

Sequestrate fungi of New Zealand: *Elaphomyces* (Ascomycota, Eurotiales, Elaphomycetaceae)

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Four species of the sequestrate fungal genus *Elaphomyces* are reported from New Zealand: *Elaphomyces bollardii* sp. nov. associated with *Leptospermum* spp. and *Kunzea ericoides*, *E. luteicrustus* sp. nov. associated with *Nothofagus menziesii*, *E. putridus* sp. nov. associated with *Nothofagus* spp., and an unnamed species associated with *Nothofagus* spp.

Keywords: biodiversity; systematics; Eurotiales; Elaphomycetaceae; *Elaphomyces bollardii*; *Elaphomyces luteicrustus*; *Elaphomyces putridus*; New Zealand

Introduction

Sequestrate fungi comprise those macrofungal taxa in which the spores mature in a more or less enclosed sporocarp, with spores that are usually not forcibly discharged, and in which the sporocarp itself is usually indehiscent. Most taxa are hypogeous, producing their sporocarps beneath the soil surface, although some are emergent or epigeous. Sequestrate fungi occur within the Agaricomycotina, Glomeromycotina, Mucoromycotina and Pezizomycotina (including the truffles *sensu stricto*) (Castellano & Trappe 1990, 1992; Blackwell et al. 2006). As part of ongoing studies of sequestrate Pezizomycotina in New Zealand (Trappe 1979; Trappe et al. 1992) we have examined the genus *Elaphomyces*, in the Elaphomycetaceae.

Index Fungorum (2011) lists 98 *Elaphomyces* names of taxa ectomycorrhizal with a variety of vascular plant hosts. Castellano is currently re-evaluating all species of *Elaphomyces* and

we currently accept c. 55 species as valid and distinct. The genus is widespread across the northern hemisphere including Europe, Asia (Japan, China & Singapore) and North America, and the southern hemisphere including South America (Argentina and Guyana), Central America (Costa Rica and Mexico), Australia, New Zealand and Papua New Guinea. Castellano et al. (2011) recently described 13 new *Elaphomyces* species from Australia including reassignment of a few collections that had been attributed to *Elaphomyces* species names from Europe (Cooke 1892; Rodway 1918; Dodge 1929). Recent field-work focusing on sequestrate fungi reveals *Elaphomyces* is commonly encountered in New Zealand and Australia and has also been collected in Papua New Guinea (Castellano and Trappe, unpublished data). The New Zealand material comprises three new species of *Elaphomyces* and a putative fourth as yet undescribed *Elaphomyces* species.

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Molecular evidence places *Elaphomyces* in family Elaphomycetaceae, order Eurotiales (Lumbsch & Huhndorf 2007). Elaphomycetaceae as presently conceived contains two genera, *Elaphomyces* and *Pseudotulostoma* (Miller et al. 2001). Recent molecular analysis evidence indicates that *Pseudotulostoma* is nested with *Elaphomyces* and should probably be considered a synonym of *Elaphomyces* (Reynolds 2001).

Methods

Macroscopic descriptions refer to fresh material unless specified. Colour designations follow common usage or the ISCC-NBS Centroid Color Charts (Kelly & Judd 1965) for which the colour block number is given in parentheses. Specimens were examined in 3% KOH, Melzer’s reagent and cotton blue. Microscopic descriptions are based on 3% KOH mounts unless specified. Spore measurements are based on 20 spores from the holotype collection. Spore dimensions include ornamentation. Dried spores were mounted on pegs with double-sided tape and coated with gold for scanning electron microscopy (SEM) examination with an AmRay 3300 FE field emission scanning electron microscope. Herbaria are abbreviated according to Index Herbariorum (2011).

Unless indicated, descriptions refer to mature sporocarps with fully developed gleba. Sporocarps in which the inner layer of the peridium has collapsed against the carbonaceous outer layer are referred to as over-mature.

Taxonomy

Key to New Zealand species of *Elaphomyces*

1. Peridium splitting open (like a *Geastrum*), epicutis with yellow tones and leathery, spores (22 –) 24–28 (–29) µm broad, associated with *Nothofagus**Elaphomyces putridus*
 Peridium remaining closed, epicutis black and carbonaceous, spores ≤25 µm broad, associated with *Leptospermum* or *Nothofagus*2
2. Spores 22–25 µm broad, coarsely reticulate, associated with *Nothofagus**Elaphomyces* sp.
 (‘novae-zelandiae’)
 Spores ≤12.5 µm broad, verrucose, associated with *Leptospermum* or *Nothofagus*3
3. Crust mycelium orange, epicutis of polygonal warts when dry, spores (9 –) 10–12 µm broad, associated with *Leptospermum* *Elaphomyces bollardii*
 Crust mycelium brilliant yellow, epicutis smooth when dry, spores (10 –) 11–12.5 µm broad, associated with *Nothofagus*.....*Elaphomyces luteicrustus*

Elaphomyces Nees:Fr. *Syst. Mycol.* 3: 57 (1829)

TYPE SPECIES. *Elaphomyces granulatus* Fr. *Syst. Mycol.* 3: 58 (1829)

Ascomata globose to subglobose or irregular, (5 –) 10–30 (–40) mm broad, surface brown to dark blue or black, smooth or variously warty or bumpy, often enclosed in a crust of mycelia, ectomycorrhizae, debris and soil particles. Peridium (0.5 –) 2–4 (–5) mm thick, fleshy to leathery, sometimes carbonaceous; usually hard and brittle when dried except in one species. Gleba a single chamber, often hollow in youth but usually becoming filled with ascogenous and associated cottony hyphae, and finally with a more or less powdery slate blue, purple–brown, dark brown, grey–black or black spore mass, nearly hollow with glebal remnants adhering to the inner peridial surface in one species. Asci globose to subglobose, thin-walled or thick-walled, evanescent before spore maturity, non-amyloid, with 1–8 spores. Ascospores subglobose to globose, 8–65 µm broad including ornamentation, often hyaline in youth, at maturity olive, red–brown to dark brown or nearly black, ornamentation various, usually of spines or rods aggregated in various shapes (clumps, ridges, lines), sometimes slightly to coarsely verrucose or with a partial to full reticulum in surface view, non-amyloid and non-dextrinoid.

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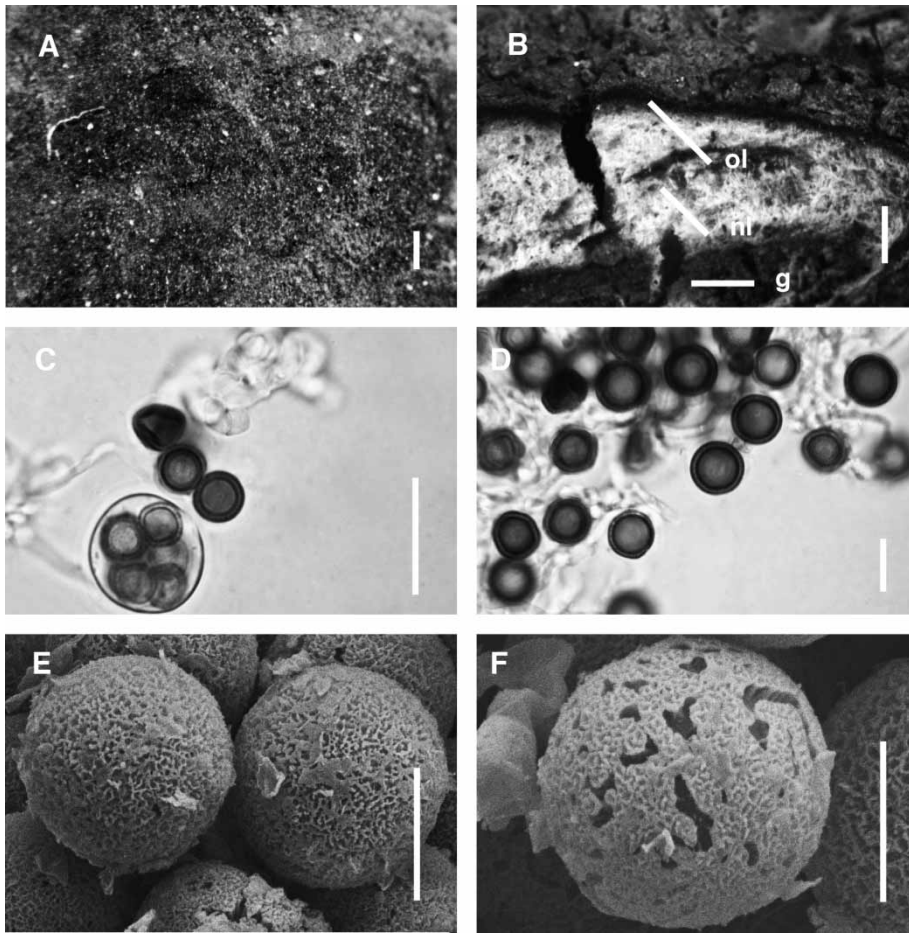


Figure 1 *Elaphomyces bollardii*, Beaver 175. A, Ascomata surface with adherent mycelium removed. B, Peridial cross-section, ol = outer peridial layer, il = inner peridial layer, g = gleba. C, Asci with 5 spores visible. D, Ascospores, photomicrograph cross-section showing edge detail. E, Electron micrograph of ascospores. F, Electron micrograph showing ornamentation detail on ascospores. Scales A = 300 μ m; B = 1 mm; C = 30 μ m; D = 12 μ m; E = 6 μ m; F = 6 μ m.

ETYMOLOGY. From Greek *elaph* (deer) and *myces* fungus, in reference to the observation of deer scraping the soil for *Elaphomyces* sporocarps.

Elaphomyces bollardii Beaver, Castellano & Trappe, sp. nov. Fig. 1A–1F

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Ascomata globose to subglobose, occasionally lobed, 7–22 mm broad. Peridial surface smooth and mottled with areas of tightly appressed

hyphae, very dark brown to mostly black; enclosed in a crust up to c. 10 mm thick of conspicuous vivid orange (#48) to vivid red (#34) hyphae intermingled with soil, debris and occasional roots, the hyphae drying grey–red–orange (#39) to strong red–orange (#35). Peridium 2-layered, 1.45–2.9 mm thick: peridial outer layer 150–200 μ m thick, carbonaceous, black or occasionally with dark brown patches; peridial inner layer 1.3–2.7 mm thick, uniform, white with occasional traces of strong red (#12) to strong purple–red (#255) abutting the gleba

and sporadically elsewhere especially when immature, soft with the texture of Styrofoam, reduced to a thin, yellow–white (#92), parchment-like layer when over-mature. Gleba powdery, dark grey (#266) to black (#267), with distinct off-white dissepiments arising from the inner layer and ramifying up to 0.5 mm into the powdery spore mass. Odour nil. Taste slightly nutty tending to peppery.

Crust hyphae 1.5–3 (–4) μm diam, thin-walled, loosely packed, sparingly branched, sparingly septate, pink–brown in KOH, red–brown and encrusted with particles in water. Peridial outer layer of very dark brown, compact hyphae, 2.5–5 μm broad, walls 1–1.5 μm thick, forming a *textura oblita*. Peridial inner layer composed of sparingly septate, hyaline hyphae, 2–5 μm broad, walls ± 0.5 mm thick, in densely packed bundles next to the epicutis forming a *textura porrecta*, near the gleba more loosely packed and anastomosing, irregularly inflated to 10 μm broad, and forming a *textura intricata*, septa not reacting with Melzer's reagent. Gleba with occasional, sparingly branched, sparingly septate, thin-walled hyphae, 1–3 μm broad, sometimes inflated to 15 μm broad. Asci (4 –) 8-spored, globose, evanescent, 20–30 μm broad, hyaline, with a short, hyaline, cone-like or cylindrical stalk 3–5 μm long by 4–5 μm broad, thin-walled; arising from thin-walled, pale green to hyaline ascogenous hyphae in knots, 4–5 μm broad. Ascospores globose, (9 –) 10–12 μm broad (mean = 11.1 μm) including ornamentation, with light microscopy ornamentation in spore surface view appearing finely punctate or verruculose; in cross-sectional view spore ornamentation appearing two layered, inner layer a palisade of pale brown, fine spines, 1–1.5 μm tall, outer layer a continuous, dark brown, thin (< 0.5 μm thick) tectum; SEM reveals the inner layer as a palisade of crowded, fine spines (< 0.25 μm broad), overlain by a distinct tectum which is mostly continuous but sometimes with irregularly circular to elongate pits 0.2–0.6 μm across, the surface of the tectum appearing as low, fine,

coral-like, labyrinthine ridges. Spore colour in KOH and Melzer's reagent green–grey in youth, golden brown when mature.

HOLOTYPE. AUCKLAND: Waitakere Ranges, Huia, Parau track, R.E. Beever 175, 28 Oct 1982 (PDD 43292, isotype OSC).

HABIT, HABITAT AND SEASON. Hypogeous up to 10 cm or more deep in mineral soil, rarely partially exposed, over-mature and perhaps years-old specimens sometimes emergent by erosion, gregarious in shrub-land and second-growth podocarp–broadleaf forest, putatively mycorrhizal with *Kunzea ericoides* (A. Rich.) Joy Thomps. or *Leptospermum scoparium* J.R. Forst. & G. Forst. Found August through November and also in January.

DISTRIBUTION. New Zealand, North Island.

ETYMOLOGY. For plant physiologist E.G. Bollard, scientific mentor to REB and supporter of mycology during his tenure as Director of Plant Diseases Division.

REMARKS. *Elaphomyces citrinus* Vittad. from Europe and *E. singaporensis* Corner & Hawker from Singapore differ in their yellow crust hyphae and larger spores (12–16 μm broad). *Elaphomyces viridiseptum* Trappe & Kimbr. from the southeastern USA differs by its green septal hyphae in Melzer's reagent and smaller spores (8–10 μm broad). See the discussion for *E. luteicrustus* for similar species from Australia. The two Australian species (*E. rugosiporus* Castellano, Trappe & Vernes and *E. symeae* Castellano, Trappe & Lebel) with orange to red mycelium enveloping the sporocarp have slightly larger spores and differ in spore ornamentation. The vivid orange or red crust of hyphae enclosing the ascoma differs from all known Asian *Elaphomyces* species.

One site contained c. 500 specimens spread across an area of 25 m² on a slope colonized by orange–yellow mycelium.

PARATYPES. AUCKLAND: Waitakere Ranges, Huia, Parau track, *R.E. Beever* 176, 20 Oct 1982 (PDD 43293, OSC); *R.E. Beever s.n.*, 17 Sep 1977 (PDD 37116, OSC); *R.E. Beever*, 25 Sep 1977 (PDD 37130); *R.E. Beever s.n.*, 19 Aug 1978 (PDD 38495) and *R.E. Beever & J.M. Trappe* 6988 (PDD 99963, OSC); Titirangi, *M. Hodgkins*, Nov 1931 (PDD 29705, OSC); *M. Hodgkins*, 1931 (PDD 29706, OSC); Little Huia, *P. Turner*, Nov 1987 (PDD 100534). Kaipara Harbour, Kaukapakapa Estuary Scientific Reserve, *R.E. Beever*, 22 Sep 1985 (PDD 88003). COROMANDEL: Little Barrier Island, *R.E. Beever* 37, 23 Jan 1980 (PDD 43287, OSC).

Elaphomyces luteicrustus Beever, Castellano & Trappe, sp. nov. Fig. 2A–2F

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Ascomata globose, subglobose to irregular, 11–17 mm broad; surface completely enclosed in a persistent husk of tightly adherent, intertwined ectomycorrhizae which gives rise to a thick (± 5 mm) layer of roots, brilliant yellow (#83) mycelium, soil and debris that forms a crust surrounding each ascoma. Peridial surface (after removal of ectomycorrhizal husk) black, with verrucae circular to polygonal or irregular in face view, mostly flat-topped or slightly rounded, 100–150 μm broad, ± 50 μm tall; crust hyphae drying yellow–white (#92). Peridium 2-layered, 1.5–2.5 mm thick: outer layer, thin, 40–100 μm thick, slightly wavy in section, black, carbonaceous; inner layer up to 3.4 mm thick, distinctly demarcated from outer layer, white to grey–white, soft, uniform in colour and texture. Gleba powdery, dark green–grey (#156) when fresh, drying grey–black (#266), with numerous pale grey dissepiments arising from inner peridial layer and extending into the powdery spore mass giving the sectioned gleba a stringy appearance. Odour nil. Taste not noted.

Crust hyphae walls 0.5–1.0 μm thick, septate, 3–5 μm broad, sometimes swollen in bulbous fashion on one side of the septa to 7 μm ,

sparingly branched, loosely packed, straight or sinuous; hyaline to pale yellow, smooth. Peridial outer layer of dark brown, isodiametric to elongate hyphae, 4–9 μm broad, walls ± 1 μm thick, forming a combination of *textura prismatica* and *textura angularis*. Peridial inner layer near the outer layer composed of compact, hyaline, mostly isodiametric hyphae, 5–7 μm broad, walls 1–2 μm thick, near the gleba less densely packed and up to 12 μm broad, forming a combination of *textura oblita* and *textura angularis*. Gleba with hyaline, sinuous, sparingly septate, thin-walled hyphae, 2–4 μm broad, occasionally swollen to 6 μm . Asci (7–) 8-spored, globose, collapsing as spores mature, 23–27 μm broad, hyaline at first then darker as spores mature, thin-walled, stalk indistinct, arising from knots of ascogenous, hyaline, contorted hyphae up to 4 μm broad, walls ± 1 μm thick. Ascospores globose, (9 –) 10–12 (–12.5) μm broad (mean = 11.2 μm), including ornamentation, with light microscopy ornamentation in spore surface view appearing coarsely warty; warts dark brown, subcircular to irregular in surface view, appearing somewhat rounded to irregular at the apex in side view, separated by narrow, pale brown, vermicular striae; in cross-sectional view spore ornamentation appearing as coarse, truncate rods, 1–2 μm tall; SEM reveals these warts or rods to be bundles of few to many individual spines fused together from their base to c. $\frac{3}{4}$ their length, spine apices digitate, the spines mostly flaring away from each other at the tip to form a corona, the bundles irregularly shaped from nearly circular to elongated ridges; in KOH and Melzer's reagent spores pale olive–grey to brown.

HOLOTYPE. TAUPO, Kaimanawa Forest Park, Kiko Rd, Ngapuketuru Track, 7 May 1987, *R.E. Beever* 707 (PDD 56293, isotype OSC).

HABIT, HABITAT AND SEASON: Hypogeous, gregarious in duff under *Nothofagus menziesii* (Hook. f.) Oerst.; May.

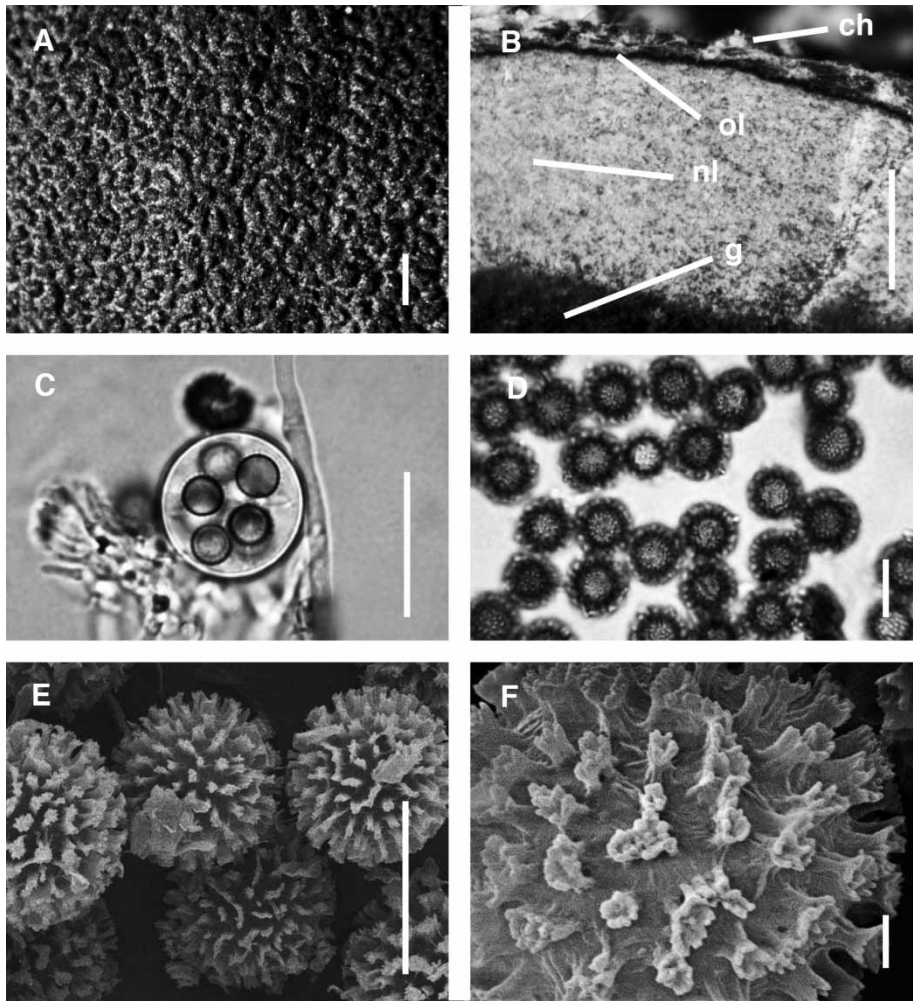


Figure 2 *Elaphomyces luteicrustus*, Beever 707. A, Ascomata surface with adherent mycelium removed. B, Peridial cross-section, ch = crust hyphae, ol = outer peridial layer, nl = inner peridial layer, g = gleba. C, Asci with 5 spores visible. D, Ascospores, photomicrograph showing surface and edge detail. E, Electron micrograph of ascospores. F, Electron micrograph showing ornamentation detail on ascospores. Scales A = 300 μm ; B = 1 mm; C = 25 μm ; D, E = 11 μm ; F = 2 μm .

DISTRIBUTION. New Zealand, North Island, known only from the type locality.

ETYMOLOGY. From Latin *luteus*, bright yellow, and *crustus*, crust, in reference to the colour of the crust mycelium.

REMARKS. This species resembles *E. bollardii* also from New Zealand, but differs in the colour

of the crust hyphae, the appearance of the spore ornamentation in cross-section, and the host association. It somewhat resembles *E. citrimus* and *E. singaporensis* from the northern hemisphere but they differ in their larger spores (12–16 μm broad). It also resembles *E. viridisepalum* but the latter has green septal hyphae in Melzer's reagent and smaller spores (8–10 μm broad). It also resembles the Australian *E. aurantius* Castellano,

Trappe & Vernes, *E. cooloolanus* Castellano, Trappe & Vernes, *E. pedicellaris* Castellano, Trappe & Vernes, *E. rugosiporus* and *E. symeae* either in spore size or colour of the mycelium enclosing the sporocarp. Both *E. aurantius* and *E. pedicellaris* may have yellow encrusting mycelium surrounding the sporocarp but the spores of *E. aurantius* are larger (14–16 μm broad, mean = 15.0 μm) and the spore ornamentation coarser, while the distinctive pedicellate spore ornamentation of *E. pedicellaris* easily separates it from *E. luteicrustus*. *Elaphomyces cooloolanus*, *E. rugosiporus* and *E. symeae* have similar-sized spores but they all have differently coloured mycelium (orange to red in *E. rugosiporus* and *E. symeae* and white to tan for *E. cooloolanus*) than the yellow that surrounds *E. luteicrustus* sporocarps; the spore ornamentation differs significantly between the four species. The brilliant yellow crust of hyphae enclosing the ascoma differs from all known Asian *Elaphomyces* species.

***Elaphomyces* sp. 'novae-zelandiae'** Fig. 3A–3F

Only over-mature, disintegrating sporocarps have so far been found for this species, which can be readily distinguished by spore characters from the other New Zealand taxa. Because the description lacks many details we do not formally name it. The informal name 'novae-zelandiae' reflects its distribution in both the North and South Islands.

Ascomata globose to subglobose, occasionally pyriform, 5–18 mm broad; traces of red–brown to brown mycelium present on peridial surface. Peridial surface black, smooth, sometimes eroded to appear finely warty, in cross-section 0.1–0.2 mm thick, 2-layered: Peridial outer layer black, carbonaceous, up to 0.2 mm broad. Peridial inner layer brown, adhering in fragments to the outer layer and gleba. Gleba powdery, dark brown–black (#65), flecked with off-white hyphae, sometimes detached and lying loose in the outer layer of the peridium. Odour not recorded. Taste not recorded.

Crust hyphae not observed. Peridial outer layer not easily discernable. Inner layer not observed. Glebal hyphae thin-walled, 2–3 μm broad, septate. Asci not observed. Ascospores globose, (18.5 –) 20–24 (–25) μm broad (mean = 22.0 μm) including ornamentation, with light microscopy the spore surface view appearing as a complete alveolate reticulum, the reticular walls dark brown, ± 1.0 μm thick, the spore surface within the walls pale brown, 1–4 μm broad; in cross-sectional view the spore ornamentation falsely appearing as dark brown, coarse, truncate warts, 2–3 μm tall; SEM reveals the ornamentation to be a complete alveolate reticulum as observed with light microscopy in the spore surface view, the alveolae 4–5-sided and 2–5 μm broad, the alveolar walls 1–4 μm tall and <1.0 μm broad with somewhat digitate margins; spores dark olive–brown to black in KOH, golden brown in Melzer's reagent.

HABIT, HABITAT AND SEASON. Hypogeous amongst roots and litter in *Nothofagus* forests, over-mature sporocarps sometimes exposed by erosion, putatively mycorrhizal with *Nothofagus menziesii*, *N. fusca* (Hook. f.) Oerst. and *N. solandri* (Hook. f.) Oerst.; April, May and October.

DISTRIBUTION. New Zealand, North Island and South Island.

REMARKS. This *Elaphomyces* species differs from the others of New Zealand and Asia in its conspicuously reticulated spores. This feature is shared with only a few other species in the genus, and they only occur in the northern hemisphere. *Elaphomyces personii* Vittad. differs in its coarsely verrucose peridium and conspicuous basal tuft of yellow mycelium; *E. cyanosporus* Tul. & C. Tul. in its papillate peridium and basal tuft of white mycelium; and *E. reticulosporus* B.C. Zhang in it smaller (17–22 μm) spores (Zhang & Minter 1989). No species described before now from the Southern Hemisphere have a distinct, coarse reticulum.

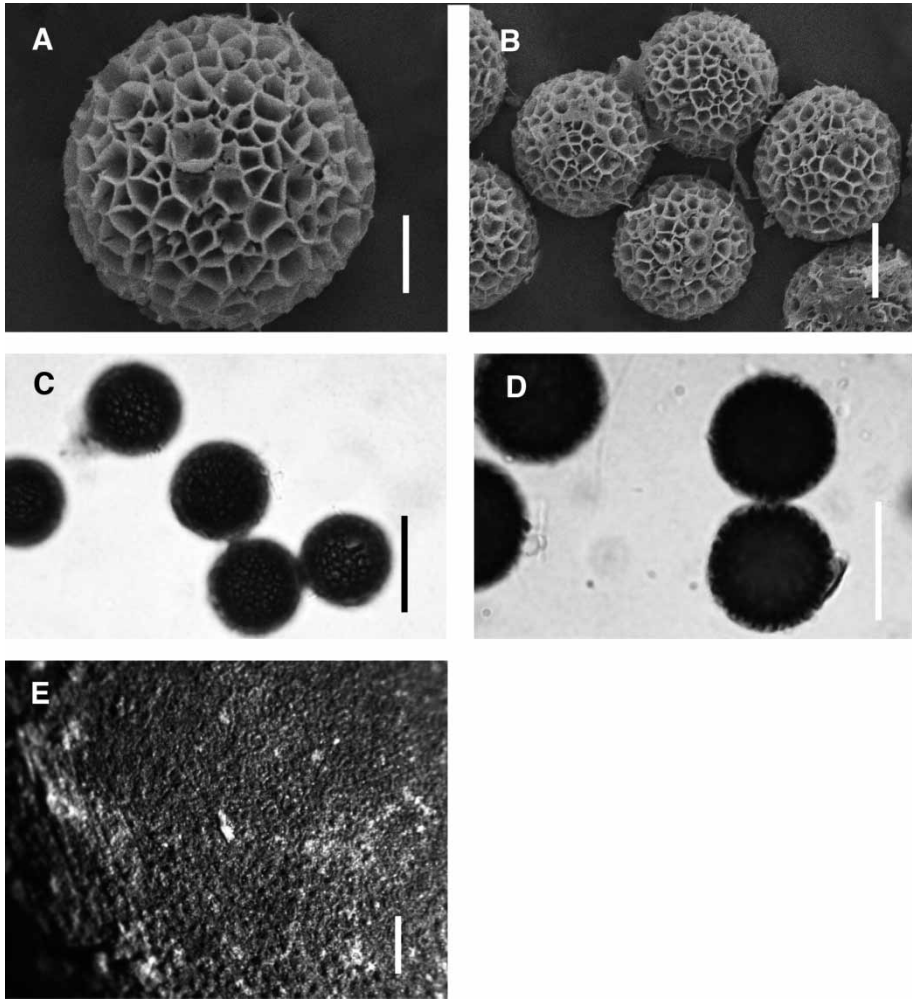


Figure 3 *Elaphomyces* sp. 'novae-zelandiae', Beaver 169. A, Electron micrograph showing ornamentation detail on ascospores. B, Electron micrograph of ascospore. C, Ascospores, photomicrograph showing surface detail. D, Ascospores, photomicrograph cross-section showing edge detail. E, Ascomata surface with adherent mycelium removed. Scales A = 5 μm ; B = 10 μm ; C, D = 22 μm ; E = 300 μm .

COLLECTIONS EXAMINED. TAUPO: Kaimanawa Forest Park: Clements Rd., *R.E. Beaver 169*, 2 Oct 1982 (PDD 43291); Kiko Rd, Ngapuketuru track, *R.E. Beaver 710*, 7 May 1987 (PDD 56295). BULLER: Murchison, Warbeck Scenic Reserve, Maruia Saddle, *R.E. Beaver 112*, 16 April 1983 (PDD 56294). FIORDLAND: Fiordland National Park, Waiiau River, Rainbow Reach, Kepler track, *R.E. Beaver 1007*, 18 May 1990 (PDD 57838).

Elaphomyces putridus Beaver, Castellano & Trappe, sp. nov. Fig. 4A–4D
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Ascomata globose to depressed globose, 12–22 mm broad, apex usually slightly indented, and indistinctly radially furrowed, the peridium breaking at maturity along the furrows and reflexed to form more or less 5 irregular rays and expose the spore mass; surface glabrous to

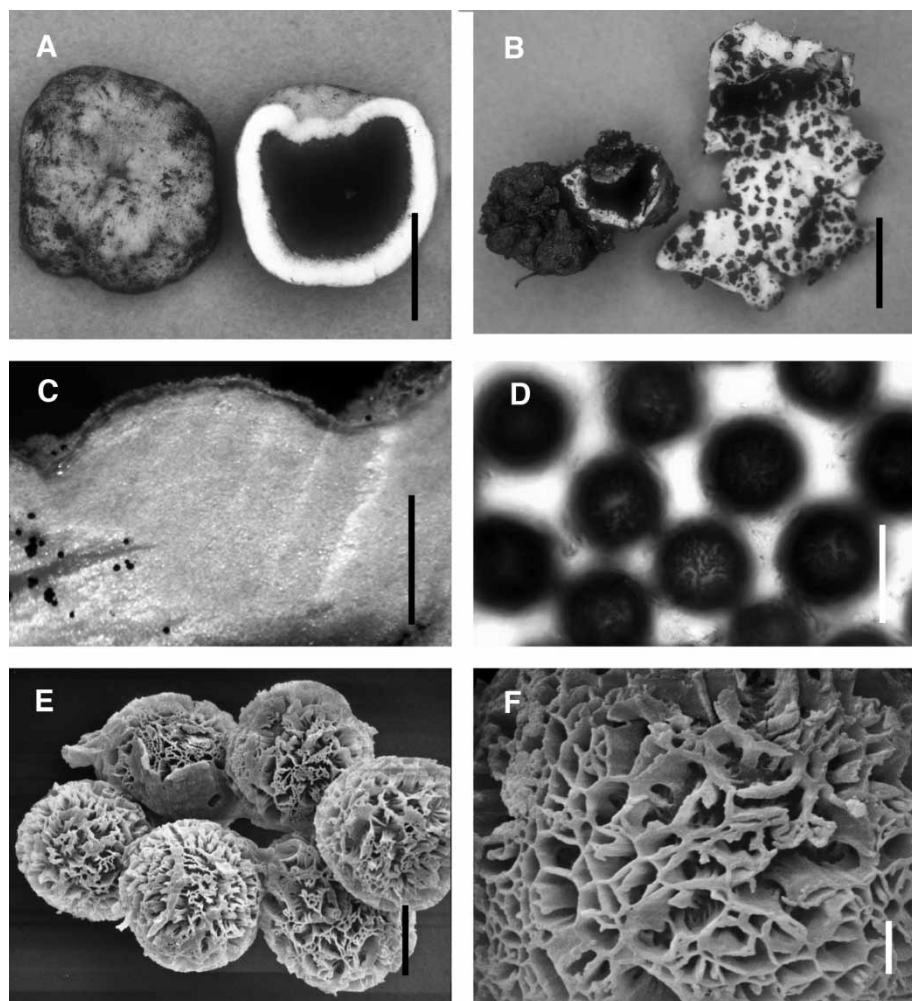


Figure 4 *Elaphomyces putridus*, Trappe 12572. A, Ascomata showing surface and in cross-section. B, Ascomata showing dehiscence with patches of glebal tissue adhering to inner peridial layer. C, Peridial cross-section. D, Ascospores, photomicrograph showing surface detail. E, Electron micrograph of ascospores. F, Electron micrograph showing ornamentation detail on ascospores. Scales A = 12 mm; B = 18 mm; C = 700 μm ; D = 25 μm ; E = 12 μm ; F = 2 μm .

minutely scurfy, the scruffiness due to low ($\pm 50 \mu\text{m}$ tall), wide ($\pm 100 \mu\text{m}$ broad), evanescent bumps, pale grey–yellow to pale yellow–brown; associated with cream-coloured ectomycorrhizae and yellow mycelium but lacking a well-developed crust. ETOH, FeSO_4 , KOH negative on surface and spore mass. Peridium 2-layered, 2–3 mm thick (1–1.3 mm thick when dried); peridial outer layer thin, concolorous with surface; peridial inner layer white, crisp, its inner

surface coarsely verrucose with irregular warts with dark brown apices. Gleba initially hollow, becoming more or less packed with clumped, aggregated to slightly powdery black spore mass. Taste mild. Odour initially faint, smelling of rotting carrion when sporocarp opens.

Associated hyphae 3–5 μm diam, sparingly branched and septate, thin-walled, pale yellow. Peridial outer layer 90–110 μm , of thin-walled ($\pm 0.5 \mu\text{m}$), elongate ($25\text{--}60 \times 7\text{--}25 \mu\text{m}$) to

isodiametric (10–18 µm) cells, hyaline to pale yellow near surface, forming a *textura angularis* to *textura prismatica*. Peridial inner layer 2–3 mm, of thin-walled (± 0.5 µm), elongate cells, 50–90 × 8–15 µm, septa 3–10 µm broad, forming a *textura intricata*, except the warts lining the glebal cavity which comprise isodiametric cells, 9–18 µm broad, forming a *textura angularis* to *globosa*. Glebal spore mass with occasional hyaline, sparingly branched hyphae, 1.5–2 µm broad. Asci with (4 –) 8 spores, hyaline, globose, 35–50 µm broad, becoming irregular as spores mature, with a small, hyaline stalk, evanescent. Ascospores globose (22 –) 24–28 (–30) µm (mean = 25.8 µm) including ornamentation; walls 2–3 µm broad, with light microscopy ornamentation in spore surface view appearing vermiculate, with irregularly shaped ridges and clumps; in cross-sectional view of the spore the ornamentation appearing as a palisade of fine spines 1.5–3.5 µm tall, not uniformly spaced, outline of spore commonly flattened in places; SEM reveals an ornamentation of spines fused together in short ridges or small bundles to form a subreticulum or irregular labyrinth of ridges and bundles, spines are often truncate. Spore colour grey–brown to black in KOH, brown to dark brown in Melzer's reagent.

HOLOTYPE. BULLER, Murchison, Warbeck Scenic Reserve, R.E. Beever & M.A. Castellano (Trappe 12572), 24 Sep 1992 (PDD 89289, isotype OSC).

HABIT, HABITAT AND SEASON. Hypogeous becoming emergent at maturity, in *Nothofagus* forests, putatively mycorrhizal with *Nothofagus fusca* and *N. menziesii*; September.

DISTRIBUTION. New Zealand, North Island.

ETYMOLOGY. From Latin *putrida*, rotting, in reference to the carrion-like smell of the mature ascoma.

REMARKS. *Elaphomyces putridus* differs from all other *Elaphomyces* species in the scanty development of the mycelial crust, the subepi-

geous habit of the ascomata at maturity, and by the splitting of the peridium from the apex into reflexed rays similarly to *Geastrum* spp. to raise the ascoma partly out of the ground. Both known collections were made during rainy weather, but we do not know whether such conditions are essential for dehiscence. We hypothesize that sporocarp dehiscence coupled with development of a carrion-like odour and aggregated rather than powdery spore mass at maturity are associated with dispersal by insects such as flies, but we did not observe insects near the sporocarps in the field.

The brown, scruffy peridium and spore size resemble *E. austrogranulatus* Castellano, Trappe & Vernes from Australia. The peridium of *E. austrogranulatus* is persistently closed and tougher (more leather-like) and its spores have an ornamentation of low amorphous warts that are easily distinguishable from the spores of *E. putridus*.

PARATYPE. BULLER: Murchison, Matakitaiki Bridge Scenic Reserve, M.A. Castellano & R.E. Beever (Trappe 12566), 23 Sept 1992 (PDD 89288, OSC).

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