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Studies of Wood-rotting Fungi. II. Basidiomycetes from the Wood-preservative Field Exposure Test Plot at Kruisfontein

by

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Abstract

In a survey of the fungi associated with decays of treated and untreated wood specimens partly interred in a wood-preservative field exposure test plot, 13 species of Basidiomycetes were identified from 120 test specimens. Basidiomycete mycelia isolated from a further 51 specimens could not be identified due to the absence of fruit-bodies or lack of matching descriptions of cultural characters. A further 179 did not yield Basidiomycete mycelia when cultured. *Paxillus panuoides* and *Stereum hirsutum* were the most common species. Species of lower Hymenomycetes were more frequently isolated than polypores.

The named species of fungi and unnamed mycelia are listed together with their hosts. Seven species, viz. *Neamatoloma fasciculare*, *Odontia bicolor*, *Paxillus panuoides*, *Peniophora aspera*, *Peniophora cinerea*, *Peniophora tenuis* and *Polyporus gilvus* are described in pure culture.

Introduction

A plot for testing the efficacy of wood-preservatives against decay in the field was established at Kruisfontein Plantation near Knysna, Cape Province, by the Department of Forestry in 1946 as one of three field exposure test plots. Two others, one at Pienaarsrivier, Transvaal and one in Durban Harbour, Natal, were established for field exposure tests of wood-preservatives against termite attack and marine borers, respectively.

The test plot at Kruisfontein consists of a rectangular fenced-in area, half an acre (0,202 ha) in extent, situated on a slight rise with a northerly aspect and grey, gritty loam soil, cleared of all trees and woody shrubs (Fig. 1). The plot is divided into four quarters for experimental purposes and is laid out in exactly the same way as the plot at Pienaarsrivier which had already been described by Coaton (1946) and Krogh (1947).

The specimens for testing consist of treated billets of *Eucalyptus saligna* and *Pinus patula*, 45 cm long and 7–10 cm in diameter, saplings of *E. saligna* of the same length but about 3 cm in diameter, and 2,5 cm square stakes of *Pinus patula* wood. Eight specimens of each type of stake and billet are treated and interred in the erect position to a depth of about 25 cm so that a total of 32 specimens treated to a particular loading of each type of preservative are under test simultaneously, eight specimens in each quarter of the plot. In addition, billets of 50 x 5 x 2 cm of different species of untreated wood, with separate billets for heartwood and sapwood, are interred along the periphery of the plot to determine their natural durability. The layout of the experiment and treatments of the specimens have been described by Krogh (1947).

This study was undertaken to determine the species of fungi which are associated with decay of the specimens under test. It was furthermore attempted to determine whether particular species of fungi are constantly associated with decayed specimens which had been treated with any particular preservative. Any such association may indicate the possible value of that fungus as a test organism for use in laboratory tests of timber preservatives. Furthermore, the termite and marine borer fauna of the respective field exposure test plots had been surveyed (Coaton, 1946; Krogh, 1958) and it was thought desirable that a similar survey of the wood-decaying fungi of the plot at Kruisfontein should be carried out.

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This survey was limited to the Basidiomycetes only. It has been shown by other workers (Merrill & French, 1966; Käärik, 1967) that Hyphomycetes play an important role in the early colonization of untreated wood in the soil or in the detoxification of certain wood-preservatives (Lyr, 1962; Madhosing, 1961). These organisms are, however, replaced by Basidiomycetes which cause extensive white or brown rots (Henningson, 1967a & b; Merrill & French, 1966) whilst some Basidiomycetes have also been found among the early invaders of treated poles in contact with soil (Käärik, 1967). Because of the method used for collecting specimens for study, however, the Hyphomycetes and Ascomycetes associated with the decayed specimens had to be ignored for the purpose of this investigation.

In the present paper the species of Basidiomycetes that were identified, are listed together with the test specimens on which they occurred. Unidentified mycelia arranged in groups according to their cultural characters, are also listed together with the specimens on which they occurred. Named isolates which have not been reported in culture from South Africa before, are described and illustrated whilst the occurrence and importance of other named species, previously described in culture from South Africa, are discussed.

Methods and Materials

The specimens under test were examined periodically as described by Krogh (1947), usually in late autumn. All specimens were examined visually for the presence of fruit-bodies of decay fungi which would allow their identification. The specimens were then removed from the soil and examined for signs of decay. Specimens of which more than 50% of the cross-sectional area was decayed, were regarded as failures and discarded. These discarded specimens were collected for the isolation of fungi.

The specimens were split lengthwise by means of a circular saw to expose the decayed areas. Small blocks of about 1 cm^3 were cut from the sound wood adjacent to the decay. These blocks were then split by means of a chisel and surface sterilized by dipping them briefly in 70% alcohol and flaming. After flaming they were placed on 1,5% Difco malt extract plates solidified with 1,5% Difco agar. These plates were incubated at 24° C and fungal mycelium appearing on the blocks or plates was transferred to fresh plates of the same medium for further growth.

When specimens could not be treated immediately upon receipt, large sections of the specimens were cut out and placed on damp sterile sand in damp chambers in order to keep the fungi alive for isolation later.

Fungi of which fruit-bodies were present on the specimens, were identified on the characters of the fruit-bodies. Cultures were made by transferring small pieces of tissue from freshly exposed, broken surfaces of the fruit-bodies by means of fine-pointed, sterile forceps to plates of 1,5% Difco malt extract agar. These cultures were used for comparison with other mycelia isolated from the specimens to determine their identity.

Fungi isolated in pure culture only were grown on 1,5% Difco malt extract agar in the dark at 24° C for six weeks and examined both macroscopically and microscopically at weekly intervals according to the methods described by Nobles (1948; 1965) and Van der Westhuizen (1958; 1971). Their characters in pure culture were compared with existing descriptions of species of which these characters are known in order to determine their identity.

The fungi were tested for the production of extra-cellular oxidase enzymes by growing them on 1,5% Difco malt agar to which had been added 0,5% tannic acid and 0,5% of gallic acid respectively as described by Van der Westhuizen (1958).

Mycelia which could not be identified from descriptions of known species, were inoculated onto a sawdust-maizemeal-malt extract mixture in order to induce fructification on blocks of *Pinus patula* wood according to a method described by Matters & Da Costa (1958).

Results

A total of 171 Basidiomycetes were found as fruit-bodies or isolated as mycelia in pure culture from the 350 specimens of decayed wood examined. Of these fungi, 120 were identified and named from fruit-bodies on the specimens or from their characters in pure culture. The named fungi as well as the specimens on which they were found and their frequence of occurrence, are listed in Table 1.

It was soon evident, that very few fruit-bodies were to be seen on the specimens during the annual inspections. Fruit-bodies of *Stereum hirsutum* were most abundant whilst fruit-bodies of *Peniophora cinerea*, *Peniophora setigera* and *Lenzites sepiaria* were occasionally seen. Most specimens, however, never showed fruit-bodies although many of them were found to be almost completely decayed.

In the course of this investigation it also became evident that no decay fungi were present in many of the decayed specimens despite repeated attempts to isolate them in culture. This was especially noticeable in the 25 mm square *Pinus patula* sticks. Many of these produced moulds only, when cultured, and *Trichoderma viride* proved to be a most important component of the mould flora. In specimens with a diffuse decay, this mould mostly grew out from the inoculum to the exclusion of all others.

From the results in Table 1, it is evident that *Odontia bicolor*, *Paxillus panuoides*, *Peniophora tenuis* and *Stereum hirsutum* are the species most frequently isolated from these specimens. *Neamatoloma fasciculare*, *Peniophora aspera*, *Peniophora cinerea*, *Lenzites sepiaria* and *Schizophyllum commune* were isolated less frequently. Among the named isolates, species of Thelephoraceae and Agaricaceae were thus most frequently isolated, rather than members of the Polyporaceae. Of these species, *Lenzites sepiaria* and *Paxillus panuoides* were isolated from softwood specimens only whilst *Neamatoloma fasciculare*, *Polyporus gilvus*, *Schizophyllum commune* and *Stereum hirsutum* were found on hardwoods only. The other species occurred on both hardwood and softwood specimens.

Most of the fungi were isolated from untreated specimens. This is to be expected since the lack of preservative treatment would allow their more rapid attack by fungi. But *Paxillus panuoides*, the most frequently isolated species, occurred very frequently on specimens which had been treated with preservatives. Since this species is known to be very sensitive to timber preservatives (Cartwright & Findlay, 1958) it's presence on the treated specimens indicate that the different preservatives had been rendered ineffective in the wood through leaching, detoxification or other similar causes during the period of duration of the test.

Besides the fungi listed in Table 1, 51 more fungi of which the cultural characters could not be matched with any existing descriptions, were isolated but their identity could not be determined. These isolates, together with their culture numbers and timber specimens on which they were found, are listed below in Table 2. The mycelia are arranged in groups according to their major cultural characters as arranged by Nobles (1958).

From the results presented in Table 2, it is clear that the majority of unidentified fungi isolated from the specimens, in culture form undifferentiated nodose-septate hyphae only. A larger number of these gave positive reactions when tested for extracellular oxidase, than gave negative reactions. Only four cultures were found in which fibre hyphae were present as well, whilst 8 cultures were found with nodose-septate hyphae with irregularly thickened walls. Most of the remaining cultures did not display any differentiated structures and few mycelia with swellings on the nodose-septate hyphae or other special structures were present. Only one culture with simple-septate advancing hyphae and clamped septa on the older hyphae, was found.

The majority of these unidentified mycelia were also isolated from specimens of untreated timber, either as untreated controls or specimens tested for natural durability.

These cultures all displayed characters which allowed their inclusion into the groups proposed by Nobles (1958). These characters however could not be matched with existing descriptions of known species so that their identity could not be determined.

Descriptions of Cultures

A number of decay fungi of which the cultural characters are not well known, were found in this investigation. Some of them are not known to be widely distributed in South Africa and the characters of the South African forms in culture have not been described before. For these reasons descriptions of their cultural characters are given below.

Naematoloma fasciculare (*Huds. ex Fr.*) *Karst.*

Growth characters (Fig. 4)

Growth is moderately fast, the colony reaching a radius of 36 mm in 2 weeks and covering the plate in 3 weeks. Advancing zone even, appressed for 1–2 mm, hyphae then raised. Mat thin woolly, with small plumules of radiating hyphae, somewhat farinaceous at the side of the dish. The plumulose areas develop into thin, felty, rhizomorphic strands which merge and diverge to form an irregular, elongated diamond-shaped pattern on the surface. The mat is white and remains so but specks of "hazel" "pinkish buff" and "cinnamon buff" appear on the surface under the mat after 2–3 weeks and gradually enlarge in size. The reverse bleaches slowly after about 2 weeks and a faint musty odour is given off. On gallic acid and tannic acid media, strong diffusion zones are formed and colonies of 16 mm and 22 mm in diameter resp. are formed after 7 days.

Hyphal characters.

Advancing hyphae: hyaline, more or less straight, branching, thin-walled, with deeply staining contents, septate, with simple clamps at the septa, often branching opposite the clamps, 2,0–4,0 μ in diameter (Fig. 5).

Aerial mycelium: (i) hyphae as in the advancing zone; (ii) hyphae as in the advancing zone but aggregated into rhizomorphic strands and often agglutinated by brown, resinlike material (Fig. 7); (iii) dendrophyses yellowish, thin-walled, curved, with short, lateral branches 4–6μ long, arising at right angles from the curved part, slightly widened and with deeply staining contents at first but later with dark-coloured, slightly thickened walls and brown contents, up to 100μ long (Fig. 6).

Submerged mycelium: hyphae as in the advancing zone.

Naematoloma fasciculare causes a white rot of hardwoods.

This fungus was described in culture by Zycha & Knopf (1966). The characteristics displayed by the South African isolates, agree very well with their description. The isolates in the present study were all very much alike displaying the strands or fibrils of hyphae which give the mat the appearance of "a wet pelt" (Zycha & Knopf, 1966). The brown, widened, curved hyphal structures with short, lateral projections (Fig. 6) designated as "dendrophyses" by Zycha & Knopf (1966), are very striking in microscopic mounts and together with the characteristic appearance of the mat, are useful diagnostic features for the recognition of cultures of this species.

N. fasciculare was isolated from hardwood specimens only on which it causes white rot. Its association with white rot agrees with its positive reaction for extracellular oxidase enzymes in culture as noted both here and by Zycha & Knopf (1966). Doidge (1950) recorded this fungus on *Pinus* stumps and other unspecified species of wood in the southernmost parts of the country and the present author found it also on *Eucalyptus* in the vicinity of the testing plot. It has been recorded on various conifers in Great Britain (Cartwright & Findlay, 1958) and is reported to be one of the commonest fungi participating in the decomposition of oak roots in the U.S.S.R. (Chastukhin & Nikolaevskaya, 1962).

Odontia bicolor (*Alb. & Schw. ex Fr.*) *Bres.*

Growth characters (Fig. 8)

Growth is moderately rapid to slow, the mat reaching a radius of up to 35 mm after one week and covering the plate in three to six weeks. Advancing zone even to slightly bayed, appressed for short distance then raised. Mat thin, white, appressed, downy to fine woolly at first and with a combed appearance, later developing thin, branching and anastomosing lines of more compact mycelium which radiate out from the inoculum. After 2–3 weeks indefinite, concentric zones of raised mycelium, 20–30 mm wide, which end abruptly on zones of mycelium more closely appressed to the agar, may develop in some isolates.

Reverse bleaching slowly, becoming milky white. No odour is emitted. On gallic acid medium a strong diffusion zone of up to 40 mm in diameter is formed without growth taking place. On tannic acid medium strong diffusion zones of up to 50 mm and colonies of up to 40 mm in diameter are formed.

Hyphal characters.

Advancing mycelium: hyphae hyaline, thin-walled with deeply staining contents, nodose-septate, branching often from the clamps, 2,0–5,0μ in diameter (Fig. 9).

Aerial mycelium: (i) hyphae as in the advancing mycelium, often aggregated into thin strands; (ii) cystidia numerous, each consisting of a short stalk up to 15μ long, arising as a lateral branch of a trailing hypha, terminally expanded into a subglobose vesicle 5–10μ in diameter, and surmounted by a cap of large jagged crystals, the cap 12–25μ in diameter (Fig. 10); (iii) oidia present in some isolates, 3–10 x 1,5–3μ.

Submerged mycelium: hyphae as in the advancing zone.

This fungus was isolated from 14 specimens of different species of hardwood, both treated and untreated with preservative, and one of softwood. On all specimens it caused a white, somewhat stringy rot.

In cultural characters, the South African isolates agree very well with the description of *Odontia bicolor* by Nobles (1953), and with two cultures of this species received from Dr. J. H. Ginns, Ottawa. The texture of the mat, positive reaction for extracellular oxidase enzymes, and the capitate cystidia with caps of large, angular crystals, allow the easy recognition of this fungus in culture.

Nobles (1953) reported that *O. bicolor* causes a decay of considerable importance in the heartwood of the butt and roots of a number of broad-leaved and coniferous trees. In a survey by the Canada Department of Agriculture (1952) *O. bicolor* was listed as one of the three important white rot fungi which caused 85% of the decay of *Abies lasiocarpa* in the Prince George Forest District. This importance was emphazised by the work of Smith (1963) who listed *O. bicolor* in association with root rot of *Abies* spp. Basham & Morawski (1964) listed *O. bicolor* as one of 23 species which cause 91% of decay losses of timber species in Ontario, but considered it to be of economic importance in balsam fir and spruce only. Duncan & Lombard (1965) listed *O. bicolor* as one of the species frequently isolated from gymnospermous wood in the United States. Harmsen (1967) described *O. bicolor* as one of the important fungi capable of attacking structural timber treated with preservative.

Few previous records of the occurrence of *O. bicolor* in South Africa exist. Doidge (1950) has no record of it but Talbot (1958) described two collections from South Africa. In view of the frequent occurrence of *O. bicolor* on the test specimens from Kruisfontein and the importance accorded to it in overseas reports, *O. bicolor* must be regarded as a much more important agent of decay of timber in contact with soil in South Africa than had been generally realized before.

Paxillus panuoides *Fries.*

Growth characters (Fig. 11)

Growth is slow to very slow, the mat reaching a radius of 30 mm after 3 weeks while the plates are seldom covered at 6 weeks. The margin is even to bayed with hyphae raised to the limit of growth. The mat is coarsely woolly, raised, consisting of

loosely intertwined rhizomorphic strands of mycelium radiating out from the inoculum. Mat at first forming a yellowish ball on the inoculum but then grows out over the agar as "light buff" to "cartridge buff" strands often with tinges of reddish purple or violet developing on the inoculum.

The reverse darkens, the dark zone extending well beyond the mat into the agar within one week after inoculation of the plates. No odour is emitted.

On gallic acid and tannic acid media dark diffusion zones are formed. Growth, up to 5 mm in one week on gallic acid, none or trace only on tannic acid.

Hyphal characters.

Advancing mycelium: hyphae hyaline, thin-walled, nodose-septate, branching sparingly opposite the clamp connections, 1,5–5,0μ in diameter (Fig. 12).

Aerial mycelium: hyphae as in the advancing zone, often aggregated into strands and with walls frequently yellow (Fig. 13, 14).

Submerged mycelium: hyphae as in advancing mycelium but often wider, up to 7μ in diameter and more frequently branched.

Paxillus panuoides was associated with brown rot in stakes of *Pinus patula*, some of which had been treated with wood preservatives.

Paxillus panuoides has been described in culture by Findlay (1932) and Siepmann & Zycha (1968). The South African isolates described here agree very well with these descriptions and with two cultures of this species obtained from Dr. Siepmann. The South African isolates were grown in culture with some difficulty as they preferred low incubation temperatures, 16–20° C, their growth being completely inhibited at 25° C while some growth still occurred at 10° C. This, together with the fact that this species requires an acid medium (Findlay, 1932) made isolation possible only after the species had been identified from a fruit-body which developed on a block of wood cut from a decayed test specimen and kept in a damp chamber. Cultures of this species may however be recognized quite readily by the woolly, dull yellow mat, with tinges of violet near the inoculum.

The brown rot caused by *P. panuoides* is not in agreement with the positive oxidase reaction shown by cultures of this fungus when grown on gallic acid and tannic acid media. The reaction is weak on both media and the darkening in colour of the media is possibly due to the brown pigment produced by the fungus diffusing into the medium.

Paxillus panuoides is well-known as a cause of brown rot of coniferous wood (Southam & Ehrlich, 1950; Cowling, 1957; Cartwright & Findlay, 1958; Duncan & Lombard, 1965). The difficulty with which this fungus is isolated in pure culture, also experienced by Siepmann & Zycha (1968), may have a negative influence on observations of its importance as the cause of decay. In the present study it was observed on 26 different test specimens but only five isolates were obtained in pure culture, an experience which supports the previous remarks.

Paxillus panuoides was found most frequently of all species, named and unnamed, on the test specimens. This in itself is surprising as Doidge (1950) lists only three records of its occurrence in South Africa, none of them from the Knysna district. Cartwright & Findlay (1958) state that this fungus is extremely sensitive to wood-preservatives. Its presence on the specimens that had been treated with preservatives indicates then that the concentration of these preservatives must have been reduced to extremely low values in the specimens before they were attacked by this fungus. Its frequent occurrence and constant association with extensive brown rot of these test specimens, are contrary to Henningson's (1967c) observation that fungi with temperature optima below 25° C have low decay ability.

Peniophora aspera (*Pers.*) *Sacc.*

Growth characters (Fig. 15)

Growth is slow, the colony reaching a radius of 10 mm after one week, but does not cover the plate after 6 weeks. Advancing zone even, mat thin, hyphae raised to limit of growth. Mat at first downy, hyaline-white, gradually becoming slightly more compact to thin woolly. After 3 weeks more compact, small patches of mycelium appear, scattered over the older parts of the mat and gradually developing into more compact lumps of mycelium.

The reverse remains unchanged and a faint mushroomy odour is given off. No growth occurs on gallic acid and tannic acid media but small, weak diffusion zones are formed after 7 days.

Hyphal characters.

Advancing mycelium: hyphae hyaline, simple or branching, nodose-septate with large clamps at the septa, thin-walled, with deeply staining contents, 2,5–4,5μ in diameter (Fig. 16).

Aerial mycelium: (i) hyphae as in the advancing zone; (ii) chlamydospores hyaline, thick-walled, globose or sub-globose, terminal 6,0–9,0μ in diameter.

Submerged mycelium: hyphae as in the advancing mycelium.

Peniophora aspera had apparently not been described in culture before and, despite its world-wide distribution, had not received much attention as a decay fungus. In culture it displays no character which might distinguish it from the many other species which form slow-growing, white mycelia lacking in distinguishing features. Not one of the cultures examined produced the characteristic septate cystidia which characterize fruit-bodies of this species (Slysh, 1960).

Isolation of this species from six specimens of treated and untreated wood, indicate that it may be of more importance as a decay organism or detoxicating agent of certain types of wood-preservative than had been suspected hitherto. This view is supported to some extent by the report by Bergman, Nilson & Jerkeman (1970) who found *P. aspera* as one of the white-rot fungi at test points in chip piles where temperatures had not exceeded 40° C. In these piles the effect of *P. aspera* was not very marked at the points of isolation. This was thought to be due to inhibition by *Trichoderma viride* because laboratory tests had shown *P. aspera* to be capable of causing high losses in dry mass of test blocks.

Peniophora cinerea (*Fries*) *Cooke.*

Growth characters (Fig. 17)

Growth is moderately rapid to rapid, the mat reaching a radius of up to 45 mm in one week and covering the plate in 2–3 weeks. Margin even with the hyphae raised to limit of growth. Mat woolly at first, white, with sectors of dense, more felty mycelium becoming gradually more dense with age and remaining so or developing irregular, scattered patches of dense, finely farinaceous mycelium over the surface and sides of dish, white at first and remaining so, or, becoming "warm buff" but soon changing to "sayal brown", later darkening to "warm sepia" or "bister". Mycelium on the sides of the dish form white, felty lumps which soon change colour to "warm buff" or "pale ochraceous salmon" and enlarge, coalesce and gradually darken to "russet", "warm sepia", "mars brown" or "bister", oozing droplets of dark, reddish-brown liquid.

The reverse is bleached at first but darkens later due to the diffusion of a brown pigment. No odour is given off. On gallic acid and tannic acid media, strong diffusion zones up to 85 mm in diameter and colonies of up to 80 mm in diameter are formed in one week.

Hyphal characters.

Advancing mycelium: hyphae hyaline, branching, thin-walled with deeply staining contents, nodose-septate, 2,0–4,5μ in diameter (Fig. 18).

Aerial mycelium: (i) hyphae as in the advancing mycelium; (ii) nodose-septate hyphae with brown, thickened walls, often with swellings and short, lateral projections and encased in drops of brown resin-like material which apparently bind them together in the dark brown aerial parts of the mat (Fig. 19).

Submerged mycelium: hyphae as in the advancing mycelium.

Cultures of *Peniophora cinerea* lack special structures which may be of value in establishing their identity. They lack the conical, thick-walled, heavily incrusted cystidia which are present in the carpophores of this species (Slysh, 1960). The brownish, nodose-septate hyphae embedded in droplets or sheaths of brown resin-like material in the brown-coloured, felty patches of the otherwise white, woolly-felty mat together with the rapid growth rate and strong positive reaction when tested for extra-cellular oxidase enzymes, may however serve to distinguish cultures of *P. cinerea* from those of otherwise similar species.

Peniophora cinerea is not well known from previous records of its occurrence in South Africa. Doidge (1950) lists only three collections. In the present investigation however it was recorded on ten specimens affected by white rot, which includes both treated and untreated hardwoods and softwoods. Very little is known about its importance as the cause of decay of wood however. It was not listed in the United States by Cowling (1957) and Duncan & Lombard (1965) but Nilsson (1965) found this species to be one of the important Basidiomycetes causing decay of birch chip piles in Sweden. Its relatively frequent occurrence on test specimens from Kruisfontein, may indicate that this fungus has more importance as a wood destroyer than had been generally realized.

Peniophora tenuis (*Pat.*) *Massee.*

Growth characters (Fig. 20)

Growth moderately slow to slow, the mat reaching a radius of 30–45 mm after 2 weeks and covering the plates in 4 to 6 weeks. Advancing zone even, thin, appressed with thin, sparse, radiating strands of hyphae. The mat is thin, downy at first and somewhat farinaceous, white, with thin, sigmoid strands of mycelium radiating from the inoculum towards the margin. The mat gradually thickens towards the inoculum where it becomes thick, felty. Minute droplets of clear liquid appear on the mat especially on the rhizomorphic strands. The mat gradually thickens with time.

The reverse is bleached but no odour is given off. On gallic and tannic acid media no growth or a trace of growth takes place but fairly strong diffusion zones of about 20 mm in diameter are formed on both media.

Hyphal characters.

Advancing mycelium: hyaline, branching thin-walled, nodose-septate, with simple clamps at the septa, 2,0–5,0μ in diameter (Fig. 25).

Aerial mycelium: (i) hyphae as in the advancing mycelium; (ii) cystidia hyaline, elongate-ovoid, to cylindrical (Fig. 22, 23); (iii) capitate cystidia globose 5–8μ in diameter, with deeply staining contents, pedicellate on clamped hyphae, lateral or terminal (Fig. 21); (iv) stephanocysts ovoid, hyaline, two-celled with deeply staining contents and with a row of minute spines along the median septum, 12–15 x 6–7μ, sessile on short lateral protuberances of clamped hyphae (Fig. 24).

Submerged mycelium: nodose-septate hyphae as in the advancing zone, often inflated to up to 8μ diameter.

Peniophora tenuis was isolated from 18 specimens of different species of hardwood and softwood, which includes specimens both treated and untreated with preservative, on which it caused white stringy rot.

Peniophora tenuis was described in culture by Boidin (1950) who figured and named the stephanocysts which are also present in fruit-bodies of this species. Similar structures have been reported from fruit-bodies of a few other species of *Peniophora*,

closely related to *P. tenuis*, by Boidin (1950; 1958), Cunningham (1963) and Burdsall (1969). The stephanocysts described here agree closely with those of *Peniophora tenuis* as described by Boidin (1950; 1958) and Burdsall (1969). In other characters, the cultures described here also agree well with Boidin's description and, as fruit-bodies of *Peniophora tenuis* were present on some of the specimens from which these isolations were made, there can be no doubt about the identity of this species. The presence of the characteristic two-celled stephanocysts in the thin, white, felty mycelium of cultures which give a positive reaction when tested for extra-cellular oxidase enzymes, serves to distinguish this species in culture.

Stephanocysts identical to those described above, were reported by Burdsall (1969) from cultures and carpophores of *Hyphoderma tenue* and from carpophores only of *H. guttuliferum* and *H. puberum*. He also stated that the cystidia may be (i) subulate, embedded and slightly thick-walled, to long subulate, or, (ii) cylindrical and slightly thick-walled, and embedded, or, (iii) cylindrical, thin-walled and protruding beyond the hymenium. These three types may occur in the same carpophore but none react with sulfobenzaldehyde. Species which possess stephanocysts are included in the genus *Hyphoderma* Wallr. emend. Donk by Parmasto (1968).

Little is known about the ability of *Peniophora tenuis* to decay the wood in which it grows. Harmsen (1967) listed this species as one of the Corticiaceae capable of breaking down timber treated with wood preservatives. The frequent isolation of this species in the present study together with Harmsen's (1967) report indicates the importance of *Peniophora tenuis* in the earlier stage of the decay of timber.

Polyporus gilvus *Schw. ex Fr.*

Growth characters (Fig. 26).

Growth is moderately rapid to slow, the mat reaching a radius of up to 20 mm in one week and covering the plate in 3–5 weeks. Advancing hyphae even, raised to limit of growth. Mat at first thin, white, cottony, minutely striate with striae radiating from the inoculum, with irregular white, cottony patches around the inoculum. Mat darkens gradually to areas of "warm buff" "honey yellow" to "yellow ochre", the patches of mycelium around the inoculum increasing in size and number and coalescing to form irregular rounded lumps, at first "warm buff" but darkening to "buckthorn brown" and often developing minute pores. Against the sides of the dish, thin, lacquer-like areas of "buckthorn brown" to "russet" develop after five weeks.

Reverse darkens gradually, finally assuming a mottled appearance due to formation of dark-coloured areas on the mat. A faint, fragrant, mushroomy odour is given off.

On gallic and tannic acid media strong diffusion zones are formed. Little or no growth occurs on gallic acid medium but colonies up to 20 mm in diameter may form on tannic acid.

Hyphal characters.

Advancing mycelium: hyphae hyaline, branching, thin-walled, with deeply staining contents and simple septa, 2,0–4,5μ in diameter (Fig. 27).

Aerial mycelium: (i) hyphae as in the advancing zone; (ii) fibre hyphae reddish brown, branching or unbranched, thick-walled, aseptate, 2,5–4,5μ in diameter and variable in length, arising from thin-walled, septate hyphae (Fig. 28).

Fructification: (i) thin-walled, septate and reddish-brown aseptate, fibre hyphae as in the aerial mycelium; (ii) setae dark reddish-brown, subulate, conical or somewhat ventricose, 15–35 x 2,5–6,0μ (Fig. 29).

Submerged mycelium: hyphae as in the advancing zone but often somewhat distended, up to 7,0μ in diameter.

Polyporus gilvus had been described in culture before by Davidson, Campbell & Blaisdell (1938), Davidson, Campbell & Vaughn (1942), Hirt (1928), Refshauge & Proctor (1936) and Nobles (1948; 1958; 1965). The isolates of this species from South Africa agree very well with the descriptions by these authors. This species may be recognized fairly easily in culture if the small-pored fructification, bearing the setae, are formed. Cultures which lack these are however rather featureless and may be confused with a number of other species with very similar cultural characters.

Overholts (1953) reported that the basidiospores and setae formed in fructifications in culture are identical to those present in fruit-bodies found in nature.

The micromorphological characters of the structures formed in cultures of *Polyporus gilvus* agree very well with those of structures present in its carpophores as described by Fidalgo & Fidalgo (1968).

Polyporus gilvus is well known as an important white rot fungus of timber of various species of broad-leaved trees (Cartwright & Findlay, 1958). It is also a common and widely distributed fungus in South Africa and had been reported on wood of various species from the Knysna area on many occasions (Doidge, 1950). Despite its widespread distribution, it has been isolated from two specimens only during this present investigation.

Fungi isolated from the test specimens but previously described from S. Africa.

Coniophora arida (*Fries*) *Karst.*

This fungus was isolated in culture only once in the course of this study. Its cultural characters closely agreed with the author's earlier description (Van der Westhuizen, 1958). It is recognizable by the pale greyish-brownish mycelial mat which tended to soften the surface of the agar and the presence of whorls of clamps at the hyphal septa with branches often arising from the clamps. No diffusion zones were formed on gallic acid and tannic acid-malt agar although colonies of up to 45 mm and 15 mm in diameter respectively, formed on the two media in 7 days.

This fungus was associated with a brown rot of wood of *Quercus palustris.*

Kemper (1937) described the morphology of the fruit-bodies and cultural characters of *Coniophora arida.* He reported that *C. arida* caused more extensive disintegration of spruce and pine test blocks than *C. puteana.* Southam & Ehrlich (1950) found *C. arida* to be one of the fungi most frequently associated with brown rot of *Thuja plicata* poles. Under experimental conditions it was capable of causing up to 57,5% loss in dry mass after 6 months when inoculated in test blocks of western red cedar sapwood. Duncan & Lombard (1965) listed *C. arida* as one of the 10 most prevalent fungi on softwoods as well as one of the common species on hardwoods. It was also isolated frequently from the underground decayed portions of experimental pine sapwood stakes at Madison, Wis., and Corvallis, Oreg., that had been treated with various preservatives. No information on the tolerance limits of *C. arida* to various preservatives are available however.

Lenzites sepiaria (*Wulf. ex Fr.*) *Fr.*

This fungus was isolated from three specimens of wood of *Pinus* spp. on which it caused a brown rot. In cultural characters the isolates agree closely with the descriptions by Cartwright & Findlay (1958), Nobles (1948; 1965) and Van der Westhuizen (1971). The cultures also formed fructifications on blocks of *Pinus patula*, according to the method described by Matters & Da Costa (1958) which allowed their identification.

Although this fungus is one of the important species causing brown rot of timber in the United States (Duncan & Lombard, 1965) and Europe (Cartwright & Findlay, 1958) it is known in South Africa only since 1961 (Van der Westhuizen, 1971). Its comparatively frequent occurrence on these test specimens is thus in contrast to its brief history in South Africa.

Polyporus adustus *Willd. ex Fr.*

The characters of this isolate in culture agreed very well with those described by Nobles (1948; 1965), Zycha & Knopf (1966) and Van der Westhuizen (1971) for this species. Despite its association with a white rot, no diffusion zones were formed on gallic acid and tannic acid media. Colonies of up to 35 mm in diameter formed on gallic acid but no growth occurred on tannic acid. These characters together with the general texture of the mycelial mat which lack strong distinguishing micromorphological characters, serve to identify this isolate with this species.

Polyporus adustus was isolated only once and from an untreated hardwood specimen on which it was associated with a white rot. This species is not very common in South Africa, only 10 collections having been recorded (Doidge, 1950). Most of these are from the cool moist, belt of the southern Cape Province. It is one of the few isolations of a species of polypore in the present study.

Polyporus sanguineus *L. ex Fr.*

The characters of the cultures and carpophores of this species as well as the other two orange-coloured species of polypores included in the genus *Pycnoporus* Karst., were described and compared in great detail by Nobles & Frew (1962). They demonstrated by means of interfertility tests that two of these species viz., *P. sanguineus* and *P. coccineus* (Fr.) Bond & Sing. occur in South Africa and that they are very similar in cultural characters. The isolate studied here displayed the texture and colours of the mat associated with cultures of *P. sanguineus*. For this reason and because of the fact that carpophores of this species were very abundant on slashings and prunings in the immediate vicinity of the Test Plot, this isolate is assigned to this species.

This fungus was isolated from one specimen only, an untreated test stake of *Quercus mexicana* in which the orange-red mycelium was clearly evident in the white, decayed parts. This is one of the commonest and most widely distributed species of polypore in South Africa. Its carpophores were frequently seen in great numbers on prunings in the plantations around the Test Plot. Its low frequency of occurrence on these stakes is therefore rather surprising but it is not listed as a cause of decay of living oaks by Davidson, Campbell & Vaughn (1942) or of wood products by Duncan & Lombard, (1965). This indicates that the conditions prevailing in the underground portions of wooden stakes under test may not be suitable for the development of this species.

Schizophyllum commune *Fries.*

Cultures of this fungus are readily recognized by the raised, woolly to felty, white mat, the formation of a weak diffusion zone on tannic acid-malt agar but not on gallic acid-malt, and the presence in the mat of hyphae with numerous, minute lateral projections (Nobles, 1948; Van der Westhuizen, 1958). Fruit-bodies which allow the identification of the fungus, often develop on most new isolates.

S. commune is one of the commonest and most widely distributed decay fungi in South Africa (Doidge, 1950). It is listed by Duncan & Lombard (1965) as a frequent invader of wood products in the United States and of birch and aspen pulpwood in Sweden by Henningson (1967b). Cartwright & Findlay (1958) however maintain that it does not cause extensive decay despite its frequent occurrence on timber in England.

Stereum hirsutum (*Willd.*) *Pers.*

This species had been described in culture by Van der Westhuizen (1958) and the cultures isolated from the test specimens in the present study agreed very well with these descriptions. In culture this species is readily recognized by the presence of wide hyphae, 6–10μ in diameter, in the advancing mycelium with whorls of large

clamps at the septa, and the formation of a thick, felty mat which develops tough, smooth felty pads of "pinkish buff", "light buff" to "ochraceous tawny" colour. Strong diffusion zones and colonies up to 60 mm and 50 mm in diameter are formed after one week on gallic acid-malt and tannic acid-malt agar respectively.

This species, which is very common and wide spread in South Africa, was isolated from 24 test specimens, which ranks it as second in the frequency of the species encountered. Its fruit-bodies were also very numerous on decaying prunings and other woody debris in the vicinity of the Test Plot and it was one of the very few species of which fruit-bodies were present on the test stakes. It was always associated with extensive creamy white rot of both treated and untreated test specimens. Cartwright & Findlay (1958) regard this fungus as the most important cause of decay in sapwood of oak logs after felling in England. Duncan & Lombard (1965) do not list it as a cause of decay of wood products in the United States but Cowling (1957) reported it on stored hardwood lumber and pulpwood logs. Henningson (1967a, b) recorded *Stereum hirsutum* as one of the first Basidiomycetes to appear on birch and aspen pulpwood and it remained active for the entire period under observation (30 months), fruiting abundantly in autumn. He also reported it to be one of the most aggressive species in the decay of stored chips (Henningson, 1967c).

Discussion

A relatively small number of species of Basidiomycetes were recorded in this survey but some interesting facts and observations emerged nevertheless.

A surprising observation was the almost complete absence of fruit-bodies of decay fungi on the test specimens. The reasons for this are not at all clear. As the specimens were examined and collected only once per year in late autumn it is not unlikely that the prevailing conditions could have been unfavourable for fruit-body formation for many species. Removal of the specimens before they were completely decayed may also have been an important factor. But the absence of fruit-bodies made the identification of the mycelia obtained in culture almost impossible. Consequently only those species for which adequate descriptions of cultural characters exist or for which cultures could be made from fruit-bodies, could be identified reliably.

Another interesting fact is the almost complete absence here, of those species which have been used traditionally as test organisms in laboratory tests devised to evaluate the toxicity and efficacy of various wood-preservatives. Closely allied to this observation is the very low incidence of polypores, only *Lenzites sepiaria*, *Polyporus adustus*, *Polyporus gilvus* and *Polyporus sanguineus* being present. This latter species was found on one specimen only despite the fact that its conspicuous fruit-bodies were present in large numbers on prunings in the vicinity of the Field Exposure Test Plot.

The absence of polypore species is the more striking if viewed in the light of the micromorphological characters of the unidentified mycelia isolated from these specimens. The great majority of these cultures show no differentiation of hyphae into fibre hyphae or special structures. This indicates that these mycelia must belong to species of the lower Polyporaceae and Thelephoraceae, in which such structures are not present, and the Agaricaceae. The higher polypores with complex, tough fruit-bodies were thus almost entirely absent from the specimens under test.

Of the fungi identified on the test specimens, *Stereum hirsutum* proved to be one of those encountered most frequently. This is one of the commonest and most widely distributed species in South Africa (Doidge, 1950). Two other species of lower Hymenomycetes, *Odontia bicolor* and *Peniophora cinerea* were also of frequent occurrence though both were virtually unknown in South Africa before (Doidge, 1950; Talbot, 1958). Of the species which occurred most frequently however, *Paxillus*

panuoides, had been recorded in South Africa on three previous occasions only (Doidge, 1950). Their frequent presence on the specimens studied here, in comparison with their few previous records of occurrence, together with the observed general absence of fruit-bodies on the test stakes, indicate that these species must have been overlooked previously because of inconspicuous or suppressed fruit-bodies.

The species of fungi isolated and identified in this investigation agree in general with those of Henningson (1967a, b, c) who found that wood in chip piles were invaded first by species of lower Basidiomycetes with low wood-destroying activity, resulting in slow initial decay. *Stereum hirsutum* was found to be one of the early and very aggressive invaders which were followed much later by polypores. The results thus indicate that the wood specimens from Kruisfontein, examined here, had been removed while they were, in general, still in the early stages of decay, despite the fact that they have been discarded as failures. This could also account to some extent for the almost total absence of fruit-bodies on the specimens. The presence of species such as *Peniophora cinerea* which are not generally regarded as severe wood-destroyers, indicate, however, that they must play an important part in the early stages of decay of timber in contact with soil.

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TABLE 1.—Species of wood-rotting Basidiomycetes identified, the affected timber species, preservative treatment and number of specimens affected in the Wood-preservative Field Testing Plot at Kruisfontein.

Fungus	Timber	Treatment	No. of specimens
Coniophora arida	Quercus palustris	Natural durability	1
Lenzites saepiaria	Pinus patula	5% Celcure A	1
	Pinus palustris	Natural durability	1
	Pinus taeda	Natural durability	1
Neamatoloma fasciculare	Berlinia sp.	Natural durability	1
	Eucalyptus capitulata	Natural durability	1
	Eucalyptus pillularis	Natural durability	1
	Gymnosporia acuminata.	Natural durability	1
	Heywoodia lucens	Natural durability	1
Odontia bicolor	Eucalyptus saligna	5% Celcure	1
	Eucalyptus saligna	Lignolite	1
	Eucalyptus saligna	SATMAR creosote substitute	1
	Pinus patula	5% Magnesium silicofluoride	1
	Adina macrocephala	Natural durability	1
	Afrormosia angolensis	Natural durability	1
	Cordia caffra	Natural durability	2
	Eucalyptus botryoides	Natural durability	1
	Eucalyptus corymbosa	Natural durability	1
	Eucalyptus globulus	Natural durability	1
	Eucalyptus propingua	Natural durability	1
	Mellitia caffra	Natural durability	1
	Syncarpia laurifolia	Natural durability	2

TABLE 1.—Species of wood-rotting Basidiomycetes identified, the affected timber species, preservative treatment and number of specimens affected in the Wood-preservative Field Testing Plot at Kruisfontein (*Continued*).

Fungus	Timber	Treatment	No. of specimens
Paxillus panuoides	Pinus patula	5% Celcure A	2
	Pinus patula	Copper - 3 - phenylsalicylate	1
	Pinus patula	0,257% Dieldrin	1
	Pinus patula	5% Monochloronahpthalene	3
	Pinus patula	Rosin amine "D" acetate	1
	Pinus patula	Rosin amine "D" pentachlorophenate	1
	Pinus patula	Sodium orthophenylphenate	1
	Pinus patula	1% Triolith + 0,68% Copper sulphate	1
	Pinus patula	Untreated control	14
	Pinus oocarpa	Natural durability	1
Peniophora aspera	Eucalyptus saligna	SATMAR creosote substitute B	1
	Pinus patula	Sodium orthophenyl phenate	1
	Pinus patula	Untreated control	2
	Curtisia dentata	Natural durability	1
	Pinus pinaster	Natural durability	1
	Pterocelastrus tricuspidata	Natural durability	1
Peniophora cinerea	Eucalyptus saligna	Albolineum	1
	Eucalyptus saligna	0,257% Dieldrin	2
	Pinus patula	Sodium orthophenyl phenate	2
	Pinus patula	Untreated control	1
	Ekebergia capensis	Natural durability	1
	Fraxinus americana	Natural durability	3
	Ptaeroxylon obliquum	Natural durability	1
	Quercus mexicana	Natural durability	2
Peniophora tenuis	Eucalyptus saligna	Sodium orthophenylphenate	2
	Eucalyptus saligna	Copper naphthenate, 5%	1
	Eucalyptus saligna	Dieldrin	1
	Eucalyptus saligna	Lignolite	1
	Eucalyptus saligna	10% Metanate zinc naphthanate	1
	Eucalyptus saligna	Rosin Amine "D" acetate	1
	Eucalyptus saligna	5% Wykamol	2
	Eucalyptus saligna	Untreated control	1
	Pinus patula	Magnesium silicofluoride	2
	Pinus patula	Orthophenyl phenol	2
	Pinus patula	SATMAR creosote	1
	Pinus patula	Tanalith "U"	1
	Pinus luchuensis	Natural durability	1
	Pinus michoacana	Natural durability	1
Polyporus adustus	Ilex mitis	Natural durability	1
Polyporus gilvus	Albizzia gummifera	Natural durability	1
	Eucalyptus sideroxylon	Natural durability	1
Polyporus sanguineus	Quercus mexicana	Natural durability	1
Schizophyllum commune	Fraxinus pennsylvatica	Natural durability	1
	Populus serotina	Natural durability	1
	Vepris lanceolata	Natural durability	1
	Zyzygium cordatum	Natural durability	1

TABLE 1.—Species of wood-rotting Basidiomycetes identified, the affected timber species, preservative treatment and number of specimens affected in the Wood-preservative Field Testing Plot at Kruisfontein (*Continued*).

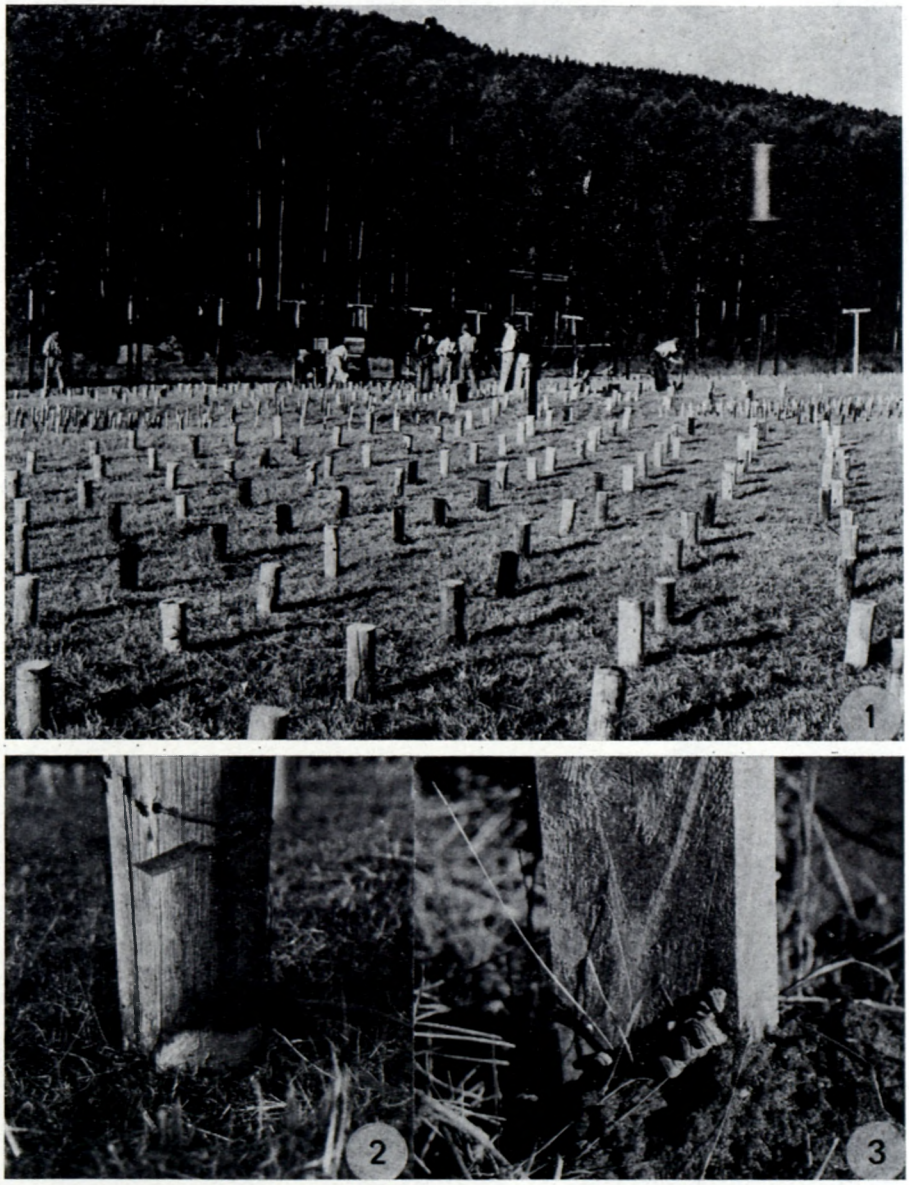
Fungus	Timber	Treatment	No. of specimens
Stereum hirsutum.....	Eucalyptus saligna.....	5% Celcure "A".....	2
	Eucalyptus saligna.....	5% Copper naphthanate + 1% Sodium dichromate	2
	Apodytes dimidiata.....	Natural durability.....	1
	Betula sp.....	Natural durability.....	2
	Eucalyptus paniculata...	Natural durability.....	1
	Eucalyptus pedunculata..	Natural durability.....	1
	Eucalyptus saligna.....	Natural durability.....	1
	Fraxinus americana.....	Natural durability.....	3
	Gymnosporia acuminata.	Natural durability.....	2
	Kempas.....	Natural durability.....	1
	Nuxia floribunda.....	Natural durability.....	4
	Quercus mexicana.....	Natural durability.....	2
	Rapanea melanophloeos.	Natural durability.....	2

TABLE 2.—Unidentified mycelia of Basidiomycetes together with the species of timber and preservative treatment from which they were isolated, arranged according to their main cultural characters.

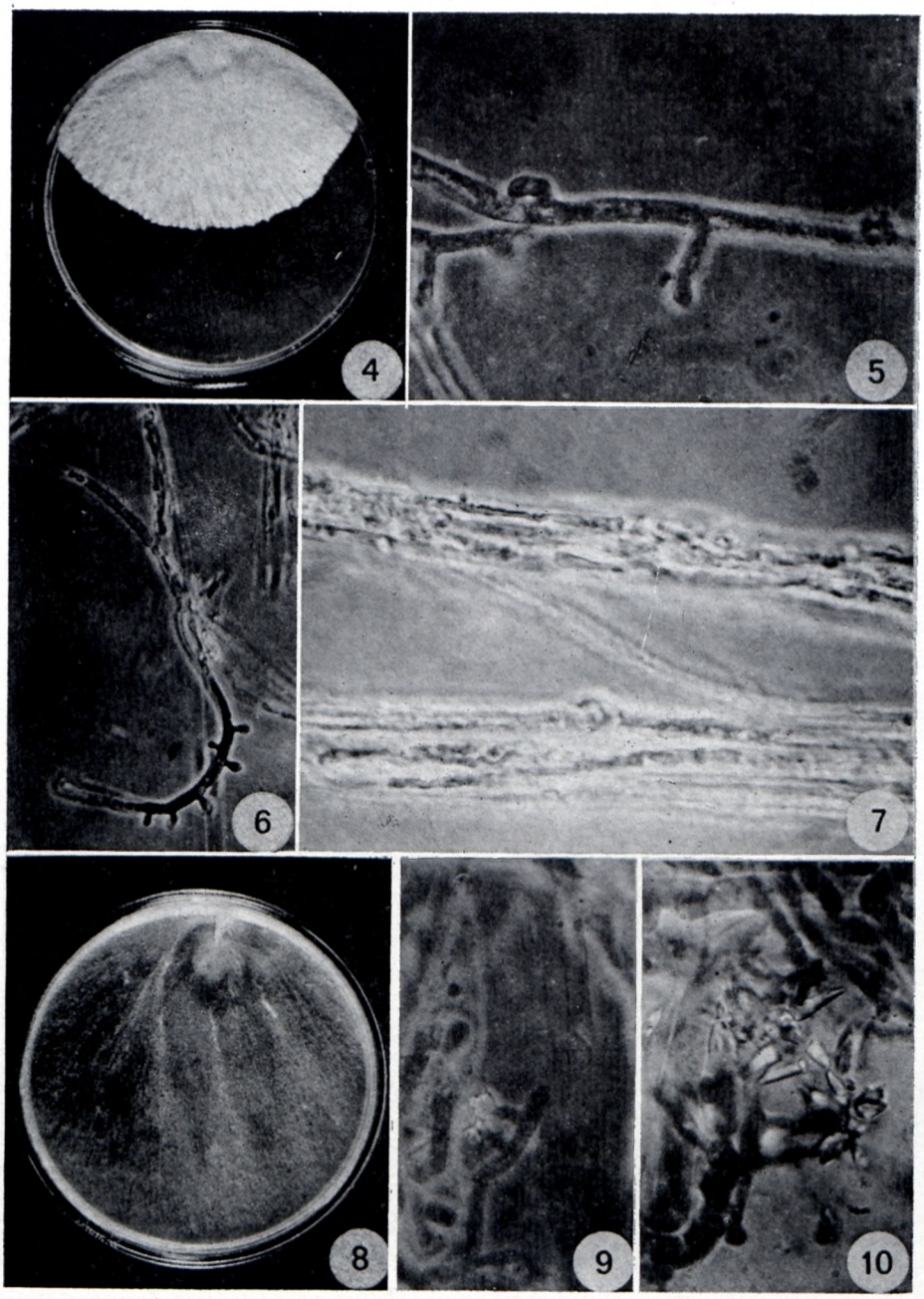
Cultural characters	Isolate no.	Timber species	Preservative treatment
1. Extra-cellular oxidase reaction negative;			
1.1 Thin-walled hyphae nodose-septate;			
1.1.1 Hypha undifferentiated, hyaline:	106	Eucalyptus saligna.....	Creosote.
	198	Albizzia gummifera.....	Natural durability.
	207	Zyzygium cordatum.....	Natural durability.
	220	Pinus patula.....	5% Zinc silicofluoride.
	270	Eucalyptus saligna.....	Permatox W.R. + Varnolene.
	271	Eucalyptus saligna.....	Coppernaphthanate + Varnolene.
	292	Pinus patula.....	Ortho-phenylphenol.
	295	Vepris lanceolata.....	Natural durability.
	297	Vepris lanceolata.....	Natural durability.
	393	Pinus patula.....	Natural durability.
1.1.2 Clamped hyphae with irregularly thickened walls also present:			
	187	Eucalyptus saligna.....	25% Permatox W.R. + 75% Varnolene.
	285	Curtisia dentata.....	Natural durability.
	289	Pinus patula.....	Sodium ortho-phenylphenate.
	303	Populus serotina.....	Natural durability.
	304	Pinus patula.....	Relysol.
	305	Pinus patula.....	Untreated control.
	403	Pinus patula.....	Untreated control.
1.1.3 Swellings on clamped hyphae:			
	192	Pinus patula.....	2% Sodium orthophenylphenate.

TABLE 2.—Unidentified mycelia of Basidiomycetes together with the species of timber and preservative treatment from which they were isolated, arranged according to their main cultural characters (*Continued*).

Cultural characters	Isolate no.	Timber species	Preservative treatment
	283	Eucalyptus saligna.....	Albawax in kerosene.
	287	Eucalyptus saligna.....	Copper-3-phenylsalicylate.
1.1.4 Differentiated thick-walled fibre hyphae also present:			
	223	Pinus patula.....	Untreated control.
1.2 Thin-walled hyphae simple-septate, undifferentiated:			
	188	Eucalyptus saligna.....	10% Coppernaphthanate in diesel oil.
	203	Pinus patula.....	Untreated control.
1.2.1 Advancing hyphae simple septate, older hyphae nodose-septate:			
	229	Quercus mexicana.....	Natural durability.
2. Extra-cellular oxidase reaction positive;			
2.1 Thin-walled hyphae nodose-septate;			
2.1.1 Hyphae undifferentiated, hyaline:			
	100	Eucalyptus saligna.....	2% Copper sulphate + 1% Sodium dichromate.
	103	Apodytes dimidiata.....	Natural durability.
	104	Eucalyptus saligna.....	Cresoleum.
	105	Eucalyptus obliqua.....	Natural durability.
	106	Eucalyptus saligna.....	Creosote.
	190	Eucalyptus saligna.....	Albolinium.
	202	Pinus patula.....	Untreated control.
	205	Pinus patula.....	Untreated control.
	206	Pinus patula.....	Untreated control.
	272	Eucalyptus saligna.....	Coppernaphthanate in diesel oil.
	302	Populus serotina.....	Natural durability.
	396	Eucalyptus gomphocephala	Natural durability.
	399	Gymnosporia acuminata.	Natural durability.
	402	Pinus patula.....	3,75% Tim-Bor.
	405	Pinus patula.....	Watco Timber guard.
	408	Pinus oocarpa.....	Natural durability.
	410	Gymnosporia acuminata.	Natural durability.
2.1.2 Differentiated fibre hyphae also present:			
	145	Fraxinus americana.....	Natural durability.
	150	Harpephyllum caffrum...	Natural durability.
	235	Rapanea melanophloeos.	Natural durability.
2.2 Thin-walled hyphae simple septate;			
2.2.1 Hyphae undifferentiated:			
	109	Nuxia floribunda.....	Natural durability.
	234	Fraxinus americana.....	Natural durability.
	288	Eucalyptus saligna.....	Sodium orthophenyl phenate.
	412	Pinus patula.....	Untreated control.
	413	Heywoodia lucens.....	Natural durability.

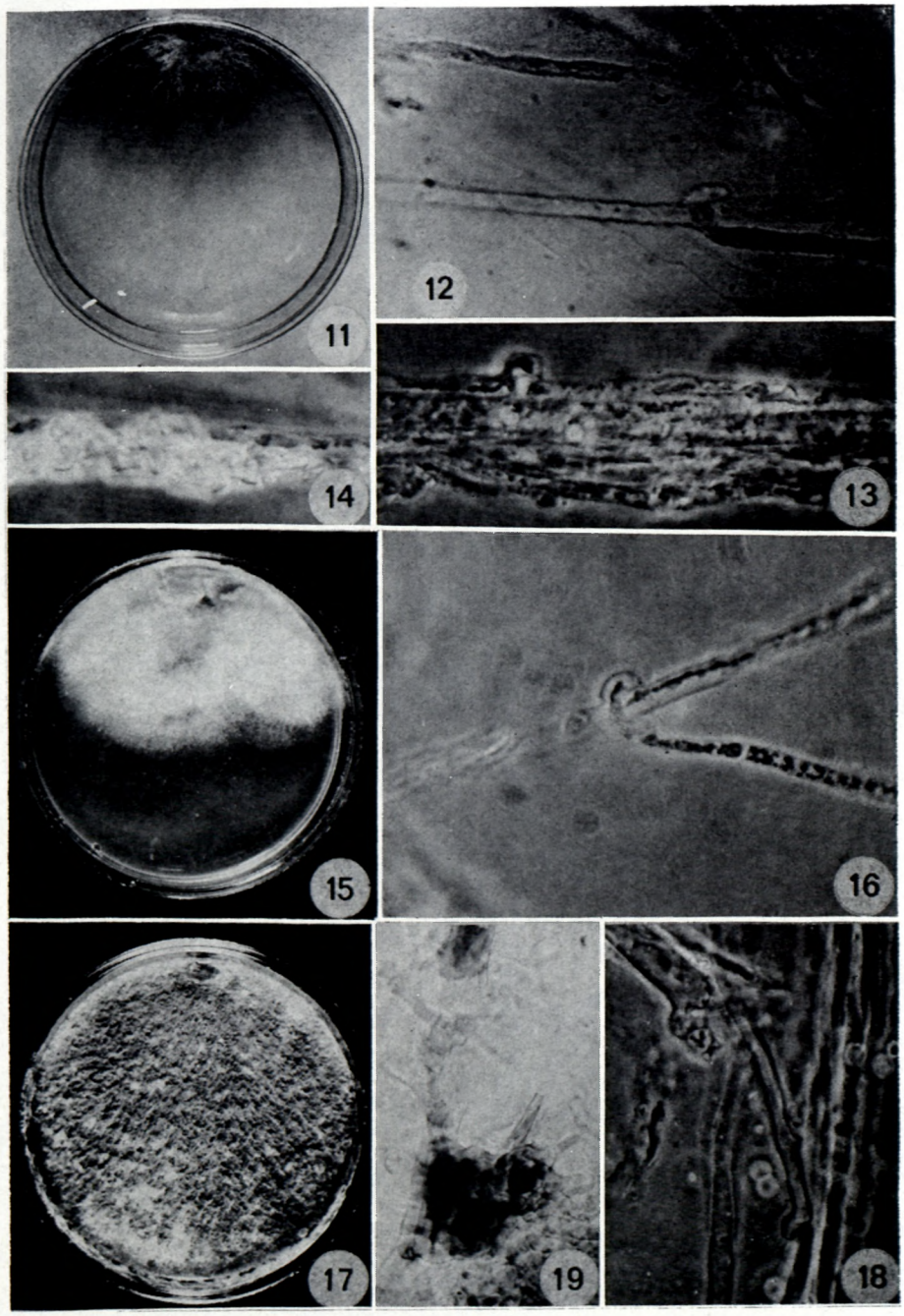


FIGS. 1–3.—General views. Fig. 1, the wood-preservative field exposure test plot. Fig. 2. Test specimen with fruit-body of **Peniophora** sp. at groundlevel. Fig. 3. Fruit-bodies of **Stereum hirsutum** on billet under test for natural durability.



FIGS. 4–7.—**Naematoloma fasciculare.** Fig. 4, culture at two weeks. Fig. 5, nodose-septate hyphae from advancing zone, x 1000 phase contrast. Fig. 6, dendrophysis from aerial mycelium, x 500 phase contrast. Fig. 7, strands of aerial hyphae, x 1000 phase contrast.

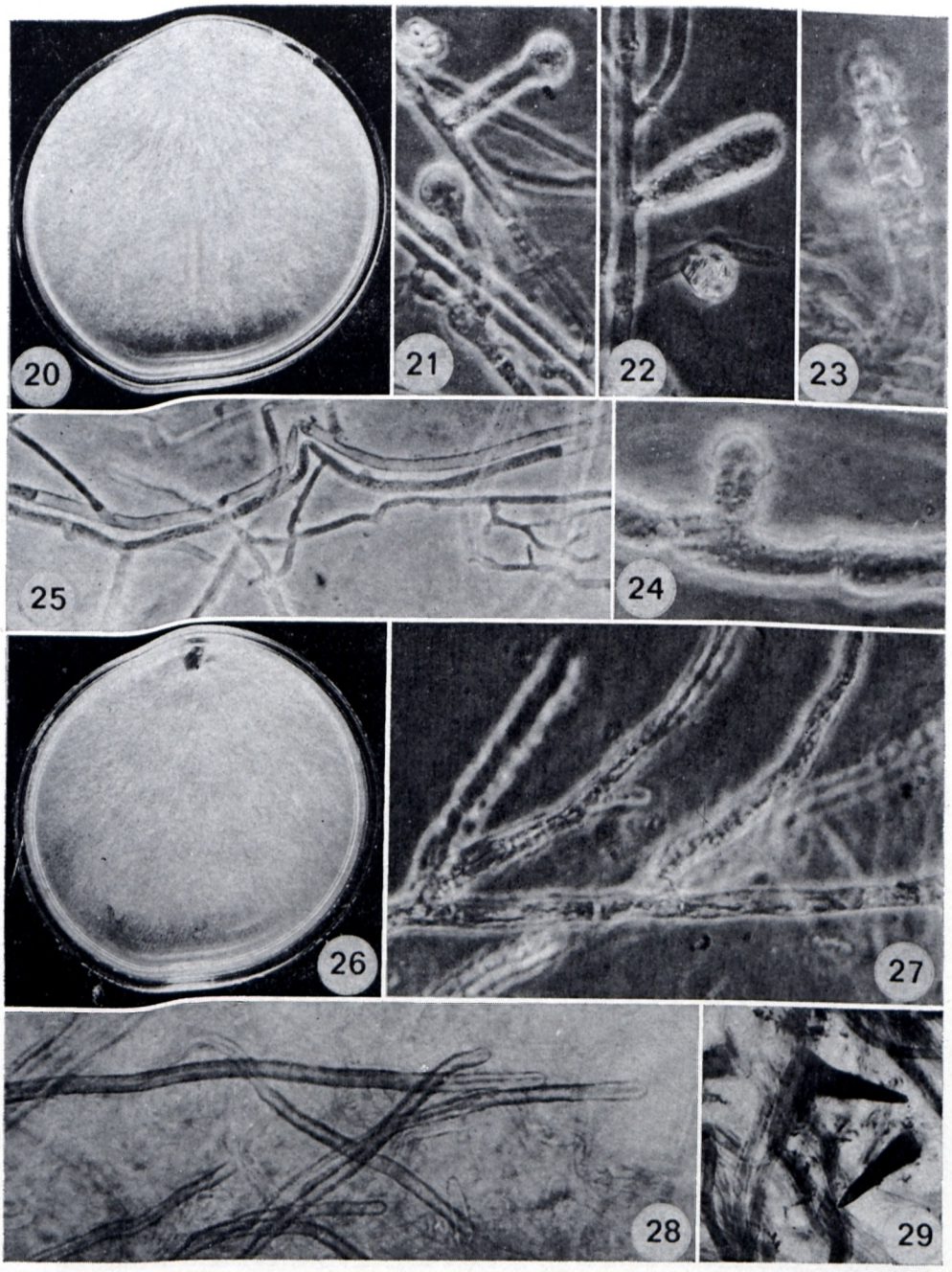
FIGS. 8–10.—**Odontia bicolor.** Fig. 8, culture at four weeks. Fig. 9, nodose-septate hyphae and capitate cystidia, x 1000 phase contrast. Fig. 10, capitate cystidia with encrusting crystals, x 1000 in lactophenol with Cotton Blue.



FIGS. 11–14.—**Paxillus panuoides.** Fig. 11, culture at 4 weeks. Fig. 12, nodose-septate advancing hyphae, x 1000. Fig. 13, hyphal strand from aerial mycelium, x 1000 phase contrast. Fig. 14, crystalline incrustations on hyphae, x 1000 phase contrast.

FIGS. 15–16.—**Peniophora aspera.** Fig. 15, culture at 4 weeks. Fig. 16, nodose-septate hypha from advancing zone, x 1000 phase contrast.

FIGS. 17–19.—**Peniophora cinerea.** Fig. 17, culture at 4 weeks, Fig. 18, nodose-septate hyphae from advancing zone, x 1000 phase contrast. Fig. 19. brown hyphae with drops of brown, resin-like material, x 500.



FIGS. 20–25.—**Peniophora tenuis.** Fig. 20, culture at 4 weeks. Fig. 21, capitate cystidia, x 1000 phase contrast. Fig. 22 and Fig. 23, cystidia with crystalline incrustations, x 1000 phase contrast. Fig. 24, stephanocyst, x 1000 phase contrast. Fig. 25, nodose-septate hyphae from advancing zone, x 500 phase contrast.

FIGS. 26–29.—**Polyporus gilvus.** Fig. 26, culture at 4 weeks Fig. 27, simple-septate hyphae from advancing zone, x 1000 phase contrast. Fig. 28, brown, aseptate fibre hyphae, x 500. Fig. 29, setae, x 500.

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