

North American Fungi



Volume 3, Number 7, Pages 261-267
Published August 29, 2008
Formerly *Pacific Northwest Fungi*

Armillaria solidipes*, an older name for the fungus called *Armillaria ostoyae

Harold H. Burdsall, Jr.¹ and Thomas J. Volk²

¹Center for Forest Mycology Research, Forest Products Laboratory, One Gifford Pinchot Drive, Madison, WI 53726, USA and Fungal & Decay Diagnostics, LLC, Black Earth, WI 53515 USA burdsall@fungaldecay.com, www.fungaldecay.com; ²Department of Biology, 3024 Cowley Hall, University of Wisconsin – La Crosse, La Crosse, WI 54601 USA, volk.thom@uwlax.edu; <http://TomVolkFungi.net>

Burdsall, H. H., Jr., and T. J. Volk. 2008. *Armillaria solidipes*, an older name for the fungus called *Armillaria ostoyae*. *North American Fungi* 3(7): 261-267. doi: 10.2509/naf2008.003.00717

Corresponding author: H.H. Burdsall, Jr., burdsall@fungaldecay.com. Accepted for publication July 9, 2008. <http://pnwfungi.org> Copyright © 2008 Pacific Northwest Fungi Project. All rights reserved.

Abstract: The name *Armillaria ostoyae* has been applied for nearly 40 years to the *Armillaria* species that causes a major root-rot of conifers throughout Europe, the northern United States, much of Canada, and more recently in China. However, C.H. Peck described this species in 1900 under the name *A. solidipes*, well before the name *A. ostoyae* was coined by Romagnesi in 1970. Thus, the name *A. solidipes* must be used for the taxon wherever it occurs.

Key Words: root-rot, conifer, *Armillaria solidipes*, *Armillaria ostoyae*

Introduction: Nine named species of *Armillaria* (Fr.:Fr.) Staude are known from North America. Several of these, the most common, have taken their names from similar appearing and apparently genetically compatible European *Armillaria* species, including *A. mellea* (Vahl: Fr.) P. Kummer, *A. gallica* Marxmüller et Romagnesi, *A. cepistipes* Velenovský, *A. tabescens* (Scopoli) Emel, and *A. ostoyae* (Romagnesi) Herink. The others, *A. sinapina* Bérubé et Dessurealt, *A. calvescens* Bérubé et Dessurealt, *A. gemina* Bérubé et Dessurealt and *A. nabsnona* Volk et Burdsall were described from North America. Another biological species, North American Biological Species (NABS) X, is known only from vegetative culture and has not been described and named.

Armillaria ostoyae (= NABS I, = European Biological Species (EBS) C) is a common associate of conifer forests in north temperate latitudes, associated with root disease centers wherever it occurs (Kile et al, 1991). However, it is not restricted to conifers as a host. It may occur on hardwoods and is a serious problem in Michigan in *Malus* and *Prunus* orchards (Proffer et al, 1987). It fruits in various size clusters (often of 100 or more basidiomes) at the base of dead or dying trees and from stumps. Individual basidiomes can grow to large dimensions, especially in the Pacific Northwest.

Volk and Burdsall (1995) addressed the nomenclature of *Armillaria* species and the problems that resulted in the coining of the epithet for *A. ostoyae*. The problems included a number of competing epithets that lacked sufficient means of interpretation or were superfluous, e.g. *Armillaria obscura* (Schaeffer) Herink, *Armillariella polymyces* (Persoon) Singer & Cléménçon, *Armillaria montagnei* var. *umbrinobrunnea* Singer, and *Agaricus congregatus* Bolton. This resulted in the

publishing of the new name *Armillariella ostoyae* Romagnesi (1970) for that fungus, later transferred to *Armillaria ostoyae* (Romagnesi) Herink (1973). Later, Korhonen (1978) used the biological species concept to demonstrate mating incompatibility of EBS C (now called *A. ostoyae*) with the other four European biological species, thus supporting the morphological distinctions. Anderson and Ullrich (1979) and Anderson et al. (1980), using the biological species concept in North America, delimited the native representatives of the genus. Their work identified several unique North American biological species (NABS) and several NABS that demonstrated compatibility with European biological species, including NABS VI, which was compatible with EBS C, *A. ostoyae*. From that point to date, the *Armillaria* species causing an important root-rot of conifers in the northern United States and in Europe was called *A. ostoyae*. In their nomenclatural treatment of *Armillaria* and *Armillariella*, Volk and Burdsall (1995) also accepted that conclusion, that the European and North American representatives were conspecific.

In addressing another name, *Armillaria solidipes* Peck (1900), in that publication Volk and Burdsall (1995) stated that from the description that this name appeared to represent a true *Armillaria* species. The description reads:

“*Armillaria solidipes*

Pileus fleshy, convex, even, glabrous, tawny or yellowish brown, tinged with red in drying, flesh whitish; lamellae rather close, adnate or slightly decurrent, white or whitish; stem long, firm solid, colored like the pileus.

Pileus 2.5 – 5 cm. broad; stem 10 – 25 cm. long, 6 -12 mm thick.

Densely cespitose. About spruce stumps. Colorado. September. E. Bartholomew. Spores not seen.”



Figures 1 – 4. *Armillaria solidipes*. Fig. 1. Holotype specimen label (FH). Figs. 2 – 3. Holotype specimen. Fig. 4. Basidiospores from oltotype.

Materials and Methods: We examined the specimen that Peck designated “type” of *A. solidipes* (FH), (Figs. 1 – 4). A number of specimens from several localities in the USA identified as *Armillaria ostoyae* were also examined. Representatives are cited below. Specimens were examined microscopically as hand sections mounted in 2% aqueous KOH and also in Melzer’s reagent.

Results: The holotype specimen is in good condition but has been pressed and has crystalline deposits (preservative?) scattered over the surface (Figs. 2 – 3). Critical microscopic study along with evaluating the collection data, indicates that it is not only a true *Armillaria* species but also revealed that it agrees in every way microscopically with North American specimens called *A. ostoyae*. The macroscopic description agrees with what is presently called *A. ostoyae* and the ecology/habit/habitat (Densely caespitose. About spruce stumps.

Colorado. September) is typical of that species. A description of the preserved type specimen follows:

Pileus (Figs. 2, 3) 2.5-4.5 cm diam, planate (due to specimen having been pressed?), slight indications of a surface tomentum, color tan to reddish brown, slightly darker toward the center; margin regular, even, rolled under, concolorous or paler brown than the disc. Lamellae well formed, extending to the margin, concolorous with the pileus and stipe, 2.0-3.0 mm deep, decurrent by a thin line, giving a slight striped appearance to the apex of the stipe. Stipe central (Figs. 2, 3), 95-105 X 6.0-12.0 mm, nearly cylindrical above, widening in the lower half to as much as 12 mm before tapering to pointed base as the aggregated stipes are compacted; surface smooth, concolorous with other parts of the basidiome, surface fibrils not evident. Stipe flesh loose and fibrous, stipes appear to have been nearly hollow before pressing of the specimens.

Annulus not evident except for a small floccose area on the margin of one pileus. Pileus flesh up to 3.0 mm thick over disc, thinning toward the margin.

Pileus cutis a compact layer about 100µm thick, hyphae 3.0–5.0 (-7.5)µm diam, smooth, thin walled, simple septate, arranged parallel to the pileus surface. Poorly preserved apparent aggregations of vertically arranged hyphae 2.5–4.0 (-7.5) µm diam, (remnants of surface fibrils and tufts?) of various lengths, smooth, nearly hyaline but with a pale yellow or yellow-brown tint, thin walled, simple septate. The cutis grades abruptly into the pileus trama, the latter composed of interwoven hyphae 2.5–7.0 (-12) µm diam, narrow hyphae cylindrical, wider hyphae broadly ovoid or short cylindrical, hyaline, smooth, mostly thin walled, simple septate. Lamella trama continuous with the pileus trama, becoming more vertically oriented, loosely interwoven to nearly parallel, hyphae 2.5 – 4.0 (7.5)µm, some smaller ones with inconspicuous clamp connections at the septa, especially in or near the subhymenium. Subhymenium rather abruptly differentiated, tightly compact, hyphae 2.5–4.0µm diam, hyaline, smooth, thin walled, simple septate or with clamp connections at some septa, giving rise to basidia. Basidia clavate, hyaline, 4-sterigmate, smooth, thin-walled, some with clamp connections at the base. Cystidia lacking. Basidiospores (Fig. 4) 7.5–9.5 X 5.0–6.5 µm, smooth walled, ellipsoid with slight adaxial flattening, hyaline, smooth, with slight wall thickening, not reacting with Melzer's reagent.

For comparison, a composite description of *A. solidipes*, derived from the study of a number of specimens previously determined as *Armillaria ostoyae* follows:

Armillaria solidipes Peck, Bull. Torrey Bot. Club 27(12):611. 1900. (Figures 5 & 6)

=*Armillaria ostoyae* (Romagnesi)

Herink, Herink, J., 1973. Taxonomie

Václavky Obecné- *Armillaria mellea*

(Vahl: Fr.) Kumm. Vysoká Skola Zem_d_lska V Brné. Vyznamenaná Rádem Prace BRNO; J. Hasek, ed. pp. 21-48

=*Armillariella ostoyae* Romagnesi, Bull. Trimest. Soc. Mycol. France 86:260. 1970. (See Volk and Burdsall 1995, for complete synonymy)

Pileus (Figs. 5, 6) 4–10 cm diam, at first nearly hemispherical, becoming broadened and planate, sometimes with a slight umbo, early stages dark brown and with dense tomentum of fibrils, later becoming paler, tan to brown to yellowish brown or reddish brown, smooth or with fibrils (darker brown than ground color) scattered over the surface, more densely concentrated toward the center of the pileus, often as an appressed tomentum as in the very young stages; margin regular, even, at first rolled under, often remaining turned down even in age, concolorous with the center or paler brown or tan, sometimes with shallow radially arranged ridges extending about 2 - 5 mm toward the disc, in age somewhat hygrophanous, unevenly colored, frequently smooth due to the loss of the surface fibrils.

Lamellae substantial (neither coarse nor fragile), extending to the margin, cream-color at first but soon becoming shades of buff and darker to rose or nearly burgundy where bruised, 2 - 5 mm deep, with several series of lamellulae, decurrent by a thin line, these white to cream-color at first giving a slight striped appearance to the stipe above the annulus.

Stipe central, 50–120 X 3–50 (-70) mm, nearly cylindrical above and widening in the lower half to as much as 70 mm before tapering to pointed bases as the aggregated stipes are compacted, smooth or with scattered (sometimes many) floccose remains of the partial veil over upper portion, base pale cream-color to tan, soon becoming brown, sometimes with an olive tint, often with a fibrous appearance on the surface of



Figures 5 – 6. *Armillaria solidipes*. Basidiomes from Idaho, United States.

the base, above the annulus pale pink between white to cream-colored narrow streaks that are extensions of the lamellae..

Annulus heavy, fibrous to cottony, persistent although sometimes remaining attached tightly to the pileus margin, with a wide thick margin that is heavier than the attachment to the stipe, white to cream-colored, with areas of yellow or brown pigment similar in color to the squamules on the stipe.

Pileus flesh up to 10 mm thick in disc, thinning quickly toward the margin, white, at first appearing fibrous but soon softening and becoming infested with insect larvae, pink to light red pigments develop around the insect holes. Stipe flesh similar to the cap flesh but more distinctly fibrous, soon infested by larvae and becoming nearly hollow, with pink pigment in the larva holes which quickly become brown. Pileus cutis a tightly compacted tissue 100-120

um thick, composed of vertically arranged hyphae 2.5-5.0 (-7.5) μm diam, mostly of the narrowest diam, of various lengths, nearly hyaline but with a pale yellow or yellow-brown tint, thin walled, simple septa, smooth walled; the cutis hyphae giving rise to surface fibrils composed of aggregations of hyphae up to 5-12 (-20) μm in diam and up to 120 μm in length, walls up to 2 μm thick and yellow-brown. The cutis grades abruptly into the pileus trama, the latter composed of interwoven hyphae 2.5-16 (-20) μm , narrower hyphae cylindrical, wider hyphae broadly ovoid or short cylindrical, hyaline, mostly thin-walled, simple septate. Lamella trama continuous with the pileus trama, becoming more vertically oriented, at first divergent but soon appearing loosely interwoven or nearly parallel in some areas, hyphae variable in size and shape 2.5 - 16 (-20) μm , some smaller ones with clamp connections, especially near the subhymenium. Subhymenium rather abruptly differentiated, tightly compacted, hyphae 2.5 - 4 μm diam, hyaline, thin-walled, with clamp connections, giving rise to basidia. Basidia clavate, hyaline, 4-sterigmate, thin-walled or in older specimens rarely to frequently with walls up to 2 μm thick. Cystidia lacking. Basidiospores white in mass, 8-11 X 5.5-7 μm , ellipsoid with slight adaxial flattening, hyaline, with slightly thickened walls, but sometimes with walls up to 1.5 μm thick, smooth or with slight surface irregularity, not reacting with Melzer's reagent.

Representative specimens examined: Holotype: Coll. E. Bartholomew, *North American Fungi* 2690, Sept. 2, 1899, at the base of old spruce (*Picea* sp.) stump, Mill Creek, Gunnison County, Colorado (FH); (others filed as *A. ostoyae*). Canada - British Columbia, Ancient Cedars Trail, HHB-13497, on living *Pseudotsuga menziesii*; Brandywine Falls Trail, HHB-13591, on *Tsuga heterophylla* stump; Cougar Mt., HHB-13607, on *Tsuga heterophylla*. USA - Idaho, Bonner County, HHB-12893, on *Linnaea borealis*; HHB-12907, on *Thuja plicata*; Kootnai County, HHB 12916, on unidentified conifer stump. Wisconsin,

Sawyer County, SA-4, on *Abies balsamia*;
Ashland County, SA-6, on *Pinus strobus*. (All
CFMR)

Comment: It should also be mentioned that in Volk and Burdall (1995) the citation for the original description of *A. ostoyae* is in error. It is indicated as page 265, which is location of the Latin diagnosis. The description of the new species, "*Armillariella ostoyae*" begins on page 260. The correct citation is used above in the synonymy.

When the description of the type specimen of *A. solidipes* is compared to the description of specimens called *A. ostoyae*, the extreme similarities are obvious. Therefore, we consider the two conspecific. Such a conclusion leads to an unsettling result, which is to change the name of this root-rot pathogen that is reasonably well established in forest pathology literature. The *Armillaria* species causing the important root-rot in conifer forests of North America should be called *Armillaria solidipes*. The name *A. solidipes* is older by 70 years than *A. ostoyae*. Therefore, according to Article 11.4 of the International Code of Botanical Nomenclature (McNeill et al, 2006) must be applied to the North American species. This name change also may impact the European taxon, unless future genetic or molecular research support the North American and European representatives as being distinct species. For now, *Armillaria ostoyae* must be considered a synonym of *A. solidipes*, and the name *A. solidipes* applied in Europe as well as North America. Should future research determine them to be distinct, *A. ostoyae* may be used for the European taxon. Qin et al. (2007) performed crosses of single spore isolates of Chinese *Armillaria. ostoyae* with 518 single spore isolates of *A. ostoyae* from North America and Europe and found 69.5% intercompatibility, so it appears that the Chinese species is also conspecific with the North American and European species.

Our interpretation of these results is that it demonstrates the taxa in all three locations are conspecific. That being the case, *Armillaria solidipes* is the appropriate name in all North America, Europe, China and other areas where it may occur. An argument can be made for the conservation of the epithet "ostoyae" for the taxon because of the 40 years that it has been in use. However, we believe that conservation should be used more conservatively and prefer to apply the oldest name in this case. Should someone believe strongly in the conservation of "ostoyae" the case can certainly be made and a decision rendered by the IAPT, Committee on Nomenclature. Until such conservation is enacted *Armillaria solidipes* Peck, having priority, should be the name that is used.

Acknowledgement: Dr. R.P. Korf is gratefully acknowledged for his counsel regarding this work.

Literature Cited

- Anderson, J. B., K. Korhonen, and R. C. Ullrich. 1980. Relationships between European and North American biological species of *Armillaria mellea*. *Experimental Mycology* 4: 87-95.
[http://dx.doi.org/doi:10.1016/0147-5975\(80\)90053-5](http://dx.doi.org/doi:10.1016/0147-5975(80)90053-5);
[http://dx.doi.org/doi:10.1016/0147-5975\(80\)90054-7](http://dx.doi.org/doi:10.1016/0147-5975(80)90054-7)
- Anderson, J. B. and R. C. Ullrich. 1979. Biological species of *Armillaria mellea* in North America. *Mycologia* 71: 402-414.
<http://dx.doi.org/doi:10.2307/3759160>
- McNeill, J. (Chairman), F. R. Barrie, H. M. Burdet, V. Demoulin, D. L. Hawksworth, K. Marhold, D. H. Nicolson, J. Prado, P. C. Silva, J. E. Skog, J. H. Wiersema, and N. J. Turland 2006. International Code of Botanical Nomenclature. (Vienna Code). *Regnum Vegetabile* 146. A.R.G. Gantner Verlag KG.

Herink, J., 1973. Taxonomie Václavky Obecné-
Armillaria mellea (Vahl. ex Fr.) Kumm. Vysoká
škola Zemědělská v Brně. Vyznamenaná Rádem
Práce BRNO; J. Hasek, ed. pp. 21-48.

Holmgren P. K. and N. H. Holmgren. 1990. Index
Herbariorum, Part 1 : The Herbaria of the World,
8th ed., Regnum Vegetabile, Vol. 120, New York
Botanical Garden, N.Y.; on-line at:
www.nybg.org/bsci/ih/ih.html

Korhonen, K., 1978. Interfertility and clonal size
in the *Armillaria mellea* complex. *Karstenia*
18:31-42

Peck, C. H. 1900. New Species of Fungi. Bulletin
Torrey Botanical Club 27: 609 – 613.
<http://dx.doi.org/doi:10.2307/2477998>
<http://dx.doi.org/doi:10.2307/2477738>

Qin, G.-F., J. Zhao and K. Korhonen. 2007. A
study on intersterility groups of *Armillaria* in
China *Mycologia*, 99:430-441.

Romagnesi, H. 1970. Observations sur les
Armillariella (I). Bulletin Trimestriel Société
Mycologique France 86: 252 - 265.

Kile, G. A., G. I. McDonald, and J. W. Byler.
1991. Ecology and Disease in Natural Forests.
Chapter 8 in: Shaw, C. G. III and G. A. Kile .
Armillaria root disease. USDA Forest Service,
Agriculture Handbook No. 691. 233 pp.
Washington.

Volk, T. J. and H. H. Burdsall, Jr. 1995. A
nomenclatural Study of *Armillaria* and
Armillariella species. *Synopsis Fungorum* 8: 1 –
121.