

Goodness! Gracious! Great Balls o' Dirt! (or... Va-va-va-VAM!)

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The 2006 New Mexico mushroom season came to an interesting end with the appearance in mid-September of odd little organisms in the grassland around our home near Ribera, New Mexico (Figs. 1-4). They popped up just like regular mushrooms but they had no outer skin or membrane, no internal structure, or any other obvious means of holding themselves together. They



Figure 1.



Figure 2.

just look like dark little balls of dirt. They crumble into a kind of oily dust between your fingers when dry (which they usually are, around here) and are kind of spongy-crumbly, like cake, when they're wet. They did not seem to "fit" anywhere in any of the usual mushroom literature, and had my mycological friends and me scratching our heads wondering what they were!

Intrepid New Mexico Mycological Society member Ted Stampfer finally asked Dr. Jim Trappe of Oregon State University, the North American



Figure 3. Courtesy Billy Stone.



Figure 4.

authority on truffles and other things hypogeous (below ground), who suggested that they might belong to

the recently-erected fungal Class Glomeromycetes, which are known as Arbuscular Mycorrhizal Fungi or AMF (formerly also called Vesicular-Arbuscular Mycorrhizal fungi or VAM fungi). Most of these form symbiotic associations with plants. We sent him some specimens and this led to a lengthy and as yet incomplete story.

On November 25, 2006, Dr. Trappe responded that this was the first time he had seen the species, since he examined the type collection, and that the mystery fungus was *Acaulospora sporocarpia*, originally described in 1985 by Shannon Berch (*Mycotaxon* 23: 409-418) from a collection made in 1955 from "a borrowed pit 40 miles SW of Winslow, Arizona." collected by D.J. Stouffer, New Mexico. There was also one collection known from Pakistan, but he noted that the Pakistan material, however, differed in several ways and probably was a different species. He wrote that it evidently is a species of arid lands and is rarely collected, and speculated that it may be common but overlooked.

Dr. Trappe then forwarded two of the specimens to Dr. Chris Walker in England, the world authority on this and related genera for an opinion and in the hope that it could be tested to see if it was indeed a mycorrhizal fungus. He also expressed interest in receiving any other hypogeous fungi from the area because few collections had been made in New Mexico, but there must surely be plenty of such species, many that would be unusual or new to science.

Later that month, Dr. Walker responded, expressing interest, and even excitement about the find of *Acaulospora sporocarpia*. He pointed out that the fungus, from the original

description, is unlike any other in the genus, or even in the entire phylum. The chance of establishing a culture was discussed, and it was pointed out that if it is really an *Acaulospora*, it would have to be grown in symbiosis with a plant. He also thought it might be possible to extract DNA to examine its phylogenetic position in relation to other members of the phylum.

In December, Dr. Walker wrote again, confirming the identity of the fungus, and explaining that the reason he was so interested in the specimens of *Acaulospora sporocarpia* was because the only other record he knew of was the original collection, and this was only the second time the organism has been collected. Being relatively fresh, it therefore was the only material that has any chance of still being alive. Therefore, it is very important in that such material has a better chance of containing good quality DNA suitable for study than the old, long-dried herbarium material of the past. If it were possible to extract DNA, then this collection could be instrumental in answering the question of whether or not *A. sporocarpia* really belongs to the genus. It is the only sporocarpic (that is, forming its spores in something approaching a "spore body," rather than singly in the soil) member of the entire order, and it therefore raised his suspicions that, even if it did prove to belong with the AME, it perhaps would belong in a different (and new) genus.

Unfortunately, after several attempts, there was only failure in trying to establish mycorrhizas with spores of *A. sporocarpia* as inoculum, and it was not possible to extract DNA with the methods available. Dr. Walker wondered if failure to establish pot cultures might be because they are host-specific, or perhaps they require soil more like that of New Mexico or Arizona soil. So, it all is a bit mysterious.

By June, 2007, it was clear that not only was it impossible to establish cultures, but DNA extraction had also failed. Dr. Walker suggested digging some *Bouteloua*, complete with roots, and very thoroughly washing away all the soil and any attached decaying vegetation, and planting them up in pots containing sterilized local soil and

examining them after some months (at least three) to see if the fungus sporulated in the substrate. He noted the fungi in this phylum are difficult to work with, and many had taken more than a decade to sort out.

Field Description

Habitat: Solitary to scattered, occasionally two found contiguous or conjoined, in open, sandy, predominantly blue grama (*Bouteloua gracilis*) grassland soil (pH=7.3 +/-) in Piñon/Juniper woodlands, up to 10 meters outside of tree drip-line. Not noticed inside drip-line. Fruitbody forming cracked "mushrump" in soil, not extending more than 1-2 cm above edge of crack. Cracked soil settling down around fruitbody with rain, leaving fruitbody partially to fully free and exposed on the soil surface. Fruitbody persistent, slowly weathering down over time.



Figure 5.



Figure 6.

Description: Width: 1-2.5 x 1-2.5 cm, roughly circular. Height: 1.5-3.5 cm, rounded top, generally tapering, sometimes narrowly, to base (Figs.

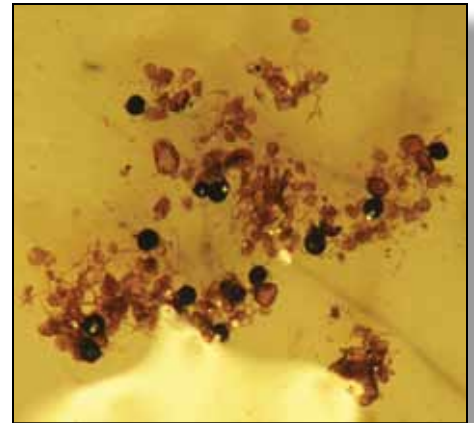


Figure 7. Courtesy Ted Stampfer.

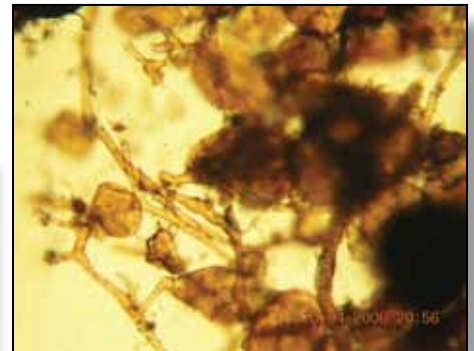


Figure 8. Courtesy Ted Stampfer.



Figure 9. Courtesy Ted Stampfer.

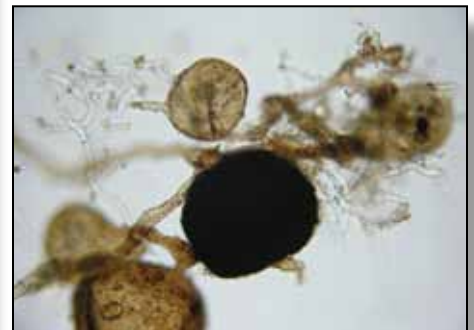
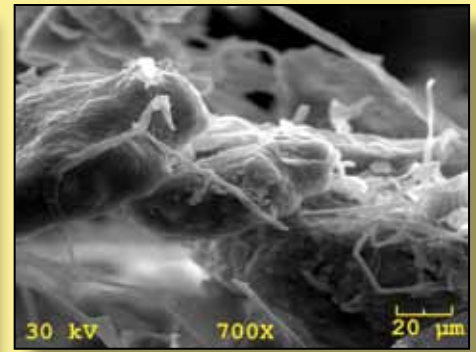
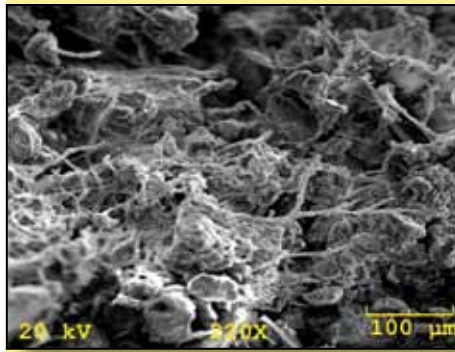


Figure 10. Courtesy Ted Stampfer.

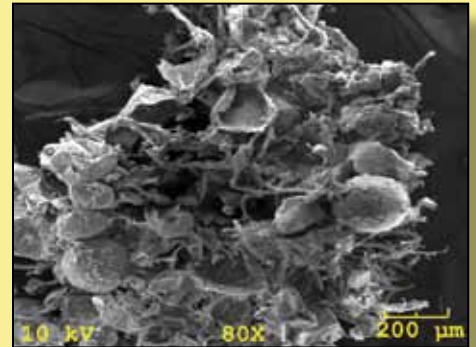
5-6). Fruitbody surface encrusted with soil, sometimes showing some pitting, no exterior membrane/peridium. No rooting structure. Crumbly with an oily, moss-like feel when dry, spongy when wet. Odor similar to linseed oil noticed after being enclosed in container. Interior blackish to reddish brown, apparently composed of sand and soil bound together with undifferentiated cellular network. When viewed with a hand lens, hyphae can be seen protruding from the surface (Figs. 7-8), giving it a slightly velvety appearance, with shiny black spheres (spores) (Figs. 9-11) and grains of sand visible throughout. No visible columella or chambering. ♣



Figure 11. Courtesy Chris Walker. Dr. Walker says, "Just for interest, I reckon this is reasonable evidence of content flow, though as it is a still image, I suppose I don't know which way it is going. Of course, it also is *Archaeospora trappei*, not an *Acaulospora*, but I reckon the principle is the same."



Intrepid Myco-Photographer Billy Stone has been working with a Scanning Electron Microscope (SEM), and Goodness! Gracious!, he's looking at Great Balls o' Dirt! Here are some images of *A. sporocarpia*, up close and personal. In the first two images, the context of the sporocarp (hyphae binding grains of sand) can be seen quite clearly. From the third image, you can see what appear to be empty, deflated spore sacs, presumably remaining after the mature spores have popped out and dispersed. All SEM images courtesy of B. Stone. ♣





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