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TAXONOMY OF PHANEROCHAETE CHRYSORHIZON

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During type studies leading toward a monograph of *Phanerochaete* Karst., the type specimen of *Hydnum chrysorhizon* Torrey in Eaton (1822, p. 309) [≡ *Phanerochaete chrysorhizon* (Torr. in Eaton) Budington et. Gilbn.] and the type specimens of its facultative (taxonomic) synonyms were studied. Among these synonyms was the name *Hydnum omnivorum* Shear (1925). This name was applied to a species that Shear felt was probably the perfect state of *Phymatotrichum omnivorum* (Shear) Duggar (1916) [≡ *Phymatotrichopsis omnivorum* (Shear) Hennebert (1973, p. 199)]. These two species are probably not, as Shear supposed, different states of the same organism but to date this has not been demonstrated unequivocally.

When he published the name *Hydnum omnivorum*, Shear indicated (1925, p. 477) the "type" to be his number 5267, on *Maclura aurantiaca* [≡ *Maclura pomifera* (Ref.) Schmeid.], near Paris, Texas, September 1903, and provided a painting

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of the specimen. In BPI^{2/} a specimen with the same collection data was found (cited by Gilbertson 1964, p. 22). Further indication that it is the same specimen referred to by Shear is the fact that it matches exactly the painting accompanying the description provided by Shear. The twigs and thorns of the twigs branch at the same angle and are located in the same place relative to each other as they are in the painting. There is no doubt that this is the type specimen for *H. omnivorum* Shear.

The use of the name *Hydnum omnivorum* has been challenged recently by Hennebert (1973, p. 199), who states that the name refers to a Basidiomycete but is based on a type specimen that is a member of the Fungi Imperfecti. His studies of the type specimen apparently revealed neither basidia nor basidiospores, and he, therefore, considers the name illegitimate.

However, our studies of the type specimen revealed the presence of a basidiomycetous hymenium with cystidia, holobasidia, and basidiospores. Shear reported seeing none of these structures but was not in doubt as to the specimen's being a Basidiomycete, as indicated by his text and the name he provided for it.

The epithet *omnivorum*, although probably an unfortunate choice since it is probably not the perfect state of *P. omnivorum*, fulfills the requirements for both legitimate and valid publication.

The recent use of the epithet *chrysorhizon* also deserves discussion. Gilbertson (1964, p. 23) treated *H. omnivorum* as a synonym of *H. chrysorhizon*. The two were also considered conspecific by Gilbertson, et al. (1974, 1976), Lindsey and Gilbertson (1975), and Burdsall (1976). In all four publications the name *Phanerochaete chrysorhizon* was used to encompass both species. More recent studies, however, indicate that *H. omnivorum* is a distinct species, differing from *H. chrysorhizon* in basidiocarp color, basidiospore size, cystidium characters, and distribution.

^{2/} Herbarium abbreviations are those of Holmgren and Keuken (1974).

Parmasto (1967, p. 384) proposed the genus *Hydnophlebia* Parm. for *H. chrysorhizon*. If this genus is recognized, then *Hydnum omnivorum* should be included. However, we do not feel that the hydneous basidiocarp, which is the only character by which these species differ from members of *Phanerochaete*, warrants this segregation. We recognize both as members of the genus *Phanerochaete*.

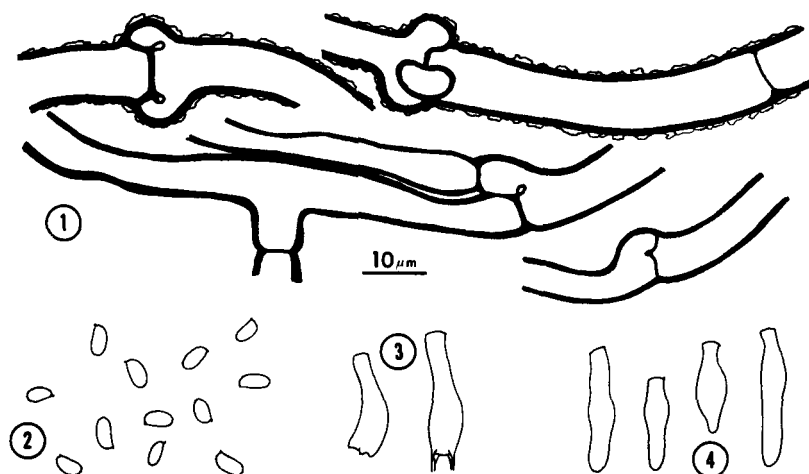
A description of the basidiocarp characters and culture characters of each species is offered. The specimens marked with an * are those from which cultures were studied. All specimens and cultures cited are on deposit at CFMR unless otherwise indicated.

- Phanerochaete chrysorhizon (Torr. in Eaton) Budington et Gilbn. Southwest Nat. 17:417. 1973. Figs. 1-9.
- ≡ *Hydnum chrysorhizon* Torr. in Eaton. Manual Bot., Ed. 3, p. 309, 1822.
- ≡ *Oxydontia chrysorhiza* (Torr. in Eaton) Rogers et G. W. Martin. Mycologia 50:308. 1958.
- ≡ *Mycoacia chrysorhiza* (Torr. in Eaton) Aoshima et Furukawa. Trans. Mycol. Soc. Japan. 7:135. 1966.
- ≡ *Hydnophlebia chrysorhiza* (Torr. in Eaton) Parm. Est. Nsv. Tead. Akad. Toim. 16:384. 1967.

Basidiocarp broadly effused, extending up to 20 x 10 cm, thin, membranous, easily separable, reddish orange (7A8)^{3/} to deep orange (near 5A8), hydneous, teeth widely spaced to dense, up to 1.5 mm long, cylindrical or tapered to rounded apex, orange white (5A2) to pale orange (5A3); margin fimbriate to rhizomorphic, up to 1 mm diam, reddish orange (near 7A8).

Hyphal system monomitic; subiculum not differentiated from abhymenial surface, 250-500 μm thick (excluding teeth), a textura intricata to textura porrecta; hyphae (Fig. 1) 4-7 (-9) μm diam, hyaline to pale yellow, thick-walled (walls up to 2 μm thick) or with only slight thickening, usually densely encrusted with hyaline crystals, septa widely spaced, lacking clamps at most septa, some septa clamped, rarely with several clamps at one septum,

^{3/} Color notations are those of Kornerup and Wanscher (1967). The notation indicates plate number, vertical column, and horizontal columns, respectively.



Figs. 1-4.—*P. chrysorhizon* (type). Line drawings of microscopic structures from basidiocarps. 1. subicular hyphae. 2. basidiospores. 3. basidia. 4. cystidia.

branching frequent, mostly at nearly right angles; tooth trama a compact *textura porrecta* oriented perpendicular to substrate, hyphae like those of subiculum; subhymenium a compact *textura porrecta*, short-celled, hyaline, thin-walled, lacking clamps, smooth, or lightly coated with pale yellow granules; cystidia (Fig. 4) ventricose, smooth, thin-walled, hyaline, $18-40 \times 4.5-6 \mu\text{m}$, lacking clamps at basal septa; basidia (Fig. 3) clavate to broadly clavate, $15-20 \times 4.5-6 \mu\text{m}$, hyaline, thin-walled, lacking clamps at basal septa, 4-sterigmate, sterigmata $3-3.5 \mu\text{m}$ long; basidiospores (Fig. 2) $4-5 \times 2-2.5 \mu\text{m}$, ovoid to narrowly ovoid, slightly flattened adaxially, hyaline, thin-walled, smooth, negative in Melzer's reagent, acyanophilous.

Specimens Examined: FLORIDA—HHB 4720, HHB 4733, and HHB 6372, on *Quercus* sp. (oak), behind Mall, State Route 441; HHB 6452, on oak, University of Florida Horticulture Unit; HHB 6468, on *Liquidambar styraciflua* L. (sweetgum); and HHB 6478*, on *Carpinus caroliniana* Walt. (American hornbeam), Hogtoun Creek Basin, NW 8th Street; all from Gainesville, Alachua County; HHB 7202, on *Nectandra coriacea* (Sw.) Griseb. (Jamaica nectandra), Gumbo Limbo Trail, Everglades National Park, Dade County. MARYLAND—

HHB 622*, on oak, Patuxent Wildlife Research Refuge. Laurel, Prince Georges County. MISSISSIPPI--HHB 8870*, on oak, and HHB 8871*, on *Pinus taeda* L. (loblolly pine), both 5 miles W of Wiggins, S of Red Creek, Stone County; HHB 8917, on *Cornus florida* L. (flowering dogwood), Hammock. Harrison Experimental Forest, Harrison County. NEW YORK--RLG 5507*, on *Populus grandidentata* Michx. (bigtooth aspen), Otisco Rd., Otisco, Onondaga County. NORTH CAROLINA--HHB2652. on *Fraxinus* sp. (ash), Scaly School-Dryman Chapel Rd., Nantahala National Forest, Macon County; HHB 4352, on flowering dogwood, along Kephart Prong, Great Smoky Mountains National Park, Swain County. SOUTH CAROLINA--Curtis 2608, on oak, April 1849, Society Hill. Darlington County, isotype of *Hydnum fragillissimum* Berk. et Curt., (FH). TENNESSEE--HHB 3012*, on *Juglans* sp. (walnut), near Cable Mill, Cades Cove, Blount County, and HHB 4134, on *Acer* sp. (maple), Snake Den Trail, Cocke County, both from Great Smoky Mountains National Park. WISCONSIN--HHB 9375, on *Populus tremuloides* Michx. (quaking aspen). Blue Mounds State Park, Iowa County.



Fig. 5.--Cultures of *P. chrysorhizon* (on right showing no growth) and *H. omnivorum* (on left) grown at 36 C on malt extract agar for 14 days.

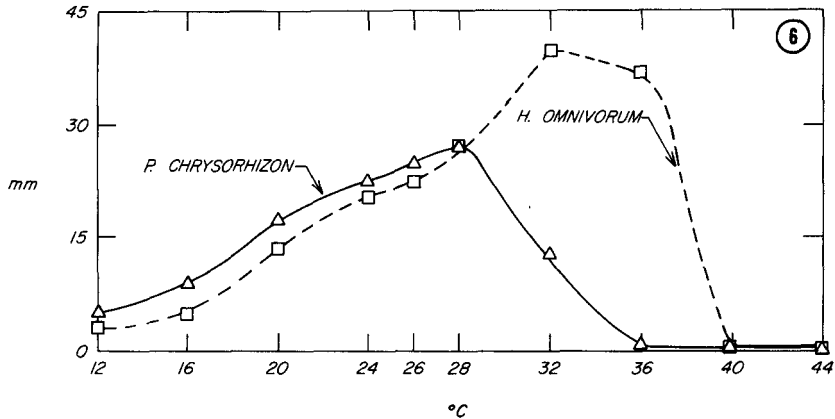


Fig. 6.--Graph showing growth of *P. chrysorhizon* and *H. omnivorum* at 10 constant temperatures on malt extract agar after 7 days.

Culture description

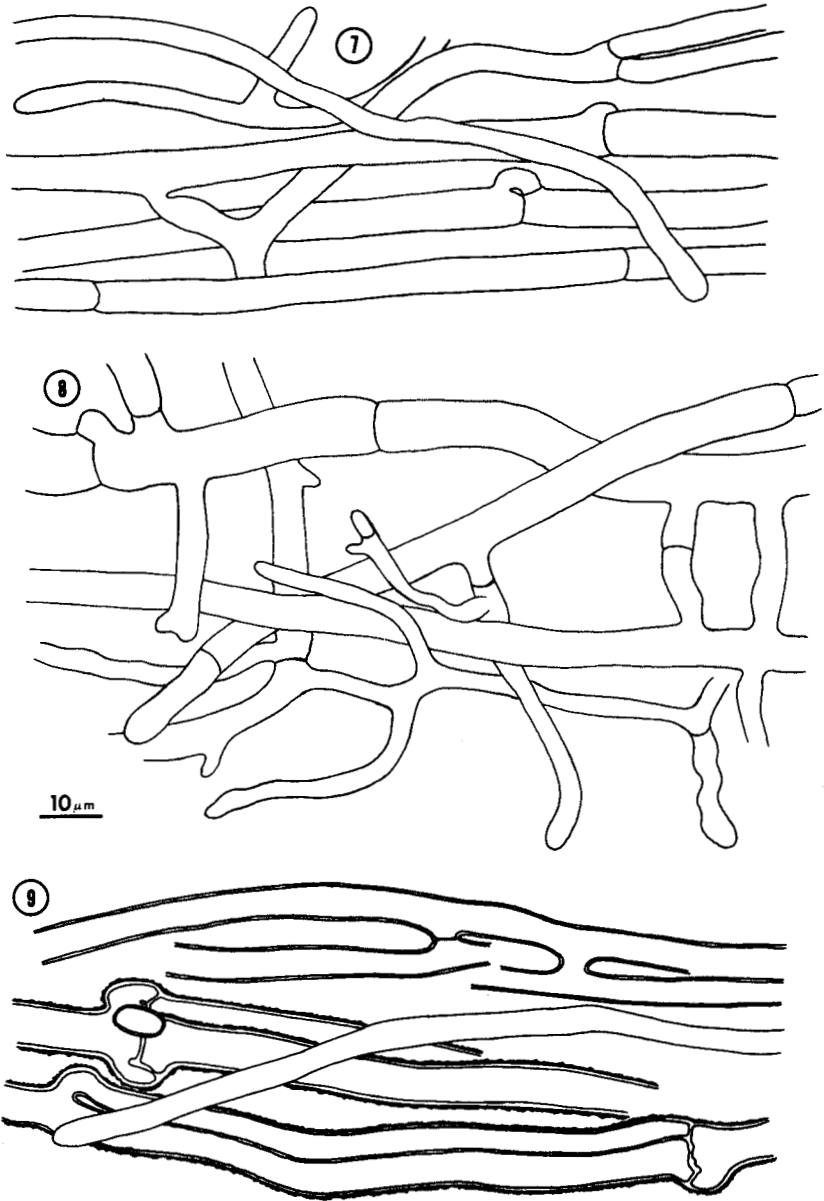
Species Code : 2.5.16.32.37.40.42. -43.54.55 (using Nobles (1965) system).

Key Pattern : B-P-I-1-10-14 (using Davidson et al. (1942) system).

Growth on 1.5% malt extract agar at 25 C moderate, 25-35 mm radius/wk, optimum growth at 28 C, trace of growth at 36 C (Figs. 5, 6); mat thin, appressed, white, becoming slightly orange, some isolates eventually with zones of orange wooly aerial hyphae, hyphae near inoculum orange; margin indistinct, even; reverse bleached; odor mild; not fruiting in 6 wk.

On gallic acid agar after 1 wk at 25 C diffusion zone up to 35 mm diam, light reaction, trace of growth; on tannic acid agar diffusion zone up to 20 mm diam, light reaction, no growth.

Marginal hyphae (Fig. 7) 2.5-7 μ m diam, hyaline, thin-walled, with occasional branching, especially on narrower hyphae, mostly simple septate, with rare single or multiple clamps; aerial hyphae (Fig. 9) (2.5-) 4-7 μ m diam, hyaline to pale yellow, with slightly thickened to thick walls, often aggregated to form orange cordons, usually covered



Figs. 7-9. -*P. chrysorhizon* (HHB 8871). Line drawings of microscopic structures from culture. 7. hyphae of margin. 8. submerged hyphae. 9. aerial hyphae.

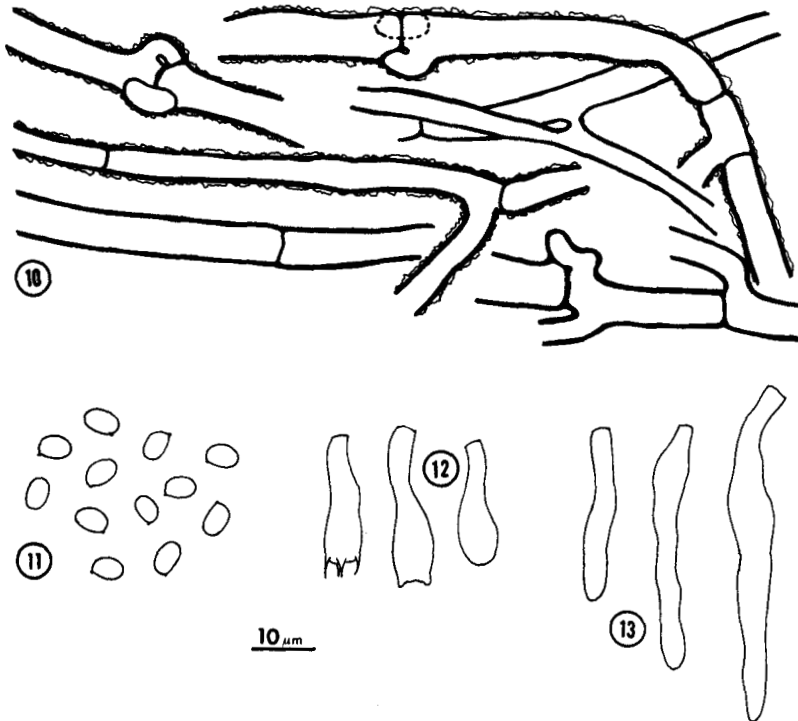
with yellow granules, mostly simple septate with rare single or multiple clamps; submerged hyphae (Fig. 8) 5-7 μm diam, hyaline, thin-walled, with rare clamps, broad hyphae with infrequent branching usually producing narrow much branched hyphae.

Phanerochaete omnivorum (Shear) comb. nov.

Figs. 5, 6, 10-16.

\equiv *Hydnum omnivorum* Shear, J. Agric. Res. 30:476. 1925.

Basidiocarps effused in small often poorly developed patches, thin, membranous, creamy yellow, adnate to somewhat separable, hydnceous; teeth up to 1 mm long, tapered to apex; subiculum white, fibrous to byssoid; margin white, thick, fibrillose and irregular in outline or rhizomorphic; rhizomorphs white, usually poorly developed, occasionally well developed and up to 0.25 mm diam.



Figs. 10-13.-- *H. omnivorum* (type). Line drawings of microscopic structures from basidiocarps. 10. subicular hyphae. 11. basidiospores. 12. basidia. 13. cystidia.

Hyphal system monomitic; subiculum a texture intricata, hyphae (Fig. 10) 5–9 (–12) μm diam, with slight wall thickening, hyaline, with clamps at some septa, sometimes multiple clamps present, with dense encrustation on some hyphae, branching at near right angles; subhymenium a compact textura porrecta, hyphae 3.5–4.5 μm diam, some areas with irregular swellings up to 6 μm becoming a textura epidermoidea, hyaline, thin-walled, much branched, smooth or with scattered hyaline granules; hymenium with cystidia and basidia; cystidia (Fig. 13) poorly developed, hyphoid, thin-walled, hyaline, of irregular length, up to 4 μm diam, protruding up to 20 μm beyond basidia; basidia (Fig. 12) (15–) 20–25 (–27) \times (5.5–) 6–7 μm , clavate, hyaline, thin-walled, lacking clamps at base, 4–sterigmate, sterigmata up to 4 μm long; basidiospores (Fig. 11) 5–6 \times 3–3.5 μm , nearly ovoid, slightly flattened adaxially, hyaline, thin-walled, smooth, negative in Melzer's reagent, acyanophilous.

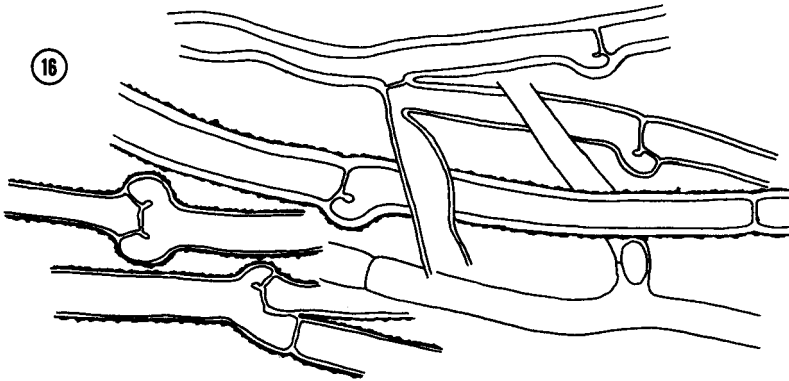
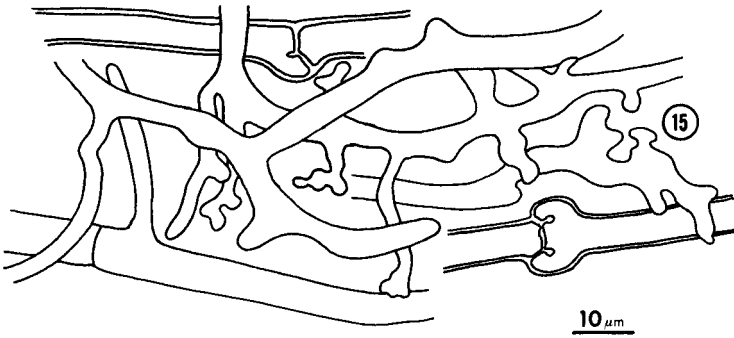
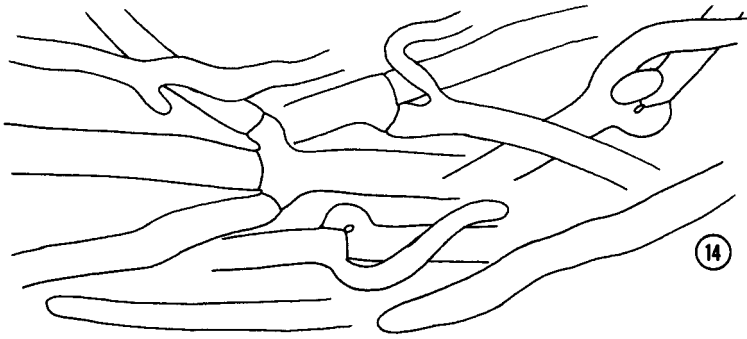
Specimens Examined: ARIZONA—HBB 6218 and HBB 6227, on *Platanus wrightii* S. Wats. (Arizona sycamore), and HBB 6228*, on *Acacia* sp. (acacia), all from Peloncillo Mts., Cochise County; KKN 187 on *Fouquieria splendens* Engelm. (ocotillo), highway 90, milepost 299, Cochise County (ARIZ). HBB 5969*, on Arizona sycamore, and HBB 5972, on *Chilopsis Linearis* (Cav.) Sweet (desert willow), Redington, Pima County; HBB 8426, on *Baccharis* sp. (desert broom), Tucson, Pima County; RLG 10887 and RLG 10888, on *Prosopis juliflora* (Sw.) DC (mesquite), Santa Catalina Mts., Pima County (ARIZ); JPL 72, on *Carnegia gigantea* (Engelm.) Britt. et Rose (saguaro), Saguaro Nat. Monument—West Unit, Pima County (ARIZ); KKN 90, KKN 102, KKN 112*, and KKN 113, on ocotillo, Santa Rita Expt. Range, Pima County (ARIZ); RLG 10857, on ocotillo, Santa Catalina Mts., Pima County (ARIZ); RLG 10391, on mesquite, Galliuro Mts., Pinal County (ARIZ); RLG 10507, on mesquite, Baboquivari Mts., Santa Cruz County (ARIZ).

Culture description

Species Code: 2.5.16.20.24.32.37.40.42.-43.54.

Key Pattern: B-P-M-1-9-11-14-16.

Growth on 1.5% malt extract agar at 25 C moderate, 25–35 mm radius/wk, optimum growth at 32 C, rapid growth at 36 C (Figs. 5, 6); mat thin, wispy downy to woolly cottony, white, becoming yellow orange near inoculum, eventually



Figs. 14-16.--*H. omnivorum* (HHB 6228). Line drawings of microscopic structures from culture. 14. hyphae of margin. 15. submerged hyphae. 16. aerial hyphae.

spreading over plate and developing cordons; margin appressed, even; reverse bleached; odor mild; not fruiting in 6 wk.

On gallic acid agar after 1 wk at 25 C diffusion zone 15–20 mm diam, very light reaction, no growth; on tannic acid agar diffusion zone 35–40 mm, very light reaction, no growth.

Marginal hyphae (Fig. 14) 3.5–7 μm diam, hyaline, thin-walled, frequently branched, mostly simple septate with rare single or multiple clamps; aerial hyphae (Fig. 16) 4–7 μm diam, hyaline to pale yellow, thin- to thick-walled, often aggregated to form cordons, usually encrusted with yellow granules, simple septate with rare single or multiple clamps; submerged hyphae (Fig. 15) of two types: (a) similar to aerial hyphae but lacking encrustations; (b) 1.5–5 μm diam, hyaline, thin-walled, septa rare, clamps lacking, irregularly branched and contorted, nonstaining in KOH-phloxine mounts.

Remarks: Macroscopically *P. chrysorhizon* and *P. omnivorum* are distinguished on the basis of basidiocarp color and rhizomorph development. *Phanerochaete chrysorhizon* is bright orange with well developed orange rhizomorphs and somewhat paler spines; *P. omnivorum* is yellow or cream (including spines) with a white fimbriate to slightly rhizomorphic margin.

Microscopically *P. omnivorum* can be separated from *P. chrysorhizon* because of its broader spores, usually fewer cystidia, and a tendency toward thinner-walled hyphae (walls usually 1 μm thick while those of *P. chrysorhizon* are often 2–3 μm thick).

In culture the two species can be separated readily when grown at 36 C (Figs. 5, 6). *Phanerochaete chrysorhizon* grows only 1–2 mm in 2 wk while *P. omnivorum* nearly covers the plate in that time. At 25 C the two are not readily distinguishable.

Ecologically these species occupy vastly different niches. *Phanerochaete omnivorum* occurs on desert hardwood shrubs and trees, while *P. chrysorhizon* inhabits hardwoods

(rarely conifers) in more moist areas. The specimens examined indicate that *P. omnivorum* occurs in the southwestern United States and east into Texas while *P. chrysorhizon* occurs throughout the eastern United States and west into Mississippi. An overlapping distribution in Texas is to be expected because there the dry and moist regions meet.

LITERATURE CITED

- Burdsall, H. H., Jr. 1976. Taxonomic and distributional notes on corticiaceous fungi of the southern Appalachians, pp. 265-286. In Parker, B. C., and M. K. Roane (Eds.), Distributional history of the biota of the southern Appalachians. IV. Algae and fungi. Univ. Press of Virginia, Charlottesville, 416 pp.
- Davidson, R. W., W. A. Campbell, and D. B. Vaughn. 1942. Fungi causing decay of living oaks in the eastern United States and their cultural identification. USDA Tech. Bull. 785. 65 pp & 2 pl.
- Duggar, B. M. 1916. The Texas root rot fungus and its conidial stage. Ann. Missouri Bot. Gard. 3:11-23.
- Eaton, A. 1822. Manual of botany. Third edition. Albany. 524 pp.
- Gilbertson, R. L. 1964. Resupinate hydneous fungi of North America. Pap. Michigan Acad. Sci. Arts Lett. 49:15-25.
- Gilbertson, R. L., H. H. Burdsall, Jr., and E. R. Canfield. 1976. Fungi that decay mesquite in southern Arizona. Mycotaxon 3:487-551.
- Hennebert, G. L. 1973. *Botrytis* and *Botrytis*-like genera. Persoonia 7:183-204.
- Holmgren, P. K., and W. Keuken. 1974. Index herbariorum. I. Sixth edition. Reg. Veget. 92:1-397.
- Kornerup, A., and J. H. Wanscher. 1967. Methuen handbook of colour. Second edition. Methuen and Co., Ltd., London, 243 pp.

- Lindsey, J. P., and R. L. Gilbertson. 1975. Wood-inhabiting Homobasidiomycetes on saguaro in Arizona. *Mycotaxon* 2:83-103.
- Nobles, M. K. 1965. Identification of cultures of wood-inhabiting hymenomycetes. *Can. J. Bot.* 43:1097-1139.
- Parmasto, E. 1967. Corticeaceae URSS. IV. Descriptiones taxonum novorum. *Combinaciones novae. Est. NSV Tead. Akad. Toim.* 16:377-394.
- Shear, C. L. 1907. New species of fungi. *Bull. Torrey Bot. Club* 34:305-315.
- Shear, C. L. 1925. The life history of the Texas root rot fungus *Ozonium omnivorum* Shear. *J. Agric. Res.* 30:475-477.

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