Robert J. Cummings, Ph.D. 1992-1993

Lecture Dedication

THIS LECTURE is dedicated to ***Professor Ian K. Ross*** *. . . We have all had special persons, usually teachers, in our lives who had faith in us, encouraged us, and guided us. The words "inspirational" and "enthusiastic" come to mind when I think of my mentor, Dr. Ian Ross. In the true meanings of those words he "breathed into" me the love and joy of teaching, and exemplifies the "inner passion" for education and knowledge which I emulate.*

Memorable Quotations

The most important discoveries of the laws, methods and progress of Nature have nearly always sprung from the examination of the smallest objects which she contains.

~ Jean Baptiste de Lamarck

The immediate principles of living bodies would be, to a degree, indestructible if, of all the organisms created by God, the smallest and apparently most useless were to be suppressed. And because the return to the atmosphere and to the mineral kingdom of everything which had ceased to live would be suddenly suspended, life would become impossible.

~ Louis Pasteur

When we contemplate the whole globe as one great dew drop, striped and dotted with continents and islands, flying through space with other stars all singing and shining together as one, the whole universe appears as an infinite storm of beauty.

~ J ohn Muir

Every particular in nature, a leaf, a drop, a crystal, a moment of time is related to the whole, and partakes of the perfection of the whole.

~ Ralph Waldo Emerson

The universe is not rough-hewn, but perfect in its details. Nature will bear the closest inspection . . .

~ Henry David Thoreau

The outstanding scientific discovery of the twentieth century is not television, or radio, but rather the complexity of the land organism. Only those who know the most about it can appreciate how little is known about it. The last word in ignorance is the man who says of an animal or a plant: 'What good is it?' If the land mechanism as a whole is good, then every part is good, whether we understand it or not. If the biota, in the course of aeons, has built something we like but do not understand, then who but a fool would discard

seemingly useless parts? To keep every cog and wheel is the first precaution in intelligent tinkering.

~ Aldo Leopold

Truffles, Death Caps and the Chanterelle

Revelations from the Third Kingdom

Robert J. Cummings, Ph.D.

Presented in the James R. Garvin Memorial Theatre March 10, 1993

DR. MacDOUGALL, MEMBERS of the Board, esteemed colleagues, students, my family and friends, thank you all so much for coming today. Receiving the Faculty Lecture award is among the greatest thrills of my life, and it is definitely the greatest thrill and honor of my teaching career. Those of you who know me know how astounded I was last spring when the Faculty Lecture Committee came to my office and dropped the news on me. You could have knocked me over with a feather. The reason for my surprise is that there are so many excellent, dedicated teachers at Santa Barbara City College.

At that time I asked myself, for a number of reasons, "Why me?" It's an overwhelming honor, and I'm so grateful for it. It's a big responsibility, and it causes one deep introspection. I have spent the better part of a year pondering questions like "Why me?" and "Did I choose the right profession?" and "Am I good at what I do?" and "What's the meaning of life, after all?" I'm serious, one thinks this way.

Well, I'm still pondering the meaning of life. I didn't quite get to that one, but I did come to a conclusion of "Why me," and that conclusion makes me a lot more comfortable standing up here before you today. My conclusion is that this award is not just about me, after all. I happen to be standing here this year, but many other fine teachers have stood here before me, and many others will stand here after me to receive the same kind of recognition. This award is about students thanking their teachers; and it's about the educational process, and how important that process is in our lives.

We've all had excellent teachers. Our teachers have made all the difference in our lives. We've all been guided to higher roads of intellectual endeavor, knowledge, even wisdom by our teachers, with their care and patience. I've been teaching for 20 years, and I also know a lot of teachers. My brother and his wife are both teachers, and so is my wife. We cover everything from second grade through adult education.

In this spirit, I am proud to accept this award in the name of all teachers, and I definitely want to thank my own special teacher in my life, my mentor, my academic father, Dr. Ian K. Ross. Dr. Ross and his wife, Muriel, are here today, and I would like him to stand and share in this honor with me. Thank you, Dr. Ross. Without your support and belief in me, I wouldn't be here today.

This is such a special time. So many people who have been so important in my life are here. Two people, who shocked me when they walked in, are here. I must introduce Dr. Harry Thiers and his wife, Ellen. Dr. Thiers is probably the premier mycologist in the United States at this time. If I'd known he was coming, my slide show would be very different, because I have to admit, the names of the fungi are always changing, and I'm probably going to name some species incorrectly, and he's going to know it! Dr. Thiers, would you please stand and be recognized.

They told me I could talk about anything I wanted to today, so naturally I chose fungi. Truffles, death caps and chanterelles are all mushrooms, and mushrooms are part of the "Third Kingdom," the fungi. I guess I could have talked about algae, which is my other specialty. I am a botanist, but my two specialties are lower plants, fungi and algae. My students ask me what my Ph.D. is in and I tell them "molds and pond scum," which is not far from the truth. They're usually nonplussed when I tell them that, but, then again, so was I when I first began my study of plants and related organisms.

I've discovered, as one takes more classes and becomes more educated, one gains a broader perspective. You begin to see the subtle connections among species, the commonality in different forms of life, and the beauty and the perfection of evolutionary design. I hope you got the message already from my opening slide show, that everything in nature is linked together and in perfect balance. As you become more sophisticated, these insights appear to you.

I have three goals for today's lecture, and the first one is to broaden your perspective on biological diversity. Most people don't know much about fungi, for instance, and I'm going to tell you what an interesting group of organisms this is, and how important they are in our lives and in the balance of nature. My second goal is to talk about the various ecological roles of the fungi. Some of their activities are beneficial, and some are destructive, of course. And my final goal, and maybe not the least important, is to make sure that no one who is listening to this lecture ever dies of mushroom poisoning. It will never happen to you.

So, what exactly do mycologists do? Well, you'll have to get yourself a hat and come to our meetings and find out (Fig. 1). If you don't have a hat, you can improvise. No, we don't really wear mushroom hats, although, if this news clipping is an indication, it could become a fashion trend.

Figure 1.

"And what does the Mushroom Society do, exactly?"

You can see the five kingdoms of organisms on earth in this diagram (Fig. 2). There are two primitive kingdoms near the bottom of the diagram, the bacteria and protista, which are unicellular organisms, not visible without a microscope. The plants and the animals are the two most familiar kingdoms of large, visible, multicellular organisms. The fungi used to be grouped with the plant kingdom, but actually didn't fit well there.

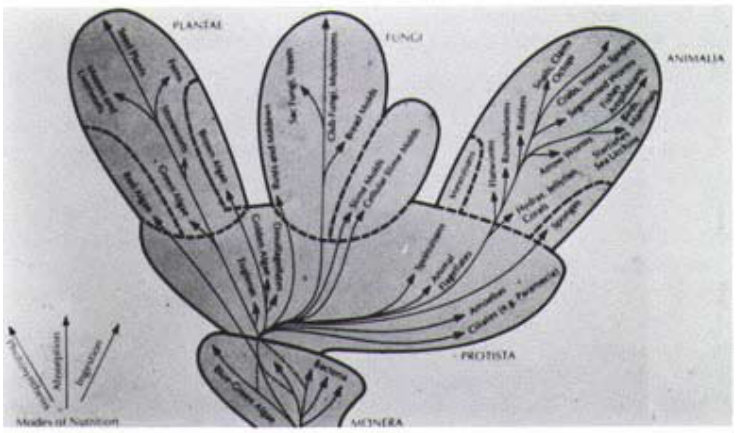

Figure 2.

Fungi don't photosynthesize, they don't make their own food like plants do. Neither do they run after their food, catch it, drag it down and eat it the way animals do. Fungi have a very different lifestyle. They are decomposers of dead organic material, generally, and sometimes parasites of living plants and animals. We mycologists finally got lucky in the last 20 years or so; they gave us our own kingdom for this unique lifeform, the fungi, which I've referred to today as the "Third Kingdom."

I asked my colleague, Dr. Larry Jon Friesen, to make some art for me comparing the number of species of fungi with other kinds of organisms on earth. Maybe I asked the wrong person, I'm not sure (Fig. 3). For those of you who don't know, Dr. Friesen is an entomologist. He seems to have drawn the beetle largest, which would indicate that there are many more species of insects than any other type of organism. This was actually done by a student of Dr. Friesen's, a wonderful artist, but he

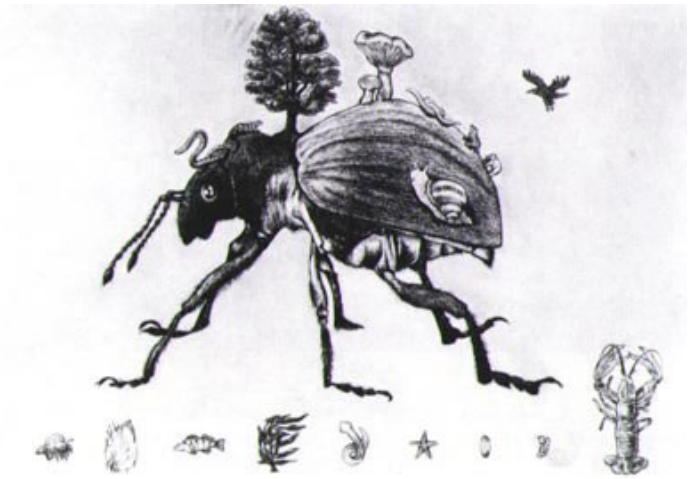

Figure 3.

told her what to draw. Actually there are indeed more species of insects than anything else on earth, and the diagram is correct. But there may also be as many as 500,000 species of vascular plants on earth, and possibly even that many species of fungi! These are large, important groups of organisms.

One of the reasons the fungi are so important on earth is that, as decomposers, they recycle carbon, the main element of which our bodies are composed (Fig. 4). There is a limited amount of carbon for the biosphere, mostly existing as carbon dioxide in our atmosphere. But there is only three-hundredths of one percent of CO2 in this reservoir, and if all of it was taken up by plants in photosynthesis and it remained locked up in their bodies as organic materials (sugars, cellulose, lignin and other compounds) even after the tree died, there would soon be none left in the atmosphere for the continuation of life.

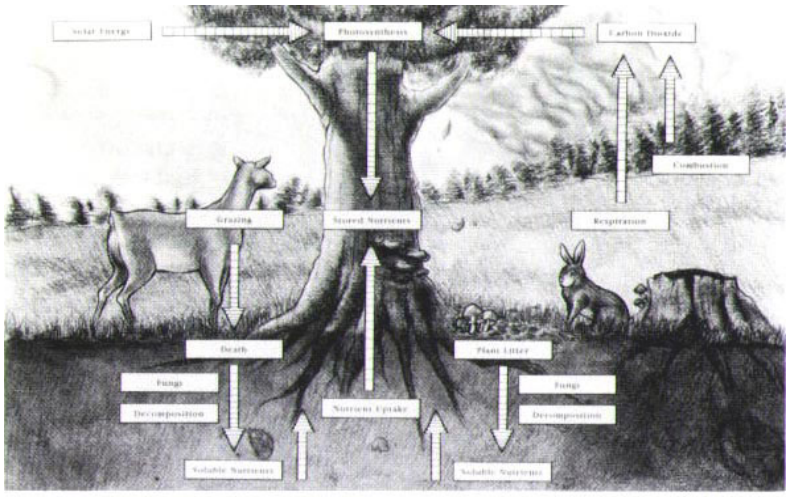

Figure 4.

It is the job of the fungi to decompose dead plants, animals and all other organic compounds; to recycle them. Whenever you see a leaf decomposing on the forest floor, you can be sure the fungi are at work, and this saprophytic lifestyle, by returning those elements to the biosphere, is a beneficial activity. On a decomposing log in the forest you can see the mycelium, the thread-like body of the fungus, penetrating the wood and decomposing it, turning the cellulose and other components back into usable elements. The decaying wood is full of mycelium, and the emerging mushroom is just the spore-producing structure, the fruiting-body.

The rotten two-by-four in this slide is an example of a fungal decomposition activity which is not so good, dry-rot. Whenever lumber gets above 30% moisture content it is subject to dry-rot. Recently we had to replace the floors in both our bathrooms at home, which had rotted due to leaking water. I study mushrooms, so that's fitting, I suppose. "Live by the sword, die by the sword." It couldn't have happened to a better guy. By the time you see the fruiting-body of the dry-rot fungus (this one doesn't have the gills characteristic of many mushrooms), you've got problems.

Herman's discovering some of these problems in this cartoon (Fig. 5). He's got mushrooms coming out of his carpet and everywhere else, and this is not as far-fetched as you might imagine. This is a friend's '72 Ford van. He came to school and said, "Bob, I've got mushrooms growing out of the carpet in my van and I'm going down to clean them out." I said, "Wait, let me get my camera. I want to record this!" This is Coprinus, one of the "inky caps."

Figure 5. *"Apart from a little dampness, Herman, how's everything else?"*

Certain pathogenic fungi cause disease. Ringworm is not a worm at all. It is a fungus which inhabits the superficial layers of our skin. The spores of this fungus must have landed in the center of those circular lesions, because the mycelium grows radially, outwards, forming an increasingly larger ring. In a lawn you can see the same pattern of mycelial growth of certain mushroom species, resulting in what we call "fairy rings." Remember, the mushrooms are just the reproductive structures, the mycelium is down in the soil decomposing organic material. The mushrooms are produced at the growing edge of the ring, only when the conditions are favorable, and the ring will get bigger each year.

Some of the larger fairy rings are spectacular. We found some huge rings in the Cuyama Valley (Fig. 6). I ran out and sat in the middle of one, hoping to see some of the "little people" I've heard about in fairy rings. I sat there a long time, but nothing happened. My poor friends. They're always suffering with my strange habits. Driving by the Santa Barbara Mission the other day with my friends, I saw this ring of mushrooms (Chlorophyllum molybdites, a very poisonous mushroom) about 50 feet across. Of course, we had to go back and get the camera and get everyone around the edge of the ring and photograph it.

Figure 6.

Another destructive lifestyle of certain fungi results in a disease of living trees called "heart-rot." The mycelium of these fungi don't form fairy rings in the soil, but live in and decay the centers of trees where waste materials are stored, the heartwood. The fruiting-body of the heart-rot

Figure 7.

fungus, Ganoderma, forms a woody bracket or shelf
(Fig. 7). Its mycelium gained entrance into the center of the tree through a sawed-off or broken branch. As the heartwood is destroyed, the tree will eventually be weakened to the point that it will fall down. The tree uses heartwood not only for waste storage, but also for support.

One benefit of this woody, shelf-like fruiting-body is that you can dry it and carve or etch on the smooth, white, bottom surface. Ganoderma is called the "artist's fungus," and there are some hanging in the Louvre. We've had our own experience with heart-rot here at SBCC. A heart-rotten Monterey pine crashed on the football stadium in 1979. There used to be many old Monterey pines and cypresses on campus, but they have all succumbed to heart-rot.

Another interesting but destructive fungal activity is demonstrated by Armillaria bulbosa, seen in this recent newspaper clipping, billing the fungus as the world's largest organism. This mycelium supposedly covered 30 acres of forest, but actually may be much bigger. This species is closely related to our local "honey mushroom" which some of you enjoy eating. Unfortunately, both of these fungi are parasites on the roots of trees, and are slowly but inexorably damaging them.

Some people's first impulse when they see a mushroom on the ground near a tree is to think that the fungus is attacking the tree, and they kick the mushroom. Many people are "mycophobic." But when you find mushrooms with trees, they are not always harmful.

One of my purposes here today is to make you more understanding and tolerant of the fungi. These mushrooms are actually most beneficial for trees (Fig. 8). There is commonly a symbiotic association between the mycelia of certain fungi and the roots of certain trees. They are living together in a mutually beneficial way. The association is called "mycorrhiza," which means "fungus root." Indeed, although it is little known, most trees have a mycorrhizal fungus associated with their roots These mycorrhizal fungi have a metabolic insufficiency; they cannot break down the very common, complex molecules, such as cellulose and lignin. They need simple sugars. Trees, being photo-synthetic, are the source of those sugars, which move from the tree roots to the fungus. This sounds like parasitism so far.

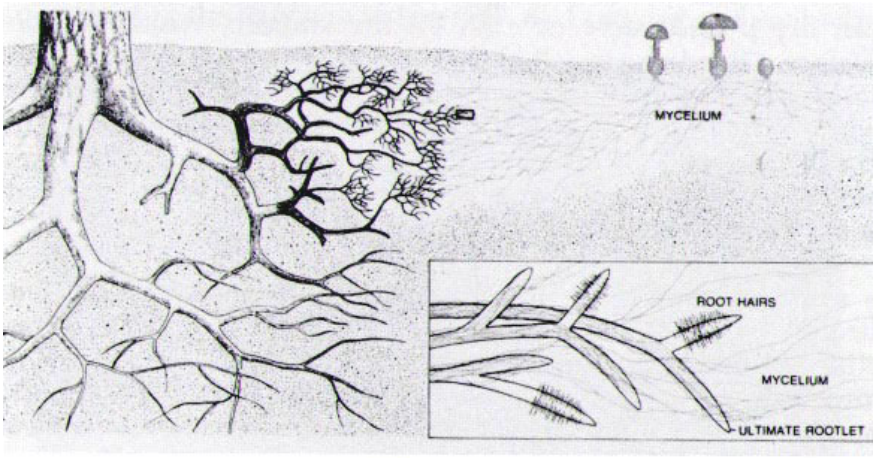

Figure 8.

What is the tree getting from this association? It has been shown that trees which are mycorrhizally associated have a competitive edge over their neighbors. They are receiving extra nitrogen, phosphorous, potassium and other essential elements from the fungus, which it has obtained from the soil. In effect, the absorptive capacity of these roots is greatly enhanced by the presence of the mycelium. As we come to understand this association better, we will probably see the standard use of mycorrhizal fungi in reforestation projects in the future. We've already exported one of our own California mushroom species, Amanita muscaria, to South America to be used in tropical reforestation projects.


Mushrooms That Kill

Fungi Fan Looks Back at a Brush With Death After He and Friend Dined on a 'Perfect' Death Cap

Figure 9.

The mushroom in this diagram is an Amanita, an important mycorrhizal genus, usually linked to oak and pine in our area (Fig. 9). There are many species of Amanita, such as Amanita phalloides, the "death cap." This man mistook a death cap for an edible mushroom, a bad mistake. He survived only because he had a liver transplant. The toxin is a simple protein, deadly poisonous in many cases. The fatality rate from

Amanita phalloides poisoning, however, is decreasing as we use better general supportive therapies and newer techniques, such as hemoperfusion and liver transplants.

This man actually sued the author and the publisher of the mushroom field guide he was using when he picked and misidentified the death cap. I don't know the outcome of the suit yet, but I'm not publishing my book! I do have a book that I use, because I'm the one who goes to the hospitals to identify mushrooms people have eaten. Dr. Ross does too, and I know Dr. Thiers does also in San Francisco. We see the results of some of these mushroom poisons.

Amanita phalloides is probably the most toxic mushroom on earth. One-tenth of a milligram per kilogram of body weight, or about two ounces of fresh mushroom, is sufficient to kill an average adult. This species, along with Amanita ocreata, the "destroying angel," is common in Santa Barbara County (Fig. 10). I hope you can see some of these mushrooms in the display I've set up for you in the foyer of the Theatre.

Figure 10.

The Amanita toxin goes into the stomach and intestine and causes severe intestinal bleeding, vomiting and bloody diarrhea. Unfortunately, these symptoms don't start for from six to 24 hours, giving the toxins time to be absorbed and begin their destructive work. There is often enough time even to have another meal of them, and feed them to friends and family. The toxin destroys both liver and kidneys, and is not easily excreted, but keeps recycling in the system. That's why hemoperfusion is now used, to remove the toxin from the blood. Death comes from liver and kidney failure after four or five days. Headlines of mushroom poisoning are fairly common. People have sometimes mistaken these deadly mushrooms for the edible "paddy straw mushroom" of Oriental cuisine. Our own local Volvariella speciosa is similar to the Oriental paddy straw mushroom. Unfortunately, it resembles the deadly Amanita. You have to know the diagnostic characteristics of both species so that you don't make a mistake which could be fatal. There is no simple rule for identifying poisonous mushrooms.

This man is happy (Fig. 11). He just made his day's wages. You probably recognize what he's got. He's just found a truffle. Truffles last year were selling for around $500 per pound. These are subterranean, mycorrhizal fungi, growing with the roots of oaks and beeches in many parts of Europe. This is the black Perigord truffle from Perigord, France. Actually he didn't find it, his truffle hound did. That dog is very valuable. Dogs have a keen sense of smell, and can be trained to hunt truffles. They're good because they are fast, energetic and don't tire out like a pig does (yes, they also use pigs).

Figure 11.

In the life cycle diagram of the truffle you can see the beech tree host, and the mycelium associated with its roots. The truffle is produced underground, but must somehow get itself above the ground to disperse its spores. That may be the selective value of the very strong odor and flavor of truffles. It may be a way to get someone to dig you up. They do use pigs to find truffles. Dr. Ross, do you remember this postcard you sent me from France? Did you go out truffling with these folks?

Let me ask you all a question—is this a male or female pig? Incredibly enough, the smell that truffles produce is an androsterol, a sex pheromone that male pigs also produce, and that's why female pigs are so good at finding truffles. And you don't have to train them! The trouble with pigs though is that they get tired easily, and they'll eat the truffle if you don't pull it away from them. Truffle hounds are better. There are many species of truffles and false truffles in California, and I've found some of them by looking where the squirrels have dug in the ground under trees. Unfortunately, most of these species have a terrible smell and a terrible flavor!

There are other species of edible mushrooms besides truffles that are known and prized in different cultures around the world, such as the chanterelle, the morel, and the king bolete (also known as porcini or steinpilz). The king bolete, Boletus edulis, is found occasionally in our area, growing mycorrhizally with oaks. But make sure you don't get this similar-looking species, which probably contains the nerve toxin, muscarine. This toxin will cause intense symptoms of sweating, tearing, heart palpitations, nausea and vomiting. This species bruises blue, which is a valuable field characteristic. Notice also that boletes produce their spores in pores on the underside of the cap, instead of gills.

The morel is hard to mistake (Fig. 12). with its sponge-like top. Last year, I put several truckloads of fir bark on the pathways in my yard, and the morels sprouted up in it during the subsequent rains. I had flush after flush of morels. I must have picked at least 50 pounds of them, easily. Michael Hutchings at Michael's Waterside and I became very good friends. And so did Silvio DeLoreto and I. We had so many morels! I was putting morels on my pancakes in the morning. They are delicious, but don't eat them raw. I saw these French morels selling recently for $8.50 per ounce. Multiply that by 16.

Figure 12.

However, if you want to collect morels, there could be a problem. There are several species of "false morels," and we're not sure of their edibility. This is "Verpa bohemica, one of the false morels.

For the same reason you shouldn't eat morels raw, you shouldn't eat Verpa raw, or maybe even at all, although it is listed in most books as edible. Some false morels may contain a poison called gyromitrin, and it is changed by stomach acids and by cooking into a potent poison, monomethyl hydrazine. You might know it as rocket fuel. This toxin is volatile, and there are reports of people dying just from breathing the fumes when cooking false morels.

As you can see, there is not just one type of poison that causes just one type of symptom. When we go to the hospital to identify a poisonous mushroom someone has eaten, the physician needs to know the exact identification of the mushroom to be able to initiate the appropriate treatment protocol. If it were an Amanita, for instance, the hospital would have to get on the phone and start looking for organ donors. Monomethyl hydrazine poisoning can be as serious as Amanita poisoning. It is known to cause the breakdown of red blood cells and damages both liver and kidneys.

So how do you tell the poisonous species from the edible ones? One of the standard ways, for the amateur collector, is by spore color. If the mushroom gills are brown, you can guess the color of the spores, but you should let the cap drop the spores onto paper to check the spore color for sure. The gills and the spore color of Amanita is white. But sometimes recognition of spore color may be a little more subtle—and more difficult.

Poor Fred. His wife just remembered it was "pink that's poisonous" (Fig. 13). Certain kinds of mushroom poisoning do happen very quickly—in 20 to 30 minutes you could be throwing up, which is physiologically beneficial, because you'd be getting the poison out of your system. Remember, you don't get sick with Amanita the death cap, until the poison has been absorbed into the system, and the damage is irreversible.

"I just had it backward, Fred. With this kind, it's ***pink*** *that's poisonous."*

Figure 13.

The "shaggy parasol" is a white-spored species, considered an edible mushroom. Just don't get it confused with Chlorophyllum molybdites. The name means green gills; this is the only greenspored mushroom. It looks similar to the edible shaggy parasol, but is a very poisonous mushroom. The gills and the spore print are green. If you're going to collect and eat wild mushrooms, you have to look carefully for the diagnostic characteristics. I've been to local hospitals many times and identified this species, and I've seen some very sick, severely dehydrated people.

This species grows in abundance in Santa Barbara. Here's a whole ring of Chlorophyllum on the lawn at the Sheraton Inn. This woman is probably telling that other lady, "See these mushrooms? They have green spores, so don't eat them!" (Fig. 14). Here's a ring right outside our Administration Building. As a matter of fact, isn't this your office right here, Dr. MacDougall? You should make sure people don't eat the mushrooms when they come out. Apparently they are very tasty; at least that's what the victims I've interviewed tell me. Even the deadly Amanita is reported to be delicious. Isn't this odd?

Growing in the lawns around campus you might also find the "shaggy mane," Coprinus comatus, also listed as edible, at least before the gills begin to liquefy to release the spores. But there is a similar species, Coprinus atramentarius, the "inky cap," which contains an odd toxin called coprine (Fig. 15). This toxin causes severe distress indirectly by inhibiting an enzyme in the metabolic pathway for metabolizing alcohol. So you'll only get sick if you have alcohol in your system when eating this mushroom. You won't be able to metabolize the alcohol completely, and an intermediate chemical called acetaldehyde builds up, causing heart palpitations, sweating, tearing, flushing and extreme discomfort. Interestingly, there is a medicine that recovering alcoholics use called disulfiram ("Antabuse" is the tradename), which has a similar effect. When you take this medicine, you're fine as long as you don't drink alcohol. You could eat this mushroom and do the same thing.

Figure 14.

Figure 15.

Agaricus campestris is an edible mushroom closely related to the "button mushroom," Agaricus bisporus, you buy at the grocery store. But in Santa Barbara, we mostly find two other slightly poisonous species, Agaricus californicus and A. xanthodermus (Fig. 16). I often find big fairy rings of these mushrooms, and often get phone calls about their potential edibility. Actually, they have an unpleasant odor, and most people suffer gastrointestinal distress eating these species. Both species bruise yellow, an important field identification characteristic.

Figure 16.

In 1986, Sunset magazine carried an article about some commercially available, edible mushrooms. Included in the article was the "butter mushroom," Pholiota aurivella, which many books list as edible. The article also included a note about how some of the mushroom testers suffered "severe, though shortlived distress" from eating these

mushrooms. And they didn't even say which mushrooms may have caused the distress! It could have been the oyster mushroom, as some people are sensitive to it, especially raw or undercooked. Or it could have been, and probably was, the butter mushroom, to which many people are sensitive.

If you are going to try eating some of these exotic, commercially available mushrooms, go slow, eat a little and see how you react. This is good advice with any new food. Of course, I would never encourage anyone to eat a wild mushroom of unknown identity. It could be an uncomfortable, if not fatal, experience. I've got to be careful here, as I've been quoted out of context in the past, making it sound like I was encouraging people to eat unknown species to see how they were affected—as a way of determining edibility.

The sulfur shelf is a species which is listed as edible in most identification guides. In Santa Barbara, people often get sick eating it. This is not a safe mushroom in my estimation. It grows here on Eucalyptus, and perhaps that has something to do with it being toxic here and not elsewhere, where it usually grows on oak. The chemical identity of the toxins are still unknown.

Figure 17.

Figure 18.

The chanterelle is an important edible mushroom in several European cuisines (Fig. 17). It has shallow ridges and folds, instead of deep gills, and has a fragrant apricot odor. We know the chemistry of it very well. Look where it grows, underneath the oaks. It is mycorrhizal with oak, but what is that other shrub in the understory? Ah, ha, poison oak! Raise your hand if you've ever chased a chanterelle into the poison oak. Just because I know about chanterelles, people think I should know how to cure poison oak, too. I recommend Derma-Pax, because it's made right here in Goleta by Recsei Laboratories, and Mr. Recsei was my organic chemistry teacher at UCSB in 1964.

But of course there is also a false chanterelle, Omphalotus olivascens (Fig. 18). It looks like a chanterelle if you're not paying careful attention to the diagnostic traits. It always grows on wood; it is not mycorrhizal. It has deep gills, and doesn't smell like apricot. Actually, it smells and tastes rather unpleasant, but many people persist in eating it

anyway, with extremely unpleasant results. It also contains the nerve poison, muscarine. Another name for this species is the Jack-O-Lantern mushroom, because it is bioluminescent. I worked for weeks, at night in my dark garage (my wife thinks I'm crazy, and I probably am), trying to get a picture of these bioluminescent gills. I finally captured it with an eight-hour exposure.

Well, most puffballs are considered edible, as long as they remain white inside. They're called puffballs because the spore mass inside becomes dry and can be "puffed" out like a puff of smoke. Puffballs can get very big; there are reports of specimens up to three feet in diameter. My friends, Cherie and Jeannette, found these and made a puffball man for me (Fig. 19). Sometimes puffballs can assume very rude poses. I don't know why it is, but very often they exhibit a cleavage such as this.

Figure 19.

I get all kinds of phone calls you wouldn't believe about strange mushrooms. When my phone rings, I never know what it's going to be. One lady called and said she had this thing growing in her yard that was about two feet tall, with a long woody stem. It was Battarrea phalloides (named for its rather phallic stature), a stalked puffball. But you haven'tseen anything yet.The scientific name of this unique fungus is Phallus impudicus, the "impudent phallus," and it's a stinkhorn, a type of puffball (Fig. 20). I get calls on this one all the time, and the people are very embarrassed trying to describe it to me over the telephone, but I let them talk on awhile before I tell them what it is. The spore mass of the stinkhorn is a slimy mass that smells unpleasant and attracts flies. They land on it and get spores all over them and fly away, dispersing the spores. Puffballs are a strange group.

Figure 20.

I'm always getting fooled out in the woods by what I call "pseudocarps," or "false mushrooms." I practically wrecked the car when I saw this one. It's true, my wife won't let me drive anymore during mushroom season, because I'm always looking back over my shoulder saying, "Did you see that mushroom?" Anyway, this is a soccer ball, but it really got my attention (Fig. 21). If you liked that, you're going to love my "pleated Coprinus"!

Figure 21.

There is an increasing awareness of edible mushrooms from other cultures these days. In the store last week, oyster mushrooms were $11.79 per lb. We find oyster mushrooms sometimes, like this time in Lopez Canyon, by the bushel basket. They're delicious. And they grow on wood, not in manure like the button mushroom. Likewise, the shiitake mushroom (which means "oak mushroom" in Japanese) is grown on oak logs. Shiitakes are easily grown at home (Fig. 22). I got some oak logs, drilled holes in them, bought the mushroom spawn, put it in the holes, and harvested shiitake mushrooms every spring for several years. I made the mistake of trying to eat one of these raw though. I had a taste like burned rubber in my mouth for about a week.

Figure 22.

Enoki mushrooms are also popular now, but the most popular mushroom in the Japanese cuisine is the matsutake, or pine mushroom. It contains methyl cinnamate, which gives it a very spicy aroma and flavor. My friends up in Brookings, Oregon, tell me that the commercial pickers there were getting up to $20 apiece for matsutakes last fall. The mushrooms are driven to San Francisco and flown out to Japan each night. Perfect specimens are said to be bringing up to $100 each in Japan.

My last topic concerns the folklore associated with mushrooms in our culture. Fungi seem to have attained an unsavory reputation with most people. Perhaps psychoactive species, like this Amanita muscaria, the "fly agaric," that have been used for centuries in magico-religious ceremonies, are partly responsible for this general mistrust of fungi (Fig. 23). It does have some muscarine in it and often causes severe symptoms. But it also has ibotenic acid and muscimol in it, toxins which affect the central nervous system. One can supposedly have visions and experience other uncommon effects. Similar species, such as Amanita gemmata and A. pantherina, which are very common in our area, contain a large amount of muscarine, but not the other compounds, and one just gets very sick.

Figure 23.

We have in our folklore the familiar "hookah-smoking caterpillar," seen here sitting on a mushroom. Certainly you can find in our area psychoactive mushrooms containing the central nervous system toxin known as psilocybin (Fig. 24). These mushrooms often stain blue as the psilocybin is oxidized to psilocin, which is the active agent, causing hallucinations. Many cultures have used these types of psychoactive fungi for centuries. There are records of Aztec priests eating "sacred mushrooms," species of Psilocybe, which were called teonanactl, "the flesh of the gods." This was not a recreational use of the mushroom, but rather a religious ceremony. The priest was communing with the gods.

Figure 24.

Ergot is a parasitic fungus on grains, such as rye. It produces the most potent hallucinogen known, lysergic acid, or LSD. It is probably a hundred times stronger than psilocybin. Medicinally, ergot derivatives (such as ergotamine) have been used for centuries for a variety of conditions, which include easing migraine headaches, controlling bleeding (it's a vasoconstrictor) and controlling uterine contractions in childbirth. But many times throughout history, when ergoted grain was baked into bread, epidemics of madness and "Saint Anthony's Fire" (because of tingling sensations in the extremities as a result of vasoconstriction), occurred.

The book, The Day of Saint Anthony's Fire, is the most frightening book I have ever read—and it is a true story. In 1952, the people in a little town in France got ergot poisoning as a result of the town's bread supply being contaminated with ergoted rye.

There were people hallucinating that they were being eaten by tigers, for days at a time, and they couldn't be convinced otherwise. Horrendous stories.

The indole nucleus of these psychoactive molecules, psilocybin and LSD, is identical to that of serotonin, 5-hydroxytryptamine, which is the most abundant neurotransmitter in the brain. These similar compounds interact with the normal chemistry in our brains, causing altered states of consciousness.

Most cultures have some inebriant, used in various ways. In Western culture, the most common inebriant is wine. Wine is produced by yeast, which is a fungus. Along with our wine, we might eat bread, again made with yeast, and such cheeses as bleu and Roquefort. Even these cheeses are made with the help of fungi. Turn over the package of Roquefort cheese and you may see the name of the fungus, Penicillium roquefortii. You may recognize the scientific name of this fungus and associate it with another fungal product of incalculable value to human beings, the antibiotic penicillin.

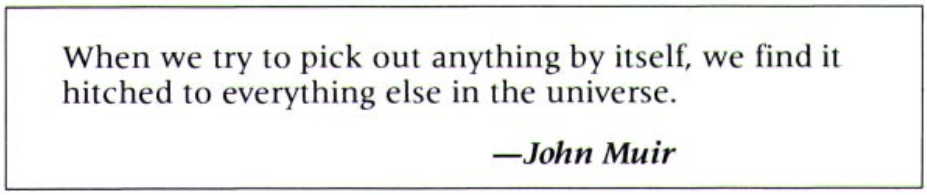

Figure 25.

You can see that fungi and fungal products are everywhere, and fungal activities affect many aspects of our lives. I also hope you have seen some of what I love about the "Third Kingdom," and I hope you realize that as John Muir observed, "Everything is hitched to everything else" (Fig. 25). I thank you so much for coming.