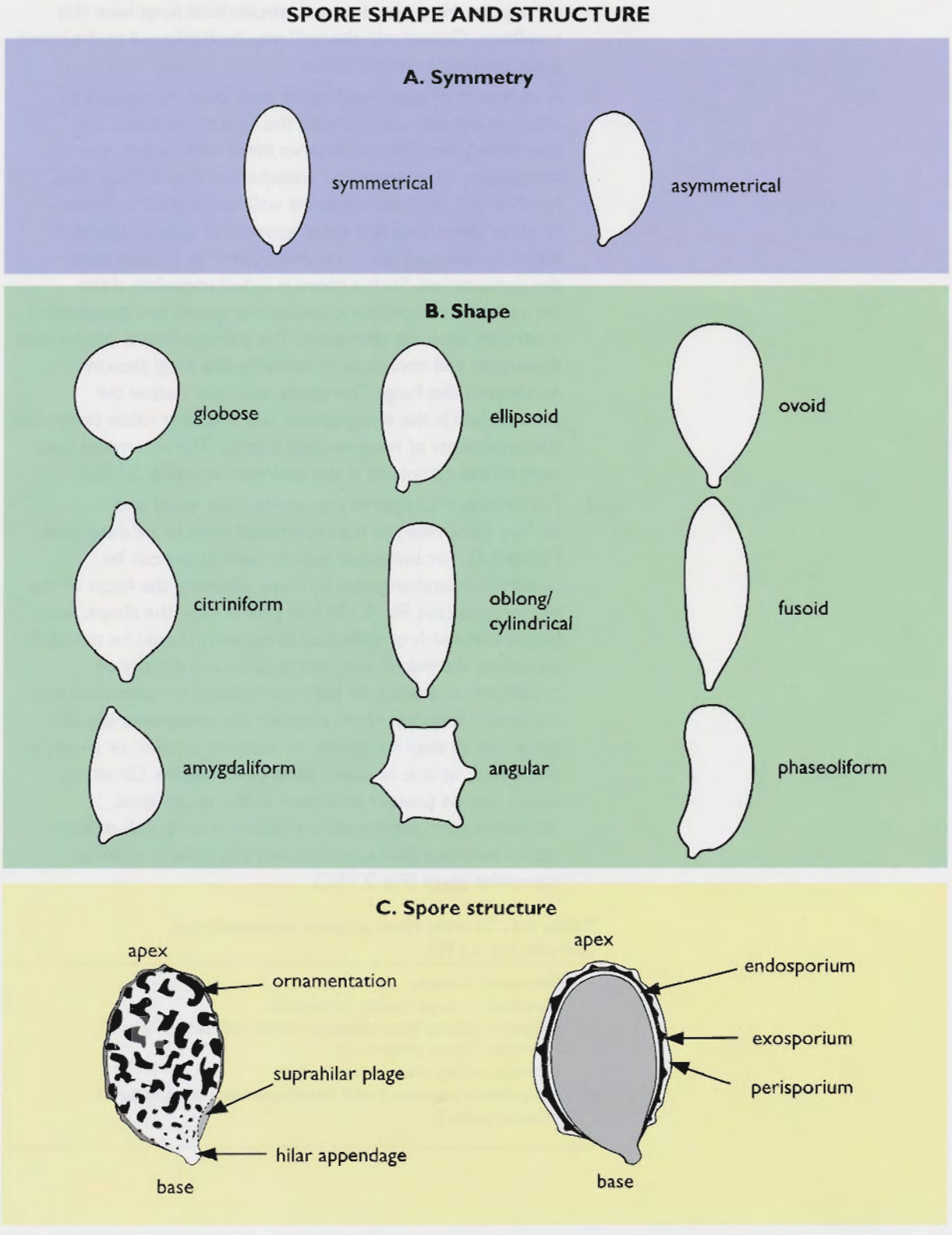


Figure 2.12. Spore morphology.

A. *Symmetry of spores (note, both spores are shown in profile (side) view. Many asymmetrical spores can appear symmetrical in face view while being asymmetrical in side view).*

B. *Some main spore shapes of fungi.*

C. *Main structures and wall layers of spores. Note that the spore shown is loosely based on a rough-spored Cortinariaceae species. Spores of other fungi may not have all these structures.*

germ pore. However, few ectomycorrhizal fungi have this condition. Conversely, the wall may be thickened at the spore apex, forming a distinct callus.

3. A multitude of spore wall layers have been recognised by electron microscopy, but with the light microscope it is usually only possible to observe three main layers, the *perisporium, exosporium and endosporium* (Fig. 2.12C). The number and thickness of spore wall layers differ between fungi. In some fungi the outer spore wall layer can form a distinct separated layer that may appear as a loose sack — the perisporium. Such a spore is called utriculate if the perisporium completely encloses the spore, and calyptrate if it partially encloses the spore. The perisporium is often more developed and conspicuous in truffle-like fungi than in mushroom-like fungi. The spore wall layer below the perisporium is the exosporium, and this layer often comprises the ornaments of rough-walled spores. The innermost layer next to the cytoplasm is the endosporium (Fig. 2.12C).
4. For ornamented spores the profile (side view) and surface (face view) of the ornaments need to be described (Table 2.6). For individual spores, both views can be observed interchangeably by finely adjusting the focus of the microscope (see Fig. 2.13A). In profile view the shape, apex, length and width of individual ornaments should be noted. In face view, the shape, size, distribution and density of ornaments and whether they are isolated or connected are important features. Note whether the ornaments are the same size all over the spore, or become smaller, or larger, or are absent, in one or more parts of the spore. Ornamentation may be present or absent at the spore apex. Sometimes the ornaments are absent from a well-defined region near the hilar appendix and this zone is called a suprahilar plage (Fig. 2.12C).

Table 2.6. Six main types of spore ornamentation (see also Fig. 2.13B).

- Verrucose — warts
- Nodulose — large knobbly ornaments
- Ridged — ranging from striate to ribbed with large ridges
- Punctate — small projections
- Echinate — long sharp pointed spines
- Reticulate— ornaments with interconnections in a regular or irregular pattern

SPORE ORNAMENTATION

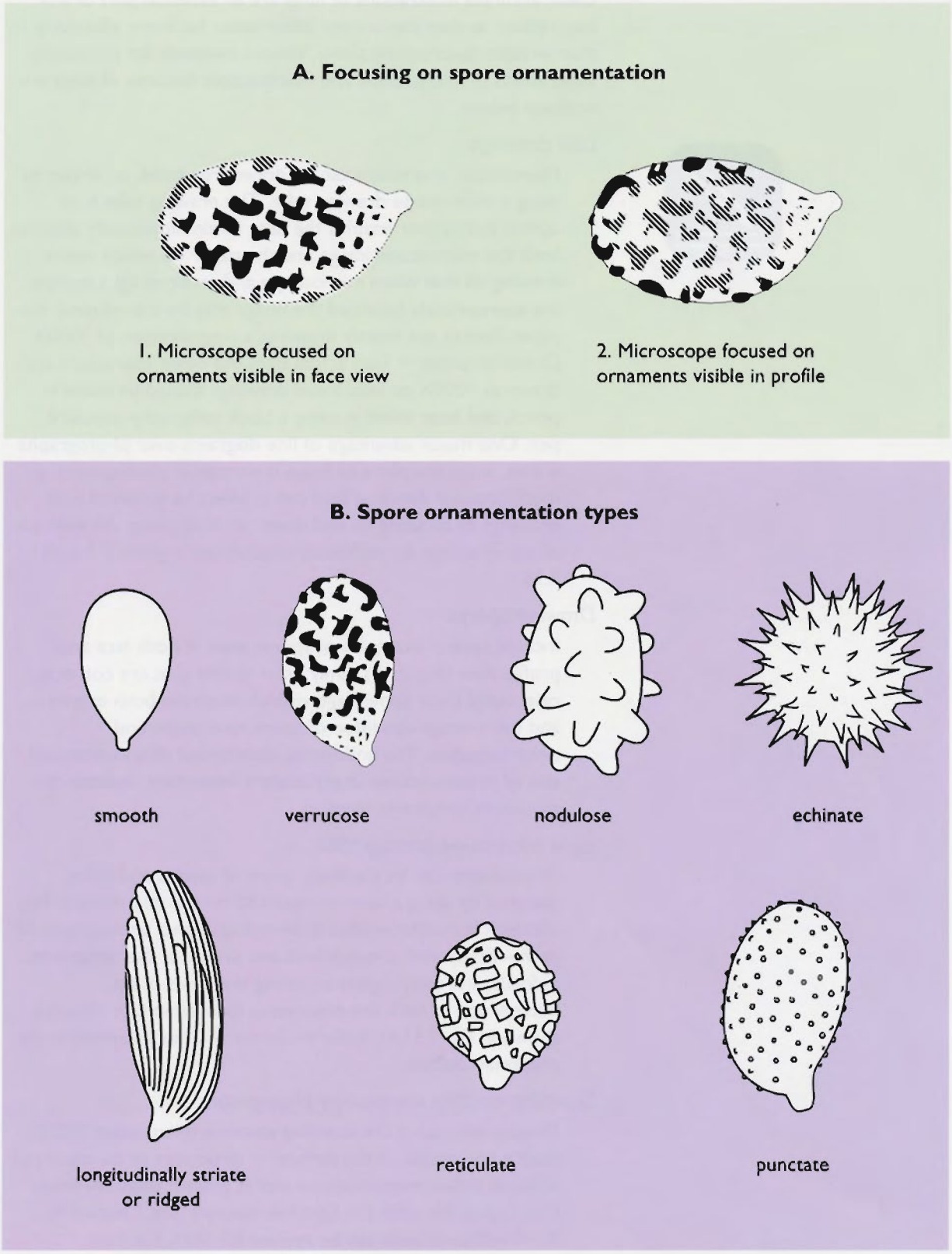


Figure 2.13. *Spore ornamentation:*

A. *Different views of spore ornamentation obtained by fine adjustment of microscope focus.*

B. *Some common types of spore ornamentation.*

E. Illustration of microscopic structures

Clear, accurate illustrations of fungi are an essential part of any description, as they can convey information far more effectively than written descriptions alone. Various methods for producing illustrations of microscopic and macroscopic features of fungi are outlined below.

Line drawings

Microscopic characters can be drawn free-hand, or drawn by using a microscope drawing tube. The drawing tube is an optical device that enables the user to simultaneously observe both the microscope image and the paper on which one is drawing so that when microscope and external light sources are appropriately balanced the image may be traced onto the paper. Spores are mostly drawn at a magnification of 2000X (2 mm on paper = 1µm actual size). All other characters are drawn at 1000X or less. Initial drawings should be made in pencil, and later inked in using a black calligraphy-standard pen. One major advantage of line diagrams over photographs is that, while the plane of focus is narrow in photographs, a much broader depth of field can in effect be achieved with drawings by focusing up and down while drawing. An example of line drawings for *Hebeloma westraliense* is given in Figure 2.15.

Drawing Spores

Include several examples of spores seen in both face and profile view (Fig. 2.15). Only draw spores that are correctly orientated (hilar appendage visible). Illustrate both extremes and the average condition of spore size, shape and ornamentation. The uniformity, density and distribution and size of ornamentation is particularly important. Indicate the mountant which was used.

Light microscope photographs

Photographs can be routinely taken of spores and other features, by using a camera mounted on the microscope. For spores it is recommended to always take two photographs of each – firstly with the side wall and profile of the ornaments in focus, and then slightly adjusting the focus of the microscope to have the ornaments focused in face view (as shown in Fig. 2.13A). Refer to Section 1.7 for information on photomicroscopy.

Scanning electron microscope photographs

Photographs using the scanning electron microscope (SEM) enable fine details of the surface of structures to be observed at much higher magnifications and at greater depth of focus than is possible with the light microscope (see Chapter 4). Air-dried specimens can be revived for SEM, but fresh

material fixed in buffered glutaraldehyde may give better results with delicate structures. Spores of ectomycorrhizal fungi are particularly suitable candidates for SEM (see Fig. 2.14, and Pegler & Young 1971), although other structures such as cystidia and clamp connections can be observed. More information on SEM procedures is provided in Chapter 4. Three methods of handling fungal spores for SEM are listed below.

1. Use a portion of a spore print on paper. Put paper through whole dehydration series and then stick it to SEM stub after critical point drying either with 2-sided tape, silver paint or nail varnish.
2. Use gill material. Put gill through whole series then after critical point drying, scrape spore 'dust' onto round coverslip, mounted on stub with silver paint.
3. Use a gelatine-based film — moisten with water, scrape on spores. Mount onto stub with silver paint after critical point drying.

F. Compiling detailed descriptions of fungi

Publishing taxonomic data on ectomycorrhizal fungi

A number of written and unwritten rules apply when publishing taxonomic data on named or new taxa. Specifically, the latest rules of the International Code of Botanical Nomenclature (ICBN) must be adhered to for valid publication. The Code covers rules such as the necessity of providing a Latin description, nominating a type specimens (the nomenclatural type on which the name is based), synonymy and priority rules. Priority principles and synonyms are particularly important.

Priority principles and synonyms — in cases where two or more different names have been independently given to the same taxon, the oldest name available must be used. All of the more recent names become synonyms. Names given to fungi before a certain date are invalid and it is not necessary to consider any names published before the nominated dates, as follows: for some fungi including Gasteromycetes the starting point is taken as 31 December 1801 — *Synopsis Methodica Fungorum* by Persoon. For other fungi including Hymenomycetes and Ascomycetes the starting point is taken as 1 January 1821 — *Systema Mycologicum* Volume 1, by Fries.

Publishing descriptive data about named species

In taxonomic works it is necessary to provide a list of synonyms for the species, i.e. mostly invalid names incorrectly applied to a species after it had already been validly published as a legitimate name initially, and their place and date of publication, i.e. indicate whether the synonym was based on the same specimen as the initial name was applied to (indicate by ≡), i.e. a nomenclatural synonym, or based on another specimen (=), i.e. a taxonomic synonym.

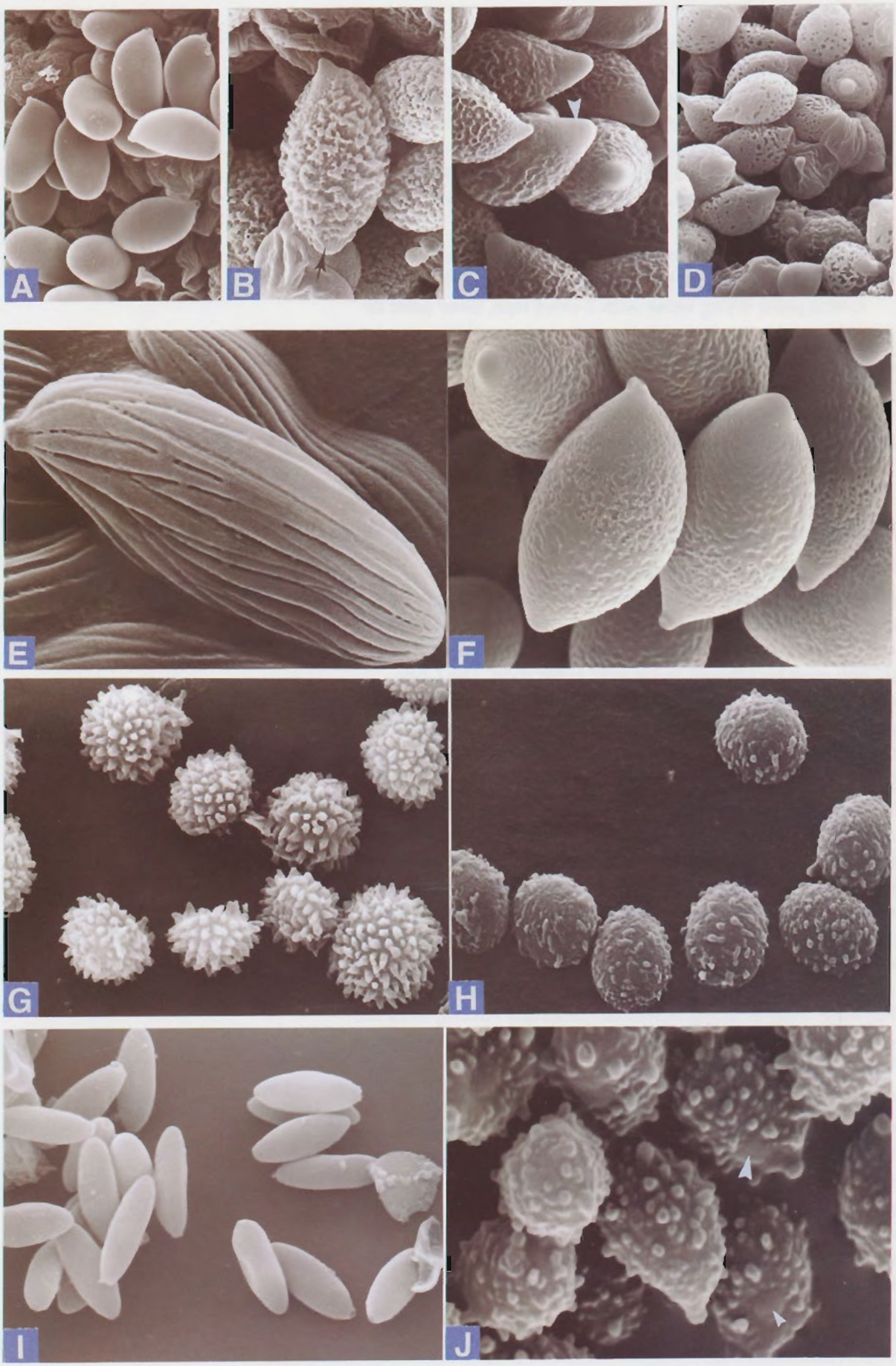

A
B
C
D
E
F
G
H
I
J

Figure 2.14. Scanning electron microscope photographs of fungus spores.

A. Pholiotina aporos — *smooth, ellipsoid.*

B. Descolea majestatica — *coarsely verrucose, ellipsoid, with roughened callus at apex (arrow).*

C. Descolea recedens — *verrucose, amygdaliform, with smooth attenuated apex (arrow).*

D. Descolea flavoannulata — *verrucose with perisporium partially covering surface, ellipsoid.*

E. Boletellus obscurecoccineus — *longitudinally ridged, fusoid-cylindrical.*

F. Descolea maculata — *finely verrucose, amygdaliform.*

G. Pisolithus tinctorius — *echinate, globose.*

H. Russula sp. — *warty-nodulose, broadly ovoid.*

I. Hysterangium sp. — *smooth, fusoid-oblong, with truncate base.*

J. Leucopaxillus lilacinus — *nodulose, ellipsoid-ovoid, with smooth suprahilar plage (arrows).*

Sample showing synonyms for a fungus

Scleroderma areolatum Ehrenb. (1818). *Sylv. Myc. Berol.*, p. 27.

= *Scleroderma lycoperdoides* Schw. (1882). *Schrift. Naturf.* Ges. Leip. 1, 61.

= *S. verrucosum* (Vaill.) Pers. subsp. *typicum* Sebek var. *violacens* Herink ex Sebek (1953). Sydowia 7, 176.

= *S. verrucosum* Pers., sensu Guzman (1967). *Ciencia* 25, 199.

After providing a description of your specimens (similar to the description provided below for a new species), it is useful to outline any differences between your specimens and previously published data on the species.

Publishing new species

Delimitation of a new species should not usually be based only on differences in a single character but at least several characters. Macroscopic characters such as fruit body colour and size can vary according to environmental conditions and are not always reliable for determining differences between species. It is therefore best to have several different collections from different locations before attempting to describe a new species. Also microscopic characters must be very distinct to separate species. For example, if one collection has larger spores than another, but there is some overlap in size, this difference does not define separate species unless other characters differ markedly between the collections.

In cases where specimens appear to be different to all named species, a thorough literature search must be conducted to obtain comparative taxonomic data of all potentially similar fungi. Furthermore, it is often desirable, if not essential, to obtain a loan of type or other authenticated material of named species from herbaria, in order to directly compare with specimens of the potentially new species. Another step in the process may be to consult a taxonomic mycologist who is familiar with the fungi being investigated.

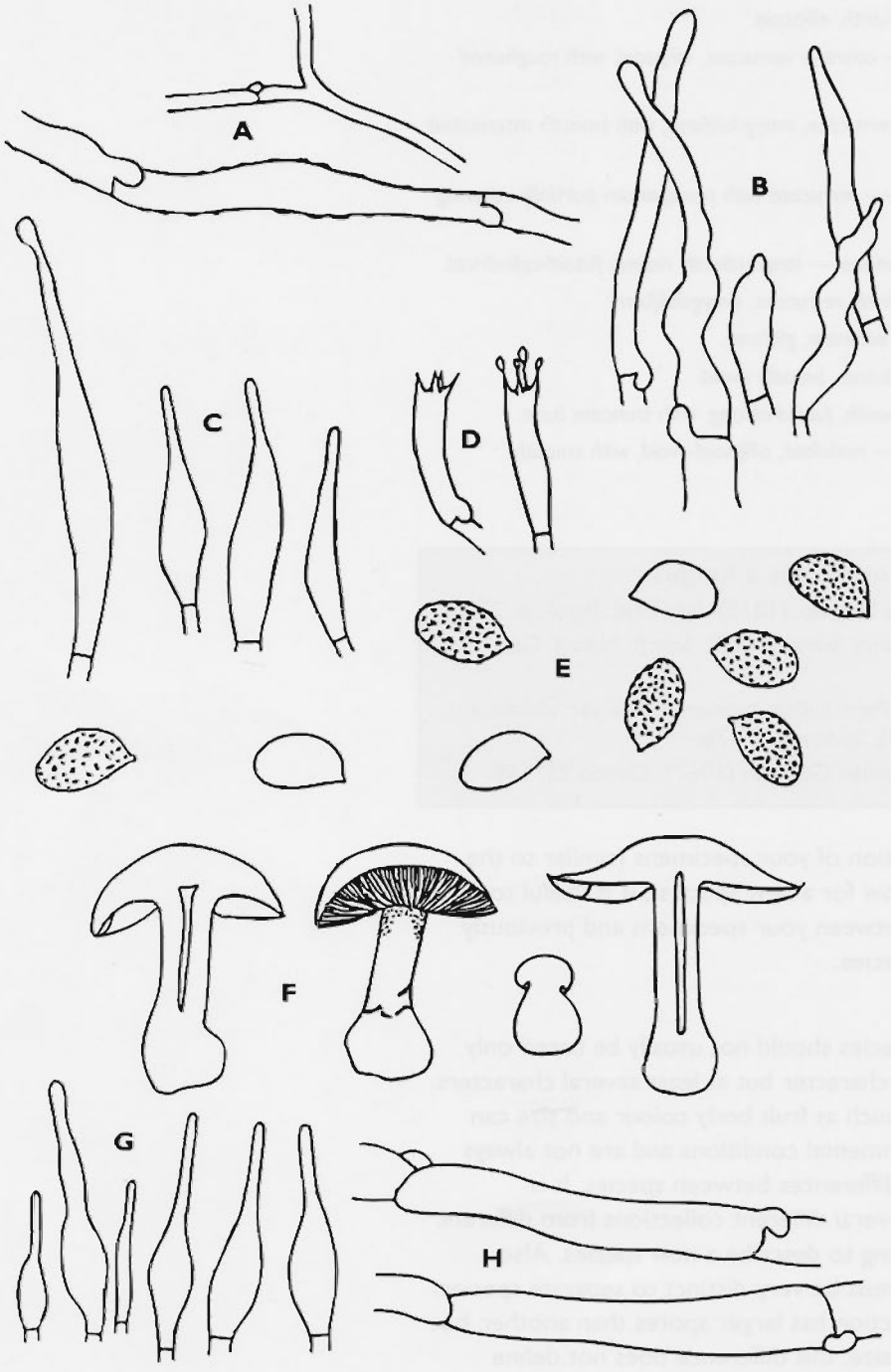


Figure 2.15. An example of line drawings of microscopic features of Hebeloma westraliense.

A. *Hyphae from the pileipellis.*

B. *Caulocystidia from the stem surface.*

C. *Cheilocystidia from the gill margins.*

D. *Basidia from the gill hymenium, showing four sterigmata.*

E. *Spores shown with and without ornamentation in face and profile views.*

F. *Young and mature fruit bodies of the species in side view and cross-section.*

G. *Pleurocystidia from the gill face.*

H. *Hyphae from the gill trama with clamp connections.*

If thorough literature searches and direct comparative investigations show that the specimens cannot be assigned to any described species, a new species may be proposed by valid publication preferably in an internationally circulated journal. The author should aim to convince the readers that the species being published is indeed newly discovered and unique. Generally, a comprehensive description with clear illustrations and logical evidence of the uniqueness of the proposed species is needed. For each proposed new species, the author needs to follow the following steps.

1. State the name of the new species and its genus (the binomial), and its author. Clearly state that the name is proposed as a new taxon.
2. Provide a description or diagnosis in Latin.
3. Compile a comprehensive macroscopic and microscopic description of all characters in English or the favoured language of the journal.
4. Provide illustrations of macroscopic and microscopic features, and a photograph of the fruit bodies where possible.
5. Clearly nominate a single collection to represent the holotype (nomenclatural type) of the species and give its herbarium location (and number) (isotypes may also be nominated). Collections must be lodged in recognised, safe herbaria (preferably those with an Index Herbariorum acronym).
6. Provide full details of collections examined.
7. Discuss the unique characters that define the new species.
8. Provide evidence that specimens (preferably type material) of closely related taxa have been examined, or, if not, that the differences are beyond doubt based on published data in the literature.

The following example of a published description of a new species of a mushroom-like ectomycorrhizal fungus is from Bougher et al. (1994). Line drawings and photographs of macroscopic and microscopic structures for each fungus were also provided in the publication.

Example of a published new species description

Rozites metallica Bougher, Fuhrer & Horak **sp. nov.**

Pileus ad 140 mm, primo convexus dein umbonato-applanatus, primo griseoazureus maturitate pallide griseus, zonis argillaceis vel cremeoluteis in umbone, glutinosus, radialiter rugulosus, squamulis albis evanescentibus reliquiis veli obtectus. Lamellae adnexae vel subdecurrentes, primo cremeae vel pallide virides, dein argillaceae, acie concolori subfimbriata. Stipes ad 150 x ad 15 mm, cylindricus, subclavatus vel apicem versus attenuatus, albus, siccus, minute squamulosus. Annulus membranaceus, albus, persistens. Odor saporque nulli. Caro subazurea ad apicem stipitis. Sporae 9.5–12 x 7.5–8.5 µm, amygdaliformes vel ellipsoideae, grosse verrucosae. Septa hypharum fibulata. Ad terram in sylvis nothofagineis, Australia (Tasmania), 22. v. 1993. Holotypus HO.

Etymology (derivation of species name)

Metallica refers to the distinctive bluish-grey colour of young basidiomes.

Pileus 40–140 mm broad, at first convex or broadly parabolic with plane, entire margin (sometimes with adhering velar remnants), slowly expanding via a campanulate stage to applanate at maturity with translucent striate, eroded margin; when young uniformly bluish grey (19E6), markedly hygrophanous, fading to pale grey (19D2) with tan or cream yellow central zone (near 4A4) and grey near pileus margin (19F3), brown tints eventually becoming more evident with age, surface smooth at first but radially wrinkled with age, strongly glutinous when wet and innately radially streaked as drying out, not bruising, context cream (a bluish tint sometimes evident in young specimens). *Lamellae* (L: 22–38, l: 44–64) 5–10 mm broad, adnexed with small decurrent tooth at first remaining adnexed at maturity, crowded then close, with abundant lamellulae (1 or 2 between each pair of lamellae), cream with slight greenish tinge at first (near 4A2), becoming pale tan (5B5 to 6C4) then darker tan (5D6) at maturity, edges concolorous, minutely fimbriate, not bruising. *Stipe* 50–150 x 7–15 mm, variable from cylindrical, slightly tapering towards apex, to having a swollen base up to 20 mm broad, solid, white, dry, shiny and longitudinally appressed fibrillose, overlain by superficial (easily removed on handling), abundant white small squamules and hyphal bundles (recurved near stipe base), attaining watery brown stains upon handling/bruising, context cream (bluish at apex in youngest specimens), basal mycelium white and may extend partially along the stipe base as an appressed covering. *Annulus* superior or central, membranous, smooth or faintly striate, flanging, white on surface and underside except where discoloured by spore deposit, persistent but sometimes fragmenting with age. *Universal veil* white, appressed, matted, fibrillose, squamules on the pileus, conspicuous at first but evanescent.

Macrochemical test 15% KOH reddish purple on pileipellis, 10% $FeSO_4$ no reaction on pileipellis, pileus context, or stipe context. *Odour* mushroom. *Taste* mild. *Spore print* brown (6D7 to 6D8) when fresh drying also brown (near 6E6).

Basidiospores side view 9.5–12 (12.5) x (7) 7.5–8.5 µm (n = 30), mean 10.5 x 7.8 µm, mean L/B ratio 1.3. Face view (9) 9.5–12 x (7) 7.5–8.5 µm (n = 21), mean 10.4 x 7.8 µm, mean L/B ratio 1.3. Yellow brown in 3% KOH. Broadly amygdaliform to pip-shaped in side view, broad ellipsoid in face view, mucro absent, coarsely verrucose. *Basidia* 32–41 x 10–14 µm, clavate, hyaline, thin-walled, sterigmata to 5 µm in length, 4-spored, clamped at base. *Lamellae trama* parallel, hyphae to 5 µm broad, hyaline, smooth-walled, septa clamped. *Subhymenium* undifferentiated. *Sterile marginal cells* 15–30 x 4–10 µm, clavate to filiform, hyaline, smooth-walled, with 1 or multiple septa, infrequent along lamella edge, not emerging beyond hymenium. *Sterile facial cells* undifferentiated. *Caulocystidia* absent. *Pileipellis* inner pellis subcellular, thick-walled, cells up to 30 µm broad, with golden encrusted walls less than 1 µm broad. Outer pellis of hyaline, thin-walled, smooth, clamped, hyphae (5–15 µm broad), with walls intact, loosely entangled in a hyaline matrix. *Stipitopellis* not differentiated. *Stipe trama* longitudinally arranged hyaline, thin-walled, clamped, hyaline hyphae (3–9 µm broad). *Pileus trama* hyaline, thin-walled, clamped hyphae with constricted septa, some inflated to 30 µm broad. *Clamp connections* present on all septa.

Habit and Habitat

Among litter in *Nothofagus* forests in Tasmania and Victoria. Locally abundant, with large numbers of basidiomes occurring within small areas.

Specimens Examined

Tasmania, Mount Field National Park, near Lake Fenton in dense, entangled, low forest dominated by *Nothofagus gunnii*, 22 May 1993, coll. N. Bougher, B. Fuhrer & S. Bolsenbroek *s.n.* (holotype HO 307262, isotypes at ZT and CSIRO E4929). Tasmania, Cradle Mountain — Lake St Clair National Park, Hounslow Heath, Waldheim in forest with *Nothofagus gunnii*, 20 May 1993, coll. N. Bougher & B. Fuhrer *s.n.* (paratype CSIRO E4911, HO 307263). Victoria, Donna Buang Road near road to summit of Mt Donna Buang, around base of *Nothofagus cunninghamii*, 18 May 1985, coll. T. May & B. Fuhrer *B343* (MEL, CSIRO E5053).

Further Notes

R. metallica is readily recognised in the field by the bluish-grey colour and conspicuous white veil fragments of young, near mature, and sometimes mature basidiomes. Weather conditions during development largely determine how long the juvenile colours persist, and individual basidiomes within the same location may vary in the rate at which they transform to grey and brown tints with maturity. The macroscopic appearance and the coarsely ornamented, broad spores separate this species from all others in the genus.

G. Glossary of terminology

Amyloid(y) — blue reaction of spores, hyphae or other structures to Melzer's reagent.
Asci — sack or tube-like structures containing the developing ascospores of Ascomycetes (singular = ascus).
Ascospores — sexual spores of Ascomycetes, borne in asci.
Asymmetrical spore — a spore which is not bilaterally symmetrical, i.e. cannot be divided axially into mirror images.
Ballistospore — spore which is forcibly discharged from the basidium. The spores are usually asymmetrical.
Basidia — club-like structures bearing the developing basidiospores of Basidiomycetes (singular = basidium).
Basidiospores — sexual spores of Basidiomycetes, borne on basidia.
Calyptrate — spores partially enclosed by an outer spore wall in the form of loose sack.
Caulocystidia — cystidia on the stem of a mushroom-like fruit body.
Cellular hyphae — inflated and packed together to resemble plant parenchyma.
Clamp connection — swollen structure or loop located at the septa (cross-walls) of some Basidiomycetes hyphae, involved in allowing nuclei to migrate into new cells after mitotic division.
Cyanophilic — spore or hyphal wall staining dark blue in cotton blue.
Cystidia — sterile cells of distinct shape, colour and/or size in the hymenium or other locations (see also caulocystidia, pileocystidia).
Dextrinoidy — brown reaction of spores, hyphae or other structures to Melzer's reagent.
Endosporium — the innermost spore wall layer next to the cytoplasm.
Exosporium — the spore wall layer immediately below the perisporium. This layer often comprises the ornaments of rough-walled spores.
Germ pore — a zone of reduced wall thickness at the spore apex (opposite end to the hilar appendage).
Heterotrophic — a spore which is borne obliquely on the sterigma. This type of attachment facilitates spore discharge. The spores are asymmetrical.
Hilar appendage — a projection at the base of basidiospores where the spore was attached to the sterigma. Sometimes referred to as the hilar appendix or apiculus.
Hyaline — clear and uncoloured as seen under the microscope.
Hymenial trama — tissue composed of sterile hyphae which support and nourish the hymenium, e.g. located in between the hymenial layers of the gill in mushroom-like fungi.
Hymenium — an organised layer that supports and includes the fertile structures bearing ascospores or basidiospores.
Hypha — microscopic tube forming fungal mycelium and fruit bodies. Each hypha may be separated or not into cells by septa (plural = hyphae).
Melzer's reagent — iodine solution used to test amyloidy and dextrinoidy of spores and other structures.
Mycelium — aggregation of hyphae (see Section 1.3C).
Orthotropic — a spore which is borne centred on the sterigma. Discharge is not forcible. The spores are usually symmetrical.
Pellis — outer edge (skin) of fungal fruit bodies.
Peridium — outer edge (skin) of truffle-like fruit bodies.
Perisporium — outermost spore wall layer, often evanescent, but sometimes persisting in mature spores and inflating out to form a loose calyptrate or utriculate sack.
Pileipellis — outer edge of the pileus (cap cuticle) of mushroom-like fungi.
Pileocystidia — cystidia in the pileipellis of mushroom-like fungi.
Pileus — cap of mushroom-like fungi.
Septa — cross-walls delimiting cells that comprise hyphae.
Statismospore — spores which are not forcibly discharged from the basidium. These spores are usually axially symmetrical.
Sterigma — projections on basidia to which developing basidiospores are attached before separation. Most often 4 per basidia, but may be any number ranging from 1 to about 8.
Stipe — stem of mushroom-like fungi.
Stipitopellis — outer layer of the stipe.
Suprahilar plage — a depressed or flattened spot near the hilar appendage of spores often distinguished by the absence of ornaments.
Symmetrical spore — if a spore viewed in face, side, and end views can be divided into mirror images it is considered symmetrical.
Trama — sterile tissue of the gills, cap or stem of fruit bodies, e.g. the cap trama constitutes and supports the bulk of a mushroom-like fruit body.
Utriculate — spores entirely enclosed by an outer spore wall in the form of loose sack.
Veil — outer layers of tissue that protect developing fruit bodies of some Basidiomycetes.
Veil remnants — hyphae or cells overlying the pellis, particularly pileipellis, usually derived from the universal veil.

The main aims of a herbarium collection

1. *Safe maintenance of specimens into the long-term future with up-to-date nomenclature.*
2. *High level of associated descriptive and illustrative data associated with the specimens.*
3. *Accessibility of physical data (i.e. the specimens) and electronic data (i.e. database) for rapid and flexible retrieval.*

2.5. MANAGEMENT OF COLLECTIONS AS A GENETIC RESOURCE

Representatives of all fungi collected should be retained for future reference. If retained, collections of ectomycorrhizal fungi undertaken over a period of time can result in the accumulation of a valuable genetic resource. The amount of accumulated finance, time and effort put into collecting the fungi is invariably large, and if specimens were discarded the cost of undertaking the collection phase would be enormous, i.e. each specimen has a high monetary value. The cost of maintaining a herbarium as a perpetual reference source of data is in comparison small (Bridson & Forman 1992).

A. Herbaria

Taxonomy, which provides names data about identity, biology and relationships, is ultimately based on data derived from specimens. Herbaria are the perpetual source of specimen-based information. Modern day specimen-based information is of two main types — physical, i.e. the specimens available for direct examination, and electronic, i.e. database having recorded information about the specimens. Specimens are an indispensable component of herbaria. They are essential for continual checking, confirmation and revision of taxa and names applied in published taxonomic and non-taxonomic works. Inaccuracies in published descriptions and other studies based on named organisms can be revealed by direct examination of specimens. If specimens were not lodged in herbaria but instead discarded soon after collecting, taxonomy then would entirely depend on a literature or electronic-based system. This would be totally inadequate for future purposes, as even the most comprehensive written notes and published descriptions will not cover all future requirements. For example, characters that were not recognised or recorded before the specimens were discarded may in the future become critical to studies using more advanced or different analyses. The actual specimens will be required to clarify and interpret taxonomic information in the literature long into the future.

The herbarium should aim to function as a service to provide accurate and rapid specimen data and identifications for research such as mycorrhizal and biodiversity work. Additionally it can form the basis of taxonomic revisions of selected taxa of ectomycorrhizal fungi by direct examination of locally housed specimens and comparison with specimens housed in other herbaria throughout the world obtained by two-way exchange.

It is highly desirable for herbaria to accumulate large numbers of specimens. Type specimens are important as they are the material on which species names are based. However, taxonomic research cannot be carried out on Type specimens alone, as this would ignore the variation that occurs in species. To assess spatial and temporal variation, specimens of a species need to be obtained from many points throughout its geographic range, and

over a long time-scale. The need to maintain historical collections is exemplified by old collections made in areas that have since been modified in some way either by natural succession, or by urbanisation. The old specimens now represent and contain significant ecological and taxonomic data about what was in that location in the past before the change. Similarly taxa may have become locally or globally extinct since collection. In all cases data about the taxon can be retrieved from the herbarium. Historical collections enable the accumulation of long-term data of geographic distributions, seasonal occurrences, and evolutionary variation in taxa over time.

Physical structure of a herbarium

Herbaria range from totally dedicated purpose-built buildings to drawers or cupboards located in a general laboratory. Cabinets with drawers suitable for standard mycological herbarium packets may be custom-built, or normal cupboards may have to suffice, at least when beginning a new herbarium. The larger the number of collections, the greater the need for specialised housing for specimens as the level of required accessibility and value of the specimens increase. In all cases, an insect-free situation needs to be established and maintained. If fumigation is used to control insects (see discussion below), the building itself and the drawers or cupboards may need to be specially sealed. Timber construction should be avoided especially in the tropics as it encourages unwanted fungal growth and insects.

Arrangement of collections

Specimens may be arranged in various ways.

1. Alphabetical — not recommended, as names of taxa change, and the arrangement does not reflect relationships. However, it is an easy way for non-mycologists to find taxa and to lodge collections in the herbarium.
2. Chronologically in order of collection time — suitable for herbaria not primarily for systematic research but those used mainly for a multidisciplinary group of researchers to consult. Difficult to find taxa by name.
3. Taxonomically in order of taxonomic groups — the best arrangement for herbaria in which systematic research is being carried out, because the arrangement does reflect relationships and all similar fungi will be physically grouped together.

Type collections

Specimens of a new taxon which have been nominated by the author of the taxon as representing the new name constitute type material of that new taxon. The holotype is the principal type to which the name of a taxon is attached. An isotype is any duplicate specimen from the holotype collection and is usually lodged at a different herbarium to the holotype for safety reasons, e.g. if the holotype is lost or destroyed, an isotype becomes the lectotype (new holotype). Type material requires special protection and some herbaria house it separately from the main collection in

Fundamental requirements of a Herbarium

- Insect-free, low-humidity room (dedicated to herbarium-only use if possible).
- Drawers or cupboards for housing specimens.
- Packets for filing specimens.
- Labels for data on specimen packets.
- Freezer for controlling insects (see below) or method of fumigating.
- Facilities for air-drying specimens.
- Computer for database specimen data.

fire-proof conditions. If the safety of the herbarium is in doubt, e.g. unsafe old building, or uncertain funding to continue into the future, type material (at least the holotype) should be lodged in a larger herbarium. As a rule, herbaria without an Index Herbariorum acronym (see below) should not hold holotype collections.

Herbarium procedures

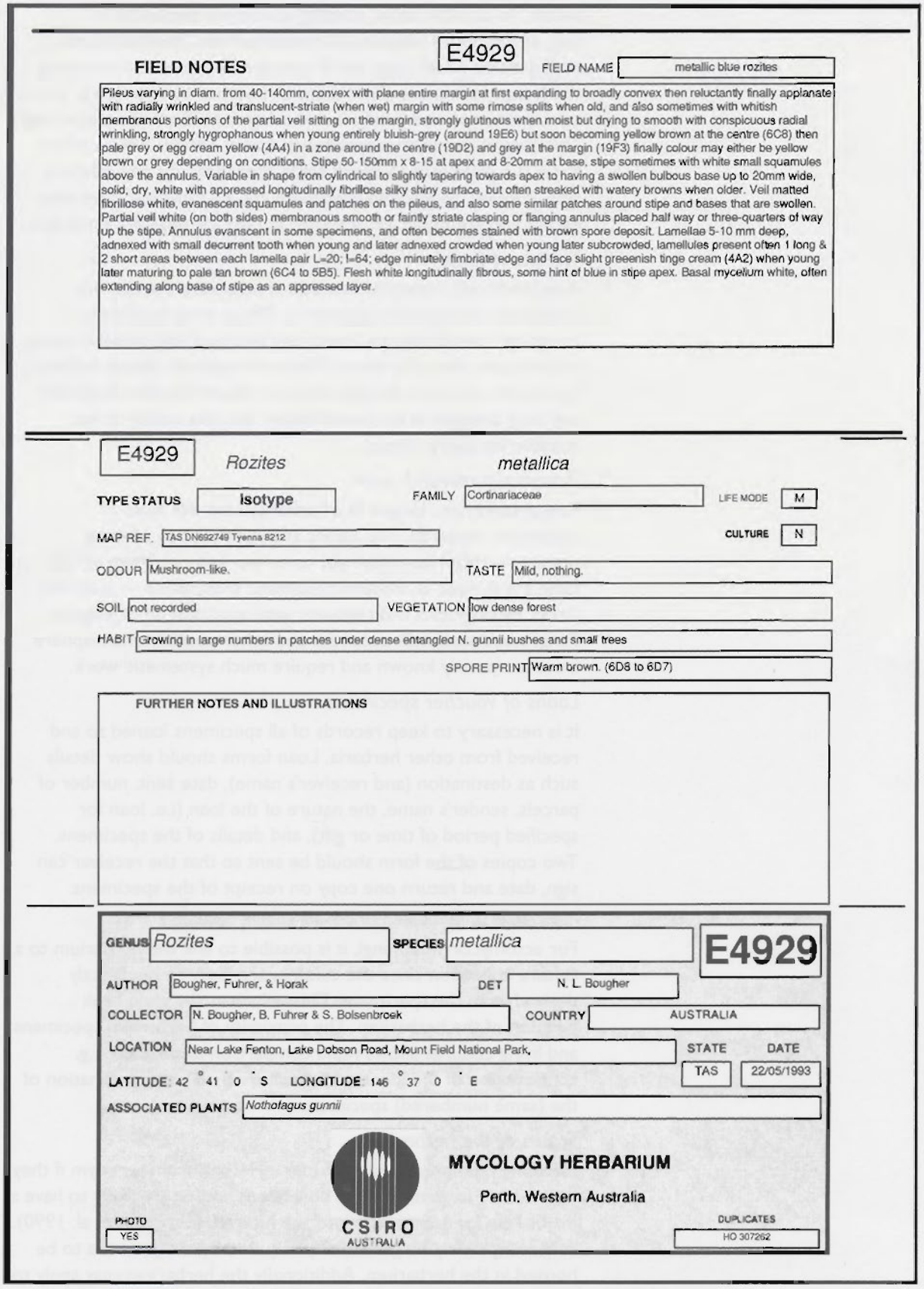
A herbarium requires funding for basic curation to maintain the quality of specimens without deterioration. Furthermore, the herbarium ideally should be curated by a trained mycologist who is familiar with the taxonomy of fungi and is actively carrying out systematic research. The curator should also provide services such as loans to other herbaria, facilities to visiting scientists and distributing duplicate specimens, and be able to identify fungi brought in by researchers and the public. Exchange of specimens with other herbaria may not be possible unless a high level of curation can be proved or guaranteed.

Processing and lodgment of collections from the field

1. Fresh specimens brought in from the field should have been processed as described above, in a location that is well separated from the herbarium. When that process is completed the dried specimens and associated data should be ready for further processing to allow their lodgment in the herbarium. A herbarium collection may consist of a single fruit body, but preferably at least several fruit bodies.
2. After removing any excess soil or dirt, specimens should placed in paper packets labelled with the accession number, taxa identity and some site details (Fig. 2.16). Labels may be written in ink by hand or generated by computer (see discussion of database, below). The packets may be constructed by folding A4-sized sheets of plain paper (Fig. 2.16). Acid-free paper is preferable but very expensive. Within the packets, air-dried specimens together with spore prints (where appropriate) and a tag with the accession number should be sealed in zip-lock type plastic bags. Alternatively, paper envelopes can be used, and must be used if fumigation is preferred to freezing as the method for insect control. For extra large collections, use boxes but also keep a sample in the normal packet with a note reading 'more specimens in box'.
3. Specimens and their packets need to be frozen or fumigated before lodgment in the herbarium to kill any potential insect pests (see discussion of insects, below).

Insect prevention

A regular routine for preventing insect damage to specimens must be undertaken. Methods used in herbaria include enclosure of insecticides such as naphthalene in the packets containing specimens, and/or periodic fumigation of the whole herbarium with chemicals such as methyl bromide. These methods are not well favoured now due to their detrimental effect on human



FIELD NOTES

E4929

FIELD NAME: metallic blue rozites

Pileus varying in diam. from 40-140mm, convex with plane entire margin at first expanding to broadly convex then reluctantly finally applanate with radially wrinkled and translucent-striate (when wet) margin with some rimose splits when old, and also sometimes with whitish membranous portions of the partial veil sitting on the margin, strongly glutinous when moist but drying to smooth with conspicuous radial wrinkling, strongly hygrophanous when young entirely bluish-grey (around 19E6) but soon becoming yellow brown at the centre (6C8) then pale grey or egg cream yellow (4A4) in a zone around the centre (19D2) and grey at the margin (19F3) finally colour may either be yellow brown or grey depending on conditions. Stipe 50-150mm x 8-15 at apex and 8-20mm at base, stipe sometimes with white small squamules above the annulus. Variable in shape from cylindrical to slightly tapering towards apex to having a swollen bulbous base up to 20mm wide, solid, dry, white with appressed longitudinally fibrillose silky shiny surface, but often streaked with watery browns when older. Veil matted fibrillose white, evanescent squamules and patches on the pileus, and also some similar patches around stipe and bases that are swollen. Partial veil white (on both sides) membranous smooth or faintly striate clasping or flanging annulus placed half way or three-quarters of way up the stipe. Annulus evanscent in some specimens, and often becomes stained with brown spore deposit. Lamellae 5-10 mm deep, adnexed with small decurrent tooth when young and later adnexed crowded when young later subcrowded, lamellules present often 1 long & 2 short areas between each lamella pair L=20; l=64; edge minutely fimbriate edge and face slight greeenish tinge cream (4A2) when young later maturing to pale tan brown (6C4 to 5B5). Flesh white longitudinally fibrous, some hint of blue in stipe apex. Basal mycelium white, often extending along base of stipe as an appressed layer.

E4929 *Rozites* *metallica*

TYPE STATUS: isotype

FAMILY: Cortinariaceae

LIFE MODE: M

CULTURE: N

MAP REF.: TAS DN692749 Tyenna 8212

ODOUR: Mushroom-like.

TASTE: Mild, nothing.

SOIL: not recorded

VEGETATION: low dense forest

HABIT: Growing in large numbers in patches under dense entangled N. gunnii bushes and small trees

SPORE PRINT: Warm brown. (6D8 to 6D7)

FURTHER NOTES AND ILLUSTRATIONS

GENUS: *Rozites* SPECIES: *metallica* **E4929**

AUTHOR: Bougher, Fuhrer, & Horak DET: N. L. Bougher

COLLECTOR: N. Bougher, B. Fuhrer & S. Bolsenbroek COUNTRY: AUSTRALIA

LOCATION: Near Lake Fenton, Lake Dobson Road, Mount Field National Park. STATE: TAS DATE: 22/05/1993

LATITUDE: 42 ° 41 ' 0 " S LONGITUDE: 146 ° 37 ' 0 " E

ASSOCIATED PLANTS: *Nothofagus gunnii*

CSIRO AUSTRALIA

MYCOLOGY HERBARIUM

Perth, Western Australia

PHOTO: YES

DUPLICATES: HO 307262

Figure 2.16. *Example of a herbarium packet and a front label suitable for ectomycorrhizal fungi. Note that the packet is made from an A4-size sheet and has been reduced in size in this figure.*