



## Seven wood-inhabiting Aphyllophorales (Basidiomycotina) new to Taiwan

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**Abstract.** Seven wood-inhabiting Aphyllophorales (Basidiomycotina), all new to Taiwan, are described and illustrated. These are *Cymatoderma lamellatum* (Berk. et Curt.) Reid, *Xylobolus frustulatus* (Pers.: Fr.) Boidin, *X. subpileatus* (Berk. et Curt.) Boidin, *Perenniporia ohiensis* (Berk.) Ryv., *Polyporus melanopus* Fr., *Tyromyces incarnatus* Imazeki and *T. subcaesius* David. All of them had positive oxidase tests, indicating that they are white rot fungi. Two *Xylobolus* species are associated with white pocket rot. They were observed growing on decayed stems, roots or twigs of either hardwoods or conifers.

**Key words:** Aphyllophorales; Taiwan.

### Introduction

The taxonomic studies of Aphyllophorales in Taiwan have been briefly reviewed in previous papers (Chang, 1992a,b). In addition, some Aphyllophorales fungi, especially in the family Corticiaceae and new to Taiwan, were described (Lin and Chen, 1990; Wu, 1991; Wu and Chen, 1992a,b). During the survey of the lignicolous Aphyllophorales, in Taiwan, the author has reported nineteen species in the order Aphyllophorales new to Taiwan (Chang, 1992a,b). In this report, seven wood-inhabiting fungi in the order Aphyllophorales, new to Taiwan, are described and illustrated.

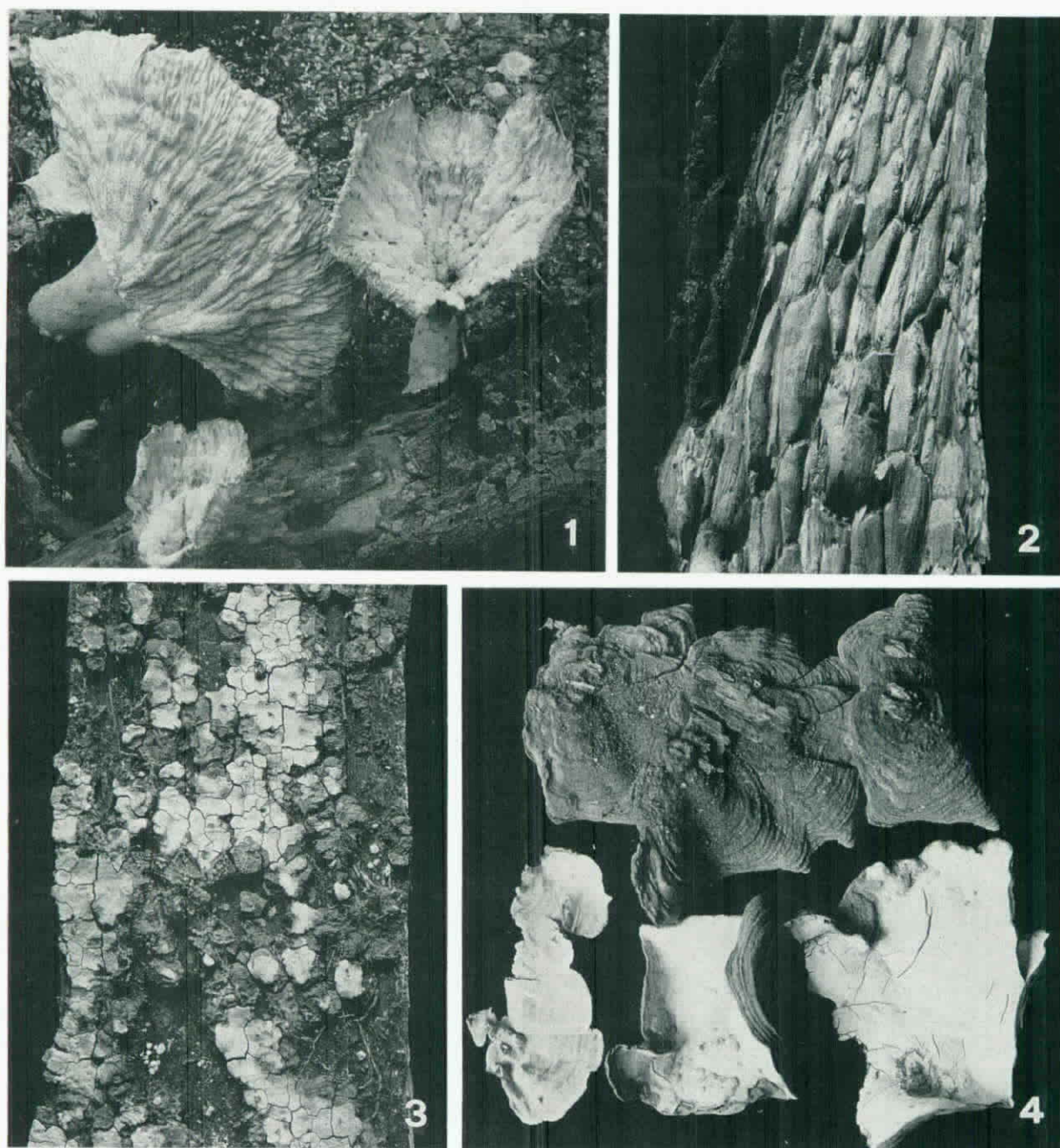
### Materials and Methods

The methods used for examination of fruiting bodies have been described in previous papers (Chang, 1992a,b). Gilbertson and Ryvarden (1986), Imazeki (1943), Imazeki and Hongo (1989), Reid (1965), Rattan (1977) and Boidin (1958) were used as the key references in identification. All specimens have been deposited at the Laboratory of Forest Pathology, Taiwan Forestry Research Institute (TFRI). In addition, the method of

Bavendamm (1928) was employed to test secretion of phenol-oxidases. The cultures of the tested fungi were grown on malt-extract agar (MEA: 2% malt-extract and 2% Bacto agar), MEA + 0.5% tannic acid or MEA + 0.5% gallic acid and incubated at 25°C for one week. When cultures became brown on MEA + 0.5% tannic acid or MEA + 0.5% gallic acid, the fungus was classified as white rot fungi. On the other hand, when cultures did not turn brown on MEA + 0.5% tannic acid and MEA + 0.5% gallic acid, the fungus was classified as brown rot fungi. All fungal cultures used for the test of rotting types were isolated from fresh fruiting bodies. The exposed surfaces of fruiting bodies were cut out with a sterilized blade. Pieces (CA. 2 × 2 × 2 mm) of newly exposed tissue were cut and transferred to MEA in petri plates and incubated at 25°C. The fungus growing from the tissues of fruiting bodies was transferred to 2% water agar. Single hyphal tips cut from the margin of colonies growing on water agar were cultured and maintained on MEA.

### Results and Discussion

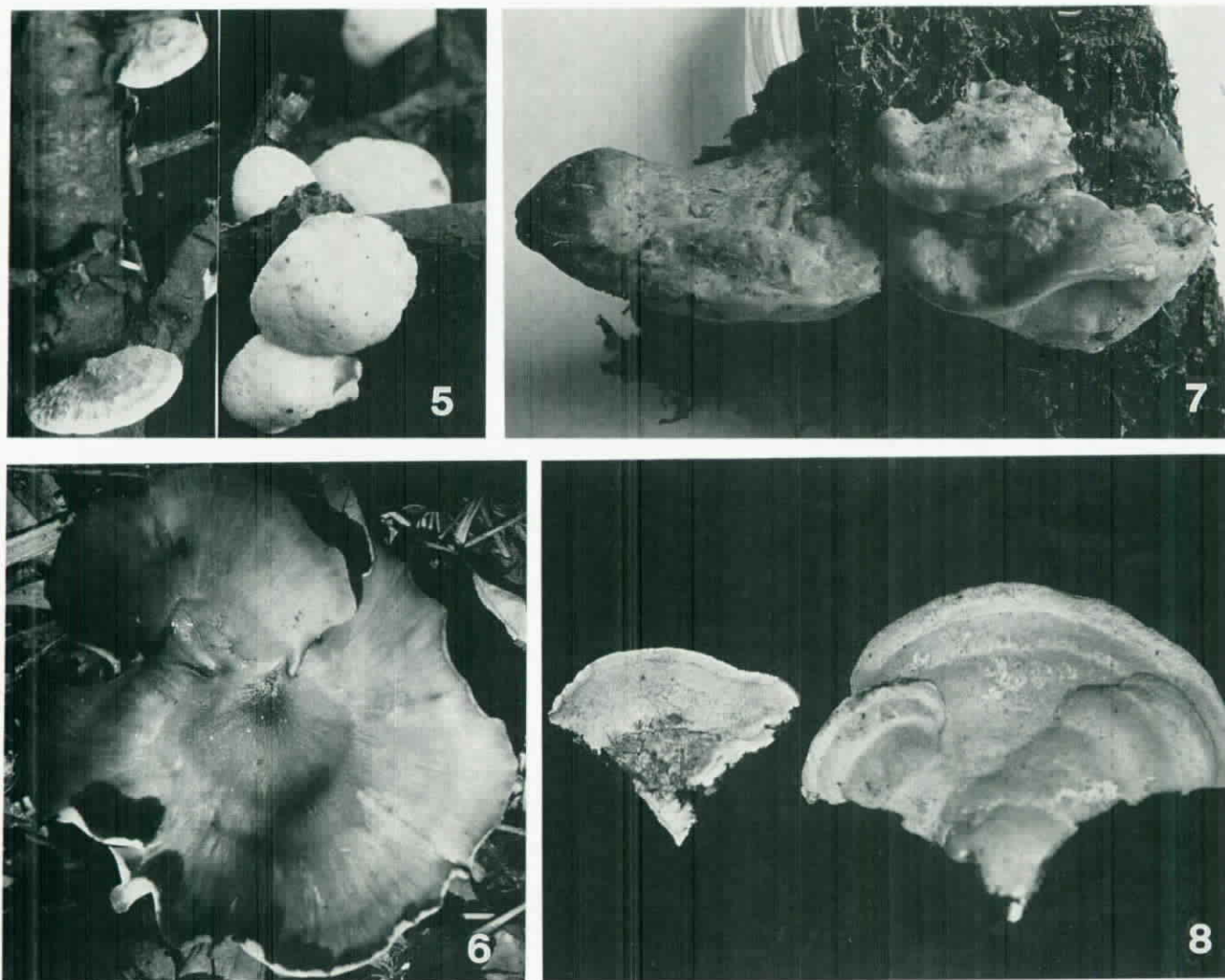
***Cymatoderma lamellatum*** (Berk. et Curt.) Reid. Kew Bull. 10, 631, 1956 (Figs. 1 and 9)



Figs. 1-4. Basidiocarps and appearance of wood rot. 1, Basidiocarps of *Cymatoderma lamellatum*; 2, White pocket rot caused by *Xylobolus frustulatus*; 3, Basidiocarps of *Xylobolus frustulatus*; 4, Basidiocarps of *Xylobolus subpileatus*.

Fruitbodies coriaceous, pseudoinfunduliform or infunduliform, usually with a well developed pseudocentral stipe which is covered by a thick felt-like tomentum, usually large, up to 5 cm high and 20 cm wide; adjacent fruitbodies sometimes confluent. Pileus up to 20 cm wide and 0.5 cm thick, covered by a thick felt-like tomentum which obscures the underling

radiating knife-edged ridges on the surface of the sporophore, pale grey to fawn. Stipe up to 5 cm long and 2 cm wide, covered by a thick pale grey to fawn felt-like tomentum. Context white to pale grey, up to 1-2 mm thick. Hymenial surface white, pale grey to fawn, and ornamented with broad, obtuse, radiating folds which bear scanty warts or spines. Hyphal system dimitic,



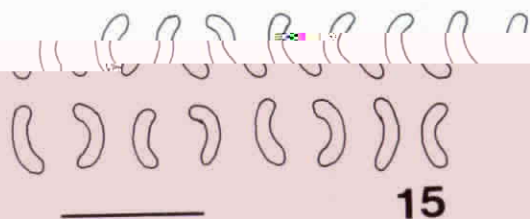
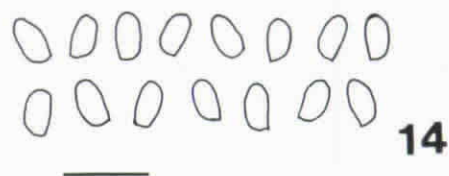
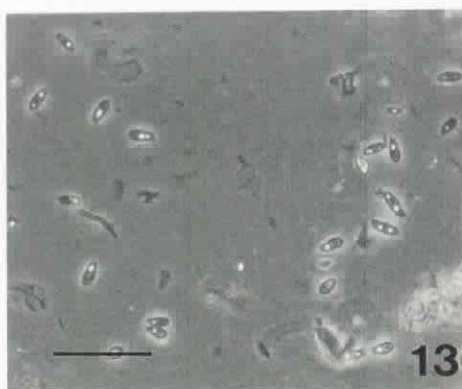
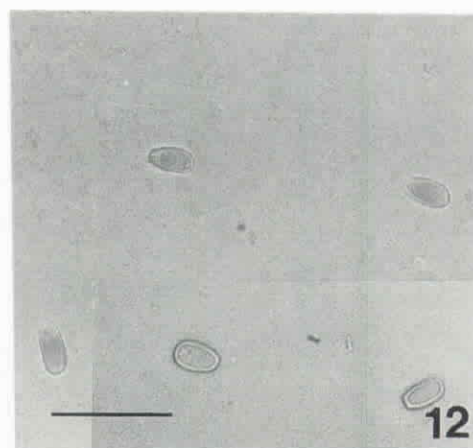
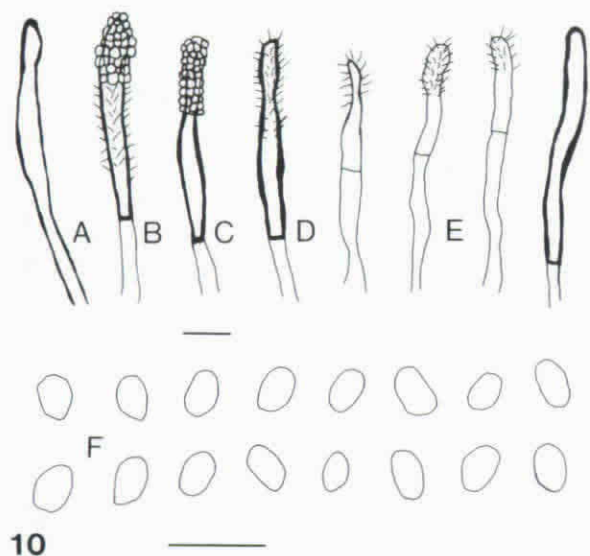
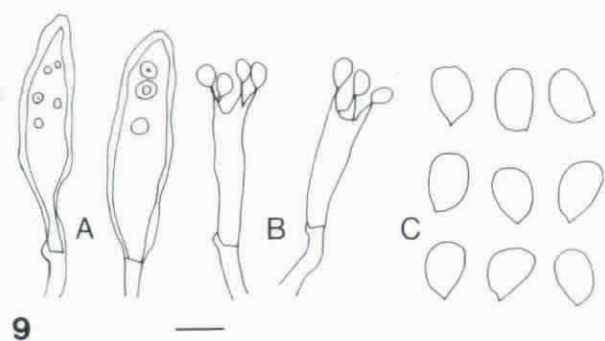
Figs. 5–8. Basidiocarps. 5, *Perenniporia ohiensis*; 6, *Polyporus melanopus*; 7, *Tyromyces incarnatus*; 8, *Tyromyces subcaesius*.

generative hyphae thin to thick walled, up to  $6\ \mu\text{m}$  in diameter, with clamps; Skeletal hyphae up to  $7\ \mu\text{m}$  in diameter, tapering to narrow obtuse. Cuticle layer,  $15\text{--}45\ \mu\text{m}$  thick. Cystidia clavate,  $45\text{--}60 \times 12\text{--}20\ \mu\text{m}$ . Basidia clavate, usually 4-spores,  $25\text{--}45 \times 5\text{--}7\ \mu\text{m}$ . Basidiospores thin-walled, hyaline, broadly ellipsoid to subglobose, IKI–,  $6\text{--}8.5 \times 4\text{--}5\ \mu\text{m}$ .

Fruitbodies were observed on decayed stems of hardwoods. They were collected at Hsipao, Hualien county (TFRI-384, June, 1992, alt. 500 m). An isolate of the fungus gave positive oxidase tests on tannic and gallic acid media, indicating that it is a white rot fungus. It had been reported that *C. lamellatum* was a white rot fungus (Reid, 1965). The genus *Cymatoderma*, which has been considered in connection with the

stipitate steroid fungi, was established by Junghuhn (1840) and only based on one species (*C. elegans* Jungh.). He described an adequate genus and gave an excellent account of the species. However, *Cymatoderma* was never accepted by Fries, and consequently, it was forgotten. Fries used the generic name *Cladoderis* Pers. ex Berk. for those species related to *C. elegans*, and all mycologists subsequently followed him in adopting this name (Reid, 1965). Therefore, *Cladoderis* was proposed as a nomen conservandum against *Cymatoderma* by Donk (1941), but it was rejected by the special Committee for Fungus Nomenclature (Taxon 2: 31, 1953). Thus, *Cladoderis* turns out to be a synonym of *Cymatoderma*. Two species of *Cymatoderma*, *C. dendriticum* (Pers.) Reid (= *Cladoderis dendritica* Pers.)





Figs. 9-11. Basidia, basidiospores, pseudocystidia, acanthophyses and cystidia. 9, *Cymatoderma lamellatum*: A, cystidia; B, basidia; C, basidiospores. 10, *Xylobolus subpileatus*: A, pseudocystidia; B, incrustated acanthophysoid pseudocystidia; C, incrustated pseudocystidia; D, acanthophysoid pseudocystidia; E, acanthophyses; F, basidiospores. 11, *Xylobolus frustulatus*: A, acanthophyses; B, acanthophysoid pseudocystidia. Bar=10  $\mu$ m.

Figs. 12-15. Basidiospores. 12, *Perenniporia ohienensis*, Bar= 20  $\mu$ m; 13, *Polyporus melanopus*, Bar = 20  $\mu$ m; 14, *Tyromyces incarnatus*, Bar= 10  $\mu$ m; 15, *Tyromyces subcaesius*, Bar= 10  $\mu$ m.

(Sawada, 1931) and *C. elegans* Jungh. (= *Cladoderris spongisa* Fr.) (Sawada, 1942), have been recorded in Taiwan.

***Xylobolus frustulatus*** (Pers.: Fr.) Boidin. Revue Mycol. 23: 341, 1958 (Figs. 2,3 and 11)

Fruitbodies perennial, woody, resupinate to effused-reflexed, stratose, adnate, up to 5.5 mm thick, light brown to brown or yellowish brown. Hymenial surface cream, pale yellowish cream to yellow-ochre, smooth, deeply creviced to almost broken forming polygonal to irregular frustules, the frustules remain attached to the substratum by a narrow base and continue to grow as a result of which the margin becomes slightly raised. Margin concolorous with the hymenial surface. Context light brown to brown or yellowish brown. Tissues turn black in 3% KOH. Hyphal system dimitic; generative hyphae 2–3.5  $\mu\text{m}$  in diameter, clamps absent, thin-walled subhyaline; skeletal hyphae 3–5  $\mu\text{m}$  in diameter, light brown and thick-walled. Acanthophyses 5–8  $\mu\text{m}$  in diameter, clavate to clavate-cylindrical, with numerous spines, especially in the upper 1/2 part, the walls thin to slightly thick, subhyaline to pale brown. Basidia 4.5–6  $\mu\text{m}$  in diameter, clavate-cylindrical, 4-spored. Basidiospores ellipsoid, shortly apiculate, thin-walled, subhyaline, smooth, amyloid, 4–4.5  $\times$  2.5–3  $\mu\text{m}$ .

Fruitbodies were found on dead stems of a hardwood collected at Wuling, Nantou county (TFRI-277, March, 1992, alt. 1500 m). The isolate of this fungus had positive oxidase tests on tannic and gallic acid media, indicating it is a white rot fungus. It has been reported that white rot and white pocket rot are associated with this fungus (Hjortstam *et al.*, 1988; Rattan, 1977).

***Xylobolus subpileatus*** (Berk, et Curt.) Boidin. Rev. Mycol. 23: 341, 1958. (Figs. 4 and 10)

Fruitbodies perennial, woody, stratose, effused-reflexed to pileate, often forming large patches up to 50 cm broad, 30 cm long and up to 6 mm thick, pileus from narrowly reflexed margin to quite large and irregular, not imbricate or rarely so, flabelliform to petalliform or dimidiate; hymenial surface deep cream to yellowish brown, smooth to unevenly tuberculate, rarely creviced; upper surface yellowish brown, brown to finally blackish brown, concentrically zonate, quite uneven and rough, densely tomentose when newly formed especially near the margin but the tomentum is soon

replaced by a hard bark-like rind; margin acute, paler concolorous. Context light brown, composed of compactly arranged parallel hyphae with a thick brown cuticle on the abhymenial side. Hyphal system dimitic; generative hyphal 2–3  $\mu\text{m}$  in diameter, clamps absent, thin-walled, subhyaline; skeletal hyphae 3–5  $\mu\text{m}$  in diameter, light brown, thick-walled. Cystidia of variable length, 4–6  $\mu\text{m}$  in diameter, cylindrical, immersed or projecting slightly out of the hymenium, incrustated with crystalline matter especially in the upper 1/3 part, the walls subhyaline to pale brown, thick, smooth or occasionally with a few spine-like processes. Acanthophyses 20–50  $\times$  3–6  $\mu\text{m}$ , clavate to clavate-cylindrical, naked or sometimes covered with fine crystals, the walls subhyaline to rarely tinted brown, thin to thick, smooth but often covered with spines. Basidia clavate-cylindrical, 4-spored. Basidiospores ellipsoid, subhyaline, smooth, amyloid, 4–5  $\times$  2–3.5  $\mu\text{m}$ .

Fruitbodies were observed on dead stems of *Chamaecyparis formosensis* Matsum. and hardwoods collected at Yuanshan, Ilan county (TFRI-258, March, 1992, alt. 700 m), Wuling, Nantou county (TFRI-103, september, 1991, alt. 2100 m) and Kuanwu, Hsinchu county (TFRI-190, January, 1992, alt. 2000 m). Isolates of this fungus had positive oxidase tests on tannic and gallic acid media, indicating the fungus belongs to white rot fungi. It has been pointed out that white rot and white pocket rot are associated with this fungus (Imazeki and Honugo, 1989; Rattan, 1977). Although this species has only been found in the hardwood forests (Imazeki and Hongo, 1989; Rattan, 1977), it has been observed on *Chamaecyparis formosensis* in Taiwan.

*Xylobolus* is a fungus related to *Stereum*. They share some characteristics such as simple septate hyphae, the occurrence of acanthocystidia, and smooth, amyloid basidiospores. However, *Xylobolus* is separated from *Stereum* by its vertically arranged hyphae and by the pseudocystidia, which turns greyish black in sulphovanillin. It also causes a white pocket rot, which is not associated with *Stereum* (Hjortstam *et al.*, 1988). One species of *Xylobolus*, *X. princeps* (Jungh.) Boidin (= *Stereum princeps* Jungh.) (Sawada, 1959), has been recorded in Taiwan.

***Perenniporia ohiensis*** (Berk.) Ryv. Norw. J. Bot. 19: 143, 1972. (Figs. 5 and 12)

Fruitbodies annual, effused-reflexed or sessile.

Pilei solitary, dimidiate, up to  $2 \times 3 \times 4$  cm. Upper surface ivory to brown, glabrous, azonate or faintly zonate, shallowly sulcate; margin ivory glabrous, rounded. Pore surface ivory, the pores circular, 3-5 per mm, with very thick, entire dissepiments. Context white to tan, faintly zonate, firm-corky, up to 4 mm thick. Tube layers concolorous and continuous with the context, indistinctly layered, each layer up to 4 mm thick. Hyphal system, dimitic generative hyphae hyaline, thin-walled, with clamps, rarely branched, 2-4  $\mu\text{m}$  in diameter; skeletal hyphae thick-walled, rarely branched, nonseptate, 2.5-4  $\mu\text{m}$  in diameter. Basidia broadly clavate,  $25-35 \times 12-16 \mu\text{m}$ , with a basal clamp. Basidiospores ellipsoid to ovoid, truncate, hyaline, thick-walled, smooth, dextrinoid,  $13-16 \times 7-10 \mu\text{m}$ .

Fruitbodies were found on dead stems of *Prunus mume* Sieb. ex Zucc. and other hardwoods collected at Tungshin, Taichung county (TFRI-324 and TFRI-332, May, 1992, alt. 300-400 m) and Kuanwu, Hsinchu county (TFRI-404, July, 1992, alt. 1500-2000 m). An isolate of the fungus had positive oxidase tests on tannic and gallic acid media, indicating it is a white rot fungus. *P. ohiensis* is associated with white rot of dead hardwoods (Gilbertson and Ryvarden, 1986). One species (*P. fraxinea* (Ball.: Fr.) Ryv.) in this genus has previously been recorded in Taiwan (Chang, 1992b). *P. ohiensis* is characterized by a very distinctive morphology with its small basidiocarps, large truncate, dextrinoid basidiospores, and weakly dextrinoid context and tramal tissue.

**Polyporus melanopus** Fr. Syst. Mycol. 1: 347, 1821. (Figs. 6 and 13)

Fruitbodies annual, stipitate, terrestrial; stipe central, simple, blackish and velvety above, dark brownish-black and glabrous below, up to 12 cm long and 2 cm thick. Pilei circular, solitary, up to 8 cm in diameter, and 0.5 cm thick. Upper surface reddish-brown to smoky blackish-brown, azonate, smooth to finely scurfy; margin concolorous, often undulating or reflexed. Pore surface whitish, the pores circular to angular,

hyaline, thick-walled, nonseptate, with occasional branching, 2-5  $\mu\text{m}$  in diameter; fusoid cystidioles present,  $16-21 \times 4-5 \mu\text{m}$  with a basal clamp. Basidia clavate,  $18-28 \times 6-8 \mu\text{m}$ , with a basal clamp. Basidiospores cylindric, hyaline, smooth, IKI-,  $7-9 \times 3-3.5 \mu\text{m}$ .

Fruitbodies were found on the ground, collected at Yuanshan, Ilan county (TFRI-420, July, 1992, alt. 600 m). Although *P. melanopus* had terrestrial basidiocarps, it had positive oxidase tests on tannic and gallic acid media, indicating the fungus belongs to white rot fungi. Therefore, its basidiocarps are presumably developed from buried wood.

**Tyromyces incarnatus** Imazeki, Bull. Tokyo Sci. Mus. 6, 1943. (Figs. 7 and 14)

Fruitbodies annual, sessile, solitary or imbricate, dimidiate, 3-6 cm in diameter and 1-1.5 cm thick. Upper surface pale red to red, becoming whitish red when dry, glabrous, smooth to appressed-fibrillose. Pore surface concolorous, the pores round 3-4 per mm, with thin, entire dissepiments. Context white to whitish red, soft, fibrous, up to 7 mm thick. Tube layer concolorous, up to 4 mm. Hyphal system monomitic, generative hyphae hyaline, thin-walled, with clamps, 3-5  $\mu\text{m}$  in diameter. Basidia clavate,  $18-28 \times 6-8 \mu\text{m}$ , with a basal clamp. Basidiospores ovoid to subglobose, hyaline, smooth, IKI-,  $4-5 \times 2.5 \mu\text{m}$ .

Fruitbodies were observed on dead trunks of hardwoods, collected at Hsihhsien, Taipei county (TFRI-419, July, 1992, alt. 800-1000 m). Since the rotting type of this species was unknown, Imazeki (1943) tentatively arranged it to the genus *Tyromyces*, based on the assumption that the fungus belongs to white rot fungi. However, if it is a brown rot fungus, it should be put in the genus *Oligoporus* (Imazeki and Hongo, 1989). Unfortunately, the author did not obtain a pure culture of this fungus to test its rotting type. Therefore, the original taxa position is still used. Although it has been reported as being native only to Japan (Imazeki and Hongo, 1989), it has also been observed in Taiwan.

velutinate to finely pubescent, becoming smooth with age, whitish to grayish blue, margin sharp and undulating. Pore surface white to pale grayish, the pores angular and finely dentate in the pore-mouths, about 4 per mm, tubes concolorous, up to 8 mm deep. Context soft when fresh, harder when dry, white to grayish, up to 5 mm thick. Hyphal system monomitic, generative hyphae with clamps and weakly amyloid. Basidiospores allantoid and bent, smooth, hyaline, weakly amyloid in fresh specimens,  $4-5 \times 1-1.5 \mu\text{m}$ .

Fruitbodies were found on dead trunks of hardwoods, collected at Yuanshan, Ilan county (TFRI-198, January, 1992, alt. 700-800 m). The isolate of this fungus had positive oxidase tests on tannic and gallic acid media, indicating it is a white rot fungus. It is associat-

lophorales (Basidiomycotina) from Taiwan. Bot. Bull. Acad. Sin. 33: 327-334.

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genus is new to Taiwan. So far, only *Tyromyces incarnatus* and *T. subcaesioides* have been found in Taiwan.

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## 七種台灣新紀錄之木材腐朽無褶菌

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本文報導七種台灣新紀錄之木材腐朽無褶菌 *Cymatoderma lamellatum*, *Xylobolus frustulatus*, *X. subpileatus*, *Pereniporia ohiensis*, *Polyporus melanopus*, *Tyromyces incarnatus* 和 *T. subcaesius* 上述七種無褶菌均屬白色腐朽型。*P. melanopus* 雖採自土壤，但由於其為白腐朽菌，因此假設其生長自埋在土壤的木材。兩種 *Xylobolus* 菌類可引起白口囊腐朽。上述七種菌類採自腐朽闊葉樹或針葉樹之莖、根或枝條。