Illinois Wildlife Preservation Fund Grant #12-021W
Final Report

Investigations of native *Pinus echinata* (shortleaf pine) in southwestern Illinois

I.

A survey of macrofungi associated with relict native shortleaf pine populations

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January 26, 2012

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Project Objectives

Objectives set in the original Special Wildlife Funds Grant Application – Illinois Wildlife Preservation Fund (12-021W submitted March 31, 2011) were to

1. Investigate the presence and distribution of known and suspected native shortleaf pine in southern Illinois;
2. Survey macrofungi (mycorrhizal associates and trunk-decay species) for comparisons between Illinois sites;
3. Collect cones and pollen from selected individuals to ascertain whether all Illinois and Missouri populations have a shared genetic heritage;
4. Verify the utility of local mycobiota for separating native from introduced pines in southern Illinois;
5. Describe, in detail, characteristics of Illinois communities with native shortleaf pine.

Completed or Unmet Project Objectives

Following is a summary of met or unmet project objectives:

Objective 1. Investigate the presence and distribution of native shortleaf pine in southern Illinois

Although shortleaf pine (*Pinus echinata* Mill.) is the most widely distributed southern pine on the continent (Critchfield and Little 1966) it is confined to 2 known relict sites in southern Illinois (Mohlenbrock and Voigt 1959): the Pine Hills of Union and Jackson counties and Piney Creek Ravine in southern Randolph County. Telford, in his *Third report on a forest survey of Illinois* (1926) cited other sites in Randolph County including Rockcastle Creek canyon where shortleaf pines occurred but were logged by landowners early in the twentieth century. Two other sites, a lone tree and dead specimens on bluff-tops near Valmeyer (Monroe County) and purported pine trees on Pine Knob in

southernmost Union County were cited by local citizens who thought the now-extirpated pines to be native.

Documenting existing shortleaf pine distributions: Pine Hills unquestionably has native shortleaf pines, based on any number of historical and ecological references. However, despite Telford's (1926) record and the testimony of local residents gathered in the 1970s (West 1975) the indigenous nature of Piney Creek's oak-pine community was occasionally questioned , well into the 1980s, by botanists and foresters who believed the pine was planted by settlers. My earlier studies (West 1975) and this project's field observations document similarities between macrofungi and vascular flora associates of Pine Hills and Piney Creek. This lends credence to both areas having relict shortleaf pine populations.

Although only Telford's (1926) forest survey remains today as a published record of native pine elsewhere, my reconnaissance of Rockcastle Creek natural area revealed not only a similar vascular flora to Piney Creek and segments of Pine Hills, but a pine-associated wood decay fungus on eastern red cedar (*Juniperus virginiana*) that would not have been present if pines had not once occupied the dry communities lining the canyon.

Less could be said about other potential pine sites: Valmeyer (Monroe Co.), Giant City State Park (Jackson Co.), and Pine Knob (Union Co.). At Valmeyer, some fungal pine associates were collected from the area containing dead pines, but none unique to native stands: the pine fungi from Valmeyer are also associated with plantations and landscape trees (West 1975). Late in December 2012, INPC Preservation Specialist Debbie Scott-Newman (pers. comm.) heard from a local resident that he had helped with planting pines on the blufftops of the former owner, Columbia Quarries. This may settle the question of whether native pines occur or did occur in the Valmeyer area.

The single ancient shortleaf pine located in the 1970s at Giant City was isolated by approximately 300 meters from planted pines. I searched the area carefully but could not relocate the old tree. I found evidence that the tree had died and decayed in place. My searches around the site, in the adjacent hardwood forest, and under plantation pines upslope from the presumed site of the old pine did not reveal any pine-specific macrofungi, despite there being a multitude of non-pine fungal associates present.

I was unable to visit Pine Knob and devote sufficient time to investigate historic claims of native pines in that part of the Illinois Ozarks.

Present-day southern yellow pines in southern Illinois' Coastal Plain, Shawnee Hills, and most of the Ozarks natural divisions are 2 introduced species (West 1975). From 1930s through early 1960s the U.S. Forest Service established plantations and some mixed plantings of pines and hardwoods on the Shawnee National Forest. The Illinois Department of Conservation, from the middle 1950s into the middle 1970s planted pines in abandoned fields in state parks and other conservation holds. Illinois foresters also recommended establishing pine plantations on private property as well. The majority of federal plantings in the Shawnee NF was of shortleaf pine. The state planted loblolly

pine (*P. taeda*) on Department properties and pushed for its planting on cooperating private owner's land.

Records I obtained from the Union State Nursery revealed that much of the shortleaf pine seedlings grown there, then used by the Forest Service and state originated from Arkansas and southern Missouri. Arkansas and Tennessee seed was used to produce *loblolly* pine for southern Illinois up to 1960. However, after loblolly pine provenance studies were conducted in Illinois (Woerheide 1959), the Nursery began growing seedlings from a Maryland source. In addition to the 2 southern yellow pines, there are minor plantings of white pine (*P. strobus*) and the Eurasian Scots pine scattered about southern Illinois.

So the myriads of pines gracing much of the southernmost Illinois landscape are plantations. I surveyed several plantations and the 2 native pine sites during my (1973-74) thesis work. It seemed then that there was a clear distinction between macrofungi of planted and those of native pine stands. The present study allowed me to take steps toward investigating the differences by concentrating mainly on native stands.

Some thoughts on prehistoric and historic distribution: It is probable that shortleaf pine was more common in southern Illinois prior to or near the time of settlement by people of European extraction. First, the climate in this region was decidedly more xerophytic some 2500-1500 YBP. At this time, plants adapted to dry conditions and hostile environments were more common on the land, especially on exposed slopes and cliff tops in both the Illinois Ozarks and Shawnee Hills. Probably shortleaf pine's former extent was more northerly. It may have extended into southern Illinois' Shawnee Hills and Coastal Plain-Cretaceous Hills. It was possibly contiguous with populations in what is now western Tennessee and Kentucky in addition to its occupying an even broader range west throughout the Salem Plateau. Conventional wisdom and most distributional information connect our relict stands to those of the Missouri-Arkansas Ozarks. It is possible that today our yellow pines remain disconnected from populations that originated from the east. Isolation from eastern ranges may have begun as climates shifted to create more mesophytic situations.

Thereafter, shortleaf pine may have remained a component of dry forest communities in southern Illinois, maintained by more frequent fires set by Native Americans. Its fire resistance and place in fire-dependent communities allows it to survive during mesophytic weather patterns; in marked contrast, it disappears rather quickly without disturbance by succumbing to hardwood competition (Iverson et al 1998). Shortleaf pine may have survived as larger Illinois population even to historic times, but its decline can be related to Euro-American settlement. There are no written records of Illinois pine distribution from earlier than the 1920s, but logging and less frequent fires apparently facilitated its demise. Telford (1926) suggested a preference for pinewood lumber in the Pine Hills area, noting pine structures built in nearby Wolf Lake; he also referred to early logging being the cause of losing all Randolph County stands save Piney Creek Ravine. If by any chance native pines persisted in stands outside Pine Hills and Piney Creek

Ravine into the 1900s they were certainly "masked" by those cultural plantings of the 1930s through the 1960s.

Further review of archeological studies (O'Brian 2001) and palynology (Davis 2001) can shed some light on shortleaf pine distributions and the southern Illinois relicts. More careful analyses of forestry records from both the Shawnee National Forest and Illinois Department of Natural Resources files and archives will also be valuable.

Objective 2. Survey macrofungi (pine mycorrhizal associates and trunk-decay species) for comparisons between Illinois sites.

Early in the project, I was able to verify similarities between Piney Creek and Pine Hills mycobiota that I had noticed during my 1970s thesis research. Many of the same species were present under and on shortleaf pine, though one key species (the trunk pathogen *Phellinus pini*) that was collected at both sites in 1973-74 was not relocated at Piney Creek Ravine in 2011-2012. More significant verification would have been possible had our Region not suffered from a major summer drought in 2012.

When it became evident that Objective 3 (below) was not attainable, I increased field activities west of the Mississippi River to include native stands in Missouri's Mark Twain National Forest. I surveyed seasonal mycobiota to compare the associated Illinois and Missouri populations. It appeared that comparing macrofungi was useful in verifying similarities between native pine sites. Interestingly, there were some associations that were unique to one population, not the other. Studying mycobiota in native shortleaf populations to the south and southeast of Illinois would help verify any connection of the Illinois relicts to Appalachian and Coastal Plain shortleaf pine lineages or to Salem Plateau pines.

Objective 3. Collect cones and pollen from selected individuals to ascertain whether Illinois and Missouri populations have a shared genetic heritage.

I dropped Objective 3 after discovering that scientists who could assist in this analysis were unwilling or unable to work on this aspect of the project. The few who responded to my inquiries employed approaches that were too costly for this WCF grant.

Objective 4. Verify the utility of local mycobiota for separating native from introduced pines in southern Illinois.

Mycobiota associated with native pines appeared to be distinct from those in pine plantations, even between native and introduced pine stands in close proximity.

Objective 5. Describe, in detail, characteristics of Illinois communities with native shortleaf pine.

I found no reason to dispute Voigt and Mohlenbrock's (1964) accounts of shortleaf pine-black hickory-post oak communities of both Pine Hills and Piney Creek Ravine.

However, as Parker and Ruffner (2004) summarized, rapid shifts in vegetation succession have pushed shortleaf pine to the bluff edges and driest sites where it can survive and reproduce in absence of the mesophytes that appear to be replacing oak-pine communities on the deeper soils and less hostile exposures. There are many places where there were once open ridgetop woodland communities with sparse understory conditions presently are thickets dominated by sassafras and maple saplings often overgrown with greenbriers. Pine Hills has been seriously damaged by ice storms, high winds, and a tornado over the past 6 years. Many fallen trees, pinnacles of large broken oaks, and uprooted pines are evident along ridges with the remaining shortleaf pines. Amazingly, many pines were spared during the storms and appear to have fared better than associated oaks. Storm-induced openings on rocky dry sites have numerous pine seedlings among a revitalized though sparse grass-forbs mixture.

Project Accomplishments Summary

I. TECHNICAL REPORT

Investigations on the mycobiota of native shortleaf pine (*Pinus echinata* Mill.) in southwestern Illinois and southeast Missouri.

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Introduction

Shortleaf pine in southern Illinois

Shortleaf or yellow pine (*Pinus echinata* Mill.) is the most widely distributed North American southern pine species. It ranges from Maryland south through the Carolinas and north Florida west to Louisiana, east Texas, and Oklahoma (Critchfield and Little 1966; Fig. 1). Historically, shortleaf pine is a major component of oak-pine communities the Ozark Mountains of the Salem Plateau where its northern extent is central Missouri and southern Illinois. Further east its range is largely south of the Ohio River valley. In southern Illinois, native shortleaf pine is confined to 2 sites within Illinois' Ozark Natural Division (Schwegman 1972).

The Illinois stands are relicts presumably akin to the Arkansas-Missouri populations of the Ozarks (Mohlenbrock and Voigt 1959). Although their Ozark affinity is readily accepted, shortleaf pine may have existed as a dry-forest associate with oaks throughout the southern Ozarks, Shawnee Hills, and Coastal Plan (Cretaceous Hills Section) as disjunctions from populations arising from Appalachian and Coastal Plain oak-pine communities further south.

The extensive pine presence in today's southern Illinois landscapes are plantations and mixed pine-hardwood plantings done by the U.S. Forest Service (within the Shawnee National Forest), Fish and Wildlife Service (e.g. Crab Orchard National Wildlife

Refuge), and Illinois Department of Conservation (formerly IDOC, now the Department of Natural Resources, IDNR) (in parks and other conservation holdings), as well as plantations established on private lands under recommendation of Illinois foresters.

Shortleaf pine is the most common introduced conifer species, having been planted by the Forest Service from the 1930s through early 1960s, but both shortleaf and loblolly pine (*Pinus taeda*) were planted by and under recommendation of IDOC well into the 1970s. Of these 2 southern yellow pines, loblolly was utilized more frequently by IDOC whereas Forest Service plantings were overwhelmingly placed on Shawnee lands. Shortleaf pine seedlings were ordinarily grown at the Union State Nursery from its inception in 1933[1] through the 1970s using seed obtained from the southern Missouri and northern Arkansas Ozark (unpublished records, IDNR Union State Nursery and Trail of Tears State Forest).

Reforestation was a major state and federal emphasis as abandoned worn out and eroded lands were added to a new southern Illinois National Forest during the 1930s Depression years. It appears that foresters of the day liked pines: many of them came from northern states and a few from the south, where pines were seen as good reforestation pioneers because of their hardy nature. An unconscious psychological boost to those decision-makers may have been produced by pines' evergreen nature: envisioning fast, green growth, a hue of hope, over devastated landscapes during the Depression's bleak times. If there was such a boost, it persisted well into the early 1980s as pine seedlings were readily produced and distributed to private landowners. Today, only eastern white pine (*Pinus strobus*) is grown and sold along with native hardwoods at the Union and Mason state nurseries. Most foresters and biologists now recommend community restoration using native species.

The 2 relict yellow pine Illinois populations survived Euro-American settlement and still exist today: Pine Hills in the Southern Section of the Illinois Ozarks and Piney Creek Ravine in the Ozarks Central Section near its juncture with the Southern Till Plain and northernmost (glaciated) sliver of the Shawnee Hills. There were formerly stands of shortleaf at Rockcastle Creek, north of Piney Creek and another Randolph County site, that were logged very early in the 1900s. Their presence is only known from historical records – verbal testimony of local residents from the 1970s and Telford's (1926) published survey of Illinois forest resources.

It is possible that shortleaf pine persisted as other relict sites in historic times, east in the Shawnee Hills and the Coastal Plain's Cretaceous Hills barrens into historic time. There are scattered verbal and unpublished written notes about past and present possible pine relicts: Giant City State Park (Jackson Co.), Valmeyer bluffs (Monroe Co.) and Pine Knob (Union Co.).

[1] Although the Union State Nursery was constructed as a state facility within the Union State Forest (now Trail of Tears State Forest), the Forest Service guided its establishment and management in early years as an important partner during administration of the newly formed Illini National Forest (precursor to the Shawnee). Also important to the new Nursery was the Civilian Conservation Corps (1933-1939) – the Depression-era CCC had a camp on State Forest ground. The CCC was primarily responsible for laying the foundations of the Nursery, forest trails and recreation sites, and the beginnings of technical forest management in the State Forest.

2. Shortleaf pine mycobiota

My thesis research of the 1970s focused on pine-associated basidiomycetes. I conducted surveys and listed species from both native and introduced (plantation) pine stands (West 1975). In the process, I noticed that certain fungi appeared to be present in native pine stands but not in the plantations; conversely, plantation pines frequently had different fungal associates than native pine. For over 30 years I wondered whether the differences lie in site conditions (plantations being almost pure cultures for associated fungi, often on better habitat and soil conditions than native stands) or if a relict mycobiota remained intact with the southern Illinois pine-oak communities over their 3000 year (more or less) occupation. This Wildlife Preservation Fund grant enabled me to revisit this issue.

As with most other trees of field and forest, mycorrhizal symbionts are paramount to growth and survival of pines (Trappe 1962). In yellow pines such as shortleaf, the increased fine-root surface supplied by the fungus-host mantle allows them to exploit nutrient and water resources more efficiently so they can establish populations in dry hostile microhabitats where they are less susceptible to competition from vigorous angiosperm sylvan species. Many mycorrhizal fungi are obligate with a single species, or only inoculate a certain species group or a particular genus of tree. Most gymnosperm associates are ectomycorrhizal basidiomycetes, notably Agaricales (gill fungi) of the families Amanitaceae (*Amanita*) and Russulaceae (*Russula* and *Lactarius*), and boletes (fleshy pore fungi, family Boletaceae in genera *Boletus, Boletinus,* and *Suillus*). Most mycorrhizal species exhibit host fidelity: those that invade conifer root tissues do not associate with hardwood hosts.

As with mutualistic mycorrhizal fungi, pine decay associates in the Basidiomycota are commonly host-specific. Some are restricted to decaying only wood of yellow (southern) pines, not other *Pinus* subgenera or hardwoods. These types of decay organisms are parasitic (weakly or devastatingly so) or saprophytes (secondary decay organisms). A few basidiomycete parasites enter wounds or branch scars to inflict serious inner-trunk decays. Trunk decay fungi reduce the amount of supportive tissue, weakening the stem inducing stem breakage. Others attack the living vascular tissue, leading to root-system failure. Both stem and root infestations cause tree death, followed by wind-throw (Fig. 2 and 3). Fallen pines – with broken stems or upturned root wads – are common sights on the precarious, wind-tossed oak-pine bluff communities.

Many fungi demonstrate host or substrate specificity in mutualism, parasitism, and deadwood decay. Might such specificity allow an investigator to ascertain which species are conifer or hardwood associates? If tree mycobiota vary between different species and even populations across a species' range, is it possible to track the origin or status of trees, to determine local pine population origins, to decide which are native or introduced, or acknowledge affiliations of a relict with disjunctive populations?

3. Research objectives

This study was designed to determine if

(1) native Illinois pines' and plantation-pine mycobiota are similar;

(2) there are similarities between mycobiota of Illinois relict pine communities and those in the Missouri Ozarks;

(3) shortleaf pine mycobiota can be used to distinguish between native and introduced pines, and

(4) pine mycobiota persists on sites where pines were extirpated, and whether persisting mycobiota can be used to verify reports of vanishing or lost pine communities.

Materials and Methods

1. Research sites

Pine Hills (Union and Jackson counties, Illinois): at LaRue-Pine Hills Ecological Area (including LaRue-Pine Hills RNA) I selected 10 sites to survey native pine-associated fungi and a pine plantation within the area to use in tracking mycobiota of planted pines (Fig 4).

Shortleaf pine (*Pinus echinata*) occurs within the 10 sites' oak-pine communities in thin loess soils over chert bedrock. The communities are most well-defined on the driest, most exposed aspects (xeric upland forest); the 2 northernmost sites are particularly xerophytic with a substantial amount of exposed chert on steep slopes . In xeric habitats, shortleaf pine is associated with blackjack oak (*Quercus marilandica*) and 2 species of *Vaccineum* (*V. vacillans* and *V. arboretum*). Black hickory (*Carya texana*) and post oak (*Q. stellata*) are components of some pine stands in dry upland forest communities. Black oak (*Q. velutina*), white oak (*Q. alba*) and hickories (including *C. glabra*) are mixed with pine on more sheltered, mesic sites (Parker and Ruffner 2004). The 2 latter tree associates also occur on dry sites where saplings and thickets of sugar and red maples (*Acer saccharum* and *A. rubrum*), flowering dogwood (*Cornus florida*), sassafras (*Sassafras albidum*), and brier overgrowth (*Smilax* vines and *Rhubus* patches) attests to the lack of a fire regime or other disturbance history (Suchecki 1997). Another shrub associate is shadbush (*Amelanchier arboretum*). Occasionally there are native azaleas (*Rhododendron prinophyllum*) on rocky open sites intermingled with pines, black, blackjack and post oaks. Forbs and grasses noted include several species of goldenrod (*Solidago* spp.), curly grass (*Danthonia spicata*), goat's rue (*Taphrosia virginiana*), cleft phlox (*Phlox divaricata*) and bee balm (*Monarda bradburiana*). Little bluestem (*Schizachyrium scoparium*) is not an uncommon grass of dry to xeric habitats.

Piney Creek Ravine (Randolph County): Piney Creek Ravine Nature Preserve has small oak-pine relicts on the driest aspects in a sandstone canyon carved out by Piney Branch of Mill Creek. Piney Branch and the Mill Creek watershed is within the Central Ozark

Section, Ozark Natural Division (Schwegman 1973). Three areas within the canyon have shortleaf pine (Fig. 5). The areas are small so all three were surveyed as part of a larger search area.

Plant associates of shortleaf pine here are similar to those at Pine Hills but there is a more distinction between the dry bluff communities and the upper slopes where there are deeper soils and a variety of dry-mesic species: white oak (*Quercus alba*), northern red oak (*Q. rubra*) and pignut hickory (*Carya glabra*) are dominant species of the upper slopes. Dry upland forest trees include the clusters of shortleaf pine associated with mixed oaks – blackjack, scattered black oaks (*Q. velutina*), and occasional post oaks. As in Pine Hills, low-bush blueberry (*V. vacillans*) is a common shrub beneath the oak-pine canopy particularly on exposed sandstone with thin soils. Here, the largest pines are perched near the bluff edges, often rooted precariously in cliff-face and sandstone pavement fissures. Though less so, pine reproduction is confined to areas of very thin soils and open canopies. Curly grass (*D. spicata*) is common, as is little bluestem. Voigt and Mohlenbrock (1964) reported that the Piney Creek flora had both Appalachian and Ozarkan components and stated that …

> … half of the characteristic herbaceous species listed by Steyermark (1951) for the thin acid soils underlain by sandstone in Missouri are found here …

… suggesting that the Ozarkan affinity is the strongest.

Missouri research sites: I selected 8 southeastern Missouri units in Butler, Wayne, and Carter counties between Poplar Bluff and Ellsinore, Missouri (Fig. 6). All were on federal lands in the Mark Twain National Forest, Poplar Bluff Ranger District. Their Landtype Association position within the Black River Ozark Border Subsection (OZ14) straddles the line between the Grandin Pine-Oak Woodland Dissected Plain (OZ14a) and Wappapello Oak-Pine Woodland/Forest Hills (OZ14c) (Nigh and Schroeder 2002). Cane Ridge itself appears to be the boundary between the 2 so half of sites 1 and 2 are (north) in OZ14c, (south) in OZ14a. The remainder are in OZ14a.

The majority of communities within the 8 areas were on dry, chert-strewn ridge tops and slopes. There, shortleaf pine is associated with a mixture of oaks including post oak, scarlet (*Q. coccinea*), black , and blackjack. Little bluestem and curly-grass are common components of more open sites, and many prairie (or barren, term in Missouri being savanna) species are present in the understory.

I divided Research Site 1 into 2 subunits (separated by private property). These units lie along the Cane Ridge Wildlife Management Unit under a partnership between the Forest Service, Missouri Department of Conservation, and the National Wild Turkey Federation. Although stands were mixed oak-pine, they have been managed selectively to favor the shortleaf pine component with timber stand improvement (TSI), presumed thinning, and prescribed burning. Much of the area had been burn; an intensive fire near the west end killed many pines. Some stands within Site 1 were slated for 2012 timber sales (the

logging just started near the end of this study) and others are scheduled for the next few years.

Site 2 was west of the Cane Ridge WMU near Upalika Pond. It, too, includes managed oak-pine stands but management appears to have involved less burning in the recent past. The area within 2 is also much more heavily infested with exotic plants, particularly Japanese honeysuckle (*Lonicera japonica*). Near the west end, a devastating tornado had felled much of the forest; salvage logging was done in 2012.

Site 3 is a dry-mesic hillside forest oak-pine community on the east side of Pump Hollow. At the base of the slope is an Ozark fen; apparently the area is a candidate for the Missouri Natural Areas Program. Pine is much more a component, not a dominant species, at this site. The canopy is much more extensive than in the drier sites. Interestingly pines extend all the way downhill, with a few sizable specimens rooted in the fen proper.

The 4 subunits of Site 4 are all managed oak-pine woodlands. The easternmost ones are on gently rolling or relatively flat ridgetops; 4C has open, dry slope pine-oak stands over shallow rocky soils.

Site 5 includes all the pine stands in the Pinewoods Lake recreation area, just southwest of Elsinore. There are many old, relatively pure pine stands here; canopies are closed and there is little undergrowth.

Rockcastle Creek (Randolph County): I made a single visit to Rockcastle Creek, a privately owned natural area (June 20, 2012) (Fig. 5). Like Piney Creek this site is in the Central Ozarks, though it exhibits characteristics and has features of the Mt. Vernon Hill Country, Southern Till Plain Natural Division (Schwegman 1973). The tract containing the natural area was where shortleaf pine reportedly grew but were logged from there sometime prior to Telford's report (1926). It was not difficult to locate dry bluff microenvironments with blackjack oak, post oak, black hickory, the *Vaccinium* species, shadbush, curly grass, and little bluestem, similar to the dry upland and xeric forest sites at Piney Creek; but for the sandstone substrate, the situation there is reminiscent of Pine Hills. I searched all suitable dry upland and xeric sites where I suspected pine may have occurred. There are also remnant hill prairies under management by the landowners, who cut and removed eastern redcedars and invading broadleaved shrubs.

Giant City State Park (Jackson County): In the late 1970s, Illinois Natural Areas Inventory / Natural Land Institute preservation specialist Max Hutchison and I found a very old (an increment core placed its age at potentially + 100 years) growing next to an abandoned, deteriorating small CCC-era shelter along an old roadbed in a highly disturbed dry-mesic upland forest site near the east boundary of Fern Rocks Nature Preserve (Fig. 7), within the Greater Shawnee Hills Section, Shawnee Hills Natural Division (Schwegman 1973). I was unable to relocate the single tree or remains of the derelict shelter. There were a few large pines in the area where I believed the remains existed so I expanded the search area and rechecked 3 times in the course of this study.

Valmeyer pine sites (Monroe County): questions remained about whether a few shortleaf pine trees growing at the edge of a hill prairie were native relicts. On June 20, 2012, I looked over sites where 2 dead pines now stand on the hill prairie that I visited in the 1980s and where there is a single large shortleaf pine growing in a dry-mesic ravine forest east of the hill prairie sites (Fig. 7). The pine sites are on property owned in commons with the village of New Valmeyer, the community that moved pretty much in its entirety to higher ground after the 1993 floods. The area was formerly owned and mined by Columbia Quarries; hill prairies and dry woodlands remained fairly intact and the area was listed as an Illinois Natural Areas Inventory (INAI) site. Presently it is registered as Salt Lick Point Land and Water Reserve. There is active conservation work underway to resurrect hill prairies, control invasive plants, and restore disturbed forest communities. This area is within the Northern Section, Ozark Natural Division (Schwegman 1973).

2. Collection Methods

Collecting and survey times and frequency: I began visits to the major Illinois sites (Pine Hills and Piney Creek Ravine) and southeastern Missouri in October 2011. Delays in obtaining State and Federal research, collecting, and special use permits prevented me from collecting early in this study but I made visits to document site characteristics and take notes on fungi that I saw during that period. After receiving permits in November I was able to collect and started a schedule of routine visits. During 5 periods – December -January, February-March, April-June, July-September, October-November – I made 2-4 visits each period to Pine Hills, 1-2 to Piney Creek, 1-2 to Missouri. In the secondary sites (places with extirpated pine-oak and suspected pine records) I visited Giant City 4 times and made a single trip to Rockcastle Creek and Valmeyer.

Field collection and identification methods: once in the field I did a through search on and around pines for pine mycosymbionts, decay fungi, and pathogens. I employed methods familiar to field mycologists, taking care to collect and transport specimens back to my vehicle. I wrapped most fleshy specimens in wax paper bundles or placed them in plastic containers to protect their ephemeral basidiocarps. Tough or woody specimens (brackets, conks) and resupinate or small shelf-fungi on branches and pieces of wood were more easily transported, either in wax wrappings or paper bags. I made notes on habitat/substrata, location and slope positions, character of the plant communities where I had collected specimens, as well as notes about soils, geology, and recent weather behavior (e.g. time since last rainfall). I photographed most macrofungi and include some images in the Figures that will help identify the most troublesome species.

After arriving back at my vehicle I used a color reference (Kornerup and Wanscher 1967) to describe colors. The reference name number – e.g. “milk white” (1A2) – is used for standardized color notes; names without quotation are common names used when a color plate was not available or could not be used. If time and circumstances permitted, I took all the notes I could on specimens fresh from the field to save laboratory identification time; these notes included basidiocarp measurements, texture, taste of context flesh (non-

poisonous ones!), odor, and reactions of flesh, stem or cap surfaces when bruised. Before leaving for the next locale or home for the evening, I set up a spore mass slide and white-paper receptacle for obtaining spore prints … spore mass color is an important defining character that separates families of fleshy fungi.

Whenever possible, I did as much as I could to examine and key out or speculate which species I had collected while specimens were still fresh, doing as much identification as I could using hand-lens and field references soon after I had collected them. Occasionally I arrived back for the return trip too late to do this in the field; then I took notes and dried specimens the following day. It was important to use natural light to get color notes, so a few collections had to be stowed in refrigeration overnight.

Arriving home, I removed the specimens from their containers, reset the spore print slide and paper if needed, then placed specimens under a heat lamp system to dry them. Most specimens dried sufficiently within 2-4 days but some larger thicker ones required up to a week. Following drying, specimens were inspected for insect damage and activity, then placed in a freezer. Generally I left them to freeze no less than a week, hoping to kill any remaining insect larvae or eggs. The dried, frozen specimens were then thawed and placed in temporary storage – in paper bags or boxes. Dried specimens were checked once a month for evidence of insect activities; if such appeared, the specimens were frozen again.

Identification requires microscopic examination, and I had access to a compound light microscope courtesy of the SIUC Department of Plant Biology. During identification, I took notes on spore dimensions, shapes, ornamentation; on hyphal systems – both sterile and fertile structures and tissues; any other features that separated species of fungi.

All dried specimens will be rechecked then transported to the Fungarium at the Illinois Natural History Survey laboratories in Champaign-Urbana for deposition. Each specimen has a collection label citing name, K.A. West collection number, habitat and substrate, collection location, county and state, data of collection. Field and identification notes will accompany specimens to the Fungarium.

Results

I recorded 21 species of pine-associated macrofungi – 20 basidiomycetes and 1 species of ascomycete. In addition to 2012, I include 13 species reported from native pine 1973 - 1975 (thesis research collections, West 1975).

I arranged these in ecological classes, by habitat/niche, whether they are mycorrhizal symbionts, conifer-specific wood decay species, or parasitic fungi. A fourth category, saprophytes, includes species found in pine duff, buried conifer wood, or cones, evidently living wholly on dead material, not attached to or associated with pine roots. Discussion and habitat notes highlight each species' role in or impacts upon native oak-pine communities.

1. Mycorrhizal Symbionts of Native Shortleaf Pine

***Amanita citrina* (Schaeff.) Gray** Scattered, in soil under native *P. echinata*, Pine Hills (Union Co. IL), 1973 (*West 1031*).

Discussion: this species is evidently closely related to *A. phalloides* (Vaill. ex Fr.) Secr., a highly poisonous predominately European species (Singer 1949). The discovery of the European cousin in Maryland and Delaware from both *P. taeda* and *P. strobus* (Tanghe and Simons 1973) no doubt generated a debate over whether *A. citrina* is a separate species or variant of *A. phalloides.* Its poisonous character is undeniable. It is a mycorrhizal associate that fruits in late summer and fall under "… conifers, hardwoods, or mixed woods … in eastern and central United States and Canada"; its var. *lavendula* Coker (possibly a more frequently encountered southern pine associate), has a lilac-tinged volva (Miller and Miller 2006). The volva of the 1970s collection was "milk white" (1A2) and is presumably the typical variety (West 1975).

***Amanita ravenellii* (Berk. and M.A. Curtis) Sacc.** (Fig. 8) Two developing (not fully emerged) basidiocarps under *P. echinata* under mixed oak-pine woodland, Cane Ridge (Butler Co. MO) August 15, 2012 (MO collection only: *West 1350*).

Discussion: this poisonous mushroom grows in late summer and fall, solitary or in groups of several scattered basidiocarps " … in mixed hardwood and conifer forests. Reported from Maryland to South Carolina." (Miller and Miller 2006). Both specimens were barely visible; they showed up as bumps in the litter, detectable by the white tissue mostly hidden under needle duff. The less well developed specimen was as a mass of undifferentiated white tissues encased in the volva, but when its was cut longitudinally the developing cap, stem, and veils were all definable. This species has an eastern range so it should also occur in Illinois as well as Missouri.

Other Amanita species: four other species of *Amanita* were collected from under shortleaf pines. The first appears to be a member of the deadly poisonous *A. virosa* group termed the "death cups" or "destroying angels". They are typically white or white with light tinges of flesh or yellow. This specimen from Pine Hills was "solitary under *P. echinata*" September 24, 2012 (*West s.n.* with R. Stroh). The same day we found a ghostly pure white pair under another pine stand (*West s.n.*) then a third solitary specimen of white *Amanita* under the plantation on the south end of Pine Hills. There are photographs of these in Figures 9 - 10. A fourth *Amanita* (again, 9/24/2012) (Fig. 11) was solitary on litter of a dry upland forest stand of oaks and pine. It was more of a tan shade, most likely from a different genus complex, with numerous persistent scales on its cap.

The *Amanitas* are evidently a very important pine-mycorrhizae group. The genus' systematics are presently undergoing scrutiny by mycologists and even though it was not possible to get firm identities with the resources available to me, I intend to forward the specimens to *Amanita* specialists in 2013.

Russula concialis. Pine Ridge area September 13, 1973 (*West 835 with V. West*).
***Russula queletii* Fr. (?) or *R. azarea* Bres. (?)** scattered under native pines, Pine Hills September 24, 2012 (*West s.n.* 2 collections).
***Russula sanguinea* Fr. (?)** solitary under pine, Pine Hills September 24, 2012 (*West s.n.* single basidiocarp collected).

Discussion: As if this genus was not difficult enough, the collections were made at the end of a prolonged drought; of the dozens encountered, only a few were even vaguely distinguishable. Miller and Miller (2006) claims that there are several related problematic species of *Russula*, that "… This group of purple-, reddish purple- to violet-capped Russulas needs extensive study to clarify species concepts." The 1973 *Russula* collection is probably misnamed – there is no such species listed in the available literature. All 3 collections need further study and concise identification using fresh specimens with detailed field notes and colors. The family Russulaceae, including both *Russula* and *Lactarius* is an important groups with many pine mycosymbionts. Members that are closely associated with the yellow pines, shortleaf pine included, might be very reliable candidates for studying pine populations and their biogeographies.

2. Pine Wood Decay Species

***Gloeophyllum saepiarium* (Fr.) P. Karst.** [= *Lenzites saepiaria* (Fr.) Fr.] Pine Hills(Union Co. IL), growing on rotten pine logs on the ground (*West 1285*).

Discussion: The pores of this little fungus break into gill-like (lamellate) structures. It is a pine associate that occurs in southern Illinois pine plantations as well as the native stands, but it is not as commonly seen in Illinois as other conifer decaying fungi. However, specimens from native stands appear to be more robust, with attractive wooly-zonate upper surfaces, and strongly developed lamellate spore-producing structures below. Although only collected the species once in Illinois during this project and did not see it in the Missouri stands, I was surprised to find basidiocarps on boards along my porch pillars at my old field-station house in Puxico! This discovery was a reminder that not only is it found on plantation and native pine substrata, it is a vigorous decay agent on structural wood (Zeller 1917).

***Neolentinus lepideus* (Fr.) Redhead and Ginns** caespitose on rotten log of native *P. echinata.* Pine Hills (Union Co. IL) (*West 834* as *Lentinus lepideus* (Buxb.) Fr.).

Discussion: this mushroom causes a brown rot in both conifers and hardwoods (the species prefers conifers), fruiting in spring and fall just after (but not during) cool wet weather (Miller and Miller 2006). This may be a useful species that occurs only on the native Illinois pines; more study of its distribution, habitats, and host selectivity can address its fidelity to native pines and potential relict-symbiont status.

PIAF complex*[2]*: on lower trunk near ground on decaying *P. echinata* trunk (*West 1281a*) and rotting branch of same (dead pine) lodged between trunk segments (*West 1281b*) both on steep south-facing slope in native pine-oak community over chert barrens, February 4, 2012, Pine Hills (Union/Jackson Co. IL). On rotting rosaceous twig (probably *Prunus*) June 6, 2012, edge of hill prairie near Valmeyer (Monroe Co. IL) (*West 1293*). On decaying *Juniperus virginiana* branch on south-facing bluff June 6, 2012, Rockcastle Creek (Randolph Co. IL) (*West 1294*). MO Collections from shortleaf pine wood Cane Ridge (Butler, Carter, Wayne counties MO) (*West collections 1312-1316* [March and August 2012]) Notes on my thesis collections include reports:
As *Trichaptum abietinum* (Dickson ex Fr.) Ryvarden. [= Polyporus abietinus Dicks. ex Fr. =*Polystictus abietinus* Fr.= *Hirschioporus abietinus* (Dicks. ex Fr.) Donk] (25 West collections from both native and plantation pine logs including from Pine Hills and Piney Creek 1973)
As *T. biforme* (Fr. in Klotzsch) Ryvarden [=*Polyporus biforme* Fr.= *P. pargamenus* Fr.= *P. pergamenus* Fr.=*Polystictus pergamenus* Fr.= *Hirschioporus biforme* (Fr.) Bond. and Sing.] on *P. taeda* logs (in plantations, Union Co. IL, 1973 *West 049, 212, 313*)
As *Irpex fusco-violaceus* (Ehrenb. ex Fr.) Fr. resupinate and solitary on rotten branch from living *P. echinata*, 1973, Pine Hills (Jackson Co. IL) (*West 997*); *Schanzle 453* was annotated to *Polyporus biforme.*

Discussion: the species in this complex are the most common pine saprophytes in our region (perhaps also North America and Eurasia) but, as the number of synonyms attest, some of the most taxonomically challenged. The 2012 specimens from Illinois native pine have decidedly hydnaceous lower fertile surfaces in contrast to specimens from plantation pine. If a poroid hymenium surface is present in these, it is largely confined to outer margins of old basidiocarps or to developing new growth. Plantation collections from the 1970s were mostly poroid, breaking into tooth-like projections with age. Only one 1970s specimen (*West 997*) decidedly peg-like or tooth-like (*Irpex*-like) projections with fertile surfaces. The Missouri collections mainly have *Irpex* hymenia but some have poroid or lamellate remnants. The third species, *T. biforme*, is dominantly found on hardwoods

The PIAF complex has been extensively studied over the years. Early polypore researchers initially split 2 species on basis of their hosts: *T. abietinum* causes a secondary decay in downed conifer wood and *T. biforme* is confined to hardwood species, particularly oak. *Irpex fuscoviolaceous* is a conifer rotter with basidiocarp formation, color patterns, and growth habits very similar to *T. abietinum* differing only in the pore surface being irpiciform (regularly split into tooth-like, hydnaceous spore-producing structures). All three have a distinctive violaceous pore or tooth-surface color, with spores that are white en mass.

[2] **P** is for the older – and still commonly used – genus *Polyporus* and for *pargamenus*, from an old name when *T. biforme* was known as *Polyporus paragamenus*, **I** for the *Irpex*, **A** for *abietinum,* and **F** for *fuscoviolaceous*, not giving undue attention to *Irpex fuscoviolaceous* but a nod toward the colorful hues of violet, brown-blue, and lilac that make these little saprophytes so noticeable.

Miller and Miller (2006) referred to a detailed treatment of the complex by Gilbertson and Ryvarden [1987: *North American Polypores* (vol. 2)]. Ruth Macrae (1967: Canad. J. Bot. 45(8): 1371-1398) found that there is sexual incompatibility and differences in spore dimensions between *T. (Polyporus/Hirshioporus) abietinus* and *I. fuscoviolaceous*. Most likely these *are* 2 separate species.

It is interesting to have such a common decay agent (or agents) in taxonomic flux. I hope to spend more research time to shed some light on the systematics debates and determine which species exist in Illinois and Missouri. This will involve scanning the literature and carefully reanalyzing the new collections and 1970s thesis material. This year I have observed that even though both irpiciform and poroid basidiocarps are present on the same substrata in Illinois, Missouri material is overwhelmingly irpiciform.

As with the 1970s collection, I routinely found specimens that could be assigned to one of the 3 species on decayed wood in every Illinois and Missouri stand. Two interesting collections were from Rockcastle Creek and Valmeyer, where at least the Rockcastle specimen may represent a remnant pine saprophyte employing juniper wood as an alternative to its preferred pine.

***Schizophyllum commune* Fr.** gregarious to caespitose on rotten *P. echinata* log, Pine Hills (Union Co. IL) August 6, 2012 (*West 1298*). Plantation pine 1973 collections (Alexander and Union counties IL, *West 057, 365, 918*) on dead *P. echinata* and *P. taeda* logs (one on a live, ice-damaged *P. taeda*).

Discussion: Schizophyllum commune is a widespread hardwood decay fungus but is known from the wood of 13 pine species (Cooke 1961). It appears to be an opportunistic decay species that must move easily between angiosperm and gymnosperm substrata.

3. Parasitic Pine Fungi

***Heterobasidion annosum* (Fr.) Bref.** (=*Fomes annosus* (Fr.) Karst.= *Fomitopsis annosa* (Fr.) Karst.) Solitary to imbricate on decayed stumps and roots of wind-thrown living or dead trees, on roots of standing living tree and dead trees beneath ground level in the humus, occasionally on lower trunk surfaces of standing live or dead trees up to 3 feet above the ground (9 West collections from southern Illinois plantation pines, one from apple tree roots, one specimen from Pine Ridge area of Pine Hills, Union Co. IL October 6, 1974 with V. West).

Discussion: This fungus is one of the most devastating pine root pathogens, the agent of annosus root rot in pines. It is only know on native pine as my single 1974 Pine Hills collection (West 1975). It does not always form basidiocarps and when it does, these are often buried below the duff and soil at the bases of trees. Once the roots are weakened, root systems fail and the trees are often wind-thrown. Although wind-thrown trees are not an uncommon sight at Pine Hills and in the Missouri stands, I did not find any basidiocarps on the deteriorating dead trees. Since annosus rot is spread mainly through root grafts this, like *Phaeolus schweinitzii* (below) is presumably not as serious a threat to

the Illinois native stands as in plantations or the selectively managed pine-oak communities in Missouri. Infection from spores colonizing cut stumps then traveling to healthy trees via grafts are not uncommon following logging.

***Phaeolus schweinitzii* (Fr.) Pat.** Scattered in pine duff beneath dead and dying shortleaf pine *West 1291.* (MO native pine collection only)

Discussion: This species can be a serious problem, especially in sites where prescribed fire is used: it apparently gains entry to vulnerable pinewood via fire wounds. Illinois records of this serious pine pathogen are limited: I reported a 1974 collection made in a shortleaf pine plantation at Crab Orchard NWR (*J.M. Halbrendt 002*) (West 1975: 71-73) and there is an old report from north Illinois by Moffatt (1909). Many older references (including Overholts 1967) list this species as *Polyporus schweinitzii*.

Recent Missouri collections (31 March 2012: *West 1291*) are depauperate specimens – dry, papery summer 2011 fungal holdovers. These are the first that I have collected under native pine. Where those basidiocarps were found, there appeared to be a serious infection of many trees, associated with both dead (many wind-thrown) and living trees. Not only did the infected trees exhibit the checkered red-brown rot of the lower trunk typical of this species, several of the specimens still had rhizomorphs attached to dead and deteriorating live roots. It appears that this species can generate new infections traveling to new hosts through root grafts.

Another southern Illinois specimen was provided to me by Joe McFarland, collected June 21 from under planted *Pinus strobus* in Evergreen Cemetery (adjoining Giant City State Park) (*West 1295*). It appeared even after an extended period of hot, dry weather. Although it was from native stands and in place next to a distantly related pine species, this 2012 collection was important because it verifies the presence of this species in southern Illinois.

I suspect that this species is problematic mainly in pine monocultures or pine-dominated stands, especially those with a fire history. It will probably not impact Illinois' native stands since shortleaf pine is part of a diverse community and there are fewer root grafts formed between these sparsely distributed trees.

***Phellinus pini* (Thore ex Fr.) A. Ames** Causing trunk and butt decay on native pines, Pine Hills (Union Co. IL) (*West 046, 836, 1040, 1043*); trunk decay fungus approximately 10 ft from base on bole of large native shortleaf pine, Piney Creek Ravine (Randolph Co. IL) (*West 1056*); trunk decay (1 specimen collected from base) of native shortleaf pines, weakened trees broken by high winds (2012: *West 1290, 1292*)

Discussion: This is the agent of a serious trunk decay, called "red heart" disease in the southern states. I first observed the 2012 specimens at Pine Hills in early February. There were some reports and Illinois collections of this rare fungus prior to that, first by Owens (1936 *in* Overholts 1967), by Schanzle (1971), then my thesis collections from Pine Hills (West 1975: *collections 1973-1974, the first being 2/3/1974*). This species is

scarce in the Illinois mycoflora, the only collections are from native pines. I resolved to minimize collecting it during this study and took only enough specimens to verify its presence or to obtain seasonal information on growth, development, and spore production.

Pine Hills shortleaf pines have this as a major trunk-decay pathogen, but only in the oldest, environmentally challenged pines (those on very rocky, dry, or wind-prone sites). There is evidence of red-heart in middle-aged trees, but basidiocarp formation and symptoms of advanced decay seem confined to the oldest trees. Within the past 5 years there were at least 2 major wind events (one recorded tornado and another straight-line wind) that felled some large exposed pines. After storms, tree trunks with red-heart snapped, while the root mass of pines with little or no trunk decay readily give way on wind-prone sites. Since one of the major destabilizing factors of Pine Hills pine stands is the impact of high winds in vulnerable exposed habitats, red-heart damage that happens when boles break has less impact on oak-pine communities than when root systems fail, taking part of the slope with them. All earlier collections were from living pines, single conks on trunks well above eye-level. The 2012 collections were from deteriorating or dead pines, including one stem that had failed and broken during a relatively routine thunderstorm.

The March 1974 collection at Piney Creek Ravine (*West 1056, collected with M. Myatt*) was the first collection from Illinois pine outside of Pine Hills. Because of the scarcity of *Ph. pini* in the Illinois mycobiota, its collection there verified that the Piney Creek pines were, indeed, native. I did not relocate this species at Piney Creek, though I did find what I believe are decayed remnants of the tree where I found the 1974 specimen . Though it was barely visible in the punky remains of the decayed conifer heartwood, I cut a brown resupinate polypore from inside the deteriorating shell that I suspect is *Ph. pini*. In the field notes this collection is referenced as a "way-overripe polypore" that "May be an old basidiocarp of Ph. pini". I have yet to confirm this.

Phellinus pini is an important keystone species. It can be reliably used to verify age and natural origins of pine stands. Because of its prevalence in Illinois' native stands but no where else in the State, it can be considered as much a relict as the pines it inhabits.

On the other hand, *Ph. pini* is less than rare in southeastern Missouri. Overholts (1967) did not list it from Missouri, so these records may be among the first consideration of the species in Missouri. I initially found an old basidiocarp (*West 1310*) at the base of a dead, decayed standing pine trunk in the Pinewoods Recreation Area (MO site 5), and there was some evidence that this fungus was the cause of the host's demise. I later discovered more *Phellinus pini* stands east of Pinewoods. After finding enough basidiocarps to substantiate trunk-rot symptoms – certainly more common than basidiocarps – I believe that this decay agent can be considered "uncommon" or "occasional" rather than "rare" in this portion of the Mark Twain NF. At the Illinois Natural History Survey Fungarium (ILLS) I recovered a "lost" Missouri collection of this fungus "…on living *Pinus echinata* … native stand called 'virgin pine' in Shannon Co. MO 10/18/1985" (*West 1236*).

Armillaria mellea (Vahl. ex Fr.) Kumm. (Fig. 19). A caespitose group of 4 in pine duff near *P. echinata* seedling, in oak-pine site, Pine Hills (Union Co. IL) September 24, 2012 (*West s.n.*)

Discussion: The fall of 2012 was a good one for finding this species. Pine Hills had several clusters of them growing on oak and on buried dead wood and roots, but this specimen was definitely overgrowing and infecting the root system of the little pine where it was found – the characteristic black rhizomorphs that give it the nickname "shoestring mushroom" (or "shoestring rot") were evident. This and other *Armillaria* species can be serious tree-root pathogens but *A. mellea* is a weak parasite but committed decomposer (Miller and Miller 2002). I am not aware of its being found on pine. A related species, *A. ostoyae* (Romagn.) Herink is a conifer pathogen in the west (Miller and Miller 2002).

4. Saprophytic Fungi on Pine Litter, Buried Wood, or Cones

***Entoloma strictus* (Peck) Sacc.** solitary to gregarious on rocky (chert) SW facing slope in oak-pine community. This species seems most closely associated with mosses, some interspersed with *Danthonia spicata* clumps and a species of *Carex* as well as many solitary-gregarious *Antennaria* in bloom; also in community *Vaccinium arboreum;* shadbush (*Amelanchior arboreum*) in flower; mesics such as sassafras and flowering dogwood. The dominant trees where this mushroom is found are post oaks, a few black oaks and scattered shortleaf pines; Pine Hills (Union Co. IL) March 13, 2012 (*West 1278 a and b*)

Discussion: E. striatus is reportedly a common late winter/early spring mushroom (Miller and Miller 2006). Unlike most late winter species that fruit in the hours and days *following* adequate rainfall, it appears *during* sustained rainy days, when its fruiting bodies appear rather quickly as rains arrive. This is a habit that must benefit species in dry communities such as oak-pine sites at Pine Hills. The wet, mild conditions during the winter and very early spring of 2012 were ideal for this species. It is apparently a common early spring mushroom. Though common under pines, it seemed not to have a clear preference for pine substrata. Its most favored oak-pine community habitat was in *Danthonia* clumps and cushion mosses (such as species of *Atrichum, Polytrichum* and *Mnium*). Although both of these microhabitats occurred under pine, they were also under oaks and other dry-site trees or associated with rocky places and thin soils.

***Helvella acetabula* (L. ex Fr.) Quel.** gregarious to scattered, in *Pinus echinata* duff, several ascocarps only partially visible beneath litter; in oak-pine community on dry-mesic ridge top along Cane Ridge Road, Cane Ridge Wildlife Mgt Area, Mark Twain National Forest, Butler Co. MO, March 26, 2012 (*West 1297*). Other field notes with this species: community dominated by *P. echinata* associated with *Quercus stellata* and *Q. alba* with understory shrubs sumacs, aromatic sumacs, as well as elms, sassafras,

flowering dogwood and wild black cherry; native clovers, *Astragalus*-looking sub-shrub, 2 species of *Antennaria* in bloom. (Missouri citation only)

Discussion: This is the only ascomycete that I included in this report. It was a very interesting and conspicuous fungus in the native pine during the early Missouri spring. The day's field notes state

> Collected 10 ascocarps with *Helvella*- or *Verpa*-like veined bases; forming cups – expanding with age; some were dispersing spores (seemingly when exposed to sunlight/perhaps heat … They appear to be most closely associated with *P. echinata* though (most) in a (fire-) managed oak-pine woodland …"

I also noted that since this fungus appeared more associated with pines under burned stands, it would be important to look at the fire history of these stands. This is a morel relative and it had some interesting, even strange, characters:

> Spore mass color probably hyaline … the fungi were exceedingly active in dispersing spores in large masses, including while the specimens were being dried under a heat lamp. The ascocarps are at first erect, later expanding with age to a wide cup-shaped ascocarp. The ascocarps are veined. Cups are apparently enrolled at first, spreading and tending toward becoming flat plate-like structures in larger, older specimens

***Pluteus cervinus* (Schaeff. ex Fr.) P. Kumm.** Growing at base of standing dead, decayed *P. echinata* – definitely attached to outer bark, Pine Hills (Union Co. IL) September 24, 2012 (*West s.n.*).

Discussion: this species, commonly called the "deer mushroom" decays both hardwood and conifer wood. It appears in both spring and fall. There were several specimens of this mushroom on oak and other logs, and a few that appeared to be growing on soil or duff were, in fact, attached to buried wood.

5. Other Collections and Observations

The records above are species and groups which could be identified (Table 1). I presented only those data, field observations and discussions that are useful in reporting mycobiota, their associations with native pine, and their utility in describing and delineating shortleaf pine populations. In addition to these, I collected and processed the following:

***Agaricales* (gill fungi):** 9 Collections (all IL collections from Pine Hills)

a. 4 unknown fungi not identified to genus, 1 IL, 1 IL plantation, 2 MO collections;
b. 1 unidentified IL species of *Amanita*;
c. *Crepidotus* brackets from burned pine wood in MO;
d. 2 unidentified IL plantation collections of *Lactarius*;

Table 1. Fungal associates of native shortleaf pine (*Pinus echinata*) host impacts

Association type: 1=facultative mycorrhizae 2=probably obligate mycorrhizae, at least to southern yellow pines; 3=weakly parasitic-facultative saprophyte; 4= root parasite; 5=parasitic root graft transfer; 6=parasitic butt decay; 7=parasitic trunk decay; 8=parasitic exploiting wounds; 9=parasitic fire related; 10=saprophyte

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8 Mycorrhizal Pine Symbionts

Amanita citrina (Schaeff.) Gray 2
Amanita ravenellii (Berk. and M.A. Curtis) Sacc. 2
Other Amanita species (4) 1 or most likely 2
Russula queletii Fr. (?) or *R. azarea* Bres. (?) 2
Russula sanguinea Fr. (?) 2

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4 Saprophytic Species in Litter or Other Surface Habitat

Entoloma strictus (Peck) Sacc. 10
Helvella acetabula (L. ex Fr.) Quel. 10
Pluteus cervinus (Schaeff. ex Fr.) P. Kumm. 10

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4 Pine Parasites

Armillaria mellea (Vahl. ex Fr.) Kumm 3, sometimes 4 or 6
Heterobasidion annosum (Fr.) Bref. 4, 5, 6
Phaeolus schweinitzii (Fr.) Pat 6, 8, 9
Phellinus pini (Thore ex Fr.) A. Ames 7, 8

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5 Pine Wood Decay Species

Gloeophyllum saepiarium (Fr.) P. Karst 10
Irpex fusco-violaceus (Ehrenb. ex Fr.) Fr. 10
Neolentinus lepideus (Fr.) Redhead and Ginns 10
Schizophyllum commune Fr. 10, rarely 3
Trichaptum abietinum (Dickson ex Fr.) Ryvarden (and *T. biforme*) 10

***Agaricales* (gill fungi)** (continued from page 20)**:**

e 1 IL plantation collection of a *Marasmius* species;
f 1 unknown IL species of *Mycena*;
g 2 unidentified IL *Pluteus* (probably *P. cervinus*).

***Gastromycetes-Lycoperdaceae* (puffballs):** 2 Collections - unidentified *Lycoperdon* species, 1 from MO, the other from IL.

***Aphyllophorales* (pore fungi, tooth fungi, thelephoraceus fungi):** 8 Collections

a. Resupinate fungi – 5 unknown MO corticioid species including a species of *Merulius*, 4 unknown IL species from Pine Hills, 1 unknown from the Pine Hills plantation, 1 hydnaceous resupinate species from decayed pinewood at Piney Creek;
b. A species of *Stereum* from MO collected from both pine and oak wood;

Myxomycetes (Protista): a slime mold, possibly the genus *Diderma* from rotten pinewood on Cane Ridge MO.

Pine galls: 2 Collections from MO including 1 gall with resupinate fungus on surface.

Discussion

Collecting was hindered during the summer and early fall of 2012 by a record drought. In the best years with adequate periodic rains, oak-pine communities occupy some of the driest and rockiest sites on the landscape. In Illinois, pine has retreated to the most hostile environments, namely cliff tops and xeric ridges. The sharpest topography is exposed to high winds and storms, and the remaining pines are often on the west or southwest aspects where plant life is susceptible to the worse of southern Illinois summers. Missouri pines fare some better since some are in deeper soils on broader ridgetops. Even there, fire and other disturbance, often from human intervention to maintain pine timber, can affect microenvironments crucial to plant and fungal life. The past year saw extremes in temperature and no or little rain. Hence, no macrofungi.

Late winter and early spring conditions were much better. Although there were fungal reproductive structures to be found, there was not much diversity. Interestingly there were a few fall species (e.g. *Russulas*) present in spring. A few of the summer mushrooms made an appearance in early fall. One observation based upon this season is that though the peak of southern Illinois mycobiota diversity in general appears to be the summer months (last summer's being stifled), pine mycorrhizal associates and many of the pine-favoring saprophytes are more prevalent in the fall. Evidently some of these fall fungi persist longer into early winter, and a few even reappear in spring. It may be related to climatic changes or it might be a response to drought conditions or a previous fall's early freeze.

One of the goals was to compare species of fungi between Illinois and Missouri pine areas. The summer conditions and lack of uniformity in mushroom appearances did not allow a comparison to be made between the 2 mycobiota. The comparison between pathogenic basidiomycetes was closer: 2 polypore species, *Phaeolus schweinitzii* and *Phellinus pini* were recorded, but only *Phellinus pini* appears to be a species common to native stands in both states.

That one pine associate, *Phellinus pini*, can safely be used to ascertain whether a stand is native or was planted in times past. Even its utility is limited because as plantations age, it is possible that this species will infect the oldest trees. In this case, it may represent a turning back on the landscape, a resurrection of relict biota, a reestablishment of conditions that existed if shortleaf pine was truly more widespread in pre-settlement Illinois or in early historic times. The scenario is thus: (1) shortleaf pine was planted in abandoned farmland, perhaps mixing with whatever native pines remained, (2) the pines mature as part of the landscape, (3) they become infected by *Phellinus pini.* I make no recommendations to promulgate this scenario but only offer it as a possibility that future managers may observe.

It is probable that the mycobiota of the introduced pines is quite different from native stands, but there it may not be. How mycorrhizae becomes established in seedlings, at germination or as a later invasion is dependent on a number of factors. By studying the mycorrhizal symbionts differences or similarities between these can be revealed. Probably 2 of the best mushroom genera for tracking mycobiota are those 2 pesky taxonomic groups, the *Amanitas* and *Russulas.* If even a few of these could be identified as markers of shortleaf pine populations, other species such as members of *Lactarius* and slow-moving parasites such as *Phellinus pini* and which variety of the PIAF species are found, where, can be used. Add old planting records (e.g. sources of seeds or seedlings from the 1930s-1980s and a pattern can be established for a chronicle of pine in southern Illinois. Checking for the shared genetic heritage of shortleaf pines and whether there are differences between populations will also be helpful.

The debate about the "naturalness" of pines at Piney Creek Ravine is probably moot. There are too many reports and too much evidence of pine's being a crucial part of the communities there to doubt. Pines have presumably been there a very long time, separated only by time and environmental shifting. I'd only add one more glitch: what might have been the role of Native Americans in prehistory? The rock art points toward the Ravine's holding a special place in Native American life in what is now Randolph County. Could previous residents of the land transported and planted the pines that grew into a part of Piney Creek environs? Probably not, but it is an interesting thought.

The Valmeyer pines issue has finally been addressed, at least for now: I'd predicted we'd find a human cause of the pines' presence. Late in December 2012, INPC Preservation Specialist Debbie Scott-Newman (pers. comm.) heard from a local resident that he had helped with planting pines on the blufftops of the former owner, Columbia Quarries. This might settle the question of whether native pines occurred in that area. However, there are still large "yard trees" and individuals that might not be explained away by

reforestation practices. I think this deserves a little more attention. Maybe, like Piney Creek, could prehistoric folks have been involved? How close is Cahokia and did some of the inhabitants fancy landscaping? Again, this is probably not the case.

Conclusion

Some answers to questions about native pines came from pursuing this project's objectives:

a. The project reinforces that fungi are important elements of the oak-pine communities in the 2 states;
b. The mycobiota helps the community survive, even in its diminished state;
c. Pine mycobiota are distinct from other tree species' mycobiota;
d. Pine mycobiota can help to distinguish between native and introduced and verify reports of where pine once existed.

Communities and ecosystems cannot function without fungi. They break down and recycle nutrients, allowing them to be used by plants. They provide habitats for cavity-dependent wildlife, produce microhabitats for insects and feeding stations for avian life. They help shape the communities where they are prevalent. Mycobiota is an integral part of the unique settings that define pine-dominated landscapes.

Acknowledgements

This project was supported in large part through a grant from Illinois Wildlife Preservation Fund 12-021W. I thank my IDNR regional coordinators, first Marty Kemper and secondly (present), Jody Shimp for guidance and grant administration.

The U.S. Forest Service has two outstanding biologists who guided me through the permit applications plus provided resources, directions, and information about pine ecology in their respective National Forests: Elizabeth Longo-Shimp, Forest Botanist/Ecologist for the Shawnee National Forest and Megan York-Harris, Wildlife Biologist for the Mark Twain NF, Poplar Bluff Ranger District.

Thanks to INPC preservation specialist Debbie Scott-Newman for assistance and advice particularly concerning sites and people in Randolph and Monroe counties. I am grateful to the Bluffs conservation group and City of (New) Valmeyer for information and access to the Valmeyer Pines, as well as Priscilla Bollinger and Tony Hernandez, owner-stewards of Rockcastle Creek.

The Chair of the Southern Illinois University Carbondale Department of Plant Biology, Dr. Stephan Ebbs, provided access to the SIUC Herbarium and a light microscope, necessities for mycological taxonomy. At the Illinois Natural Survey's Fungarium in Urbana-Champaign, Dr. Andrew Miller, Dr. Rick Phillippe, and Dr. J.L. Crane graciously allowed access to the largest collection of fungi in our State. Professor Emeritus-Mycologist Dr. Walter J. Sundberg and mushroom aficionado Joe McFarlane

gave invaluable help to me during surveys and identification work. Biologist Rob Stroh, my associate in OKES, assisted me with field excursions and processing collections.

The project could not have been carried out without the IDNR, INPC, IESPB, and USFS staff who administered, processed and approved the Grant and permits enabling (1) research activities and collecting within Giant City State Park, Piney Creek Ravine Nature Preserve, LaRue-Pine Hills Research Natural Area, Shawnee National Forest, and Mark Twain National Forest; (2) the taking of shortleaf pine and associated mycobiota under the Illinois Endangered Species Act. Good bureaucrats like you are really not hard to find, just underappreciated.

PROJECT DELIVERABLES

1. Digital images and maps illustrating study sites, species, and micro-habits are in the FIGURES section;
2. As required by Grant Agreement #12-021W, (1) 2 paper-copies of this report with illustrations, images, and other information and (2) a CD electronic version are supplied by the Grantee to the Grantor;
3. This report is electronically submitted to the Illinois Department of Natural Resources grant administrator;
4. All identified voucher specimens and appropriate field notes and data will be deposited in the Fungarium, Illinois Natural History Survey (ILLS) by June 30, 2013;
5. Copies of all notes, receipts for requested reimbursement, and records of Grant funds are available upon request from the Grantee.

PUBLIC EDUCATION

1. A news release has been issued to The Southern (Southern Illinoisan) newspaper describing the project and acknowledging the role of the Illinois Wildlife Preservation Fund;
2. Specimens to be deposited in the Illinois Natural History Survey Fungarium (ILLS) will be available for scientific study and now provide verification of additions to the known mycobiota of Illinois and Missouri;
3. Segments of Technical Report will be revised for a public presentation to the general public when requested to present a program at a function of the Illinois Native Plant Society, North American Mycological Association, local Audubon, or other conservation and natural history organization;
4. Contents of the Technical Report will to used in a future scientific publication when combined with results of 2013 and 2014 field season and systematic identification work.

PROJECT EXPENDITURES

A total of $6725.43 was spent on this project (Table 2). After deducting my hours and applying a15% client discount, $2019.11 remain. I request the full Grant Fund awarded,

$1870 for a loss by OKES of $149.11; this amount corresponds to final preparation and processing expenses which I am donating to the Project.

Table 2. Project expenditures and request for payment

AUG-DEC 2011 expenses			
1433 miles x 0.51 = 730.77 (less 1027 MO miles = 523.77) Hours 68 x 25 = 1700.00 (less46 MO hrs = 1150.00) Other: meals and supplies 117.61 (less MO Other 117.61)			
TOTAL AUG-DEC 2011	Expenses 2548.38	less MO 1791.38	Exp $757.00
JAN-APR 2012 expenses			
1705.3 miles x .51 = 869.70 (less MO 944 miles = 481.48) Hours 82.5 x 25 = 2062.60 (less MO 30 hrs = 750)			
TOTAL JAN-APR 2012	Expenses 2932.30	less MO 1231.48	Exp $1700.82
MAY-OCT 2012 expenses			
1267.1 miles x 0.51= 646.22 (less 361 MO miles = 184.11) Hours 96.5 x 25 = 2412.50 (less 26 MO hrs = 650) Field Tech 16 x 20 = 320 Other: meals and supplies 69.99 (less MO Other = 69.99)			
TOTAL MAY-OCT 2012	Expenses 3448.41	less MO 904.10	Exp $2544.31
NOV 2012-JAN 2013 expenses			
220 miles x 0.51 = 112.20 (less 220 MO miles = 112.20) Hours 48 x 25 = 1200 (less 19 MO hrs = 475) Field Tech 32 x 20 = 640 Other: report copying and distribution 38.00 (UPS Store, Marion)			
TOTAL NOV 2012-JAN 2013	Expenses 1510.20	less MO 587.20	Exp $923.00
Subtotal Expenses			**$6725.43**
Less West hrs (donation)			-4350.00
Less 15% (new client discount)			-356.32
Total Project Expenditures			**$2019.11**
Less OKES final preparation/processing work (loss/additional donation)			149.11
REQUESTED PAYMENT			**$1870.00**

EXPENDITURES IN ADDITION TO REQUESTED GRANT PAYMENT

Expenses not paid by the $1870 of Grant #12-021W are absorbed by the general operating fund of Ozark Koala Ecosystem Services. These include line items identified above (Table 2): hours spent on the Project by K.A West ($4350.00) and cost overrun of > 149.11, the difference between actual expenditures and the amount awarded through the Grant.

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FIGURES

FIGURES

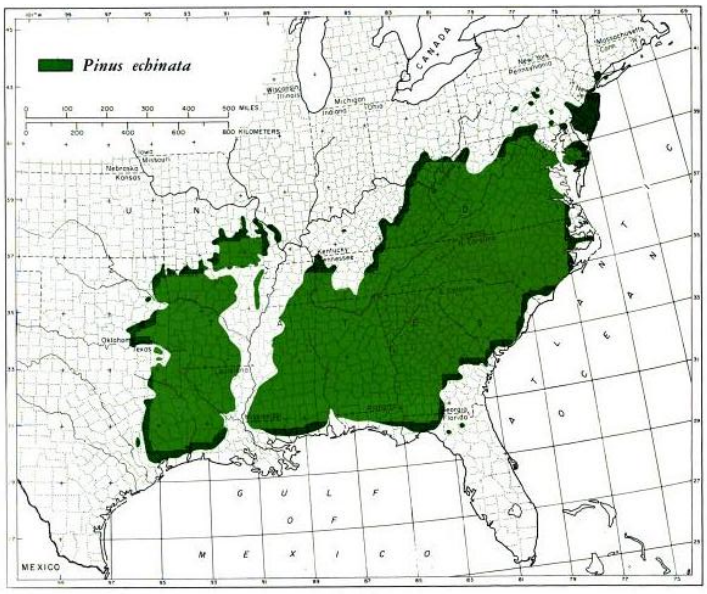


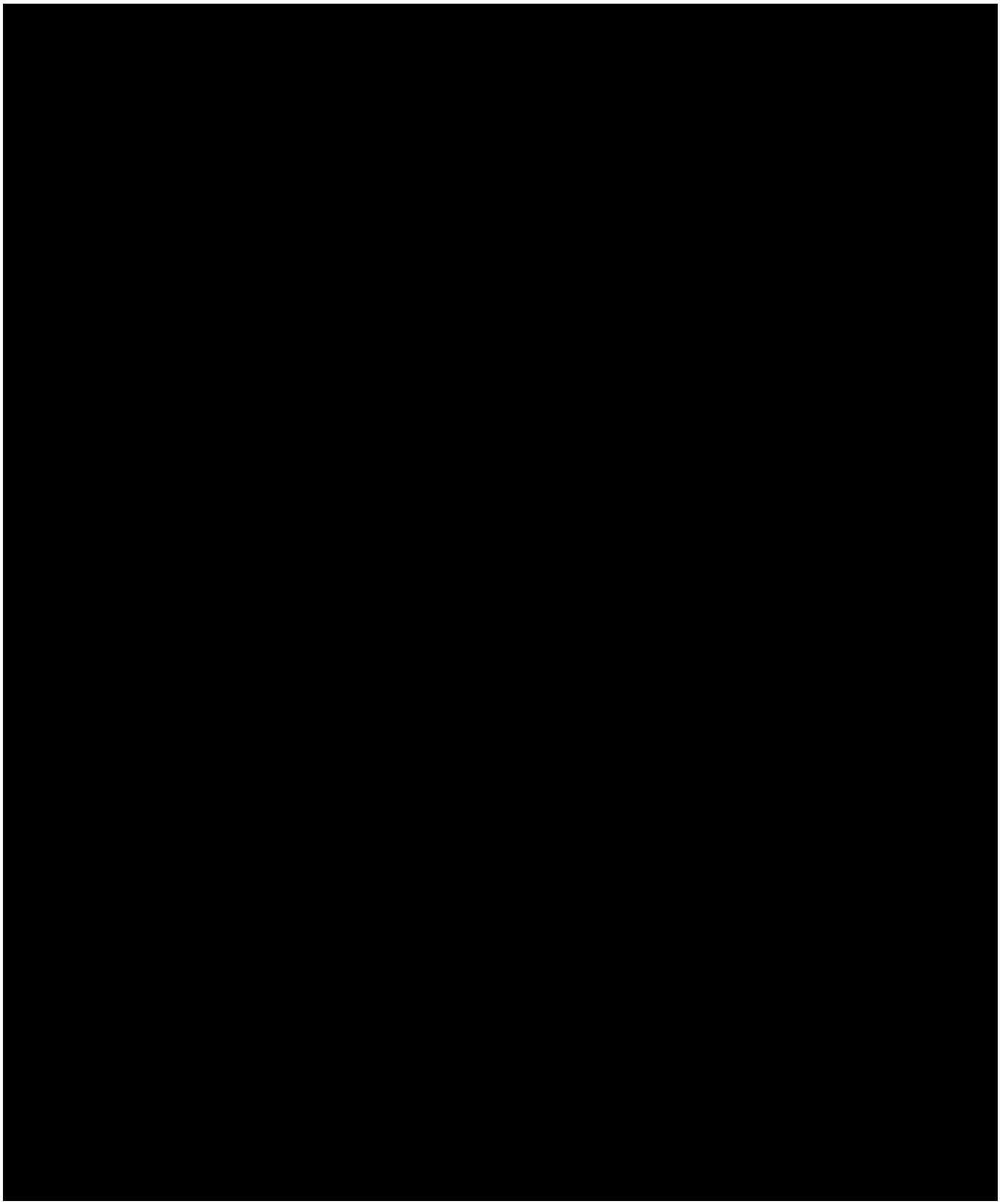
Figure 1. North American distribution of shortleaf pine

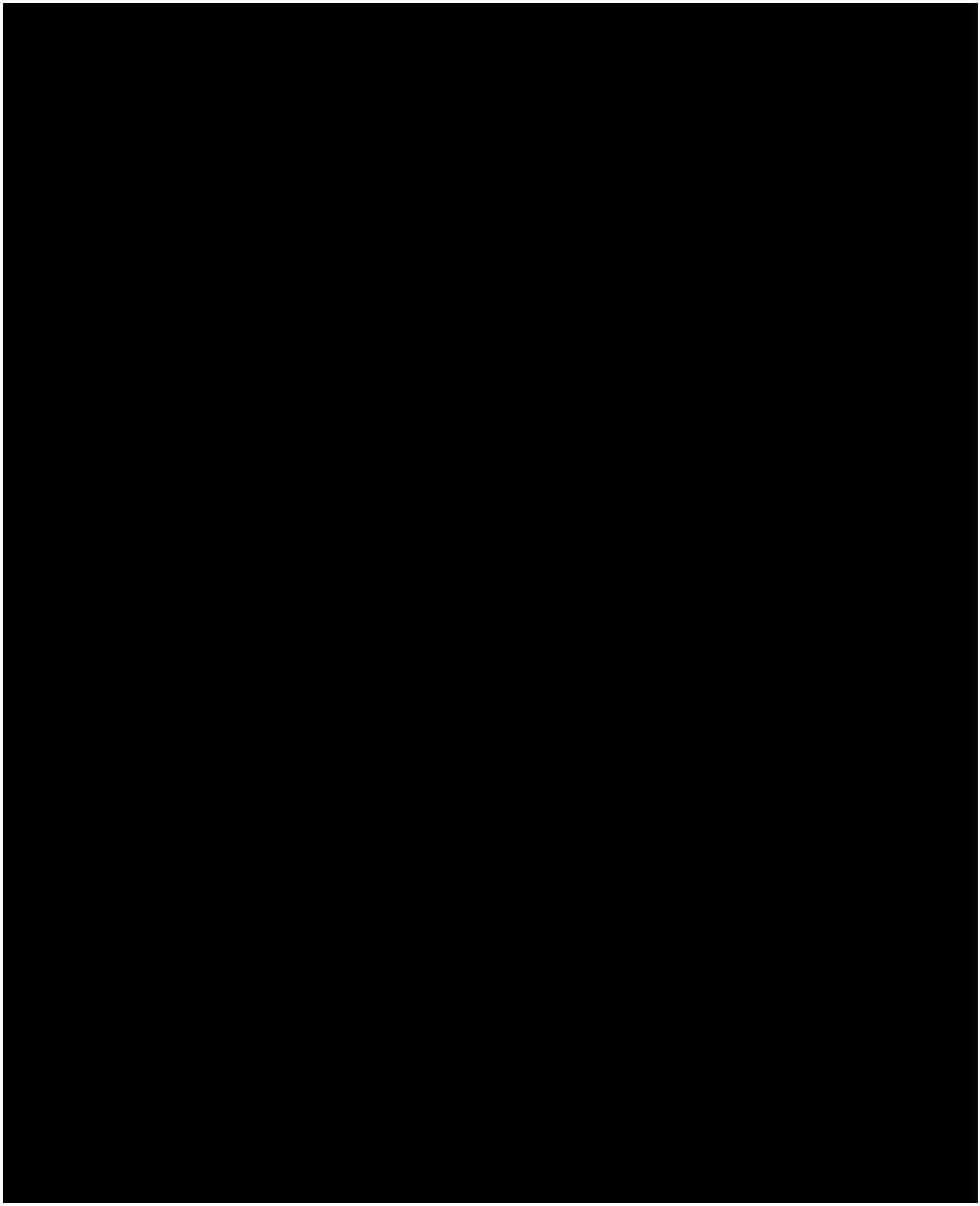
Pinus echinata Mill. MAP 42 *in* Critchfield, W.B. and E.L. Little 1966. Geographic distribution of the pines of the world. USDA Forest Service Misc. Publ. 991.

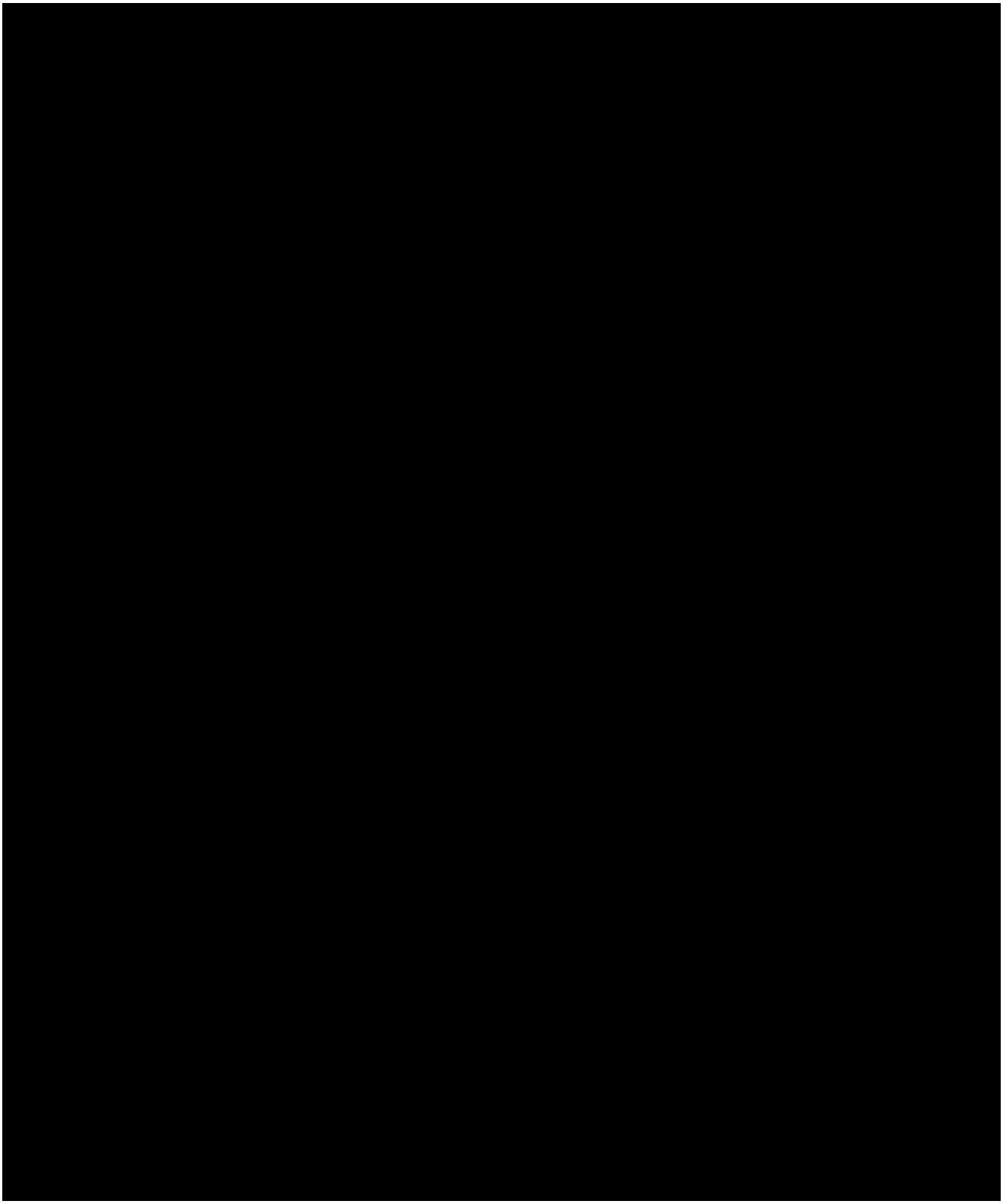
Figure 2. Trunk decay and resultant stem failure from red-heart (*Phellinus pini*)

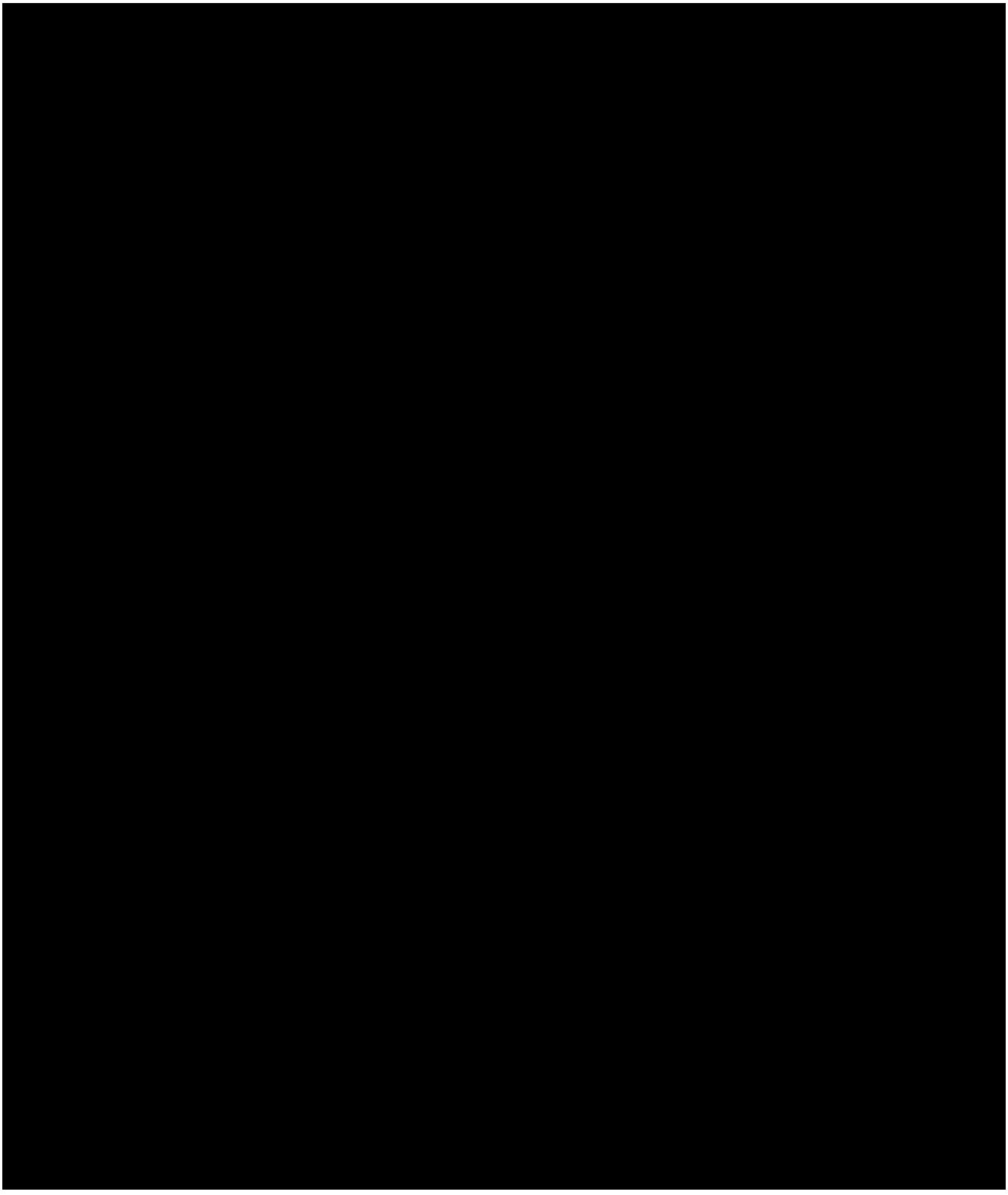
Both images – Pine Hills June 2012

Figure 3. Root mass failure on chert slope









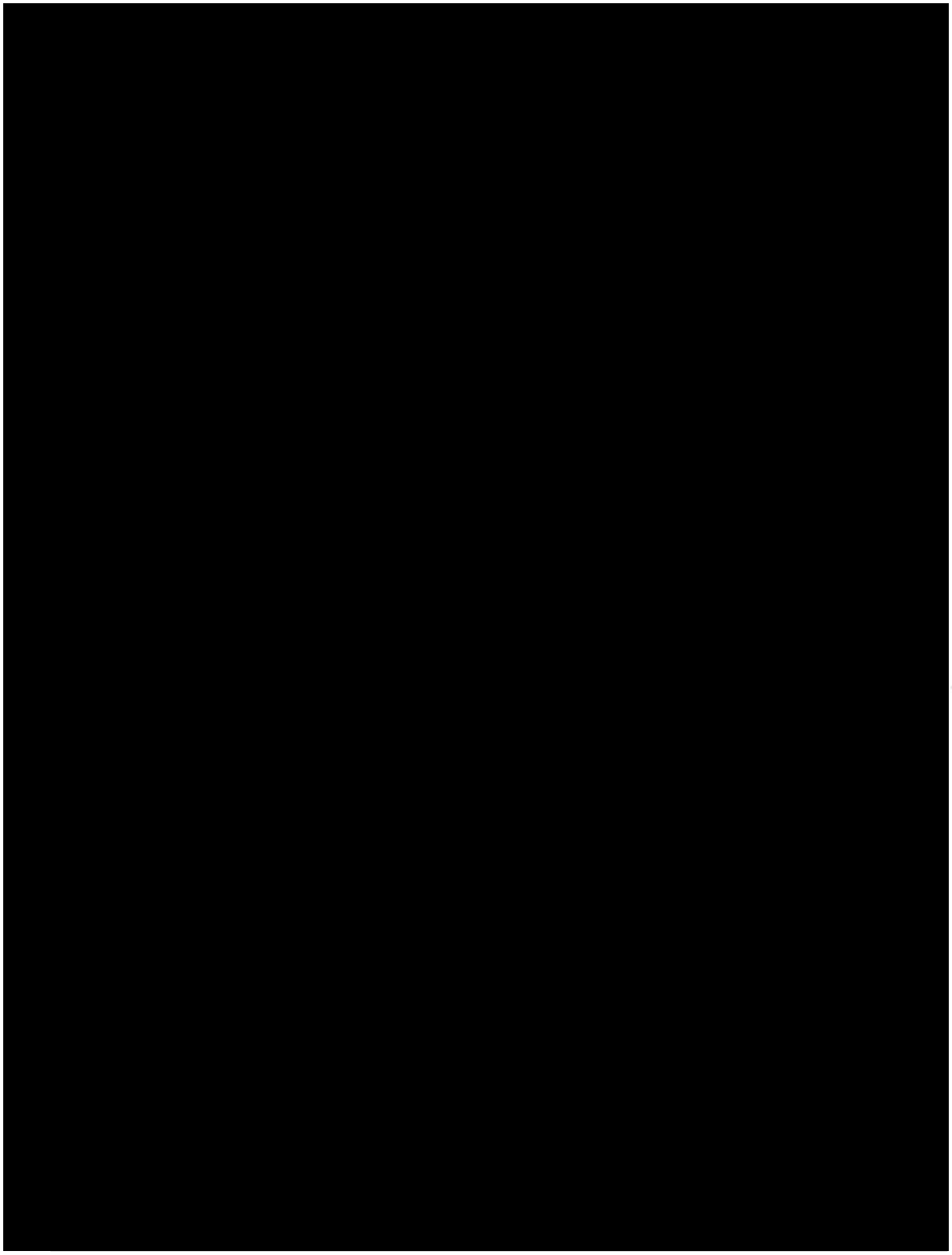


Figure 8. *Amanita ravenellii* newly emerged in litter

West 1350 Cane Ridge Wildlife Management Unit
Mark Twain National Forest (Butler Co. Missouri)
15 August 2012

Figure 9. *Amanita* of *A. virosa* complex

West s.n. Pine Hills (Union Co. IL)
24 Sept 2012 Shawnee National Forest

Figure 10. *Amanita* of *A. virosa* complex

Pine Hills IL
24 Sept 2012
Shawnee National Forest

Figure 11. *Amanita* species with persistent veil and scales on cap
Pine Hills (Union Co. IL) Shawnee National Forest 24 Sept 2012

Ozark Koala Ecosystem Services media release – conclusion of study
PINE MYCOBIOTA PROJECT

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Please release or publish after January 21. Contact: Andrew West 618 993-5114 (home), 573 820-1822 (work cell phone). May edit content for publication but review and approval by the author would be appreciated. Notify the author for more information or to use the content as basis for an expanded or condensed article to be written by media staff. [Key words: Illinois Wildlife Preservation Fund, southern Illinois ecology and biodiversity, Illinois pines, mushrooms and other fungi]

Suggested title – Wildlife Preservation Fund research suggests that studying mushrooms and other fungi may uncover origins of Southern Illinois pines

Southern Illinois pines are not native. Thousands were planted on abandoned farmlands and eroded sites from the 1930s through 1970s as tracts became part of the Shawnee National Forest. However, Illinois does have *relict native pine* populations, isolated from a larger population about 1500 years ago. These small stands of shortleaf pine and mixed oak-pine communities on dry ridges, perched on bluff tops are confined to LaRue-Pine Hills in Union County and Piney Creek Ravine in southern Randolph County.

It's commonly thought that our shortleaf pines are related to pines in the Missouri Ozarks. After all, Illinois' Ozarks is a geological sister to the southern Missouri and north Arkansas Ozark Mountains that's separated from the greater Ozarks by the Mississippi River Valley.

Being close to the greater Ozarks, though, is just one reason why southern Illinois has such a variety of plants. We are at the junction of different biological zones. The Shawnee Hills in the east, glaciated Southern Till Plain to our north, the southern Coastal Plain, and the Illinois Ozarks are parts of more expansive North American landforms. Vegetation migrated from these to build southern Illinois' diverse plant life – the dry Ozarks, species from southern swamps and forests, eastern hardwood forests, central Illinois' prairies and savannas. Shortleaf pine has the broadest range of any North American southern pine, from near the east coast to Texas, so our relict pines may have come from the southeast, not the Ozarks.

To find out more about the origins of Illinois' native pines, biologist Andrew West set out to find out how the fungi associated with Illinois relict pines differ from pine fungi in the Missouri Ozarks and from those in southern Illinois pine plantations. Certain fungi tend to be closely associated with different trees, in different habitats, and populations so pine fungi may be a tool in finding out about the origins of relict pines. The first phase of his study, a survey of pine-associated fungi was funded by a grant from the Illinois Wildlife Preservation Fund.

When a lot of folks hear fungi, they think mushrooms: tasty wild morels in the spring, Shitake mushrooms for oriental dishes, boxed or canned store mushrooms destined for pizzas and omelets. Truth is, there are many fungi besides mushrooms and they affect our lives in a multitude of ways. Some damage grain crops, trees, fruits and even us humans (athletes-foot and ringworm are both caused by fungi).

That aside, a vast majority of fungi are beneficial, such as the fruit mold that gave us penicillin. Wood-decaying mushrooms and their allies consume dead wood and other plant materials. Many fungi are closely connected to forest trees, not just their decay and disease agents but as symbiotic partnerships between tree root and fungus – mycorrhizae (from Latin, "fungus root").

In the past year West found 24 species of mushrooms and related fungi that grow with native pines. Although he has not yet drawn conclusions about the origin of Illinois pine, it appears Illinois and southern Missouri Ozark pine fungi are similar, and mushrooms in native Illinois pine stands seem to be different species than those in pine plantations.

West says that native shortleaf pines are classified as threatened under the Illinois Endangered Species Act. Learning about pine fungi fits well into Wildlife Preservation Fund goals to maintain and restore healthy populations of rare, threatened, and endangered plant and animal species. “Humble mushrooms play important roles in oak-pine forest settings,” West said, “This Wildlife Preservation Fund study established a basic groundwork to uncover ways to help Illinois’ rare, relict pines survive as part of our region’s rich natural heritage.”

Ozark Koala Ecosystem Services (named for that American marsupial, the Virginia opossum - Didelphis virginiana) offers a variety of biological research, conservation education, land management, and facilitation services to landowners, organizations, and agencies. Ozark Koala associates view their roles and missions as Plain Citizens and partners of, not dominators over, the Land (Aldo Leopold 1949 in A Sand County Almanac).