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A Survey of the Macroscopic Fungi of the Lula Lake Land Trust

by
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Departmental Honors Thesis
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ABSTRACT

I conducted a survey of the macroscopic fungi in an area designated as Chestnut Orchard #1 of the Lula Lake Land Trust from May 29, 1999 to March 8, 2000. The purpose of the survey centered on making a comprehensive list of the fleshy fungi to serve as baseline data of the fungal diversity contained on this experimental chestnut plot. The fieldwork resulted in a collection of 139 sporocarp specimens, comprising 17 families, 38 genera, 63 species and, as of yet, approximately 30 unidentified specimens. Some of the specimens collected were also determined to be edible, thus offering a possible future economic venue for Lula Lake and the surrounding areas as potential cash crops. This study provides baseline fungal information on Chestnut Orchard #1 for means of comparison for future examinations of changes in the mycological diversity that may come as the American chestnut, *Castanea dentata*, resumes its place in the forest canopy.

INTRODUCTION

Thesis Statement

The Lula Lake Land Trust has an enormous potential for success as a site for a survey of the macroscopic fungi. With its predominantly Oak-Hickory-Pine forest composition, it supplies numerous factors needed to promote a wide variety of fungal species. The high diversity of different species of trees, plants, and habitats allows for a corresponding high diversity of fungi, particularly mycorrhizal species. The forest also provides a habitat for small mammals and birds that can serve as spore dispersers that are essential for reproductive success of some mushrooms. By initiating a comprehensive study of the fungal diversity of the Land Trust, baseline information can be collected now to serve as a reference for future botanical studies.

Justification

To date no systematic survey has been done on the mycological diversity of the Lula Lake Land Trust. The current project of the Chattanooga Chestnut Tree Project and Dr. J. Hill Craddock on the Land Trust is the restoration of the American Chestnut (*Castanea dentata*). Along with providing a native population of *C. dentata* surviving chestnut blight, the

Trust also furnishes sites on which blight-resistant hybrid progeny can be bred. The reintroduction of these chestnut trees into the predominantly Oak-Hickory-Pine forest of the Trust will likely have an effect on many different aspects of the current ecosystem. The re-addition of these trees can change the chemical composition of the forest soil, provide a new source of food and shelter for small mammals, and alter the vegetative population, including the fungi. Over time, these chestnut trees will provide various factors that may or may not change fungal diversity. The roots of the chestnut trees will no doubt form symbiotic relationships with some soil fungi, resulting in mycorrhizae. Through these mycorrhizae, both the tree and fungus will benefit. The associations will afford specific fungi opportunities to form reproductive structures while increasing the nutrient, water, and overall survival of the trees (Janerette, 1991). Strong, healthy trees are needed in efforts to combat chestnut blight. Perhaps even another fungus will have the ability to symbiotically help the chestnut tree to resist the blight. Therefore, a survey on the current site of experimental hybrid chestnuts is needed to provide baseline data for future comparison purposes.

Mycology

The term mycology, the study of fungi, originates form the Greek word *mykes*, "fungus." The fungi range in size from the microscopic yeasts and molds to more popular and well known larger representative, the mushrooms. The term mushroom is thought to have originated from the French word *mousseron*, derived from the word mousse, or moss. Mushrooms

Fig. 1 – *Bulgaria rufa*

generally refer to the reproductive, fruiting body of the fungus that serve as vessels to disperse the spores of the fungus. Mushrooms are the visible, above ground portions of the fungus that emerge from a network of underground mycelia. A popular, broader definition used by both amateur and professional mycologists includes any and all large fleshy fungi, from the traditional mushrooms with a cap, stalk, and gills to boletes, puffballs, morels, and many more (Figures 1-3). Popular usage of the word mushroom has also been co-mingled with the word toadstool. Many

Fig. 2 - a jelly *Tremella* species

Fig. 3 - *Amanita spreta*, a gilled mushroom often mistaken for the deadly *A. phalloides*

works of literature have cited the difference in these two terms as a distinction between the edible and poisonous foods, while science does not acknowledge the two as separate (Marteka 1980).

Edible Mushrooms

Mushroom edibility has proved to be an especially valued characteristic. Along with acting as another identification category, edibility has given the mushroom some commercial, economic value. Many European countries assign more monetary value to the mushrooms of the forest floor than to the timber of the forest trees. Some sought after species such as *Boletus edulis* and *Amanita caesaria* produce a high demand and therefore a high price on the food market. The cultivation of some other species: oyster mushrooms (Pleurotus ostreatus) and common white supermarket mushrooms (Agaricus bisporus) functions as productive cash crops here in the United States. The discovery of edible species of mushrooms at the Lula Lake Land Trust may offer new economic venues for the people of the area if this natural resource can be cultivated and harvested.

Forest and Soil Ecology / Mycorrhizae

"The subject of ecology is organisms, and groups of organisms, interacting with their biotic and abiotic environment (Brower et al. 1998)."

This description of the field of ecology is very well suited for the Kingdom Fungi, whose existence depends on interactions and associations. At present, the Lula Lake Land Trust's oak-hickory-pine forest provides a canopy that promotes a diverse composition of flora, including canopy-sharing trees and understory shrubs and flowers. The flora, in turn provides the habitats and foods for a variety of animals. The fungi fill their ecological niches through their interactions with both plants and animals.

Mushrooms are divided up into three categories based on their roles in nature. Saprophytic mushrooms live on dead or decaying plant and animal matter such as leaves, logs, and dung. The mycelium of this type of fungus radiates outwardly in all directions. When sporocarps are formed at the circular margin of the expanding mycelium, the result is fairy ring of mushrooms. Saprophytes are often very selective of the substrate on which they grow, an important identifying characteristic. Parasitic mushrooms attack living organisms, such as plants and even other mushrooms (Marteka 1980).

Mycorrhizal mushrooms comprise the third group, in which a mutually beneficial, symbiotic relationship exists between the mushroom and the plant, mostly trees. The mycorrhizae, translated to "fungus roots," a networking of fungal mycelium and tree rootlets where nutrients and minerals are absorbed and exchanged, exist in two main forms. The ectomycorrhizae from a sheath of fungal cells surrounding the mycorrhizal root tips and a Hartig net, a specialized tissue composed of root cortex and fungal hyphae intertwined. These ectomycorrhizae are formed by many Basidiomycetes and Ascomycetes in association with woody plants such as: oak, chestnut, pine, walnut, beech, birch, willow, and eucalyptus. The second form is the more common endomycorrhiza. These form associations with grasses, vegetable crops, and some fruit trees (Janerette 1991).

Many mycorrhizal mushrooms are host specific, providing another important clue in determination and identification (Arora 1986). Contemporary studies dealing with mycorrhizal plants have shown a higher rate of establishment in less than ideal soils for plants with fungal symbionts. Mycorrhizal technology may also have a strong agricultural impact once developed for practical use. This technology could expedite the growth of plants while reducing the amount of contaminating and costly fertilizers (Janerette 1991).

American Chestnut

One particular fungus has had an extremely debilitating effect on the American Chestnut, *C. dentata*, population. *Cryphonectria parasitica* or chestnut blight was introduced by way of an importation of Japanese chestnuts

(*C. crenata*) in the late 1800s. The American Chestnut trees had once been an important economic industry providing lumber and food sources. Since then the mighty American Chestnut tree that at one point comprised up to one fourth of the forests from Maine to Georgia, has been moving closer and closer to extinction (Roane et al. 1986).

Research is currently underway to help revive the chestnut population. One solution to the problem is the experimental crossbreeding of American, Japanese, and Chinese chestnut tree resulting in blight-resistant progeny. This method requires many generations and backcrosses to obtain the Oriental blight resistance while maintaining American "timber" features. Another approach involves the biological control of the chestnut blight fungus that successfully competes against the chestnut blight. This hypovirulent strain produces superficial cankers that are less harmful to the trees. Problems with this approach are found in the case that the trees must be artificially inoculated with the strain and that once they are inoculated there is no known method to expedite the spreading of the hypovirulence (Roane et al. 1986). The trees of the Lula Lake Land Trust represent an important genetic resource; a native population of more than 20 survivors. These American chestnut trees which for now have not succumbed to the blight provide a source of germplasm and scionwood. Mining and clear-cut timber harvests from the past, however, have damaged the fertility of the soil (Janerette 1991). Efforts of the Trust to restore and preserve the land, compiled with the probable existing mycological symbionts could increase the chances of a reforestation and establishment of plants, like the American Chestnut. By providing assistance and the opportunity for the research of UTC faculty and students, along with sites to test hybrids, the Land Trust is able to assume the role of a living laboratory whose efforts aim at the restoration of the American Chestnut.

Taxonomy Problems

The classification of the fungi has always posed difficulties. First and foremost is the obstacle posed by the identification of the individual organism. Since the visible mushroom is only the ephemeral fruiting body of the underground filamentous individual, it is a matter of speculation as to whether or not the fruiting bodies spring from one or more mycelium. The next problem is largely due to the practice of taxonomic groupings based on comparisons of the sexual reproductive cycle for groupings. Little is known about a majority of the reproductive phases of a majority of the fungus. The immense range of character variation caused by a large number of evolutionary, environmental, and other pressures has further hindered the understanding of this kingdom. The systematic approach to organization of the fungi is best attempted through three "'species concepts,' the philosophical criteria through which investigators communicate their definitions of the term 'species'" (Petersen 1999).

The first concept is the morphological species concept (MSC). This most obvious method of comparison is the basis of early mushroom systematics. This concept is extremely inadequate mainly due to its dependence on the mostly ephemeral fruiting body. The production of the fruiting bodies is so dependent on environmental conditions and their appearance so short term, that collection of a sufficient supply of the organism for study is very difficult. Both macroscopic and microscopic similarities are examined in this concept. This method leaves much to the taxonomist who gets the ultimate decision on the reasons for dissimilarities, whether due to genetic hiatus or different species (Petersen 1999). Another concept, phylogenetic species concept (PSC), "requires a species to represent a monophyletic group." Here again morphological characteristics, serving as cladogram data can play a role in differentiating fungi (Petersen 1999).

The third concept is the biological species concept (BSC). This concept is less dependent upon morphological traits and more dependent on the ability of fungal populations to interbreed. Fungi exhibiting reproductive isolation via such barriers as geographic, ecological and pollination preferences, etc. that prohibited from interbreeding with another population are more adept and likely to speciate (Petersen 1999).

Petersen suggests that the development of a "universal" species concept would be extremely difficult. The speciation process would need to involve aspects of all three previously mentioned concepts in order to make use of all available data of a mushroom. He goes on to add "it is now a 'given' that various character suites (e.g., morphology, ecological preference, physiology, biochemistry, and molecular biology) change and diverge at different rates with little predictability. Through the processes of selection, it may be that sexual recognition, compatibility, and interfertility are among the last suites to diverge in allopatric situations, and that speciation is far from abrupt" (Petersen 1999).

MATERIALS AND METHODS

Collection of specimens began May 29, 1999 and continued through March 8, 2000, resulting in a total of 20 trips (Figure 4). During these trips the main area of concentration was the area designated as Chestnut Orchard #1 of the Lula Lake Land Trust (Figure 5). A certain protocol was followed for each collection session to ensure an accurate identification. Each mushroom was carefully excavated from its substrate with the aid of a trowel or knife to secure acquisition of buried parts such as volvas and pieces of mycelium, which help in identification. Upon collection, each mushroom was given a brief description based on various morphological characteristics (e.g. cap color, gill or tube color and arrangement, overall shape, presence or absence of veil remnants, etc.). Specific substrates such trees, logs, or sawdust piles and general geographic locations were recorded. Depending on the type of mushroom found, other notations including color changes and latex production were made. When available, photographs were also taken of the mushrooms to make determination and identification easier and more dependable. The specimens were then wrapped in wax paper pouches and placed in a basket for transport back to the lab. Once back at the lab, additional information like spore prints and taste tests was taken. The mushrooms were then placed in a botanical drier for at least 36 hours and then

Figure 4
Table of collection dates

Collection Dates
29-May-99
09-Jun-99
18-Jun-99
23-Jun-99
29-Jun-99
08-Jul-99
13-Jul-99
20-Jul-99
25-Aug-99
30-Aug-99
24-Sep-99
01-Oct-99
07-Oct-99
11-Oct-99
27-Oct-99
06-Nov-99
08-Jan-00
12-Jan-00
11-Feb-00
16-Feb-00
08-Mar-00

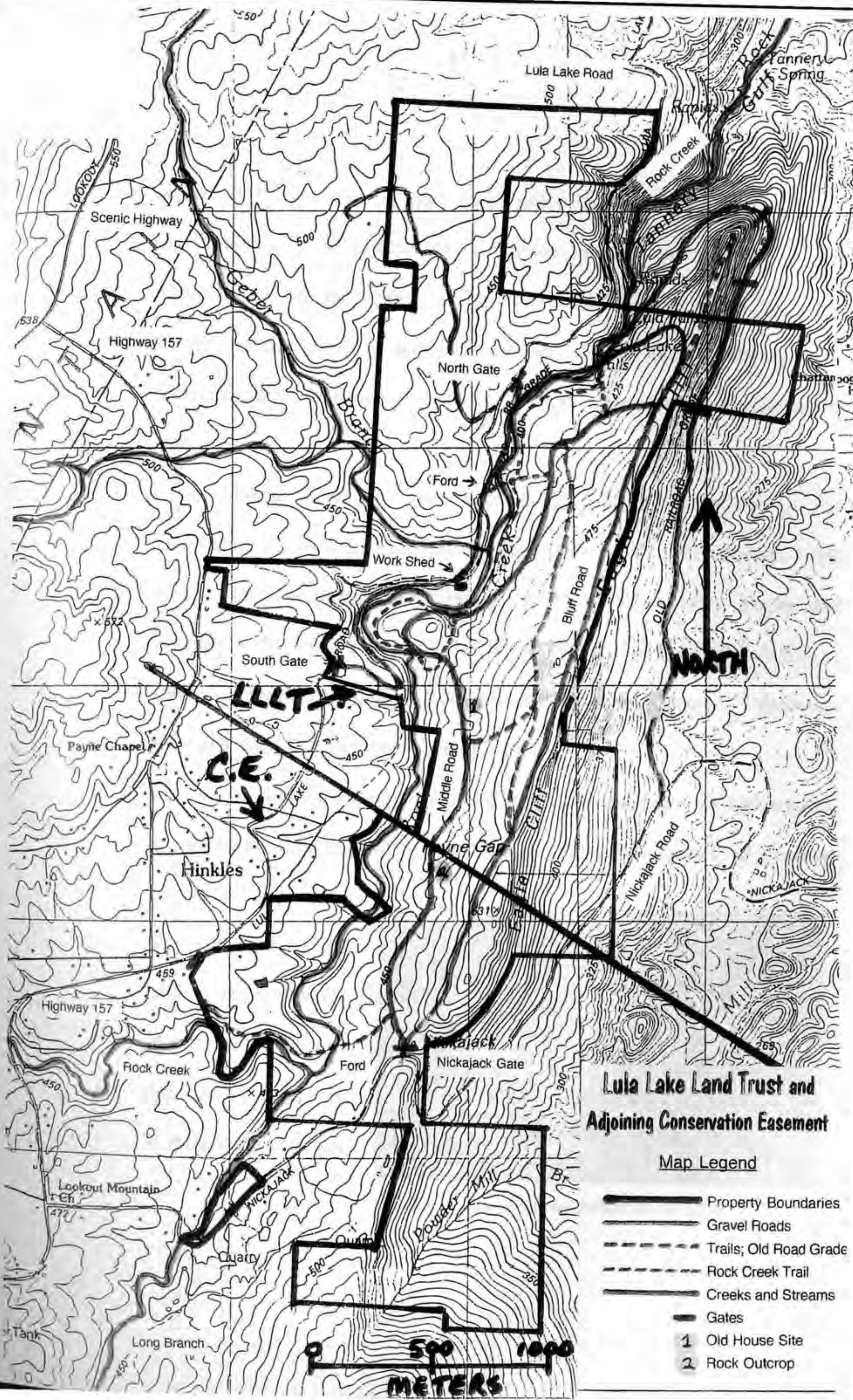

Figure 5
Lula Lake Map

into a -70°C freezer for 24 hours. This process served a dual purpose: to kill any infestations of insects and or larvae and for preservation. After identification of the specimen, herbarium labels were made and each mushroom was given an accession number, entered into the University of Tennessee at Chattanooga Museum's database, and placed in the Herbarium collection.

Several references were used as guides to both collection and identification (Arora, 1986; Bassette et al., 1995; Glick, 1979; Jordan, 1999; Jordan, 1995; Kibby, 1992; Lincoff, 1991; Marteka, 1980; Pegler and Spooner, 1991; Savonius, 1973; Smith and Weber, 1985; Smith and Weber, 1996). Herbarium specimens from the University of Tennessee Chattanooga were also used as references in identification.

The site of the study was limited to a one acre, open oak-hickory-pine woods of an experimental hybrid chestnut orchard designated as Chestnut Orchard #1 (Figure 6). The elevation of the plot is approximately 600 m (1400-ft) above sea level. The orchard is located on the Lula

Fig. 6 -Top of trail to Orchard #1 of LLLT

Lake Land Trust on Lookout Mountain in Walker County, Georgia. The Lula Lake Land Trust is a private, non-profit, scientific, educational and charitable organization established by the will of Robert M. Davenport that preserves and protects over 4000 acres of the Rock Creek watershed in the Cumberland Plateau (Figure 7). The Land Trust is dedicated to the restoration, reforestation, and preservation of endemic flora and fauna, as well as the scenic beauty and resources of the Rock Creek watershed (Figure 8). Its purpose also includes fostering the education and research of the native plants and animals and the propagation of all endangered or unique species indigenous to the Lula Lake area. The Trust supports various projects in association with the Tennessee Aquarium and the University of Tennessee at Chattanooga. One such project currently underway at the Lula Lake Land Trust is Dr. Hill Craddock's, "Restoration of the American Chestnut, *Castanea dentata*." There are two experimental chestnut plots on which saplings are growing in the local forest conditions.

Fig. 8 – a view from the Lula Lake falls

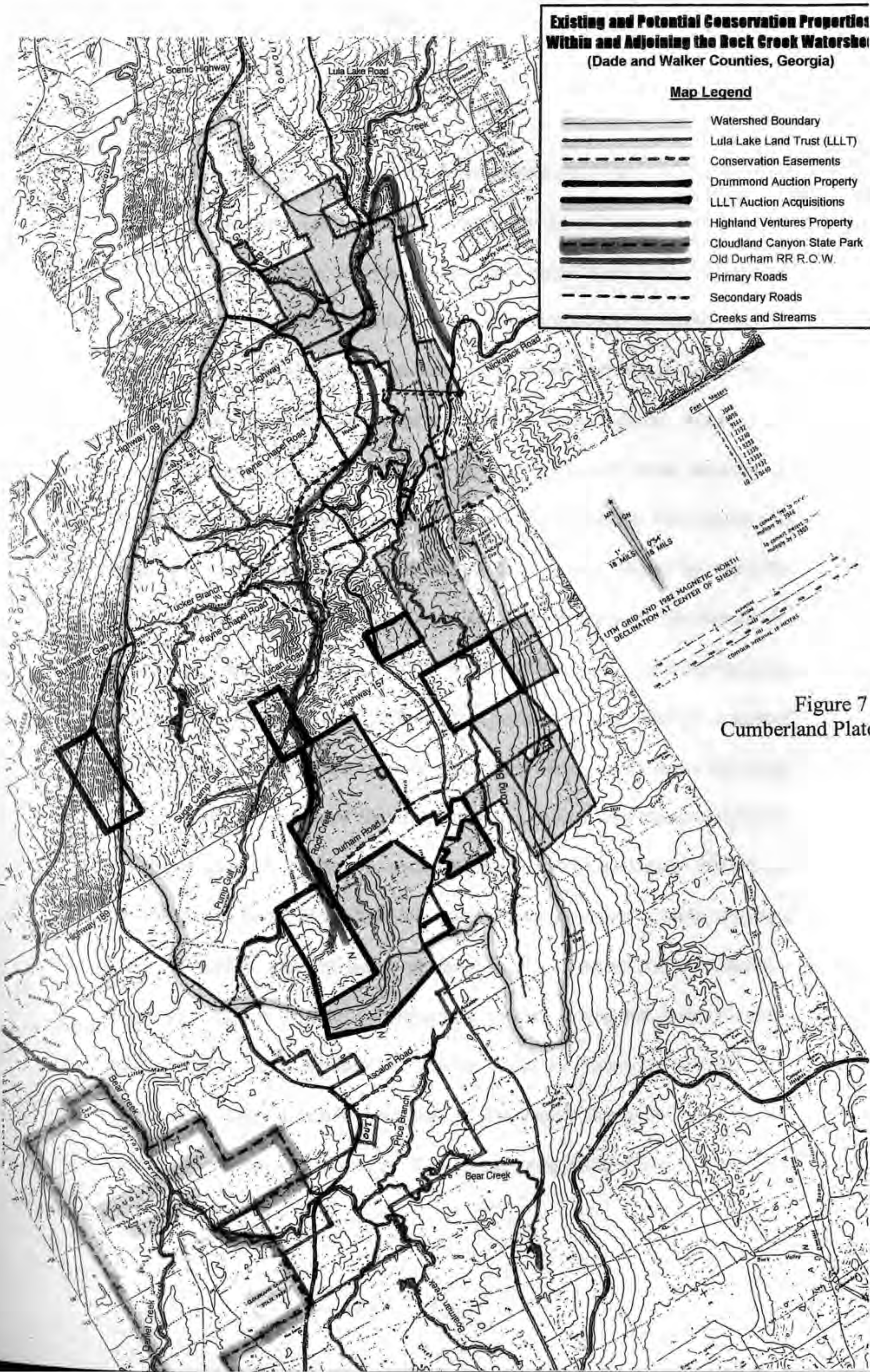

Figure 7
Cumberland Plateau Map

There were several problems faced during the course of the study at the Lula Lake Land Trust. Problems arose in the references available for mushroom identification. Although many field guides have emerged over the recent year, a majority of them describe the same, more common species existing. Over 5,000 mushrooms have been found and identified in North America, yet only 2,000 have been illustrated via color photo. Most of the rest of the are either described with only a black and white drawing or illustration or a picture with a short, non-technical definition. The majority of these less common mushroom descriptions are often found in scientific journals and publications that are only available to small percentage of the population. (Bassette et al. 1995) Since both amateur and professional mushroom collecting and identification originated in Europe, another controversy is found in the issue of identifying these North American fungi through the use of guides that reference the names and characteristics of European species. Numerous environmental and climatological differences exist between both North America and Europe providing a wide spanning array of factors that influence mushroom development and morphology. Since the smallest of details differentiate species among the fungi, it seems highly unlikely that an identical species could be found on two different continents. Gary Lincoff, president of the North American Mycological Association poses the question, "Can names originally given to European mushrooms be accurately applied to these southern Rocky Mountain populations? Are they really the "same" species (Lincoff 1996)?" While Lincoff's rationale and questioning may be sound and practical, the reality is that the only source of reference and comparison available has its roots in European mycological and botanical research and cannot be ignored.

Another major obstacle faced during the duration of the study were the drought-like conditions faced in the latter half of 1999. Both moisture and temperature have direct correlations to the fruiting of mycelium into visible mushrooms (Marteka 1980). The factor that most adversely affected this study was moisture. Below average precipitation amounts and long periods of little to no rainfall plagued the months of July, August, and September, thereby yielding a fraction of the expected summer mushroom diversity. Among those expected species not collected were: *Trametes versicolor, Dacrymyces palmatus, Schizophylum commune,* and *Exidia sp.* In some cases, like in the case of *Trametes versicolor*, the species was found but not collected due to the poor condition of the specimen (i.e. infestation, advance stages of decay, etc.). While these species were found in other locations during the same time period, a combination of variables such as elevation, temperature, and rainfall prevented them from forming at Lula Lake. Low precipitation levels and colder than average temperatures also affected the late fall and winter months of the study once again producing a narrow range of diversity and quantity (Figure 9).

If I were to repeat this study I would take more field notes and photographs. In addition I would attempt to identify each fresh specimen before placing it in the drier. Efforts would have also been made to increase the number of collection trips during periods of favorable weather.

Figure 9
Climate for Lookout Mtn, GA

Month	Highest Temp (°F)	Lowest Temp (°F)	Average Temp (°F)	Departure from Normal (+°F)	Total Precipitation (inches)	Normal Precipitation (inches)	% of Normal Precipitation (%)
May	86	42	68.6	1.7	5.03	4.37	115
June	95	58	76.8	1.5	6.92	3.52	197
July	99	67	81.3	2.6	2.82	4.85	58
August	101	61	81.7	3.8	0.45	3.53	13
September	101	44	73.4	1	0.62	4.15	15
October	83	34	62.2	1.8	3.8	3.22	118
November	80	29	55.5	4.9	4.19	4.61	91
December	69	20	45.1	4	1.83	5.17	35
January	75	17	41.2	3.9	5.1	4.89	104
February	78	20	48.8	6.9	2.43	5	49
March	82	31	55.7	7.7	2	6.03	33

source: *AccuWeather.com*

RESULTS AND DISCUSSION

Figure 21 is a table that summarizes the results of the study. The inventory represents the fungi present, collected, and identified during the duration of the study. The first column provides the accession number of each specimen found in the University of Tennessee at Chattanooga Natural History Museum database listed under Fungi Collection. The scientific binomial name of each specimen, along with the Family, Order, and collection date follow in the table. The edibility column presents the known edibility of the specimens according to various guides and references. Edibility ranges from choice edibles to inedibles. Some mushrooms are categorized as unknown edibility, with no reference or researcher venturing to try them yet. The last column provides the ecological niche that each species is known or has been observed to occupy. The roles of the fungi are described as being parasitic (P), saprophytic (S), or mycorrhizal (M) according to references literature and/or personal field observations.

Species diversity for the study of this particular plot was calculated using the Shannon-Wiener Index. This index provides a quantified value for the species richness and evenness found at this plot that can be used as a method of comparison against other sites. The value, H, is a measure of uncertainty, the higher the H, the higher the level of uncertainty. Thus in this study a high *H* value indicates a greater uncertainty or probability that a randomly chosen specimen from the collection will be the same species as the previous mushroom (Smith 1996). Figure 22 shows the identified species and the number of individuals representing each species. The Shannon-Wiener Index uses the formula: $H = - \Sigma (p_i)(\ln p_i)$, where *H* is the diversity index and the summation goes from $i = 1$ to $s =$ the number of species (in this case s=63). The variable p_i is the proportion of individuals of the total number of identified specimens belonging to the i^{th} species while *ln* is the natural log or $\log_2$. The H value for this study was determined to be 3.91.

The specimens collected were a good representation of the range of species of macroscopic fungi found at Chestnut Orchard #1 of the Lula Lake Land Trust. Most of the expected species were found but their anticipated quantities and frequencies were below what was expected. This is primarily due to the weather conditions during the survey. Overall, 139 specimens were collected and identified representing 17 families, 38 genera, and 63 species. As originally stated, the goal of this survey was to provide a baseline inventory of the macroscopic fungi appearing in this experimental plot of the Land Trust. To ensure a complete and thorough listing of all the fungi, the survey must be continued for at least another year, in the hopes that mycelia that were not afforded the ideal environmental conditions to fruit will have that opportunity and be catalogued.

Of the 17 families represented, the Tricholomataceae and Boletaceae were the most diverse with twelve identifiable species each. Following in diversity were the Amanitaceae with 8 species, Polyporaceae with 5, and Russulaceae with 4 identifiable species.

The family Boletaceae (Figures 10-11), which include genera such as *Boletus, Gyroporus, Suillus, and Tylopilus*, were well represented in quantity in the study. Most of the specimens from this family were collected early in the study during the humid months of June and July when the temperature and precipitation levels favored the development of tubed fungi. The members of this family are best identified by their spore prints and color changes of the cap, flesh, and pore surface. Many of the species are advantageous for humans with their mycorrhizal and edible characteristics. Many of the boletes form mycorrhizal relationships with a variety of the woodland plants. One example of this is the association of *Boletus bicolor* with

Fig. 10 – *Boletus hortonii*

Fig. 11 – *Suillus luteus*

some oak trees at the Lula Lake Land Trust. Several of the members of the family are also provide an economic value with their distinct and at times highly sought after flavors. During the study, several known edible species were discovered including *Suillus luteus, Gyroporus castaneus, Boletus bicolor, and Boletus cyanescens* (Arora 1986).

The Tricholomataceae family, which represents the largest and most diverse group of Agarics, also had a strong and wide-ranging showing in this survey. Members of this family were found throughout the duration of the study even occasionally during the less than favorable drought periods and winter. Most of the species found were saprophytic and primarily decomposers of wood, logs, and buried tree stumps. Among these wood-rotting fungi were the genera *Laccaria* and *Clitocybe*, found primarily in the May and June excursions, and *Oudemansiella*, found periodically from the beginning of the collection period until early

Fig. 13 -
Armillariella mellea

October (Figure 12). Another member of the family found at the Land Trust site was *Armillariella mellea* (Figure 13). This species is known to have both saprophytic and parasitic roles in its woodland ecosystem (Lincoff 1991). *Armillariella mellea* was found during the fall months of October and November often at growing from the roots or at the base of oak trees. Another constituent of the family worth mentioning found at the study site is *Marasmius siccus* (Figure 14), a small, saprophytic fungi whose genera's characteristic trait is the ability to revive itself from a dried condition with the addition of water (Arora, 1986).

Fig. 12 – *Oudemansiella radicata* growing on leaf litter on the side of a rock

Fig. 14 - *Marasmius siccus*

The Russulaceae family was well represented in the study mainly through two of its species, *Lactarius volemus* and *Russula virescens*. All of these specimens were collected in the months of June and July. Both species are believed to be mycorrhizal with specific trees including the oak trees found at Lula Lake Land Trust. The choice edible *Lactarius volemus* (Figure 15) was very abundant during that time frame and easily distinguished by its white latex and orange toned cap. The also edible *Russula virescens* (Figure 16) was equally identifiable by its green-ish cracked pattern on its cap, so much in fact that it was given the nickname of "Green Turtle" through the collection survey (Lincoff, 1997).

Fig. 15 - *Lactarius volemus* (note white spores on surrounding moss and grass)

Fig. 16 - *Russula virescens* a.k.a. "Green Turtle"

The family Amanitaceae is another mycorrhizal group of fungi found on the Land Trust that have been noted to associate with oaks. Both *Amanita rubescens* and *Amanita flavoconia* were noted to be growing near trees and at other times, in the middle of the open field among tall grasses. These white spored, volva forming mushrooms are difficult to positively identify due to many fragile features (i.e. volva, warts, veil remnants, etc.) that are often overlooked or absent due to handling or rain. This family is noted for its links to 90% of the mushroom-induced fatalities. David Arora (1986) writes of the importance of learning the characteristics of both lethal and edible amanitas over the memorization of all-encompassing catch phrases such as "Do not eat-a the Amanita." He says that: "Rather than encouraging people to use their eyes and nose and the gray mass between their ears, to approach each and every mushroom with discrimination, intelligence, and respect, such adages reinforce people's desire for expediency by fostering an unhealthy, mindless reliance on shortcuts and glib generalizations. Those who need simple rules should learn how to lay dominoes or Scrabble rather than eat wild mushrooms." He states the "Unless you are ABSOLUTELY, INDISPUTALY, and IRREFUTABLY sure of your Amanita's identity, don't eat it" (Arora, 1986). While no deadly *Amanita phalloides* (Death cap survey, it must be remembered that not all the Amanitas found were identified completely to species and that the edibility of many Amanitas are either not known or uncertain.

Fig. 17 - *Amanita phalloides*
(photo from Arora, 1986)

The family Stereaceae, particularly the species *Stereum ostrea* (Figure 18), is another fungus from the study worth mentioning. Specimens of this species were seen and noted throughout the entire collection period. This hearty, saprophytic parchment fungus is easily distinguishable from polypore look-alikes (Figure 19) by its smooth, fertile undersurface. All the specimens collected were gathered from rotting logs and fallen tree branches, particularly oak. While they do not possess any edible consumption qualities, they do play an important role in decomposition, breaking down the some of the wood littering the forest floor (Lincoff, 1997).

Fig. 18 - Fallen log covered with *Stereum ostrea*

Fig. 19 - *Trichaptum biformis*, a Polyporaceae saprophyte

The range of mushrooms found at the Lula Lake Land Trust may illustrate the another possible venue for the land. Among the specimens found were several choice edibles: *Amanita caesaria (group), Gyroporus castaneus and cyanescens, Russula virescens, Hericium erinaceus, Hydnum repandum,* *Pleurotus ostreatus* and *Cantharellus cibarius.* (Figure 20) Nutritionally mushrooms provide an alternative source of Vitamins B, D, and K. Another mushroom found during the study, *Auricularia auricula*, is known for its medicinal qualities in some Asian countries.

Fig. 20 - Edible Chanterelles

CONCLUSION

The aim of this study was to survey the macroscopic fungi present in Orchard #1 of the Lula Lake Land Trust. The data from this survey will aid in monitoring the fungal diversity of this area. Since Orchard #1 is an experimental plot for the restoration of the American chestnut, *Castanea dentata*, chestnut reintroduction may affect the mycological diversity of the area and the information in the present work will serve as valuable baseline data for future study. Over a ten month period 139 sporocarp specimens were collected representing 17 families, 38 genera, and 63 species, along with 30 unidentified specimens. The list of collected species includes some choice edible mycorrhizal fungi. Further work should be done at this site in order to completely inventory and better characterize the fungal diversity.

ACKNOWLEDGEMENTS

I would like to thank the Davenport family, Bill Chipley, and the other supporters and volunteers of the Lula Lake Land Trust for work and efforts at protecting and preserving this beautiful natural area. I greatly appreciate the opportunity and support they have lent to me, while allowing me to conduct this survey. I would also wish to thank my project director, Dr. J. Hill Craddock for the knowledge and help he has given me with these fungi. His enthusiasm and interest compensated for my lack of such at times. The work was also supported in part by Provost Student Research Grant. Last but definitely not least, I owe a great deal of gratitude to my family and friends, whom for the last ten months I have coerced into taking forays and hikes into the lands of the Lula Lake Land Trust to look for my "'shrooms." Their support and extra pair of eyes not only helped me, but also lit within themselves a small flame of curiosity and awe for these fascinating fungi.

Figure 21
Table of Results

UTC* Fungi Accession #	*Species*	Family	Order	Collection Date	Edibility	Niche
690	*Agaricus sp.*	Agaricaceae	Agaricales	6/23/99	n/a	n/a
683	*Amanita caesarea (group)*	Amanitaceae	Agaricales	6/23/99	choice	M
571	*Amanita flavoconia*	Amanitaceae	Agaricales	6/9/99	unknown	M
684	*Amanita flavoconia*	Amanitaceae	Agaricales	6/9/99	unknown	M
576	*Amanita flavoconia*	Amanitaceae	Agaricales	7/13/99	unknown	M
581	*Amanita fulva*	Amanitaceae	Agaricales	6/9/99	edible	M
572	*Amanita hemibapha*	Amanitaceae	Agaricales	7/13/99	edible	M
573	*Amanita parcivolvata*	Amanitaceae	Agaricales	7/13/99	edible	M
575	*Amanita rubescens*	Amanitaceae	Agaricales	5/29/99	edible/NR	M
578	*Amanita rubescens*	Amanitaceae	Agaricales	7/13/99	edible/NR	M
696	*Amanita sp.*	Amanitaceae	Agaricales	7/8/99	n/a	n/a
697	*Amanita sp.*	Amanitaceae	Agaricales	7/13/99	n/a	n/a
698	*Amanita sp.*	Amanitaceae	Agaricales	7/20/99	n/a	n/a
693	*Amanita sp.*	Amanitaceae	Agaricales	6/9/99	n/a	n/a
694	*Amanita sp.*	Amanitaceae	Agaricales	6/23/99	n/a	n/a
695	*Amanita sp.*	Amanitaceae	Agaricales	7/8/99	n/a	n/a
546	*Amanita spreta*	Amanitaceae	Agaricales	7/8/99	edible	M
577	*Amanita spreta*	Amanitaceae	Agaricales	7/8/99	edible	M
676	*Amanita vaginata*	Amanitaceae	Agaricales	5/29/99	edible	M
433	*Boletus affinis*	Boletaceae	Agaricales	7/13/99	edible	M

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1. NR - not recommended
2. Choice - highly sought after edible species
3. n/a - not applicable without identifed species name

Figure 21
Table of Results

UTC* Fungi Accession #	*Species*	Family	Order	Collection Date	Edibility	Niche
425	*Boletus bicolor*	Boletaceae	Agaricales	7/8/99	edible	M
429	*Boletus bicolor*	Boletaceae	Agaricales	7/8/99	edible	M
423	*Boletus hortonii*	Boletaceae	Agaricales	7/8/99	unknown	M
563	*Boletus hortonii*	Boletaceae	Agaricales	7/8/99	unknown	M
438	*Boletus hortonii*	Boletaceae	Agaricales	7/20/99	unknown	M
440	*Boletus miniato-pallescens*	Boletaceae	Agaricales	7/20/99	unknown	M
670	*Boletus piedmontensis*	Boletaceae	Agaricales	7/8/99	unknown	M
436	*Boletus retipes*	Boletaceae	Agaricales	6/18/99	bitter	M
424	*Boletus retipes*	Boletaceae	Agaricales	7/8/99	bitter	M
559	*Boletus retipes*	Boletaceae	Agaricales	7/13/99	bitter	M
555	*Boletus retipes*	Boletaceae	Agaricales	7/20/99	bitter	M
560	*Boletus subluridellus*	Boletaceae	Agaricales	7/13/99	poisonous	M
561	*Boletus subluridellus*	Boletaceae	Agaricales	7/20/99	poisonous	M
427	*Gyroporus castaneus*	Boletaceae	Agaricales	7/8/99	choice	M
430	*Gyroporus cyanescens*	Boletaceae	Agaricales	7/13/99	choice	M
435	*Suillus luteus*	Boletaceae	Agaricales	6/9/99	edible	M
456	*Suillus luteus*	Boletaceae	Agaricales	7/13/99	edible	M
452	*Suillus luteus*	Boletaceae	Agaricales	7/20/99	edible	M
426	*Tylopilus indecisus*	Boletaceae	Agaricales	7/8/99	edible	M

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1. NR - not recommended
2. Choice - highly sought after edible species
3. n/a - not applicable without identifed species name

Figure 21
Table of Results

UTC* Fungi Accession #	*Species*	Family	Order	Collection Date	Edibility	Niche
431	*Tylopilus indecisus*	Boletaceae	Agaricales	7/13/99	edible	M
439	*Tylopilus indecisus*	Boletaceae	Agaricales	7/20/99	edible	M
569	*Tylopilus plumbeoviolaceus*	Boletaceae	Agaricales	7/8/99	bitter	M
432	*Tylopilus plumbeoviolaceus*	Boletaceae	Agaricales	7/13/99	bitter	M
437	*Tylopilus plumbeoviolaceus*	Boletaceae	Agaricales	7/20/99	bitter	M
692	*Tylopilus tabacinus*	Boletaceae	Agaricales	6/23/99	edible	M
689	*Tylopilus tabacinus*	Boletaceae	Agaricales	6/23/99	edible	M
686	*Tylopilus tabacinus*	Boletaceae	Agaricales	6/23/99	edible	M
428	*Tylopilus tabacinus*	Boletaceae	Agaricales	7/8/99	edible	M
434	*Tylopilus tabacinus*	Boletaceae	Agaricales	7/13/99	edible	M
666	*Coprinus sp.*	Coprinaceae	Agaricales	6/9/99	edible	S
455	*Psathyrella velutina*	Coprinaceae	Agaricales	5/29/99	edible	S
548	*Hygrophorus marginatus*	Hygrophoraceae	Agaricales	7/13/99	edible	S
451	*Hygrophorus ovinus*	Hygrophoraceae	Agaricales	7/13/99	edible	S
557	*Macrolepiota procera*	Lepiotaceae	Agaricales	10/11/99	choice	S
682	*Lactarius griseus*	Russulaceae	Agaricales	6/23/99	edible	M

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1. NR - not recommended
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3. n/a - not applicable without identifed species name

Figure 21
Table of Results

UTC* Fungi Accession #	*Species*	Family	Order	Collection Date	Edibility	Niche
688	*Lactarius griseus*	Russulaceae	Agaricales	7/8/99	edible	M
669	*Lactarius griseus*	Russulaceae	Agaricales	7/13/99	edible	M
463	*Lactarius luteolus*	Russulaceae	Agaricales	7/8/99	edible	M
567	*Lactarius luteolus*	Russulaceae	Agaricales	7/8/99	edible	M
469	*Lactarius volemus*	Russulaceae	Agaricales	6/23/99	edible	M
550	*Lactarius volemus*	Russulaceae	Agaricales	6/23/99	edible	M
464	*Lactarius volemus*	Russulaceae	Agaricales	7/8/99	edible	M
468	*Lactarius volemus*	Russulaceae	Agaricales	7/8/99	edible	M
461	*Lactarius volemus*	Russulaceae	Agaricales	7/13/99	edible	M
466	*Lactarius volemus*	Russulaceae	Agaricales	7/13/99	edible	M
551	*Lactarius volemus*	Russulaceae	Agaricales	7/20/99	edible	M
699	*Russula sp.*	Russulaceae	Agaricales	6/9/99	n/a	M
700	*Russula sp.*	Russulaceae	Agaricales	6/9/99	n/a	M
701	*Russula sp.*	Russulaceae	Agaricales	6/23/99	n/a	M
702	*Russula sp.*	Russulaceae	Agaricales	7/8/99	n/a	M
703	*Russula sp.*	Russulaceae	Agaricales	7/13/99	n/a	M
478	*Russula virescens*	Russulaceae	Agaricales	6/9/99	choice	M
580	*Russula virescens*	Russulaceae	Agaricales	6/9/99	choice	M

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1. NR - not recommended
2. Choice - highly sought after edible species
3. n/a - not applicable without identifed species name

Figure 21
Table of Results

UTC* Fungi Accession #	*Species*	Family	Order	Collection Date	Edibility	Niche
679	*Russula virescens*	Russulaceae	Agaricales	6/23/99	choice	M
579	*Russula virescens*	Russulaceae	Agaricales	7/13/99	choice	M
562	*Armillariella mellea*	Tricholomataceae	Agaricales	10/2/99	edible	P
564	*Armillariella mellea*	Tricholomataceae	Agaricales	10/7/99	edible	P
565	*Armillariella mellea*	Tricholomataceae	Agaricales	10/11/99	edible	P
568	*Armillariella mellea*	Tricholomataceae	Agaricales	10/11/99	edible	P
667	*Armillariella mellea*	Tricholomataceae	Agaricales	11/6/99	edible	P
661	*Cantharellula umbonata*	Tricholomataceae	Agaricales	1/12/00	edible	S
566	*Clitocybe aeruginosa*	Tricholomataceae	Agaricales	7/13/99	edible	S
471	*Clitocybe gibba*	Tricholomataceae	Agaricales	5/29/99	edible	S
470	*Clitocybe gibba*	Tricholomataceae	Agaricales	6/9/99	edible	S
662	*Clitocybe gibba*	Tricholomataceae	Agaricales	6/23/99	edible	S
473	*Laccaria laccata*	Tricholomataceae	Agaricales	5/29/99	edible	S
474	*Laccaria laccata*	Tricholomataceae	Agaricales	5/29/99	edible	S
475	*Laccaria laccata*	Tricholomataceae	Agaricales	5/29/99	edible	S
476	*Laccaria laccata*	Tricholomataceae	Agaricales	5/29/99	edible	S
477	*Laccaria laccata*	Tricholomataceae	Agaricales	5/29/99	edible	S
665	*Laccaria laccata*	Tricholomataceae	Agaricales	1/12/00	edible	S

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1. NR - not recommended
2. Choice - highly sought after edible species
3. n/a - not applicable without identifed species name

Figure 21
Table of Results

UTC* Fungi Accession #	*Species*	Family	Order	Collection Date	Edibility	Niche
668	*Laccaria laccata (var. pallidifolia)*	Tricholomataceae	Agaricales	11/6/99	edible	S
674	*Laccaria ochreopurpurea*	Tricholomataceae	Agaricales	7/13/99	edible	S
472	*Laccaria ochreopurpurea*	Tricholomataceae	Agaricales	7/8/99	edible	S
450	*Marasmius siccus*	Tricholomataceae	Agaricales	7/13/99	edible	S
663	*Mycena sp.*	Tricholomataceae	Agaricales	7/13/99	n/a	S
465	*Oudemansiella radicata*	Tricholomataceae	Agaricales	5/29/99	poisonous	S
467	*Oudemansiella radicata*	Tricholomataceae	Agaricales	6/9/99	poisonous	S
462	*Oudemansiella radicata*	Tricholomataceae	Agaricales	6/23/99	poisonous	S
552	*Oudemansiella radicata*	Tricholomataceae	Agaricales	10/1/99	poisonous	S
675	*Oudemansiella radicata*	Tricholomataceae	Agaricales	10/7/99	poisonous	S
460	*Pleurotus ostreatus*	Tricholomataceae	Agaricales	5/29/99	choice	S
442	*Tricholomopsis platyphylla*	Tricholomataceae	Agaricales	5/29/99	edible	S
459	*Tricholomopsis platyphylla*	Tricholomataceae	Agaricales	5/29/99	edible	S
457	*Cantharellus cibarius*	Cantharellaceae	Aphyllophorales	6/18/99	choice	S
447	*Cantharellus cibarius*	Cantharellaceae	Aphyllophorales	7/8/99	choice	S
445	*Cantharellus cibarius*	Cantharellaceae	Aphyllophorales	7/20/99	choice	S
570	*Cantharellus ignicolor*	Cantharellaceae	Aphyllophorales	5/29/99	unknown	S

* University of Tennessee Chattanooga Natural History Museuem

1. NR - not recommended
2. Choice - highly sought after edible species
3. n/a - not applicable without identifed species name

Figure 21
Table of Results

UTC* Fungi Accession #	Species	Family	Order	Collection Date	Edibility	Niche
443	*Cantharellus ignicolor*	Cantharellaceae	Aphyllophorales	7/13/99	unknown	S
458	*Cantharellus minor*	Cantharellaceae	Aphyllophorales	6/23/99	edible	S
547	*Cantharellus minor*	Cantharellaceae	Aphyllophorales	7/8/99	edible	S
677	*Clavulina cristata*	Clavariaceae	Aphyllophorales	6/23/99	edible	S
691	*Hericium erinaceus*	Hydnaceae	Aphyllophorales	2/16/00	choice	S
449	*Hydnellum spongiosipes*	Hydnaceae	Aphyllophorales	7/20/99	inedible	S
454	*Hydnellum spongiosipes*	Hydnaceae	Aphyllophorales	7/20/99	inedible	S
444	*Hydnum repandum*	Hydnaceae	Aphyllophorales	6/18/99	choice	S
453	*Coltricia cinnamomea*	Polyporaceae	Aphyllophorales	7/8/99	inedible	S
441	*Coltricia cinnamomea*	Polyporaceae	Aphyllophorales	7/20/99	inedible	S
671	*Inonotus tomentosus*	Polyporaceae	Aphyllophorales	1/12/00	unknown	S
685	*Polyporus radicatus*	Polyporaceae	Aphyllophorales	11/6/99	edible	S
681	*Trametes hirsutum*	Polyporaceae	Aphyllophorales	11/6/99	inedible	S
680	*Trichaptum biformis*	Polyporaceae	Aphyllophorales	10/7/99	inedible	S
574	*Stereum ostrea*	Stereaceae	Aphyllophorales	5/29/99	inedible	S
678	*Stereum ostrea*	Stereaceae	Aphyllophorales	7/20/99	inedible	S
687	*Stereum ostrea*	Stereaceae	Aphyllophorales	10/7/99	inedible	S
556	*Stereum ostrea*	Stereaceae	Aphyllophorales	10/11/99	inedible	S
704	*Stereum ostrea*	Stereaceae	Aphyllophorales	11/6/99	inedible	S

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1. NR - not recommended
2. Choice - highly sought after edible species
3. n/a - not applicable without identifed species name

Figure 21
Table of Results

UTC* Fungi Accession #	*Species*	Family	Order	Collection Date	Edibility	Niche
660	*Stereum ostrea*	Stereaceae	Aphyllophorales	1/12/00	inedible	S
705	*Stereum ostrea*	Stereaceae	Aphyllophorales	3/8/00	inedible	S
549	*Auricularia auricula*	Auriculariaceae	Auriculariales	6/23/99	edible	S
706	*Lycoperdon perlatum*	Lycoperdaceae	Lycoperdales	5/29/99	edible	S
707	*Lycoperdon sp.*	Lycoperdaceae	Lycoperdales	6/9/99	edible	S
708	*Lycoperdon sp.*	Lycoperdaceae	Lycoperdales	6/18/99	edible	S
553	*Scleroderma citrinum*	Sclerodermataceae	Lycoperdales	7/13/99	poisonous	S
446	*Bulgaria rufa*	Sarcosomataceae	Pezizales	6/29/99	unknown	S
448	*Bulgaria rufa*	Sarcosomataceae	Pezizales	7/13/99	unknown	S
554	*Daldina concentrica*	Xylariaceae	Spaeriales	10/11/99	inedible	S
664	*Ustulina deusta*	Xylariaceae	Spaeriales	1/12/00	inedible	S
558	*Tremella encephala*	Tremellaceae	Tremellales	10/11/99	edible	S

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1. NR - not recommended
2. Choice - highly sought after edible species
3. n/a - not applicable without identifed species name

Figure 22
Shannon-Wiener Species Diversity Chart

Species	# of indiv	p_i	$\ln p_i$	$(p_i)(\ln p_i)$
Agaricus sp.	1	0.008	-4.828	-0.03863
Amanita caesarea (group)	1	0.008	-4.828	-0.03863
Amanita flavoconia	3	0.024	-3.730	-0.08951
Amanita fulva	1	0.008	-4.828	-0.03863
Amanita hemibapha	1	0.008	-4.828	-0.03863
Amanita parcivolvata	1	0.008	-4.828	-0.03863
Amanita rubescens	2	0.016	-4.135	-0.06616
Amanita spreta	2	0.016	-4.135	-0.06616
Amanita vaginata	1	0.008	-4.828	-0.03863
Boletus affinis	1	0.008	-4.828	-0.03863
Boletus bicolor	2	0.016	-4.135	-0.06616
Boletus hortonii	3	0.024	-3.730	-0.08951
Boletus miniato-pallescens	1	0.008	-4.828	-0.03863
Boletus piedmontensis	1	0.008	-4.828	-0.03863
Boletus retipes	4	0.032	-3.442	-0.11014
Boletus subluridellus	2	0.016	-4.135	-0.06616
Gyroporus castaneus	1	0.008	-4.828	-0.03863
Gyroporus cyanescens	1	0.008	-4.828	-0.03863
Suillus luteus	3	0.024	-3.730	-0.08951
Tylopilus indecisus	3	0.024	-3.730	-0.08951
Tylopilus plumbeoviolaceus	3	0.024	-3.730	-0.08951
Tylopilus tabacinus	5	0.04	-3.219	-0.12876
Coprinus sp.	1	0.008	-4.828	-0.03863
Psathyrella velutina	1	0.008	-4.828	-0.03863
Hygrophorus marginatus	1	0.008	-4.828	-0.03863
Hygrophorus ovinus	1	0.008	-4.828	-0.03863
Macrolepiota procera	1	0.008	-4.828	-0.03863
Lactarius griseus	3	0.024	-3.730	-0.08951
Lactarius luteolus	2	0.016	-4.135	-0.06616
Lactarius volemus	7	0.056	-2.882	-0.16141
Russula virescens	4	0.032	-3.442	-0.11014
Armillariella mellea	5	0.04	-3.219	-0.12876
Cantharellula umbonata	1	0.008	-4.828	-0.03863
Clitocybe aeruginosa	1	0.008	-4.828	-0.03863

Figure 22
Shannon-Wiener Species Diversity Chart

Clitocybe gibba	3	0.024	-3.730	-0.08951
Laccaria laccata	6	0.048	-3.037	-0.14575
Laccaria laccata (var. pallidifolia)	1	0.008	-4.828	-0.03863
Laccaria ochreopurpurea	2	0.016	-4.135	-0.06616
Marasmius siccus	1	0.008	-4.828	-0.03863
Mycena sp.	1	0.008	-4.828	-0.03863
Oudemansiella radicata	5	0.04	-3.219	-0.12876
Pleurotus ostreatus	1	0.008	-4.828	-0.03863
Tricholomopsis platyphylla	2	0.016	-4.135	-0.06616
Cantharellus cibarius	3	0.024	-3.730	-0.08951
Cantharellus ignicolor	2	0.016	-4.135	-0.06616
Cantharellus minor	2	0.016	-4.135	-0.06616
Clavulina cristata	1	0.008	-4.828	-0.03863
Hericium erinaceus	1	0.008	-4.828	-0.03863
Hydnellum spongiosipes	2	0.016	-4.135	-0.06616
Hydnum repandum	1	0.008	-4.828	-0.03863
Coltricia cinnamomea	2	0.016	-4.135	-0.06616
Inonotus tomentosus	1	0.008	-4.828	-0.03863
Polyporus radicatus	1	0.008	-4.828	-0.03863
Trametes hirsutum	1	0.008	-4.828	-0.03863
Trichaptum biformis	1	0.008	-4.828	-0.03863
Stereum ostrea	7	0.056	-2.882	-0.16141
Auricularia auricula	1	0.008	-4.828	-0.03863
Lycoperdon perlatum	1	0.008	-4.828	-0.03863
Scleroderma citrinum	1	0.008	-4.828	-0.03863
Bulgaria rufa	1	0.008	-4.828	-0.03863
Daldina concentrica	1	0.008	-4.828	-0.03863
Ustulina deusta	1	0.008	-4.828	-0.03863
Tremella encephala	1	0.008	-4.828	-0.03863
# of species = 63	**total = 125**			-3.90958
				H = 3.91

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